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On the Changing Nature of Learning Context: Anticipating the Virtual Extensions of the World

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ABSTRACT

Contextual learning starts from the premise that learning cannot take place in a vacuum, but should somehow be connected with real world attributes to make sense to learners. Today, digital media tend to bring about new dimensions of context: internet connections and mobile devices enable learners to overcome restrictions of time and location, and neglect the physical boundaries and limitations of the learning environment. This calls for reconsidering contextual learning. This paper takes a theoretical stand by conceptualising the notion of learning context in the light of its virtualised extensions. It explains the historical and pedagogical backgrounds of contextual learning and reviews existing models that deal with context parameters. The paper identifies and discusses the constituting components of context for learning and it demonstrates how attributes of virtual representations affect the nature of context. The overall purpose of the paper is re-establishing the notion of contextual learning in the light of emerging digital media and making explicit the various dimensions involved.

Keywords

Contextual learning, Mobile learning, Virtual learning, Context, Experiential learning

Introduction

Today, it is widely accepted by teachers and researchers that learning becomes more effective and meaningful when it takes place within an appropriate context that displays real world attributes. Topical pedagogies like problem-based learning (Barrows & Tamblyn, 1980), action learning (McGill & Beaty, 1995), situated cognition (Brown, Collins & Duguid, 1989; Lave & Wenger, 1991), and experiential learning (Kolb, 1984) all stress the importance of context for learning. Such context enables learners to directly link concepts with their real world counterparts and put knowledge into action. Dynamic memory theory (Schank & Cleary, 1995) stresses the importance of the extra-linguistic information that is implicitly carried by the context and that provokes subconscious learning. Also, the more general model of competence-based learning that is highly topical today supports this, since it deals with the combined application of knowledge, skills, and attitudes within real world contexts (Westera et al, 1999; Westera, 2001).

Contexts for learning can be established in many different ways, for instance by arranging a fully immersive internship where learners are challenged to adopt professional roles under real world conditions, or, alternatively, by simply providing the learners with a written case description. These approaches are not of equal standing: the context for learning is highly dependent on the mode of delivery. Today, new learning technologies are an utmost driver for context, while they enable the effortless cross linking between different locations, different resources, and different users and organisations. Indeed, internet connections overcome the restrictions of time and location, and neglect the physical boundaries and limitations of the learning environment. The arrangement of learning context is no longer under the exclusive control of teachers. Abundant, new online tools, web services and resources are usually not well integrated within official school practice, even though learners dedicate most of their time to them (Cannata, 2009). These tools can be accessed by learners without any principal barriers and produce a great diversity of the individual contexts of learning, while at the same time their impact on the processes of learning remains unclear.

Digital media tend to bring about new dimensions of context. It is of great importance to establish the nature of this digitally enhanced context and its importance for learning. Importantly, digital media not just act as neutral communication channels, but also provide important attributes of context themselves. The basic premise underlying this claim is that media cannot be regarded as simple, exchangeable tools (cf. the instrumental view on technology) but, following Borgmann (1984), Heidegger (1977), McLuhan (1964), and many others, different media produce different modes of expressions in their own right, and hence they greatly contribute to the process of making meaning. Each medium reinforces its own communication codes and communication modes. Therefore media cannot be regarded neutral carriers of information, since they inherently produce distortion, filtering or even enhancement of messages. Consequently, media are important determinants of the user's context.

In view of the ever-growing importance of digital media for learning any approach or theory of context should include the media presentation and delivery attributes. So far, however, no theory or framework that accounts for these virtual extensions of context is available. This paper aims to contribute to the development of such theoretical framework by conceptualising the notion of learning context in the light of its virtualised extensions. First, the paper will explain the historical and pedagogical backgrounds of contextual learning. Next, technology's role as a driver for contextual learning will be discussed, and existing approaches for describing context will be evaluated. Building on these considerations the paper describes the key characteristics of context, while explaining the ways these characteristics influence learning contexts.

Background of contextual learning

The basic premise of contextual learning (or context-based learning) is that learning cannot take place in a vacuum, but should somehow be connected with real world attributes to make sense to learners. Such practical context allows learners to relate symbolic learning content like concepts and principles to their real world referents. Hull (1993) gave a more general statement about contextual learning, by claiming that learning occurs only when learners are able to connect information to their own frame of reference, which is supposed to reflect their inner world of memory, experience, and response. Naturally, such personal frame of reference is largely fostered by the individual's experiences and interactions with the real world so far.

Contextual learning is not a new phenomenon: for many thousands of years apprenticeship in real world practice has been the natural and predominant model of human learning: novices in a field learn their craft in the real world workplace under the guidance of an experienced master. However, when human knowledge accumulated over subsequent generations it gradually incorporated higher levels of abstraction, generalised theories, and codified knowledge representations. Disconnections between practice and theory became apparent, possibly amplified by the different skills that were required for these, but probably also supported by the different social classes linked with craftsmen and scientists, respectively. Until today this divide between theory and practice is apparent, for instance via the proverbial distinction between white-collar workers and blue-collar workers.

Various authors (Schank & Cleary, 1995; Resnick, 1987; Johnson, 2002) suggested that the school system that has emerged over the last centuries produces adverse effects on learning, because of the absence of real world context. They argue that school tends to be an internally focused world in itself, which promotes a fundamental separation between the learning and the outside world. As a consequence, large groups of school children are unable to make connections between what they are learning and how that knowledge will be used (CTE, 2007). Gardner (1991) suggested that the dominant pedagogical pattern in school education is drill and response, and that many of the children do not actually understand what they learn. Such de-contextualisation of education tends to produce "armchair scholars", who may well obtain high marks, but lack the meaningful insights and understanding that are required for using the knowledge in a productive or creative way. This distinction between theory and practice, between abstract and concrete, and between thought and action, is supposed to have become an intrinsic characteristic of the school system and brought about self-establishing pedagogical traditions that equated learning with the one-sided accumulation of knowledge. Indeed, the act of learning has long been considered as the absorption of information rather than acting, engaging, exploring, practicing, and experimenting (Schank & Cleary, 1995).

For over a century, however, there have been efforts to restore this unwanted dichotomy at various levels of education. In the early 1900's Dewey (1938) developed his theory of experiential learning that stressed the importance of having authentic experiences. He suggested that learning should be contextualised (he probably was the first to use the term contextual learning) and tuned to real-life situations. He also pointed at the interrelatedness of all things (e.g., concepts) and proposed to focus on these interrelationships rather than on the things themselves. This proposition reflects the cautious combination of theory and practice, of content and context, of thinking and action. Actually, Dewey focused on contextualising learning content by embedding it within inquiry and problem solving processes (Innes, 2004).

Based on the theories of constructivism, cognitive apprenticeship, and situated cognition Brown, Collins, and Duguid (1989) stated that realistic learning environments should be taken into account for providing students with meaningful learning experiences. Cognitive apprenticeship argues that implicit processes involved in complex skills

are best addressed when the learning takes place in realistic (working) settings. Situated cognition takes a slightly different stand that the knowledge itself is an inextricable part of the environment and thus the process of thinking is grounded in the interaction between the individual and the environment (Roth, 1995). Kolb (1984) presented a more process-based approach that aims for a better balance between theory and practice. Kolb's main concern was to reduce the overemphasis on concreteness that would go with real world practice by extending concrete learning experiences with the creation of generalised mental models and theories. Newmann and Wehlage (1993) stressed the importance of authenticity of learning tasks and authenticity of the learning environment because of better learning efficacy and improved learner motivation. Building on Dewey's very idea of the interconnectedness of things, school gradually adopted new approaches like learning by doing and practical exercises. Also, the educational system itself has literally opened up the gates of their closed system and interconnects with the real world context by involving parents, employers, and other stakeholders (Johnson, 2002). The expansion of computer usage, the internet, and a variety of digital devices in the schools produces new gateways to the outside world. It inevitably brings about that rich and authentic context enters the learning environment in a variety of ways.

While referring to computer games Westera, Nadolski, Hummel, and Wopereis (2008) explain that the required authenticity of the environment is not necessarily related to the ways authenticity is presented. Outstanding graphic sceneries, character animations, and sound in games may certainly contribute to enhance authentic experiences, but various studies (Reeves & Nass, 1996) indicate that only very little representational or technological efforts are necessary to provoke true inter-personal responses. Apparently, what counts is not realism or authenticity, but credibility. Even fictitious, non-existing, non-authentic realities may provide valuable learning experiences and may offer interesting playgrounds for researchers.

Technology as a driver for contextual learning

Topical technological developments tend to blur the notion of learning context. Various network and media technologies procure that learning is no longer restricted to fixed locations like schools, but can be widened to include different contexts, while supporting workplace learning, learning at home, location-based learning, or learning on the move. Learners have unrestricted access to any knowledge resource, debates in discussion boards, case study descriptions, topical reports, real world video recordings etc. Firmly grounded in constructivism, exploration-based learning, and inquiry-based learning have gained popularity among teachers. Web 2.0 technologies at large tend to redefine the process chain of content creation while these enable learners to create, share, and adapt their own content and evaluate these in social media networks of peers, colleagues or others that not necessarily share the same lesson or classroom. New information and communication technologies like mobile devices, geo-positioning services, ambient environments, and ubiquitous access literally extend the learner's physical range of operation by enabling augmented reality layers superimposed on existing contexts. Sensors as well as tracking and tracing technologies provide the inputs for context dynamics through adaptive systems behaviour and personalisation. Due to these developments the context of learning becomes more dynamic and more responsive but also greatly intangible and incontrollable.

While its significance for effective learning remains, the role of context appears to change from an independent variable into a dependent variable of the learning process. Whereas the creation of an appropriate learning context for learners used to be one of the main challenges of teachers and education designers, learning context tend to include more and more emergent components that are induced by the learners themselves, dependent on the media they use and the conditions for learning they create themselves.

Existing approaches for dealing with context

Ever since the introduction of information systems context models have been used to define the data flow between the computer and its environment, including the roles of human actors, existing procedures and files, and organisational constraints. A Data Flow Diagram, DFD (DeMarco, 1978; Yourdon, 1989) is one of the first established visualisation methods for structured analysis and system design that is used to describe the flow of information through the system. It necessarily includes the relevant components that make up the context of the system. Renewed interest in context modelling was gained in the domain of ubiquitous (or pervasive) computer systems. Ubiquitous computing, which is generally considered the next paradigm of computing, refers to the

seamless integration of information processing in everyday objects, processes, and activities (Weiser, 1991; Abowd, 2000). It assumes the interconnection of a large number of devices, sensors, and controllers embedded in the environment for supporting human activity in all possible ways. For this, ubiquitous computers need to be context-aware, that is, they need to be able to recognise the users, their needs, and all kinds of situational conditions in order to be able to display adaptive behaviour (Dey & Abowd, 1999; Becker & Nicklas, 2004).

For location-aware computing Becker and Nicklas (2004) explained spatial context models as a means to integrate context information obtained from different resources, e.g. sensors, GIS systems, etc., under local constraints. Such spatial context models constitute a conceptual layer between computer applications and the physical world. Such layer allows a number of applications to make use of the gathered context information and undertake appropriate actions. Key queries for spatial context models are the position of an object (e.g. geo-location, room number), the number of objects within a certain spatial range (the number of printers in building X), and the nearest neighbour objects that are close to the position of a particular object (closest restaurant, police station). Becker and Nicklas noted that context models in practice are usually quite straightforward and made to purpose. For achieving an economy of scales, they propose to add on top of the conceptual context model a separate federation layer and a knowledge reasoning layer, based on a contextual ontology.

Today, various alternative methods and tools for context representation are available. Strang and Linnhoff-Popien (2004) have reviewed different approaches of context modelling for ubiquitous computing: mark-up scheme approaches, which use a hierarchical data structure consisting of mark-up tags with attributes and content, graphical modelling approaches like the general purpose modelling approach Unified Modelling Language (UML), object oriented models that apply encapsulation and inheritance, logic based models for AI-reasoning, and ontology based models specifying concepts and their interrelationships. Each of the approaches displays strengths and weaknesses on various criteria, like richness and quality of information, dealing with incomplete data, or the level of formality. Because of their orientation on ubiquitous computing most of these approaches have a strong technical focus. De Moor and Kleef (2004) proposed a social context model for supporting group discussions and collaborative authoring. Their model basically distinguishes 1) process elements like actor roles and objects (e.g. required resources), 2) actions that can be undertaken by participants and, 3) the change process itself, describing the socio-technical system and its alterations during the process. Yang, Huang, Chen, Tseng, and Shen (2006) proposed a context model specifically tuned to learning. They distinguish two different types of context, namely the learner's context and the domain context of learning content itself. Referring to educational games Williamson Shaffer (2006) explained how the overall context of a game environment helps learners to adopt the values, beliefs, habits, vocabulary, culture, and the overall epistemological frame that are associated with the game contents, representing a particular knowledge domain. Therefore games are claimed to greatly support contextual learning. Pedagogical context is partly covered in interoperability specifications like IMS Learning Design (IMS, 2009) that deals with instructional designs and learning arrangements. It includes learner and teacher roles, learning activities, learning objects and tools, learner support actions, and conditional learning paths. In recent years, the promise of mobile learning has lead to various models of context-aware information delivery, supporting location-based learning. Sharples, Taylor, and Vavoula (2007) used action theory which explicitly takes into account both the physical and cultural context for devising a theory for mobile learning. Zimmermann (2007) gave an operational definition of context, covering individuality, the physical environment, time and time range, relationships of entities, and activities (goals, tasks and actions). Based on Zimmermann (2007), De Jong, Specht, and Koper (2008) established a classification model for mobile learning software, which points at various context elements, e.g., pedagogy, content, sender-receiver patterns of information flow, time, and the purpose of the activities. For mobile learning Koole (2009) proposed a context framework representing the learner, the device attributes, and social relationships, while taking into account the mutual connections between these. These models all produce valuable contributions to explaining the notion of context. In many cases, however, the models only have a limited perspective on context and fail to include the role of media at producing these learning contexts.

Explaining mediated context for learning

A definition of context runs the risk to be so general and all-embracing ("all thinkable surroundings that influences the learner's learning") that it becomes meaningless. Yet it is necessary to go into the general characteristics of context and its significance for human activity. For this will use the following methodology. First, we will identify different compartments of the world that contribute to learning context, with a particular focus on mediated context

(virtualisation). Secondly, we will go into the different types of entities linked with these compartments, and explain how these entities contribute to learning context. Finally, we will investigate the process of virtualisation, in particular how it can be described by its representational attributes.

Different compartments of the world

Context arises from the interactions between an individual and the outside world. To this end different compartments of the world can be distinguished. Figure 1 displays the general layout for this.

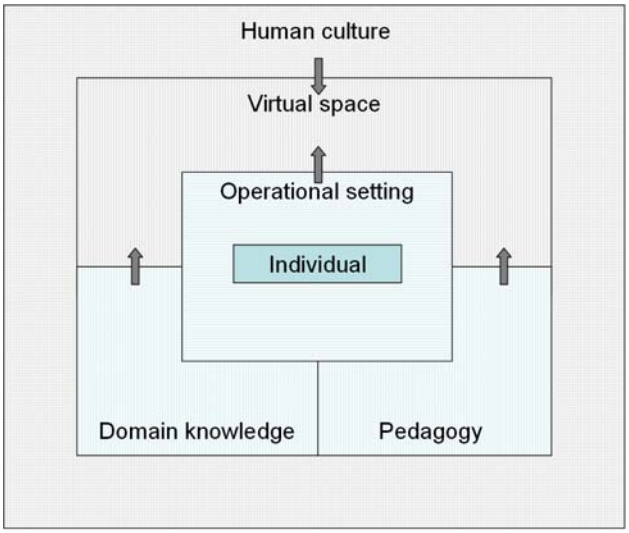

Figure 1. Different compartments of the world affecting the individual's learning context

The individual learner at the centre of the figure is literally surrounded by different contributing parts of the world; the interactions of the learner with these compartments produce the notion of learning context. The most tangible compartment for the individual learner is the concrete operational setting where the individual is acting. This operational setting is the world as we directly perceive it and act upon. It reflects the "here" and "now" of our being, and it may refer to a certain location, a building or a room, and the objects and people near at hand. The compartment of domain knowledge refers to the subject matter that learners engage in. This will be a subset of human knowledge, e.g. language, mathematics, history, engineering, or cooking. Each of these domains will go with its own vocabulary, methods and tools, thus inducing its own context. The compartment of pedagogy refers to the diverse learning and teaching strategies defining the different roles and responsibilities of learners and teachers, the learning activities, and the ways guidance, feedback and testing are arranged. For instance, classroom learning involves a different context of learning than being an apprentice at company (Fuller, Munro & Rainbird, 2004). The outer shell in the diagram refers to the world at large, in particular human culture. It is the all-embracing and interconnected whole of ideas, knowledge, beliefs, arts, laws, morals, skills and customs that has been consolidated across different generations and communities (Cassirer, 2006). Virtual space refers to the digital extensions of the world that are made accessible via digital devices in the operational setting. Virtual space offers digital resources and tools, and allows communications with the outside world. It virtually extends the human horizon of interaction beyond the physical limits of the operational setting. The arrows in figure 1 indicate the tendency of increased virtualisation of the world: the virtual compartment thus assimilates contents originating from the other compartments, but it is also a channel in its own right.

Concrete and abstract entities of the world

The world, just like its constituting compartments, is assumed to be composed of concrete entities as well as abstract constructs. Concrete entities include the material components of the world (things, individuals) and the processes or phenomena associated with it. Concrete entities are in principle observable, for instance a tree, a rainbow, a facial expression or the phenomenon of a traffic jam. Abstract constructs are ideas. Ideas are the basis of human culture and

civilisation (Von Mises, 1957). These include theories, language, social relationships, and the concepts that we use to describe and interpret the world. Note, however, that concrete entities and abstract entities are often closely linked to each other. Concrete objects (e.g. a house) cannot be viewed without directly inducing the associated cultural schemas, attributes, and semantics (e.g. "family", "childhood", "mortgage"). Generally, observation is known to be highly theory driven: it is strongly biased by the different cultural concepts and categories of different languages (Sapir-Whorf hypothesis, cf. Hoyer, 1954).

Context is largely composed by the interactions that individuals have with entities in the different compartments of the worlds. Table 1 presents an overview of diverse constituents of learning context by providing some practical examples.

Table 1. Exemplary context constituents from different world compartments

World entities	Human culture	Knowledge domain	Pedagogy	Virtual space	Operational setting	Individual
Objects	Paintings Buildings Products	Tools Resources	Tools Instructional content	Any virtual object	Machines Tools Products	Personal objects
People	Groups	Experts Professionals Researchers	Teachers Fellow learners	Any virtual character	Colleagues Customers Suppliers	Self
Processes	Economy Press	Working practices	Learning activities Guidance Feedback Testing	Any virtual process	Working practice Rain shower	Behaviours Performances
Ideas	Values Language Politics	Vocabulary Theories Concepts	Theories Goals Scenarios	Virtual culture and procedures	Location Time Behavioural codes	Personal profile Internal reference

The columns of table 1 differentiate between the various world compartments; the rows identify the world's entities, subdivided into objects, people, processes, and ideas. The table will be explained below in more detail.

Context induced by human culture

Human culture is the accumulation of ideas: these are abstract in kind, like social structures, love, economic systems, and moral values (Cassirer, 2006; Von Mises, 1957). The expression of ideas, however, gives rise to concrete observable artefacts, like books, buildings, pieces of art, products or processes. Culture is such an immanent and manifest characteristic of mankind: all human activity is imbued with cultural bias. Cultural differences entail different contexts, different behaviours, and different meanings. Either wittingly or unwittingly any learner or learner will comply with existing socio-cultural frameworks and behave accordingly (Vygotsy, 1978). These socio-cultural frameworks are major contributors to learning context.

Context induced by the knowledge domain

Naturally, any learning refers to mastering a (sub-)domain of human knowledge. The domain itself cannot avoid contributing to context. Apart from the domain's content it basically conveys the epistemic frame (Williamson Shaffer, 2006) that is attached to the domain, including the domain's vocabulary, its methods, its tools, its key actors, its social structure, its challenges, its attainments, it working practice, and many more. For example, tools for a health care worker would include infusion systems, hypodermic needles, blood pressure measurement instruments. The epistemic frame of the health domain refers to existing socio-cultural traditions and requirements, like power relationships, professional attitudes and role perceptions. These epistemic frames may differ across different domains: obviously, medical ethics would produce a different context than ballroom dancing.

Context induced by pedagogy

Next to the knowledge domain, pedagogy itself is a powerful contextual agent. Marton and Ramsden (1988) claim that pedagogical context strongly determines the learning strategies of students. For instance, the way testing and grading is arranged appears to be a most critical situational influence on learners. Also, enforced high workload in a curriculum promotes rote learning. As has been explained above, pedagogical approaches imply various principles and beliefs as to what requirements the learning context should meet. Notwithstanding the variety of pedagogical approaches available, they all share the basic pedagogical concern of addressing certain learning needs or goals by providing appropriate learning tasks, learning scenarios, learning content and tools, learner testing, learner guidance, and feedback. The involved pedagogical approaches and the associated boundary conditions have a strong contextual impact (Elton & Laurillard, 1979).

Context induced by virtual spaces

Increasingly, learning environments include digital communication media (virtual spaces). These media contribute to learning context in two different ways. First, interaction with real world objects, phenomena, ideas, and subjects is replaced with accessing digital representations. Communicating via an avatar rather than face-to-face would be an example of such replacement. Digital media offer new opportunities for individuals to include entities from the outside world, and hence procure the extension of context. Second, digital media actively contribute to context themselves because of their distorting and filtering nature and their potential of enhancement and augmentation (Baudrillard, 1995). The progressing virtualisation of life thus changes the modes of interaction and produces a media context which not only provides new communication opportunities but also creates its self-induced constraints (Borgmann, 1984; McLuhan, 1964). Salomon (1979) found that symbol systems in media play an important role in cognition and cognitive processing: symbolic operations help learning since they have a direct impact on the underlying mental structures. Not taking into account the context of media would make it impossible to compare different pedagogical approaches (Westera, 2005).

Context induced by operational setting

Naturally, the operational setting where the learning takes place (viz., the learner's location) contributes to context. It includes relevant objects (room, furniture, computers) and possible constraints. Also time, geo-location, and location derivatives (temperature, sound conditions) are linked with the operational setting. In many cases the operational setting is directly linked with a socio-cultural context, for instance "school", "work", or "home" that have wider significance than the operational level. The context of workplace learning (e.g., learning in a factory) would not only include specific physical conditions, products and machines, but also the socio-cultural patterns associated with it, like the functional purpose of the location, fellow workers, customers and the underlying viewpoints and behavioural codes that are carried by these.

Context induced by the individual

While learning is essentially the growth of individual capabilities, the individual's characteristics greatly influence the process and conditions of learning. These characteristics include both the physical and mental profile of the learner, for instance age, personal goals and ambitions, prior knowledge, school history, or physiological constraints (colour blindness, weight) (Allen, 2009). These data may also be dynamic (mood changes, fatigue). Moreover, the learner's intrinsic socio-cultural background and identity profile contribute to learning context (family conditions, beliefs, hobbies, nationality, religion). Beside these basic profile and background data, the individual context will be greatly determined by the dynamics of actual learning activities and performances. These data not only determine the individual's contexts of learning, but also can be forwarded to a student model for achieving adaptive learning environments, reflecting the intelligent and productive personalisation of learning context (Brusilovsky, 1999).

Interacting with context

The different compartments of the worlds constitute the context in which we operate. This context becomes meaningful for us mainly through the interactions we have with it, thus enabling contextual learning. The interaction between the individual and the world is conceived as the continual process of encoding and decoding of the messages that are exchanged. Messages are natural or artificial signals that can be captured and processed. Nowadays, direct observation of the signs and signals of the world is increasingly being replaced with their indirect observation using (digital) media. Hence, more and more our relationship with the world is shaped by the media we use (Borgmann, 1984). Since all media tend to add noise and distortions to the original messages, perceived contexts inevitably change accordingly.

The process of attaching meaning to messages is essentially mental in kind as it takes place in the head of the individual. This is what truly defines the process of experiential learning: ceaselessly probing one's context by interpreting the messages that are exchanged with the environment.

Two principal attributes of messages have to be considered: 1) the representational code, and 2) the message carrier. For instance, a book would be the material carrier of the story it conveys via the representational code of written text.

1. Representational code
   The representational code corresponds with the symbol systems, conventions, and methods that are used for expressing the message. According to Saussure's semiotic theory (1960) message representation always involves two components: on the one hand the "signifier" (e.g. the term "house") and on the other hand the "signified" (or referent, e.g. the material construct that people are supposed to live in). So for the purpose of communication the entities of the world (the signified) are represented by signifiers.

   Representation can either be iconic or symbolic (Pierce, 1938; Wollen, 1972). Iconic representation holds when there is a great deal of similarity between the signifier and the signified: a picture of a house would be an iconic (or analogical) representation of the actual house. Understanding such a picture would be largely a matter of recognition. For symbolic representation the signifier has no clear connection to the signified, for instance in the case of using the sequence of five symbols "h-o-u-s-e" for reference to the actual house. Interpretation of symbolic representations is a matter of knowledge about the conventions of the symbol system rather than recognition. Consequently, interpreting symbolic representations would require more mental efforts than iconic ones.

2. Message carrier
   Although message carriers used to be material in kind (e.g. the book), virtual carriers are largely taking over: a cell phone connection, a webpage, a game environment, a video conference. Essentially, each type of message carrier goes with its own bias, distortions and restrictions, affecting to contents of the message: a web page carrying a text message conveys different meaning than a print version of the very same text (Cassirer, 2006).

A meaningful context is inferred from a diversity of messages. Figure 2 displays some examples laid out on a grid of these two message attributes.

The first quadrant in figure 2 contains iconic messages on material carriers: a photo print carries the analogical representation of a real entity on paper. Also non-mediated entities, like the rainbow, or the person who is a teacher are in this quadrant (null mediation, which is a special case of iconic representation). Likewise, quadrant II covers physical objects with symbolically encoded messages. Quadrant III, comprises virtual carriers for symbolic information, while quadrant IV does the same for iconic information. Note that the virtual representations in III and IV may reflect real word counterparts, for instance the teacher may be part of the video, or may operate an avatar. Sometimes, however, virtual objects exist independent of any real world entity, for instance software code, a 3d-gaming space craft, subtitles or buildings in Second Life.

In addition to figure 2 the modality and the dynamics of interaction should be considered. Modality refers to the channel by which messages are transmitted (oral, pictorial, gesture, written). It is essentially different from a symbol system or code. For instance, the symbol system of English language may either be used in the modality of printed text or spoken words. The dynamics of interaction would include different characteristics of the transfer processes,

like public channel versus private channel, controller devices, people involved, real time versus condensed time, synchronicity, responsiveness, adaptiveness, and artificial intelligence. Also the underlying relationships between the various components of context (for instance narratives in the case of sequential relationships) are not covered by figure 2.

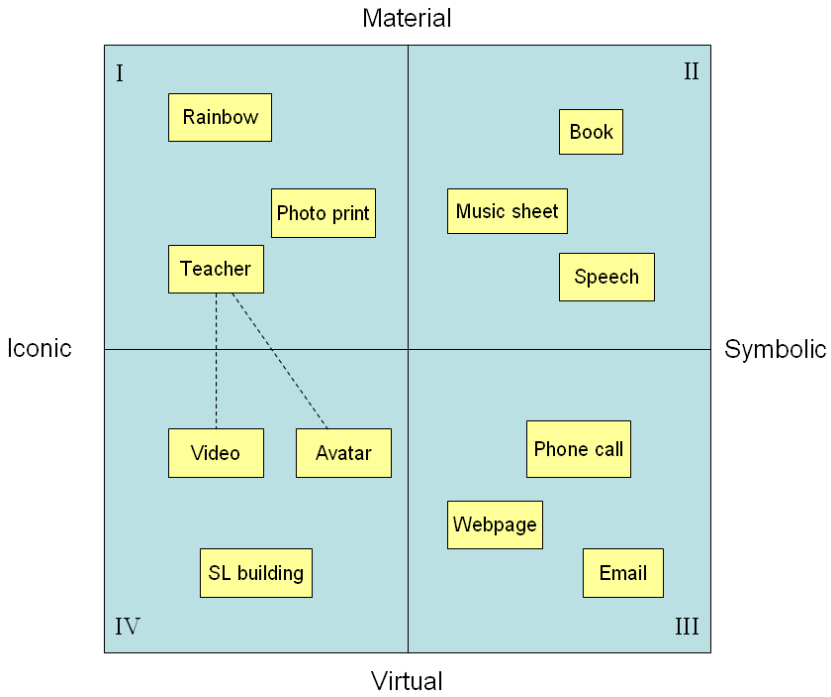

Figure 2. Media and the relationship between message representation and message carrier

Concluding remarks

This paper has explained the increased richness and complexity of learning context that is induced by new digital media technologies. These new technologies break through the confinements of school buildings and lecture halls by including extensive digital resources and real world representations. Understanding the intrinsic complexity of these digitally induced contexts is a precondition for preserving the effectiveness and efficiency of contextual learning. The mechanisms for contextualisation of human activity (including human learning) are summarised in figure 3.

Four different cases are distinguished. Individual A interacts directly with the world, without any mediating technologies. Individual B displays mediated interactions with the world via (digital) representations (e.g. a webcam image, a web page, email). Individual C interacts with virtual extensions of the world that lack any counterparts in the physical world, for example an email message or a fantasy game. Individual D assumes that all virtual artefacts have become self-evident, integrated parts of the world, so that they aren't perceived as virtual artefacts anymore: for instance, today a phone conversation is experienced much like a common face to face conversation. The sequence A-B-C-D explains how digital context is gradually accepted and incorporated as an integral part of our world. In the end, there is hardly any difference between case A and case D, be it that the latter deals with a mediated and virtually extended world.

Mediated representations inevitably go along with the restrictions and distortions reinforced by the media attributes, and tend to produce a truncated (or enriched) view of the world. Also, any mediated utterance, be it a web text or a video, may be subject of deliberate technical manipulation, thus affecting our view of the world. Therefore, media literacy competences are of utmost importance for making adequate inferences about the world (Christ & Potter, 1998). Distortion of messages is even amplified by the occurrence that messages often require cumulative conversions from one representation to another before being transferred to the learner (Cassirer, 2006). For instance,

using a website or forum for collecting comments on a photo of a rainbow would define a trajectory via quadrants I, I, IV, and III in figure 2.

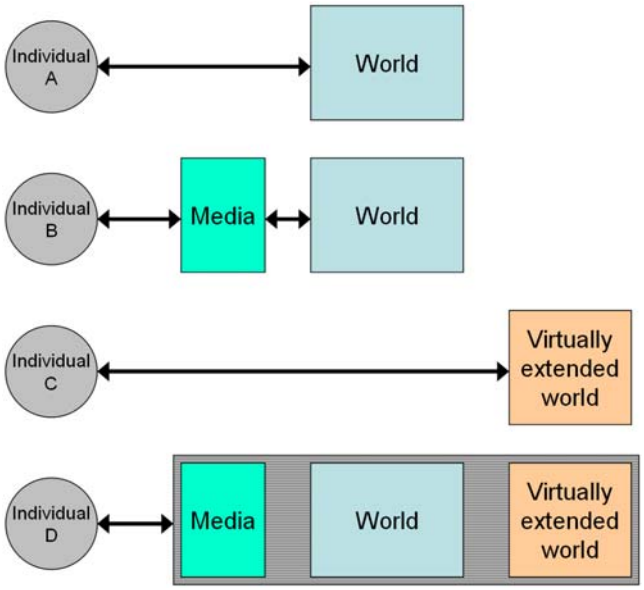

Figure 3. Separate modes of contextualisation

The continuous flow of emerging digital media keeps adding new dimensions to learning context. The present study is a first step in identifying the constituents of context and the mechanisms involved. It explained how different compartments of the world contribute to context. It explained the representational implications of the entities of the world (objects, people, processes and ideas) by distinguishing between representational codes and message carriers, by referring to different modes of interaction dynamics and modalities, and by stressing the importance of user models. Unfortunately, no methodologies or tools are available yet that treat the virtualisation of context in an explicit way. Further research is needed to develop a sustainable, descriptive framework for learning contexts and incorporating this in instructional design approaches and the associated tools. Also the progressive use of digital media urges for systematic inquiry of the learner's experiences, appreciations, and needs with respect to these expanding learning contexts.

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