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SoundScapes: Non-formal learning potentials from Interactive VEs

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Abstract

Non-formal learning is evident from an inhabited information space that is created from non-invasive multi-dimensional sensor technologies that source human gesture. Libraries of intuitive interfaces empower natural interaction where the gesture is mapped to the multisensory content. Large screen delivery and surround sound deliver the content for direct and immediate association between gesture and content response. Participant creative expression and game playing is stimulated toward engaged motivation in therapeutic sessions to optimize participation, both for client and facilitator. National and international bodies have consistently recognized SoundScapes which, as a research body of work, is directly responsible for numerous patents.

Keywords: Non-formal learning, Gameplaying, Creativity.

1 Introduction

This paper introduces the synthesis of SoundScapes [e.g. Brooks et al. 2002] and non-formal learning in Virtual Environments as defined by Petersson [2006]. The goal of this paper is to inform of the evolving multi-disciplinary platform titled SoundScapes so as to offer it as a vehicle for analogous reflection and implementation by others. European and Asian/Pacific networks have been exposed to the research with positive response and this has resulted in the annual international conference ArtAbilitation (http://www.artabilitation.net).

The SoundScapes research has evolved since being founded in 1987. It has a legacy from the field of performance art and has been featured at major global events such as the Olympics/Paralympics 1996 and 2000, European Cultural City of Europe 1996 and 2000. Interactive room installation exhibitions at internationally renown Museums of Modern Art including at the Gershwin in New York have taken place. The SoundScapes concept has focused upon people with disabilities and was found to offer new opportunities in personalized training – both for the participant and therapist/facilitator. The learning was targeted as being autonomous as fun was the prime goal of participant experience. Data from sessions is archived synchronous to user input so that the session-to-session 'learning' can be monitored.

2 Computer Generated Virtual Environments

Computer generated Virtual Environments that are responsive to human activity offer unique vocational and learning opportunities. These environments embody opportunities for creativity where all parties have the opportunity to learn and develop through participation. The presented body of research delimits to people who have physical and/or cognitive dysfunctional limitation. This segment of society is chosen so as to investigate the extremes; however, the concept is also transferable to those who may be more able. The embodied learning is referred to as being non-formal due to its autonomous nature being inherent to the targeted experiences of exploration, play and fun. This non-formal learning is the result of a system construct that addresses the individuality of each participant. The system is intuitive to control through the use of non-intrusive technologies which empower the participant. It is through this intuitive empowerment that learning takes place.

3 Interactive therapy

Designing interactive environments for learning and therapy refers to the creation of a computer-mediated space that is targeted to be accessible by all, no matter ability or limitation, age or creed, preferences or desires. The space should be fun and engaging to be in so as to enhance action and interaction. This formation implies knowledge of the user toward development of personal user profile. Furthermore, understandings of the interactive play environment in terms of the technology as such, and the use of the technology in terms of interface and quality of use. Interactive environments in general are also referred to as Virtual Reality (VR), Virtual Environments (VE), environments for virtual rehabilitation, and multimedia interactive environments, from desktop VE's to immersive interactive play and learning environments [Weiss et al. 2003; Kizony et al. 2003; Rose et al. 2005; Slater et al. 2004; Standen and Brown 2005; Reid 2002; Sutcliffe 2003; Camurri et al. 2003; Roussou and Slater 2005; Bobick et al. 1999; Penny 2000].
Engestrøm's [1987] definition of technology as a culturally constituted mediation of the user's activity is referenced. This definition is broad and has many similarities with other information- and communication technologies. However, instead of simply creating a communicative space between the user and a graphical user interface on a computer screen as other information- and communication technologies do, the technology used in this thesis does so by transforming a physical space into a computer-mediated information space for the user to freely interact with; a form of subliminal graphical user interface which reflects both the user's input and the desired change of the information space. This free interaction creates potentials for the user to move in the space, which is more or less absent in other media. It is the input and output aspects that provide these movement potentials.

Technology for the creation of interactive environments, according to our definition should enable the user:

(1) To interact freely in that environment.
(2) To interact intuitively without encumbrances in that environment.
(3) To experience a sense of fun and engagement in that environment.

From that point of view, the technology used for the creation of an interactive environment can be seen as an interface between the user and the environment, extending the user's senses and enabling interaction [McLuhan 2003]. This is in line with Latour's [1991] theories where no difference between the human and the technology is made; the focus is rather on the interaction between them. Latour names the human as well as the technology `the actant´. Thus, a situation is created where any mediating technique is invisible, which engages the user in an optimal manner through the direct and immediate responsive content feedback to his or her physiological input.

Empowerment achieved through the system acts as a dynamic concept that considers the idiosyncratic possibilities and resources associated with growth and development that is achievable through the concept towards augmenting that person's everyday interactions. By this, a holistic and process directed view on empowerment (in contrast to considering empowerment as a mental state), where the interaction in the responsive environment serves as a means to enhance the individual's communication through the feed-forward-to-feedback loop, is defined. At a philosophical level, this view enables experiences with an outcome of a more positive self-perception and belief in the own ability and capacity.

The previous section described how the technical systems used in this thesis can be considered as mediators of the user's activity. To design for mediation requires an understanding of and an awareness of use qualities.

The way the technology operates is that it sources the user's movements (feed-forward), and outputs sounds and images (feedback) through mapping and processing, which is similar as that utilized in VR technology. The uniqueness lies in the non-intrusive and easy-to-use qualities of the interface and its affordances. These factors together with the cost-effectiveness of the system reduce practical problems such as affordability, high maintenance and usability problems (i.e. expert competence requirements), which impact other products in their potential for interaction and adoption by the community (both clinical and public sectors) [see also Roussou 2004]. When it comes to the intuitiveness of the interface Bærentsen [2000] assumes that this quality of use puts fewer loads on the user's cognitive processing by being easy to use. This kind of use quality is adaptable to users with different abilities. Intuitiveness as a use quality provides a seamlessness for interaction since the user is not required to learn new skills, however, this is something that often happens as a result of the seamlessness afforded by the non-intrusive interfaces such as used in the studies presented in this thesis. The study of Human-Computer Interaction and usability most often presumes that transparency is one of the goals of good designs [e.g. Nielsen, 2000]. Considering the user interfaces, the invisible quality together with the facilitator as a reflective intervener create what Bolter and Gromala [2003] define as a good design as our system is both transparent and reflective. It reflects the user's needs and wants in all their complexity (p. 74).

The system data collected from the human has a twofold function. Firstly, it is used as a direct control means to manipulate the environment and the embedded multimedia. Secondly, it is archived as a means to monitor user response and subsequent progress according to patterns that are indicators of system effectiveness, efficiency, and utility. The first function is perceived by the user, the second is the research process that is annotated correspondingly to session video archive. This analysis is unseen by the user who only needs to experience an enjoyable play environment that is tailored to his or her specific preferences, abilities, limitations, and desires. Thus, with targeted flow a motivational experience is offered.

Usability is subject of a body of work set up in the field of human-computer interaction where usability is a key concept [Dix, et al. 2004; Preece et al. 2002; Nielsen 1994; Schneiderman 1998]. It originates from the 1970's and the field of software psychology, which was a related discipline to experimental psychology [Scheiderman in Ehn & Løwgren 1997].

Preece [et al. 2002] suggests that interactive designs are products that support people in their everyday life and the authors describe usability goals as operationalized through specific criteria. This criteria stakes that the products should be efficient, effective and safe to use in order to meet usability concerns. Further, that the products should have good utility, be easy to learn, and easy to remember how to use. Winnograd and Adler [1992] and Winnograd [2000] take another position by emphasizing the communication dimension of usability and discuss this in terms of usability as a dialogue of change. This dialogue involves the designer and the user, as an assurance for the usability and as a potential to move beyond traditional usability approaches. Brown and Duguid [2000] emphasize the issue of drawing attention to the wider context that surrounds the interactive design, as this is an element that affects the usability the designer tries to create. The authors continue that the consideration of the context involves more than only emphasizing a well-integrated user interface as it also requires the designer to take social aspects carried by the context in consideration. Løwgren and Stolterman [2004] refer to the creation and shaping of use-oriented qualities of an interactive design based on the designer's highly developed judgment skills. Jønsson [et al. 2006] emphasizes that the design of technical solutions always begins and ends with the human. Furthermore, they consider the design process as a social phenomenon, which needs to be studied in real situations. The designer's sensitivity to and understanding of the context and how interactions are embodied within these contexts are of core importance for the design of technical solutions. To sum up, the focus in usability research has moved from considering only the human system, to include a consideration of the context, with a focus on users' expected value [Løwgren 1993; Ottersten and Berndtsson 2002].

Usability issues have been considered as quality assurances based on the facilitator's judgements in and on action in a specific situation [Løwgren and Stolterman 2004], rather than as usability in the form of goals and principles. Implicitly, the focus on situated action underlines that the assurance of quality is unique and, thereby, dependent on the individuals involved in the situation. In other words, the participant's and the facilitator's competences are unique and goals and principles cannot fully control each of the situated moments as every given situation to a certain degree is unpredictable. Thus, usability is related to the situated action rather than to the usability per se and, thereby, the understanding of usability reaches beyond the immediate use [Bødker 1999]. Particular focus is on people's use of interactive environments, which primarily is viewed as empowering the user's active participation in activities to encourage learning. Here, the reader can see the following sections presenting the specific theories that form the base for a non-formal learning approach.

However, this paper does not intend to present what non-formal learning is, but rather to develop a language by which we can point at central aspects of learning in interactive environments. Accordingly, these central aspects are based on theories related to open-ended action, interactive play, and creative design based on intervention. These theories are important in order to understand the features of an individual's action and interaction when using interactive play environments and, also, in helping define links between interactivity, non-formal learning and design.

4 New Opportunities from Real-time interactive multimedia technology

The use of real-time interactive multimedia technologies in therapy is seen to be growing rapidly as a field of research and application. It is evident that many new opportunities are becoming available for digital artists who look to creatively apply themselves in a satisfying vocation that can sustain their artisan lifestyle. In other words the SoundScapes concept offers a means for digital artists to have a satisfying employment where their art is applied in helping and offering benefit to others less fortunate, whilst giving a sustainable income so as to support their traditional art. Through such a vocational strategy it is a potential

that the experiences from confronting this segment of society will influence and inspire their original art form.

These opportunities are rewarding in that they involve a form of learning that can change people's lives in a positive fashion. For the participant the rewards are improved functionality and social contact. For the facilitator/therapist who wishes to supplement traditional training methods a benefit of alleviated tedium and higher levels of participant engagement abound. The reduced boredom, when compared to traditional programs of training, is through the successful matching of the system to a participant's personal profile so that fun interactions are achieved. Resulting is optimized motivation from both parties. To address these questions SoundScapes interactive environments were created that encouraged interactions through movement empowered by non-invasive technology to control multimedia feedback. This is a contemporary phenomenon that can be said to open up new possibilities that change and affect our opportunities in many situations. Intuitive interactions based on temporal and spatial explorations of perceptions rather than memory and symbolic processing are analyzed and reflected upon.

Learning as a process of competence creation is often not considered as learning in a formal sense by the child, but as play. Hence, play can be viewed as a fundamental factor for non-formal learning. Here, the focus is on the child's `doing´ with enthusiasm and feeling emotively exhibited through being able to achieve, and to be free to create. Following the key qualities from theories on flow and aesthetic resonance are elaborated. This includes the issue that play is likely to motivate for learning if it renders complex and challenging experiences and immediate feedback [Csikszentmihalyi 1991]. Further, Vygotsky [1987] emphasizes that play stimulates new shapes of thinking through initiation of function in the zone between what is already mastered and what is to be learnt, i.e. the zone of proximal development – a space where non-formal learning occurs. In addition, free play is self-driven and has a potential of placing the player in a state of concentration and immersion [Csikszentmihalyi 1997] – a state where non-formal learning occurs.

5 Non-formal learning

The use of the term 'non-formal' learning is not new. In the 1970s formal learning was viewed as high status knowledge that is possible to generalize in a wide range of contexts, whereas the informal-, everyday-knowledge was thought of as context-specific [Bernstein 1971; Scribner and Cole 1973]. From socio-cultural and situated perspectives on learning Scribner and Cole [1973] responded to this existing dominance of formal learning by asserting the advantage of the informal and the effectiveness of learning through informal processes. Lave and Wenger [1991] undertook an important rethinking of the conception of learning when they proposed that learning is a process of participation in communities of practice, which involves the whole person, the activity, and the environment as mutually constitutive. They argued that learning is the process of becoming a full member of the community, legitimate peripheral participation (p. 29).

More recent studies on informal or non-formal learning and education have been directed to:

- Where the learning takes place, e.g. adult education, the field of life-long learning, and non-formal location such as museums [e.g. Bentley 1998; Coffield 2000; Eraut 2000; Rousseau 2004].
- How non-formal learning with ICT occurs, e.g. self-teaching or how children organize their own learning [e.g. Willet and Sefton-Green 2003; Katz 2000].
- The relationship between the use of interactive technologies and what is valued as learning, which has highlighted the role of the teacher as facilitator in structuring the content (what) that is to be taught [Rousseau 2004]. The object in these studies is, however, most often related to formal knowledge.
- How non-formal learning is built upon a high degree of motivation [e.g. Gee 2003; Harkin 2003].

In general, studies in this field have been directed to investigating distinctions between formal, informal, and non-formal learning, under strategies that polarizes the concepts against each other or to find boundaries around one of these concepts [Colley et al. 2003].

In this paper the concept of non-formal learning constitutes an umbrella that gathers corresponding theories on activity [e.g. Vygotsky 1981a; Leont'ev 1981; Wertsch 1998] and inherent concepts related to ludic activities motivated by curiosity, exploration, play and aesthetics rather than externally defined tasks. The motivated processes of action and interaction in interactive environments and their bearing on learning and therapy are key concerns. This draws on the writings of Vygotsky [1981a], Leont'ev [1981], and Wertsch [1993] in order to comment on the relationship between mediated action and the situated experience of learning in the situation; this is exemplified through the following quotation:

> Experience does not go on simply inside a person /.../ In a word, we live from birth to death in a world of persons and things which is in large measure what it is because of what has been done and transmitted from previous human activities. When this fact is ignored, experience is treated as if it were something which goes on exclusively inside an individual's body and mind. It ought not to be necessary to say that experience does not occur in a vacuum. There are sources outside an individual which give rise to experience [Dewey 1938/1963, p. 39 as cited in Cole 1995].

Vygotsky [1978] claimed that any human function should be analyzed as a triangulation, consisting of the subject, the object, and the mediating tool or sign, which results in a unit of the mediated action. Leont'ev [1981] argued that the motive of the activity was to be found in its object, where the activity is realized in the form of individual goal-oriented actions. Wertsch [1993] motivated his choice of action as unit of analysis by emphasizing action as a dimension in between the individual and the socio-cultural context, and thereby not limited by a methodological individualism. By this, action may be social and individual as well as external and internal [Vygotsky 1978; Leont'ev 1981; Wertsch1985; 1998]. The analysis of action in this paper differs from the most common approaches that focus on narrow behavioural, psychological, and idiosyncratic paradigms [e.g. Efron in Ruesch and Kees 1970; Ekman and Friesen 1981; Kendon 1981; Berthoz 2000; Law et al. 2001].

The social and cultural context referred to and studied here is not extensively focusing on the contextual level, but mainly the immediate environment of each situation (which includes the technical system and the facilitator).

6 Enjoyment

Having enjoyable and fun experiences in the interactive environment is emphasized. This means to being engaged (both consciously and unconsciously) and that the individual is offered possible choices of action. The choice in how to do things is in this case closely related to "having fun" [Gøncü 1999; Rogoff 2001]. Participants, who had profound multiple disability, were empowered to actively control selected content by body gesture. Initial activities were in establishing an understanding of the interactive space through facilitator guidance. This interaction (facilitator action) means taking the hand of the participant and guiding it through the sound space (this can also be the user's head, leg, torso, or digit – again, dependent of therapy goals). Tactile response that was exchanged between the facilitator and the participant indicated to the participant's understanding of the

space and subsequently hand and head movement explored without guidance. It is at this stage that the participant uses the mediating tool alone to accomplishing his or her interests. In relation to this, Bruner [1973] points out curiosity, the desire to show oneself and others the ability to act, and the attempt towards common goals together with others as internal motives to learn. This system is characterized by the free interaction within the computer-mediated information space. The system has the capacity to awaken and develop enjoyment and curiosity among the participants resulting in an optimized motivation to play and learn.

7 Autotelic activity and flow

In his writings, Vygotsky [e.g. 1981] states that the play is the source to the child's development. When the child is playing a potential development zone is created – the Zone of Proximal Development (ZPD). The ZPD is defined as the distance between the actual level of development, which is determined through the child's own way of solving problems and the potential level of development, which is defined through guidance of the adult [Vygotsky 1978]. Leont'ev [1982] points out the possible conflict between the child's need for action and the inability to perform this action. The motive for the action is, however, not related to the result, but rather to the content of the action, which is why the child does not need to master the actions or operations that are required. According to Csikszentmihalyi [1991], the balance between the inability and the mastery is crucial relative to curiosity and motivation.
Play is similar to what Csikszentmihalyi [1991] names autotelic activity, which is characterized as being carried out for its own sake by inner goals generating the state of flow. As such play is described as a precondition to flow. In this thesis, this is similar to the way the 'doings' or actions are described as prerequisites to playful engagement. According to Csikszentmihalyi [1991] flow experiences consist of seven components that create the conditions that make flow possible. The seven categories can be divided into two groups. The first group of components describes the basic prerequisites of flow:

(1) Clear goals and immediate feedback.
(2) Challenging activity.
(3) The paradox of having control in an uncertain situation.

By this, flow activity is not passively experienced, but requires active engagement. Play seems to be closely related to flow suggesting a goal-oriented nature of the input and a desirable outcome for making meaningful choices. This balance between challenge and sensibility is allowing and encouraging change. In an optimal experience, the participant is able to be in control without completely being in control of the situation. If there is no chance of failure, the activity is not difficult enough and refinement (intervention) to match ability to challenge is required.

The second group consisting of four components describes the effects of the flow state:

(4) Merging of action and awareness.
(5) Concentration.
(6) Melting together of doing and self-consciousness.
(7) Transformation of time.

One characteristic of the flow state is that the participant is so absorbed in the activity that it becomes almost automatic, which allows the participant's consciousness to delve deeply into the activity. The complete focusing of attention on the task is a common effect of flow. In the state of flow the participant's experience of self becomes reactive to the whole of the experience and the sense of time stretches or shrinks. This holistic mode of operation leads to unification and order of the participant's consciousness, in other words, an integration of physical, emotional and mental functions [Csikszentmihalyi 1991; Salen and Zimmerman 2004].
But, how does an experience like this happen? The answer, according to Csikszentmihalyi [1991], is that the activities are designed to make optimal experience possible to achieve. An optimal experience contains a sense of discovery, which pushes the person to higher levels of performance. Csikszentmihalyi has developed a general model which describes how the level of a person's skill and the challenge can influence the flow experience in an activity.

8 Conclusions

The findings from the concept present how mediated action and interaction shaped learning. The (invisible) interface shaped how the users played/learned and encouraged play-flow-aesthetic resonance – a powerful platform for communication, learning, and development.
Based on intervention (guiding and disturbing facilitator – tacit knowledge) the system shapes this user groups' communication and expression with implications for (re)habilitation and training. Action oriented knowledge goes beyond the alterative, which is multi-sensory-mediated-knowledge. It represents the kind of knowledge that is "learnt by doing", based on experiences of perceptual responses to action (feed forward, feedback). This kind of knowledge transmission can be considered direct, in the sense that it is natural (raw) and intuitive, since it is based on experiences and on the perceptual responses to movements (motor acts). One can compare this to dancing or playing musical instruments where the physical embodiment is a necessary condition for the achievement of action oriented knowledge. Movement is the direct perception of affordances for action. The design of the IE (interface) enabled the users to explore (feed forward) on the possible / intuitive movements and the experienced feedback from the environment, which was direct (real-time). The proposed model encompasses design and learning factors involved, but also provides a description of the mediated interaction between the user, the system, and the facilitator: making sense of how they (inter)act and communicate within IE. What is available to be learnt? We believe it is to:-

- Learn from extremes [Jønsson et al. 2004]
- Learn from the situation (be here and now)
- Learn from the context of the situation (be reflective and "non-formal")
- Learning is organic – it has an embodied life rhythm

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