Author accepted manuscript.

Version of record: Bonanno, P., Klichowski, M., Lister, P. (2019). A Pedagogical Model for CyberParks. In: Smaniotto Costa, C., et al. CyberParks – The Interface Between People, Places and Technology. Lecture Notes in Computer Science(), vol 11380. Springer, Cham. https://doi.org/10.1007/978-3-030-13417-4_23

A Pedagogical Model for Cyberparks

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Abstract

Recent conceptual developments about CyberParks and their educational potential will be discussed. Key learning characteristics and pedagogical principles will be identified through a brief review of relevant pre and post-Net learning theories and through specific results from studies that explore the interaction between cognitive, affective and psychomotor processes while using digital technologies during different activities in Cyberparks. Implications of these theories for learning and practical recommendations for people who want to use the CyberParks concept in formal educational practice and informal learning will be proposed. Examples of pedagogical scenarios in CyberParks are outlined. Relevant pedagogical models are reviewed from which a pedagogical model that describes learning experiences in CyberParks is developed. This model will be used to design learning journeys and to assess and evaluate learning scenarios in CyberParks.

Assessment and evaluation of learning activity and learners are discussed. Learning activity is assessed quantitatively considering the type, frequency and direction of interactions manifested for acquiring knowledge related to the theme of the learning journey and competences developed through use of the digital technologies and while interacting with peer learners. Learner's perceived effectiveness of learning is measured by analysing learner interactions, learner generated content and recordings of discussions / interviews with any users of the smart learning journeys using dialogic space expansion and phenomenographic outcome space variation categories using keyword or knowledge feature presence.

This chapter concludes by discussing how smart learning can provide innovative ways of interpreting, accessing, connecting and utilising technology-enhanced public spaces such as Cyberparks. The innovative aspect is manifested in the proposed connectivist-inspired process-oriented pedagogical model. More than a static design instrument this model should serve as a signpost in the process of developing adaptive expertise through which new pedagogies and innovative uses address the evolving needs of learners in technology-enhanced contexts like CyberParks.

Keywords: *C*yberparks, Pedagogy, Smart city learning, Design for Learning, Connectivism.

Digital technologies are radically changing society and transforming all aspects of our life into a hybrid reality (Cook *et al* 2015) based on blended experiences of the physical with the virtual, the individual with the collective, the local with the global. New technologies have revolutionalised every aspect of our life – how we think, communicate, learn, work, entertain and protect ourselves and our belongings. Citizens are empowered to be creative and imagine different ways of doing things and different modes of interacting with the environment and with others, and to imagine things, places and processes in different ways and combinations. Through highly reliable communication and navigation systems, combined with context aware digital tools the 'internet of things' is increasingly becoming a standard feature of our hybrid life. Though not fully appreciated in formal educational contexts, digital technologies are continually providing opportunities to enhance and transform learning that were unimagined a few years (if not months) ago. In this rapidly evolving context educators and learning designers are continually challenged to re-imagine the learning process and extrapolate the conditions of learning to formal, informal and emerging multi hybrid learning contexts. CyberParks are or have the potential to become an instance of these emerging multi hybrid contexts.

Considering a CyberPark as a technology-enhanced (open) urban space that can be used by citizens for various purposes, these spaces can pass from various stages of design and development being continually adapted for specific purposes and citizen needs. The degree of development reflects the different purposes and modes of interactions provided to users in the space. Hence a CyberPark is a hybrid space, comprising both natural and man-made features, combining the physical and digital, the local with the global, formal and informal learning. Citizen users are provided with various dimensions of interactions arising from their need to entertain themselves, socialise, pursue healthy life styles, learn about themselves and their surroundings and participate in the development and use of their physical and virtual habitat. Their presence and interactions with the physical, social and cyber environments is mediated, enhanced and possibly transformed through digital technologies and communication systems. However, examination of literature concerning technology-enhanced urban spaces and smart cities reveals that the emphasis is not only on extraneous physical and technological factors but most important on citizen-users and the enhancement of their quality of life – how they communicate, lead a healthy life-style, socialise, work and learn. Thomas *et al.* (2016) epitomises this in the concept Smart Cities as 'place, people and purpose.'

The Educational Potential of CyberParks

The educational dimension of CyberParks is a key characteristic as these spaces which may be designed, developed, and organised to promote both prescribed and informal types and modes of learning and interactions. Isaksson *et al*. (2017) considers CyberParks as physical smart learning environments exploiting the affordances of digital, context-aware and adaptive devices. This promotes better and faster learning through ubiquitous digital connectivity that enable learners to connect in context-aware scenarios to a wider network of knowledge, experts and learning communities via their 'adaptive devices'. Literature about mobile learning, emphasising the use of mobile devices, has generated the idea that the place and context in which learning takes place is not very important. However, locations (physical and virtual) are not irrelevant; on the contrary, they are becoming increasingly important and the design of learning environments needs to orchestrate the different locations in which a person can learn, combining formal and informal situations. Hwang (2014) emphasises that a smart learning environment, besides enabling learners to access digital resources and interact with learning systems in any place and at any time, actively provides the necessary learning guidance, hints, supportive tools or learning suggestions. Buchem & Perez-Sanagustin (2013) proposes four modes of learning - seamless learning, crowd learning, geo-learning and citizen inquiry - that emerge in such contexts manifesting users' interaction with the natural, historical, cultural, architectural and digital dimensions of the space. For Sharples *et al*. (2012: 24) seamless learning is evident when a person experiences a continuity of learning across a combination of locations, times, technologies and social settings. Gros (2016) quoting Chatti *et al* (2010) characterises learning in technology-enhanced environments like CyberParks as fundamentally personal, social, distributed, ubiquitous, flexible, dynamic and complex in nature. She states that one of the most important features of smart learning is that the data used serves as feedback for the learner to support personalised learning (Gros 2016:2).

Burbules (2013) notes that for learning to be effectively "ubiquitous", it requires a more distributed experience in time and space. For Gros *et al.* (2016) learning becomes ubiquitous implying a special capacity for flexibility and adaptation to different contexts. Compared to learning in formal settings where the teacher is the main source of information and students are required to stay in the same place and participate simultaneously in the same activity, in a situation of ubiquitous learning activities can be resolved in a different space and time for each student having teaching materials available at all times and accessible from any device. Ubiquitous learning extends beyond prescription providing situations in which even the student may be learning without being fully aware of the fact.

For Burbules being constantly "connected" through mobile technology is a way of life implying that the limits between "work/play, learning/entertainment, accessing/creating information, public/private, formal/informal are distinctions that have conceptually been clear but currently are becoming unclear" (Burbules 2013:2). Cronin (2016) claims that young people in the age of 'networked individualism' (Castells, 2010; Rainie & Wellman, 2012) enter higher education as networked individuals with extant and diverse informal learning practices, networks and identities.

The educational potential of Cyberparks lies in the fact that such hybrid environments trigger deep learning processes manifested as change in an individual's competence profile and in epistemological conceptions. Interactivity extends the zone of possibilities (Cook *et al* 2015) providing new focussed learning instances. As Buchem & Perez-Sanagustin (2013) contend, physical objects, including buildings, works of art or points of interest, can become part of the learning environment that, when mediated through mobile technologies and locative media, the surrounding physical environment and the digital environment can be dynamically merged into augmented, ad-hoc Personal Learning Environments. By interacting with these hybrid environments learners develop 21st century skills including accessing information and knowledge efficiently and effectively, develop inquiry/problem solving skills and develop creative, collaborative, communicative competences. Interaction in these environments nurtures the ability to be innovative in using the surrounding habitat in culturally sensitive, globally aware and ethically responsible ways. Technology has fundamentally revolutionized how people interact with these technology-enhanced spaces offering innovative ways of communicating, think, working and sharing one's experience and in the process changing our epistemologies and perceptions. Through networked technologies citizen-learners have to develop new interactional patterns with the various aspects of hybridity - the physical and virtual, the local and the global, the individual and the collective, the now and then, data consumption combined with data generation.

Thus CyberParks are evidently places that challenge people to extend their learning boundaries through acquisition of new knowledge and skills, through sharing their understanding and by contributing to the distributed knowledge and networked experience. Whatever the degree of interaction of the citizen/s with the CyberPark, they are presented with a myriad of instances where they have to acquire different type of content (both knowledge and skill) through different modes of interaction. For examples, the more citizens learn about technology and learn through technology the more empowered they become to interact with the surrounding environment. The situation is complex as it merges different epistemologies within one learning instance or calls on relevant epistemologies for different instances of learning. Citizens' epistemology, which incidentally is one dimension that needs to be challenged and updated through one's experience in a Cyberpark, is a strong determinant of one's successful (educational) interaction. Schommer (1998) and Schommer-Aikins, Duell, & Hutter (2005) give five dimensions of beliefs about knowledge acquisition and learning that come to play when one is interacting with digital technologies within technology-rich environments. These include the 'structure of knowledge', ranging from isolated pieces to integrated concepts; the 'source of knowledge', ranging from authority to reasoning; the 'stability of knowledge', ranging from certain knowledge to changing knowledge; the speed of learning, ranging from quick learning to gradual learning; and the 'ability to learn', ranging from fixed at birth to improvable.

One's interaction in CyberParks needs to promote the necessary change in these epistemological dimensions. Will interaction with technology promote an integrative or fragmented perception of knowledge? Will adult learners and those educated in formal contexts change their beliefs about the source of knowledge, hopefully shifting from authority figures to personal reasoning? Do they appreciate the fluidity of knowledge in the digital era? Is learning about technology and through technology an intuitive or a relatively challenging process? Bringing about conceptual and attitudinal changes by addressing these questions prompted by one's experience in a Cyberpark constitutes a truly deep learning experience. Learners become more tuned to appreciate the composite nature of the learning experience comprising different perspectives on knowledge acquisition, building and sharing.

Theories of learning

Learning in a CyberPark can be considered as a composite experience manifesting different modalities of learning at different moments according to ad hoc evolving needs. Pedagogically it is more healthy to consider learning in CyberParks from a wide range of perspectives ranging from intra-individual interactions between the cognitive, affective and conative dimensions but also from an inter-individual, system distributed, networked, hybrid interactional process. Anderson (2010b) distinguishes between pre-net theories (developed before the event of the internet) and Net-aware theories (characterising contexts rich in information and communication systems). Most of pre-net theories, such as constructivist and sociocultural theories continue to be useful because emerging technologies are often applied to the same challenges and problems that originally inspired educators and researchers (Anderson 2010a). In addition, some of these theories have evolved by incorporating elements of the Net (Gros *et al.* 2016).

The reality is that any learning experience in CyberParks links to different theories according to the situation and conditions. Hence these two major categories of learning theories will be briefly discussed in relation to CyberParks and determine the pedagogical and educational implications that can be considered in the design for learning within these smart, interactive learning environments.

Pre-net learner-centric theories

Behaviourist, Cognitive, Neuro-cognitive and socio-cultural theoretical perspectives describe internal processes and external behaviours manifested by learners during learning. Dron & Anderson (2014) claim that 'Cognitivist/behaviourist pedagogies centre on the individual as an autonomous entity to which certain stimuli can be applied in order to achieve a certain measurable output.' They also claim that 'Behaviourist pedagogies deliberately go no further than these observable inputs and outputs (Skinner 1974), whereas cognitivist approaches take into account the mental models and internal processes, building on a richer psychological understanding of learning and how it occurs,' Dron & Anderson (2014:38). Mayes & de Freitas (2004) and Beetham & Sharpe (2007) describe three theoretical dimensions of learning – the Associative, the Cognitive (Individual and Social Constructivist) and Situative. An experience of a visitor in a CyberPark may include aspects of the Associative approach, for example when following prescribed learning activities. This perspective assumes that people learn by association, initially through basic stimulus- response conditioning, later by associating concepts in a chain of reasoning, or associating steps in a chain of activity to build a composite skill. In this situation the main focus is on the alignment of learning objectives, with content or task analysis, instructional strategy and assessment. However, this approach to learning is not concerned with how concepts or skills are represented internally, but in how they are manifested in external behaviours, and how different instructional interventions manifest themselves in observable learning.

In contrast to this, cognitive approaches emphasise modelling of the processes of interpreting and constructing meaning. Knowledge acquisition is viewed as the outcome of an interaction between new experiences and the structures for understanding that have already been created. So building a framework for understanding becomes the learner's key cognitive challenge which is in sharp contrast to an objectivist / behaviourist model of learning as the strengthening of associations. It is also more authentic, contextual and social in nature, as these aspects are perceived as more appropriate for equipping learners with the skills they will need to participate in a constantly changing broadly societal context (Conole 2014).

Most learning experiences in a CyberPark probably will have a constructivist orientation promoting understanding through active discovery. Citizens learn by actively exploring the hybrid environment around them, receiving feedback on their actions and drawing conclusions. Then they pass to a constructionist model of learning by constructing and communicating their reactions, ideas and reflections through digital media and tools. Constructionist learning occurs 'when the learner is engaged in constructing something for others to see' (Papert, 1993; 2006:9). Learning by designing may result in effective participatory learning approaches and of embracing "ways in which the web-service-based environment offer(s) potential for learning" (Wilson, 2006 in Beetham & Sharpe, 2013:41).

Individual Constructivist learning is more concerned with how knowledge and skills are internalized than how they are manifest in external behaviour. From a social constructivist perspective learning results from achieving understanding through dialogue and collaboration. Thus peer learners and tutors play a key role in development by engaging in dialogue with the learner, developing a shared understanding of the task, and providing feedback on the learner's activities and representations. Emphasis is made on learning through collaboration and on how emerging concepts and skills are supported by others, enabling learners to reach beyond what they are individually capable of learning in the *zone of proximal development.* Attention is paid to learners' roles in collaborative activities, as well as the nature of the tasks they undertake.

The Situative Approach to learning emphasises social interaction and the context of learning which should be close – or identical – to the situation in which the learner will eventually practice. Through these interactions learners develop practice in a particular community and also develop competences related to a particular role within a Community of Practice (CoP). Thus people learn by participating in CoP progressing from novice to expert through observation, reflection, mentorship, and '*legitimate peripheral participation'* in community activities. Much less attention is paid to formal learning activities. Through varied ways technology can give access to CoP that in one way or other are linked to CyberParks, and to which it can serve as an access node.

Cognitive neuroscience provides another learner-centric framework. From this point of view, as Klichowski and Patricio (2017) show, learning in CyberParks combines two types of cerebral operations: motor and cognitive control. In spaces such as CyberParks, learners students have to learn with digital tools while on the move (Klichowski et al., 2015). However, this cognitive-motor interaction requires an appropriate allocation of cognitive and motor resources for each operation. Figure 1 shows that the human brain does not cope well with this situation, which leads to an overload of central resources, and thus to destabilization of the course of cognitive and motor processes, the consequence of which is the weakening of both cognitive and motor tasks. Thus, for example, using a smartphone while walking increases the risk of falling; performing arithmetic operations while driving reduces the accuracy of the result (Yamada *et al*., 2011). In cognitive neuroscience this effect is called dual-task cost (Takeuchi *et al*., 2016). The implication for learning in CyberParks is that one should use technology for learning while stationary such as when standing or sitting but definitely not while walking. Thus the idea of smart and immersive learning, in a sense, has to be revised.

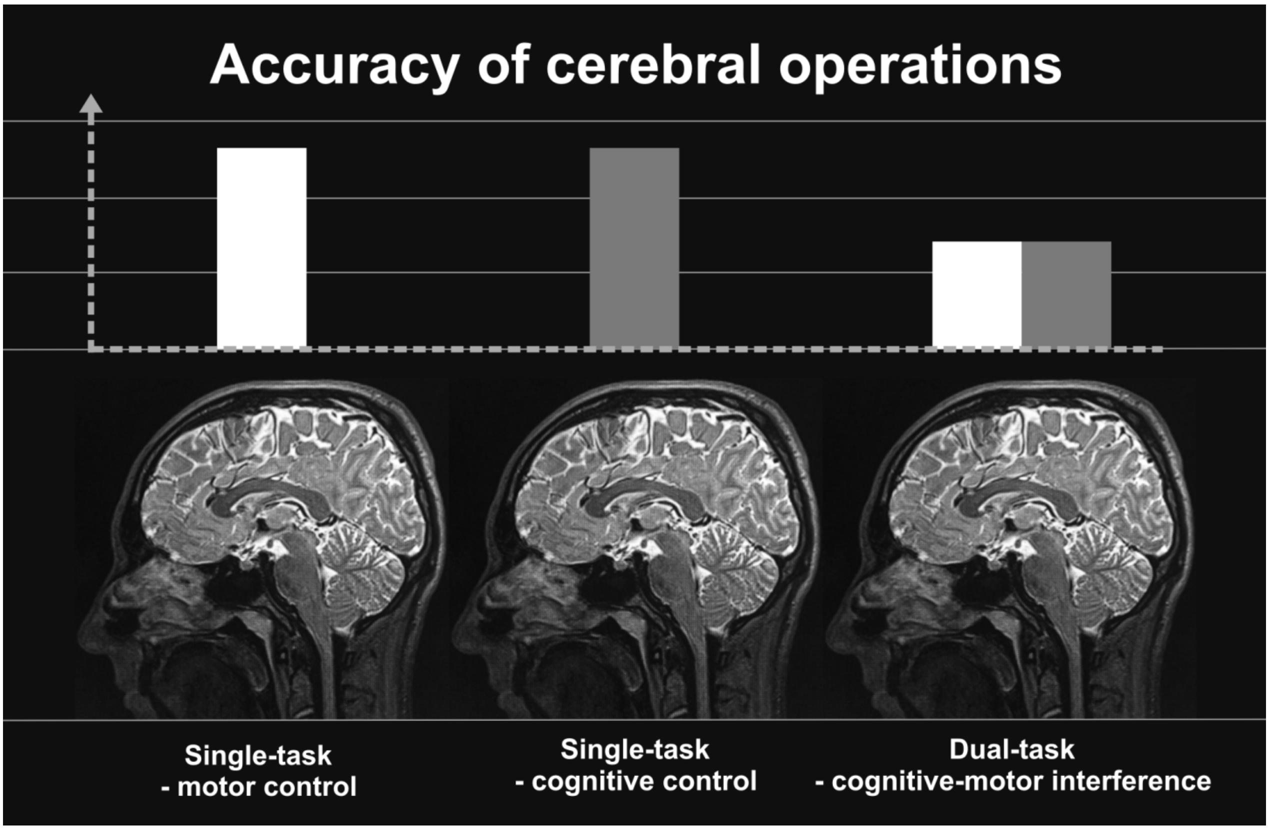

Figure 1. *The dual-task cost theory. Studies on dual-task cost show that the best cognitive or motor results are obtained when separating these processes. Their interaction weakens the results of both. Source: own work based on: Pothier, K., Benguigui, N., Kulpa, R., and Chavoix, C. (2014). Multiple object tracking while walking: similarities and differences between young, young-old, and old-old adults. Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 70, 840-849. doi: 10.1093/geronb/gbu047; Yuan, P., Koppelmans, V., Reuter-Lorenz, P. A., De Dios, Y. E., Gadd, N. E., Wood, S. J., Riascos, R., Kofman, I.S., Bloomberg, J.J. Mulavara, A.P. and Seidler, R. D. (2016). Increased brain activation for dual tasking with 70-days head-down bed rest. Frontiers in Systems Neuroscience, 10:71. doi: 10.3389/fnsys.2016.00071.*

Nevertheless, we cannot be sure that the dual-task cost is not overrated. Two experiments realized within the CyberParks Project (TUD COST Action TU1306) by Klichowski (2018) use the two behavioral paradigms and the mobile electroencephalography method (mobile EEG) will attempt to explain this problem.

Post-Net Networked Systems theories

Further to Anderson's (2010a) distinction of Pre and Post Net theories of knowledge, Gros *et al.* (2016) give three major categories of 'Post-Net Networked Systems theories: theories focused on the Network, those focused on Social-personal interaction and others that focus on the design of the network. In the first category they include Networked Learning, Connectivism and Actor Network Theory (ANT). For Goodyear *et al* (2004) Networked learning involves the use of digital technologies to promote connections between learner-to-learner, learner-to-tutors and learning community-to-its learning resources. Learning and knowledge construction is located in the connections and interactions between learners, teachers and resources, and seen as emerging from critical dialogue and enquiry. Such a perspective promotes learning as a social, relational phenomenon, and view knowledge and identity as constructed through interaction and dialogue.

In line with this theory, Connectivism (Siemens 2005, 2006) considers knowledge as a flow through a network of humans and non-humans (artefacts) comprising connections between nodes that can be individuals, groups, systems, fields, ideas, resources or communities. On the same vein Downes (2006) considers knowledge residing not only in the mind of an individual but is also distributed across an information network or multiple individuals. Siemens (2006) describes the cycle for the development of networked knowledge, starting from the individual who feeds into organizations and institutions, which in turn feed back into the network, and then continue to provide learning to individuals. Through this cycle learners remain current in their field by establishing connections so that knowledge and learning can be defined in terms of connections; “know where” and “know who” are more important today than “know what” and “know how,” Siemens (2005). Defined as actionable knowledge, learning occurs within nebulous environments of shifting core elements – not entirely under the control of the individual. The connections that enable us to learn more are more important than our current state of knowing. This aspect of Connectivism, that is, knowledge being held in the network and that "(t)he learning is the network" (Siemens, 2006:15) is one of the most debated points of Connectivism. Having transient knowledge residing in technical networks and learning externalised into human mediated distributed networks where it takes place and *is*, not restricted to a single individual to be internalised, contrast with the central tenets of previous learning theories, Downes (2007).

Siemens (2006) discusses internal and external learning networks. The former are structures that exist within our minds through which one connects and creates patterns of understanding. The latter can be perceived as structures created by individuals in order to stay current and continually acquire experience, create, and connect new knowledge. The ability to draw distinctions between important and unimportant information is vital and the ability to recognize when new information alters the landscape based on decisions made before is also critical. The main shortcoming of connectivism is its inability to explain the role of dialogues, collaboration and social practice or mutual construction of knowledge.

Connectivism denies that knowledge is propositional and that other theories are 'cognitivist', in the sense that they depict knowledge and learning as being grounded in language and logic, Downes (2007). Downes further claims that knowledge is literally the set of connections formed by actions and experience. It may consist in part of linguistic structures, but it is not essentially based in linguistic structures, and the properties and constraints of linguistic structures are not the properties and constraints of connectivism. Other digital media may play an important role in developing knowledge of a less linguistic, more affective and intuitive nature. The direct implication is the need for learners to develop skills in digital, information and media literacy, and for critical thinking, alongside their understanding of how networks work.

Connectivism differs from constructivism in that transfer of knowledge occurs through "connecting (adding) nodes" in the network, not (only) "socialisation". In terms of constructivist and connectivist epistemology, these factors both together describe the active, social learner in human and non-human networks of knowledge. But connectivism regards the knowledge construction in the network as part of 'the learning', potentially more significant than the individual learning. Siemens, in his (2006) direct defence of Verhagen's criticism, refers to Mergel (1998) who cites Ertmer & Newby's (1993) "five definitive questions ... to distinguish learning theory": How does learning occur? Which factors influence learning? What is the role of memory? How does transfer occur? Which types of learning are best explained?

Using Ertmer & Newby (1993) five definitive questions to distinguish learning theory, Siemens (2006) points out the differences of previous learning theories to Connectvism. While in Behaviourist approaches learning occurs as observable external behaviours, in Cognitivist approaches it consists of structured computational knowledge networks, and in Constructivism as personal constructions developed through social interaction. In Connectivisn learning occurs distributed within a network, is social, technologically-enhanced involving the recognition and interpretation of patterns. For Behaviourists learning is influenced by the nature of the reward, punishment or stimuli, Cognitivist learning by existing schema and previous experiences, Constructivist learning by social engagement and participation, and Connectivist learning is influenced by diversity of network. The role of memory in beviouist learning is to record experiences where reward and punishment are most influential, in cognitivist approaches to encode, store and retrieve information, in constructivist links prior knowledge to current contexts, while in Connectivism memory consists of adaptive patterns representing state as existing in networks.

In Behaviourist approaches transfer of learning occurs through stimulus and response, in Cognitivist approaches through the duplication of knowledge constructs of 'knower', in Constructivism through socialisation and in Connectivism by connecting to and adding nodes to knowledge networks.

Behviourism is characterised by task-based learning, cognitivism by reasoning, clear objectives and problem solving, constructivism by social and "ill defined" learning, whereas connectivist learning is complex, with a rapidly changing core and involves diverse knowledge sources, Siemens (2006).

Making no distinction in approach between the social, the natural and the technological, Actor-network theory (ANT) (Latour 1977, 2005) proposes a socio-technical account that explores the ways that heterogeneous networks, of both human and non-human actors, are constructed and maintained, and focuses on tracing the transformation of these heterogeneous networks. For Latour (1997) "an 'actor' is anything (human or not) granted to be the source of an action and is also a simplified network. Nothing lies outside the network of relations. There is no difference in the ability of technology, humans, animals or other non-humans to act. For Latour (2005: 16), while it is possible to render social connections traceable in simple knowledge systems, there is no means to trace these or follow the actors or their actions in complex knowledge systems because these are uncertain, unexpected and often hidden and their connections are varied, ubiquitous and open. Thus for Gros *et al* (2016) **t**he main problem of this approach is that it reduces all actors into black boxes and thus ignores internal actions such as reflecting, self-criticizing and detecting/correcting errors. This provides an incomplete, quasi-behaviourist explanation to the intra-individual and external interactions within the CyberPark hybrid environment.

The same authors discuss theories that focus on Social–Personal Interaction considering learners who navigate through hybrid environments and through their own personal networks. Learning in Cyberparks can be considered as part of the over-arching life-long and life-wide learning, based on Self-Determined Learning (SDL), an approach in which learners take control of their own learning processes and experiences through self-management, self-monitoring and extension of their own learning, Tan *et al* (2011).

Heutagogy is another theoretical framework under the Social-Personal Interaction category, defined as the study of self-determined learning (Hase and Kenyon 2000) and developed as an extension to andragogy, or self-directed learning (Blaschke 2012). According to Blaschke and Hase (in Gros *et al* 2016), compared to androgogy, heutagogy expands further upon the role of human agency in the learning process considering the learner as, "the major agent in their own learning, which occurs as a result of personal experiences," (Hase and Kenyon 2007, p. 112). Key concepts in heutagogy are:

- The teacher / instructor facilitates the learning process by providing guidance and resources, but fully relinquishes ownership of the learning path and process to the learner, who negotiates learning and determines what will be learned and how it will be learned;
- Involves double-loop learning and self-reflection by which learners consider the problem and the

resulting action and outcomes in addition to reflecting upon the problem-solving process and how it influences the learner's own beliefs and actions.
- There is a progression from pedagogy to andragogy to heutagogy, with learners likewise progressing in maturity and autonomy (Canning 2010). More mature learners require less instructor control and course structure and can be more self-directed in their learning, while less mature learners require more instructor guidance and course scaffolding (Canning & Callan 2010).
- Web 2.0 design supports a heutagogical approach by allowing learners to direct and determine their learning path and by enabling them to take an active rather than passive role in their individual learning experiences.

The last category of Post-Net Networked Systems proposed by Gros *et al* (2016) are theories focused on the Affordances or Design of the Network. They discuss the Learning as a Network (LaaN) theory that represents a theoretical framework for Personal Learning Environment (PLE) models which is an emerging concept and a new vision of learning inspired by constructivist and connectivist learning models that put the learner at the centre and provides more autonomy and control over the learning experience. According to Chatti et al. (2007) a PLE is a more natural and learner-centric pedagogical strategy that takes a small piece, loosely joined approach, characterized by the freeform use of a set of learner-controlled tools and the bottom-up creation of knowledge ecologies. LaaN views knowledge as a personal network and represents a knowledge ecological approach to learning. In line with other learning and social theories, LaaN considers learning as inherently social and that a learner needs to be a good knowledge networker as well as a good double-loop learner. Thus one can create and maintain an external network by identifying, integrating and elaborating knowledge nodes that can help to achieve better results, in a specific learning context. As a double-loop learner, one develops the ability to detect and correct errors and eventually change the theories-in-use according to the new setting.

In summary, each of these pre or post-net theories of learning can contribute in part or more holistically to emerging pedagogies that guide learners in contexts like cyberparks. In turn such pedagogies direct the design of any prescribed learning activities, together with the assessment and evaluation of formal or informal learning in the hybrid, networked and smart CyberParks environment.

Implications for Learning

Learning in Cyberparks is a composite experience integrating learning principles derived from the various pre and post-net theories. The design of prescribed learning activities making part of a learning journey is guided by Associative learning focussing on the achievement of identified learning outcomes and guiding the learner to progress through component concepts or skills by providing clear learning goals. The design provides a detailed categorisation of tasks that enables learners to adopt individualized pathways which provide constant feedback to match learning path with performance.

Constructivist approaches, evident in exploratory activities, give particular attention to how learning opportunities are presented so as to allow progressive discovery of relevant concepts or skills. Ownership of the task is achieved by emphasising the active construction and integration of concepts while solving Ill-structured problems through reflection. An interactive and appropriately challenging learning context encourages experimentation and the discovery of principles through cognitive scaffolding, experiential, experimental, problem-based and research-based learning. The learning context should also provide coaching and modelling of metacognitive skills including reflection, self-evaluation, learning management and autonomy. Credit should be given to both processes as well as outcomes and to varieties of excellence. Similarly, social constructivist approaches should be designed to promote conceptual development drawing on existing concepts through collaborative activity involving Ill-structured problems that provide ample opportunities for discussion and reflection. Such collaborative environments provide shared ownership of the tasks with appropriate challenges, encourage experimentation and shared discovery. Social-constructivist environments should also provide coaching and modelling of skills including social skills, emphasise process and participation as well as outcomes, credit varieties of excellence, develop peer-evaluation and shared responsibility.

Learning in Situated, authentic contexts, evident in any ‘Communities of Practice’ related to a CyberPark, promotes active participation in social enquiry through which learners acquire the habits, attitudes, values and skills in context. They also develop identities in relation to learning and professional relationships and networks. Thus the learning context encourages participation, supports the development of identities, facilitates learning dialogues and relationships, and elaborate authentic opportunities for learning. Participation and peer involvement should be credited and performance extended to a variety of contexts emphasising authenticity of practice considering the values, beliefs and competencies of the ‘Community of Practice’.

The dual-task cost theory from Cognitive Neuroscience emphasises that learning activities should consider the availability of brain resources and avoid over-demanding situations involving combined resource allocation for motor and cognitive processing as both processes will become less efficient. So, in CyberParks, learning activities mediated through technology should be designed to separate cognitive processing from physical motor activity.

Connectivist learning, evident when CyberPark users interact in on-line environments, is a process of connecting specialized nodes or information sources both in human minds or non-human appliances. The capacity to know more is more critical than what is currently known so the main emphasis is on nurturing and maintaining connections and thus develop the core skill and ability to see connections between fields, ideas and concepts. The main objective of connectivist learning is information and knowledge currency so special emphasis is made on accuracy and up-to-date knowledge. Since decision-making is considered itself a learning process, choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality – today’s right answer will be wrong tomorrow due to alterations in the information climate affecting the decision. Thus the learning context should point to the diversity of opinions in knowledge, encourage linking of content of learning activities to information sources and expert opinion, while pointing out to the importance of on-line knowledge, experience and expertise. Emphasis is made on assessing currency of knowledge, competence in interactional decision-making and on attitude to the transient nature of knowledge and learning.

Downes (2005) outlines conceptual factors of connectivist experiences (reiterated by Siemens, 2006), which can guide the design of smart learning activities. These are:

- Diversity - based a learning activity on the widest possible spectrum of points of view;
- Autonomy - having learner-centric interactions according to their own knowledge, values and decisions, and not reacting to some external agency;
- Interactivity - creating knowledge as an outcome of social interaction;
- Openness - based on a mechanism that allows a given perspective to be entered into the system, to be heard and interacted with by others.

In Self-Determined Learning learners’ motivation and commitment to learning are enhanced by providing opportunities to establish and control one’s own learning objectives, by directing and monitoring the associated educational tasks and by promoting interaction between the different components. This personalisation and agency in learning is a key characteristic of smart learning that can be evident in Cyberparks. In line with heutagogy, learners should be guided to determine what will be learned and how it will be learned through a double-loop learning approach that includes reflection-in-action and reflection-on-action. The learning activity should be customised through the use of digital tools. In line with LAAN Personal Learning Environments are created to act as connection hubs for personalized learning experiences. The learning process is modelled to help learners build their personal knowledge network within technology-enhanced open environments that promote networking, inquiry, experimentation and that empower learners to create connections, see patterns, reflect, (self)-criticize, detect and correct errors, test, challenge and eventually change one's theories-in-use, Chatti (2013).

The above review of relevant learning theories and similar ones such as those carried out by Dron & Anderson (2014) and Gros *et al.* (2016) identify key pedagogical factors that are at play in technology-enhanced learning environments. For Gros *et al*. (2016:17) effective and emerging pedagogies support life-long and life-wide learning, support valued forms of knowledge (ecologies of learning), recognize the importance of prior experience and learning, and scaffold learning especially through the use of technology as mindtools. Assessment has to be congruent with learning thus changing the role of the teacher and learners. Active engagement of the learner is promoted through self-regulation, co-regulation and social share regulation so that deep learning tasks are made available comprising both individual and social processes and outcomes. Informal learning is considered as a significant component of a pedagogical experience- based on socio-constructivist approaches that depend on the learning of all those who support the learning of others. Combining these principles with the Connectivist ones discussed above, a pedagogical model for describing and possibly evaluating learning experiences in CyberParks will be proposed in the next section.

A Pedagogical Model for CyberParks

With such a wide range of perspectives on learning it is important to established a relevant understanding of the term 'pedagogy'. The standard definition of pedagogy as the 'art and science of teaching' is criticised for not giving due importance to learning and learner-centred environments which in a knowledge society should be the main focus. In line with the etymological meaning, Beetham & Sharpe (2007) defined pedagogy in terms of the original sense of leading or guiding to learn. Actually this is manifested as a need that it is not confined to childhood but is applicable to all learner age categories and learning conditions (learning FOR work and learning AT work). So they propose a definition of pedagogy as 'the art and science of guidance for learning' which will be used to describe the modalities of learning in Cyberparks where emerging pedagogies and technologies meet, interact and mutate.

The composite nature of a learning experience in Cyberparks demands a pedagogy that builds on the various learner-centric and post-net learning theories. Kizito (2016) discusses the pedagogical implications for constructivist versus connectivist theories. The former involves the complex interplay among learners' existing knowledge, the social context and the problem to be solved. Connectivist learning activities promote learner interactions resulting in the formation, support and maintenance of technology-supported intra-individual (cognitive and affective) and inter-individual (social) networks, or according to Siemens (2005b) neural networks, concept networks, and external/social networks. These networks develop as an outcome of learner's interactions with the physical environment, with technology and available on-line resources and data, with other learners and with a range of knowledge areas pertinent to a particular learning moment.

For Siemems (2006) and Laurillard (2012) these interactions are more of a conversational nature. Considering post-net theories of learning, knowledge is all about conversation, and conversation has become much more significant in the process of learning in the web 2.0 / 3.0 (semantic web) era than had been prevalent in prior content text-based knowledge systems. Even knowledge and skill acquisition have moved away from the idea of an intra-individual absorptive / constructive process to one where knowledge construction occurs through dialogues. The learner can also now create and contribute to expert knowledge, with "an approach to learning that is based on conversation and interaction, on sharing, creation and participation, on learning not as a separate activity, but rather, as embedded in meaningful activities..." (Downes, 2006). In the process of learning, then, the behaviour of the learner, their agency and participation, along with the affordance and mediation of technology (wifi, GPS, smart devices), is profoundly altered by Web 2.0.

Examples of Smart Pedagogical scenarios in CyberParks

Two key elements that distinguish smart learning from other forms of technology-enhanced learning are personalisation and data richness. Gros (2016) identifies three goals of a smart learning environment - to provide self-learning, self-motivated and personalised services. For Hwang *et al.* (2015) smart learning environment are context-aware, able to offer learners instant and adaptive support and adapt the learner interface and subject contents. Available data in networks have to be identified, analysed and pedagogical decisions taken accordingly. But smart learning does not only involve acquiring or use of data but also data-generation especially in the form of learner responses to specific situations in the learning experience.

Learning experiences in Cyberparks can be formally prescribed, informal or unplanned, or a mix of both. Some are structured as smart learning journeys that enable CyberPark visitors to learn by exploring and interacting with real life contexts. Typically the activity is mediated through smartphones or tablets using relevant mobile apps. The key elements for a learning journey are: locations for learning, suitable mobile apps, interesting and suitable topic/s, good quality learning content, smartphones or tablets that can access WiFi and geo-location networks. A learning journey can be designed with different levels of complexity ranging from a simple (serial) learning journey, or complex learning journeys having complex strands of knowledge and involve many location learning points which may take days or even longer periods to complete. These can even forming part of a wider set of (within and outside class) tasks involving localised and global learners or groups. A game-based learning journey engages learners through playful explorations that provide an adaptive level of challenge by setting time on task or answering correctly set questions to progress to the next location and 'unlock' the next tasks. A 'Mystery' journey might start at one location but progress to the next location will depend on learner's choices at the first location. It is based on discovery and a gaming approach that can take different routes and outcomes.

Bonanno *et al* (2016) describes two smart learning journeys developed as part of the CyberParks eCOST Action (TUI 1306), using Valletta (the capital city of Malta) as context. A simple learning journey was created about a historical event – the attack by the Turks on Senglea point on the 15th of July 1565. Standing on the terrace of the Upper Barraka Gardens in Valletta, learners open their smartphone's camera and point it onto Senglea Point on the other side of the Grand Harbour. A 3-D digital model (of an expert designed physical model) is projected through an Augmented reality function of the Way-Cyberparks App (Pierdicca 2016) through GPS activation. The model is superimposed on the real location and a number of 'Points of Interest' (POI) provide information about the historical event. Learners are given options how to interact with the POIs and with the content of each POI. They are also requested to share their experience and contribute their digital creations (sound / video clips, images, comments).

Another more complex smart learning journey was developed, using also the Way-Cyberparks App, for the Argotti Gardens just outside Valletta. Learners had the possibility to visit GPS-activated 'Points of Interest' that provided learning activities about historical, architectural or botanical aspects of the Gardens. Learners had to share their experience through on-line facilities by send their comments, suggestions and digital creations. A very similar smart learning journey, the Cardeto CyberPark was developed, also within the CyberParks Action, by the Faculty of Agriculture and Engineering, Technical University of the Marche, Ancona, Italy. Using beacons at POI, Smartphone users are prompted for learning activities along a pre-determined route in the Cardetto Natural Park in Ancona, Italy. Learners have to go through various decision points choosing between 'Culture' and 'Nature' options. Culture options include sites or buildings of historical, military or strategic importance. Nature options include locations of Botanical or Zoological importance or sites of natural (coastal) importance. Users can give feedback by rating activity at each POI using a five star scale.

Other smart learning journeys are being designed in an attempt to merge formal and informal learning. A gamified geo-tagged learning experience about the eight Auberges of the Knights of Malta in Valletta is being designed to be used both with school students in specific History topics and with tourists visiting Valletta. Another smart learning journey, using only on-line Apps and resources, is being designed to how the evolution of 'Democracy' as documented through the ages in the architecture of the main street in Valletta. Besides prescribed content in identified 'Points of Interest' along this street, learners will be provided with the opportunity to interact with colleague learners, experts, on-line knowledge nodes and resources. They will be asked to share their experience and contribute data and content.

Thus one can consider a learning experience in a CyberPark made up of different conversational moments when a learner interacts with prescribed knowledge (for example at a geo-tagged 'Point of Interest') to understand better the history or architecture of a particular location / building. In this case associative learning principles come into play to provide the best mode of interaction with knowledge categories resulting in cognitive-affective residues within neural networks. In such data-rich networked environments learners can acquire, not only text-book type prescribed static information but knowledge embedded in network nodes and that provided by experts or other knowledgeable persons. A moment of knowledge acquisition may be followed by personal reflection linking to further information or data which can be shared with others. But it can also lead to further on-line interaction involving other knowledge nodes, peers or experts participating in on-line discussions sharing and supporting others' comments. At other moments the person may be contributing comments, reflections and (media) creations as a direct outcome of the ad hoc physical experience in the Cyberpark which may be complemented by interaction with available on-line data and streamed information. Some moments later the person may be involved in generating data in various modalities such as liking, tagging, commenting, taking and uploading images, sound or video clips. So a pedagogical model to guide this extremely fluid, transient, evolving yet immersive experience has to capture the various dimensions and levels of learner interactions.

Bonanno (2011, 2014) uses a process-oriented model based on dimensions and levels of interactions for designing ubiquitous learning experiences and learning within Social Networking environments such as Edmodo. The dimensions of interactions are the subject/knowledge domain, the technology, the data networks and the community. For learning in Cyberparks, this model can be extended by including another dimension of interactions – the physical environment.

Building on the Connectivist notion that knowledge is distributed across networks of connections, Wang *et al* (2014) developed a pedagogical model based on the characteristics and principles of interaction in complex connectivist (on-line) learning contexts. These researchers identified three categories of connectivist learning activities: personal knowledge acquisition from networked distributed knowledge, social networked learning by building communities that form a network for knowledge sharing and connection; and complex connectivist learning where learners prompt connection building and network formulation by contributing to distributed knowledge, to decision making related to complex problems, and the development of technological and pedagogical innovations. Further to Wagner (1994), Wang *et al* (2014) maintain that interaction includes the possibility of "reciprocal events" (requiring at least two objects and two actions) between humans and machines, which is an important construct in connectivist learning. Interaction between humans and technologies evolved according to the affordances of the technology at hand but with the event of social media and Web 2.0 technology, social interaction has become a much discussed topic in connected learning environments. The focus is on interaction design, analysis, evaluation, enhanced strategies and their influence on learners' satisfaction, and learning performances in different social interaction contexts.

Researchers about on-line / distance learning identified dimensions of interactions according to technological affordances. These include student-teacher, student-student, student-content interactions (Moore 1989); student-interface interaction as a fourth interaction (Hillman, *et al.*, 1994); teacher-teacher, teacher-content, and content-content interactions (Anderson & Garrison, 1998). Web 2.0 and social technologies promoted the social constructivist dimension so that various forms of interpersonal interaction were added – group-content, group-group, learner-group, and teacher-group (Dron, 2007); learner-content, learner-technology, learner-community (Bonanno 2011, 2014). Connectivist pedagogy, with its emphasis on the development and nurturing of networks as a major component of learning extended the interaction possibilities to include groups, sets and networks (Dron & Anderson, 2014).

Besides dimensions, researchers considered also levels of interaction such as learner-self, learner-resource (human and nonhuman), and a meta level learner-instruction interaction which guides the previous two types (Hirumi, 2002); operation interaction, information interaction, and concept interaction, from simple to complex and concrete to abstract (Chen 2004); learner-content, learner-interface, learner-support, learner-learner, and learner-context (Ally, 2004); pedagogical levels of Acquisition, Participation and Contribution according to novice, experienced and expert competence levels in the domain, technology and community dimensions (Bonanno 2011, 2014).

Building on this research about dimensions and levels of interaction researchers developed pedagogical models to facilitate the design, assessment and evaluation of learning in technology-enhanced contexts. Chen (2004) developed the Hierarchical Model for Instructional Interaction (HMII) in a distance learning context, based on Laurillard's conversation framework. According to this model three levels of interactions are manifested by learners that shift from concrete to abstract and from low to high levels. The most concrete level is operation interaction, in which the learner operates different media and is interacting with the media interface. For technology-enhanced learning in any context this is a critical level of interactions on which the other levels depend. The second level is information interaction, which includes learner-teacher, learner-learner, and learner-content interactions. The third level, involving concept interaction, is the most abstract one, and includes intra-individual cognitive and affective interactions that form neural networks. These three levels of interaction can occur simultaneously and recursively and are hierarchical with the operation interaction serving as the foundation of information interaction, while information interaction is the foundation of concept interaction. For Chen the higher the level, the more critical it is to the achievement of learning objectives so that only concept interaction leads to meaningful learning.

In connectivist, networked environments the nature of knowledge (fluid, complex, emerging) and its acquisition (in information-loaded environments) contrasts strongly with that of traditional, formal learning contexts (that is well-structured, with content and defined learning resources, activities, and fixed technological platforms). It is important for learners to realize how to orientate themselves in such complex information contexts, and to filter, integrate, and extract information so as to make it coherent and understandable (Siemens, 2011). Siemens proposed two means of information interaction and orientation in such complex online learning environments: wayfinding (orienting oneself spatially through the use of symbols, landmarks, and environmental cues) and sensemaking (behaviours shown in response to uncertainty, complex topics, or in changing settings).

The third level of HMII, concept interaction stimulates the deepest cognitive engagement which in connectivist learning is creation or innovation interaction a process of knowledge creation and growth (Downes, 2012). 'It includes the presentation and expression of new ideas, solutions, theories, and models through creation of new learning artefacts individually or collaboratively for further connection building. It is mainly combined with learner-content interaction, but in collaborative and formal learning environments, learner-learner, and learner-teacher interactions are also important (Wang *et al* 2014:5).

Merging Downes (2012) concept of 'Innovation Interaction' with Bloom's revised taxonomy (Anderson *et al*., 2000) that moves from remembering to understanding, applying, analysing, evaluating, and creating as cognitive processes, Wang *et al* (2014) superimpose four interaction levels onto the HMII. These are
Operation interaction, Wayfinding interaction, Sensemaking interaction and Innovation interaction. In Operation interaction learners merely practice and remember how to operate various media to build their own learning spaces. In Wayfinding interaction, learners have to master the ways to navigate in a complex information environment and connect with different human and nonhuman resources, so they have to reach

higher levels of understanding, applying, and evaluating information and connection formed in this process. Sensemaking is a pattern recognition process, mainly involving applying, analysing, and evaluating information. Innovation interaction focuses on the expression of ideas, models, or theory by artefact creation and innovation to enhance and build new social, technological, and informational connections. It thus engages learners at the deepest, creation level of Bloom's revised taxonomy.

Another process-oriented pedagogical model proposed by Bonanno (2011, 2014) integrates interactions along three dimensions (Domain, Technology and Community) within three pedagogical levels of interaction (Acquisition, Participation and Contribution). This can be represented in a grid as:

Levels	**Dimensions**		
	Domain	Technology	Community
Acquisition			
Participation			
Contribution			

The Acquisition level is similar to Wang *et al* (2014) 'Operation Interaction' dealing with basic interactional skills in the domain (information categorisation), surface structure of digital tools and interpersonal interactional skills. The Participation level links to the information interaction level comprising Wayfinding and Sensemaking within the domain, with technology and within the learning community. The Contribution level is identical to Concept interaction and innovation interaction as it deals with learners creations within the three domains.

Both these models were developed to consider interactions in on-line learning environments so that these do not capture all the dimensions of interactions that characterise technology-enhanced, networked physical environments like CyberParks. Interactions of the different agents (persons, technology, data) with the physical environments are not considered. To address this shortcoming a fourth dimension – the Physical environment - is introduced in this proposed process-oriented model. Another dimension – data – is being added considering CyberParks as smart learning environments characterised by the utilisation and generation of data. Thus to have a more comprehensive coverage of the possible interactions in a CyberPark, the two models are merged into one that is outlined in the following grid:

Levels	**Dimesions**				
	Physical Environment	***Domain***	***Technology***	***Data / knowledge networks***	***Community***
Operation interaction	Determining interactional potential of different areas of the Cyberpark	Defining a domain-related PLE	Promoting digital & info competencies. Developing effective HCI strategies.	Identify data sources relevant to PLE.	Nurturing interpersonal interactional skills within dyads, groups, sets & networks.
Wayfinding	Connecting specialized nodes or information sources related to CyberPark	Connecting key domain info and knowledge nodes to the different aspects of the	Using digital tools that mediate learner connection with info, knowledge,	Connecting to relevant data sources	Connecting with key people Identification of key features of mature identity.

		Cyberpark	resources and relevant people		
Sensemaking	Negotiation & Argumentation of understanding of the different aspects of CyberPark	Negotiation & Argumentation of domain related knowledge; development of an interdisciplinary knowledge structure	Linking technological affordances to learning modes	Developing an organisational network of data sources, data types and data capturing devices.	Identity development; dialogic space analysis and expansion.
Innovation Interaction	Re-design of CyberPark to address citizen evolving needs	Renovation of domain knowledge relevant to CyberParks	Customise tools to interact in new ways with the hybrid environment	Generating data through creation of digital artefacts.	Renovate and extend users' social networks and digital footprint.

This model captures most of the interactional possibilities that can take place in a CyberPark and can be used to design smart learning activities or to evaluate learning instances. At the basic level of learning interactions, *operational interactions* are possible in all five dimensions to build interaction spaces or a Personal Learning Environment (PLE) that merges knowledge and skill competence in different aspects of CyberParks. Changing the physical environment into a PLE implies getting to know the interactional potential of each section / area of the place and linking these to ad hoc learning strategies. A plan for a smart learning journey, indicating relevant buildings, spaces or areas and any associated 'points of interests' facilitates operational interactions in the physical environment. A PLE can be created in a particular domain relevant to any aspect of the CyberPark, whether History, Architecture, Engineering, Science or Humanities. This will involve identifying resources, support structures involving peer learners, experienced persons or experts, together with learning strategies that can be adopted ranging from instructional, exploratory, gamified, design-oriented or collaborative. Further to Wang *et al* (2014) Operational interaction is also a process of learners connecting with different technologies through learner-interface interaction to support their further learning, for connecting with different knowledge and opportunities, and for bridging learning across multiple learning and living contexts. Typical actions showing operational interactions with technology for various goals include play, download, search, read, view, listen and buy. Also learners attempt to integrate other social and network-based media into their PLEs and connect with different groups of people and information, and to change their sensemaking behaviours so that a collective distributed technological network is formed in this process. In data rich environments operational interactions enable smartphone users to connect with different data sources after rationalising relevant mobile or App interfaces to obtain (and possibly contribute) data related to their learning endeavours and PLE. Along the Community dimension interpersonal interactional skills have to be developed both with contiguous groups and on-line groups, sets and networks developing operational competence with any communication or social networking tools used.

Wayfinding Interaction involves finding the right information and people and then connecting specialized nodes or information sources and people. Thus information about different sections of the physical environment are identified and made available for access. People or special interest groups related to the different areas are also identified, organising their means of contact. Learner-content interaction and learner-group interaction are also carried out within any field of knowledge related to the CyberPark, or any part of it, thus elaborating the relevant knowledge web, the learning community and the social networks. This linking and organisational approach is applied to any available or generated data. Typical wayfinding interactions include Imitate, Communicate (Chat, Rate, Comment, Message) and Share (Send Upload, Publish).

'*Sensemaking interaction* is a pattern recognition, information (knowledge) seeking, and a collaborative process that includes information aggregation/sharing, discussion/negotiation, reflection, and decision making,' Wang *et al* (2014:6). During this participatory process, participants bring together concepts from different domains in a novel way (Siemens, 2009), and they achieve a coherent comprehension of information and make decisions quickly. Thus a detailed spatial plan and a global knowledge network are created for integrating the different sections of the CyberPark. This same process of knowledge organisation is carried out in any field of knowledge consulted which in turn are linked to the other fields thus creating a final interdisciplinary knowledge structure. With regards to technology sense making involves linking different digital tools used in various locations in the CyberPark, such as QR code systems, Augmented reality, geo-tagging and gaming into coherent functional system for promoting various modes of learning. Similar patterns are established with regards to data, by creating a bird's eye view of data sources, data types and data capturing devices. Along the community dimension sensemaking interaction manifest itself in the formation, developing and sharing of learners' knowledge networks, network identities and social presence in relation to groups, sets and networks. Techniques of dialogic space analysis based on negotiation of meaning and argumentation are used to analyse community of learning discussions for concept sharing and 'dialogic space expansion' (Wegerif & Yang, 2011). Typical Sensemaking interactions involve different modes of facilitation such as recommend, channel, tag, subscribe, filter and mentor. The outcome of sensemaking interaction are organisational networked patterns connecting tightly together nodes in geophysical, technological, data, social and concept (neural) networks which will eventually form the basis for personal contributions in innovation interaction.

Innovation interaction is the deepest learner content interaction and deepest cognitive engagement of all four of these interaction levels. Highly experienced and competent learners show their knowledge and competence status through contribution, engaging in evaluative and creative activities (Bonanno 2011, 2014). They create (digital) artefacts or elaborate existing ones and share this innovation with others bringing more networking opportunities for the learners through constructing and sharing artefacts on the open network where they are both accessible and persistent (Wang *et al.* 2014:7). CyberParks users can propose new designs or re-designs of the existing space or parts of it, in an attempt to address citizens' evolving needs. Within a field of knowledge, innovation interaction occurs when new knowledge about some particular aspect of the CyberPark is added or modified. It can also take the form of creating or modifying Open Educational Resources relevant to some particular aspect or theme. New digital technologies or applications can be customised and used to interact in new or more elaborate ways with the physical, virtual and social environments including any emerging Apps or location-sensitive digital tools. Besides utilising available networked data, CyberPark users generate new data such as digital multimedia artefacts that help them express themselves and share their ad hoc experience. New tools or elaboration of existing ones can be used to innovate and extend users' social networks and digital footprint. Thus key innovation interaction actions include customise, design, produce, contribute, program, model and evaluate.

This connectivist, process-oriented pedagogical model comprising dimensions and levels of interactions provides the necessary framework to design and assess formal or informal smart learning in Cyberparks. It can capture patterns of interactions characterising different learning instances or learner's progression in extending one's knowledge and social networks. It serves as a fine grained guide in designing or evaluating smart learning for fluid and transient context as in CyberParks. Each square of the grid represents a specific category of interactions that may emerge during activities in a CyberPark or can be used for designing focussed prescribed activities. A learning activity can be designed by identifying the dimension and level of interactions (i.e. determine square from grid) and then develop a learning strategy how to promote those interactions. A learning activity can be developed by combining the interactions from two or more grid squares.

Assessing and Evaluating smart learning in CyberParks

Assessment and evaluation of smart learning in CyberParks is a very challenging endeavour as informal learning is not about assessing set learning outcomes against formal assessment criteria. One has to acknowledge both the aim of developing a competency or skill that a learning activity sets out to achieve, as well as the process by which that aim is achieved (Marton & Booth 1997:119,126). In this context, evaluating learning through examining learning activity effectiveness rather than (only) individual learner assessment can tell us both about learner competencies and additionally about the effectiveness of the activity itself. In other words, by examining the activity in relation to the learner and vice versa, more can be understood about the activity as a whole. This would appear therefore to be an appropriate approach to evaluate the effectiveness of smart learning in CyberParks.

Evaluating smart learning in CyberParks involves evaluating both the activity and the learner. It attempts to answer two different questions: Which patterns of (learning) interactions are shown during an activity in a CyberPark? And 'What do learners in a CyberPark think about interactions making up a learning activity in a CyberPark?' The answer for the first question is a statement about reality and how one orients oneself towards the world, in this case towards CyberParks. The answer to the second question is a statement about people's conception of reality and how one orients oneself towards people's ideas about the world (or about their experience of it. Marton (1981) calls the former a 'first order' and the latter a second-order perspective, claims that both perspectives are complementary and thus advocates the use of both. The first question is answered through quantitative methodologies considering the type and frequency of interactions. The second question is answered through qualitative means, such as Phenomenography.

A learning activity in a CyberPark can be assessed using the model proposed above by creating an interactions profile for a particular activity or instance in a CyberPark. The dimension or dimensions of interactions have to be identified. Questions that guide this assessment include:

- Which dimension/s of interaction is/are involved in this activity?
- Which level/s of interaction is/are evident in this the activity?
  Is the interaction repeated over time? Can you determine the frequency of this interaction?
- Can you establish the direction of the interaction? Is the learner interacting with one or more than one node in a network?
- Is it possible to develop a pattern for interacting with different nodes?
- Is the learner interacting with only one other learner or with more? Is it possible to develop an interaction pattern identifying the originator and the receiver of the interaction? Is it possible to develop a final pattern showing originators, receivers, repliers and non-responsive nodes?

In a connectivist, smart learning environment the metrics of an activity are the type, frequency, duration and direction of interactions (Bonanno 2015). An activity involving interactions solely within the domain dimension is quantitatively and qualitatively different from one with interactions along the domain, the physical environment, technology and other learners or experts. Also manifesting one instance of negotiation or argumentation interactions is different from showing repeated interactions of this type. Interacting with a number of colleagues or experts is valued much more than repeated interactions with only one person. In group interactions one can also quantify the action categories – the originator, receiver, replier, unresponsive. An interaction pattern for an activity, a single learner or a group of learners can be developed and compared to established standards of interaction. The pedagogical value of an activity can be quantified by creating a composite interaction pattern that merges the interaction patterns developed for the different dimensions or those developed for the different levels of interaction. Comparison of these composite interaction patterns can provide a metric for determining learning effectiveness.

Phenomenography is a suitable methodology for evaluating the second order perspective of learning, that is, learning effectiveness in relation to learner experiences. Through inductive analysis of learning experiences for each learner and grouping areas of variation into outcome spaces, it seeks to establish an architecture of the variation of approaches to learning that lead to deeper or surface learning. It does not seek to develop a singular essence of the nature of learning, but is 'a second order perspective' (Marton, 1981), seeking to establish how people experience learning, and the variation of those experiences. In this sense, examining how learners experience learning in smart environments can be evaluated in terms of the variation of learner experiences. A greater understanding of differences in learning approach can assist learning and teaching practice in the fluid and flexible learning contexts that might be expected in smart learning. Thus discussing with learners their experience in a CyberPark one can lead to the identification of areas of variation into outcome spaces. Adopting an interactions approach questions that can guide this introspective exploration include:

What do you think about interactions shown during an activity in a CyberPark?

More specific questions could be:

- What did you think / feel while visiting the CyberPark or any part of it?
- What were your thoughts / feeling when considering the different areas of knowledge relevant to the different sections or activities in a CyberPark?
- What was your experience when using digital technologies in the CyberPark?
- Comment of your experience about any data you received in your smartphone or Apps? What was your experience when Liking, Chatting, Rating, Commenting or Messaging?
- What were your thoughts and feelings when communicating and sharing with others your experience in the CyberPark?

The responses to these questions have to be captured through a medium (script, audio, video) and content analysed for key themes that describe learner's thinking, feelings or behaviours. Another possibility is to analyse responses according to the levels of interaction described in the proposed model - Operation interaction, Wayfinding, Sensemaking, and Innovation Interaction. The effectiveness of a learner's experience can be gauged from the range of themes / keywords considered and the frequency for each theme. When using the 'levels of interaction' approach, the frequency of reference to any particular interactional level indicates the hierarchical rank of the learning experience. Learning effectiveness can be determine by a shift from lower to higher levels of interaction.

Conclusion: Developing adaptive expertise

In the post-net era there is a need to re-think what learning and pedagogy mean. The emergence of totally new technology-enhanced and transformed environments develops new ways of conceptualising learning, pedagogy and education. Gros *et al* (2016:8) suggest that 'Employing emerging technologies to further educational goals may necessitate the development of different theories, pedagogies and approaches to teaching, learning, assessment and organisation. Instead of applying established generic pedagogical principles to emerging technology-rich contexts, we have to adopt a diametrically opposite approach – developing pedagogies for these merging environments. Anderson (2009) uses the metaphor of dance to explain the relationship and interaction between pedagogy and technology - Pedagogies and technologies are intertwined in a dance, where the moves of one determine the moves of the other. Cyberparks can serve as emergent hybrid environments where people, spaces, technology and purpose create the movement and rhythm of the dance. Gros *et al.* (2016) claim that the use of emerging technologies in learning contexts should lead to experimentation with different lenses through which to view the world and the way learners interact with it.

After reviewing key theories of learning and defining pedagogy in terms relevant to the current hybrid reality, this chapter reviewed process-oriented pedagogical models relevant to networked learning environments. Subsequently, a pedagogical model was proposed to guide our learning concepts in

CyberParks to serve as a transient theoretical lens and a temporary practical guide for rationalising and understanding learner experience in CyberParks. This model analysed learning in CyberParks considering dimensions and levels of interactions whose intersection gives rise to a range of interactional possibilities forming part of the learning experience in CyberParks. More than serving as a static instrument to fit and analyse learners' experience in CyberParks, this model should serve as a signpost in the process of developing adaptive expertise. Gros *et al* (2016:15) claim that 'all the components of emerging pedagogies including technology, pedagogy, content and society are evolving, educators need to develop adaptive expertise to understand how these components interplay with and influence their own practices'. This model should serve as a point of departure in addressing the continual challenge to develop new pedagogies and innovative uses of technologies to fulfil the evolving needs and expectations of learners in specific contexts like CyberParks.

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