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Understanding experience complexity in a smart learning journey

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Abstract
This paper contributes to a pedagogical model for smart learning by establishing a framework of some considerations based on learner experience of smart learning journeys. Phenomenography is used to investigate variation of learner experience in smart learning journeys. Learners participate in 'Literary London', situated in London, UK, and 'Malta Democracy', situated in Valletta, Malta. An inclusive relational hierarchy of experience complexity is demonstrated with vertical, horizontal and diagonal relationships between four categories of experience variation for a smart learning journey. A pedagogical relevance structure for smart learning is discussed, supporting connectivist-inspired participatory pedagogies for smart learning environments. Sample participants consist of Education degree university students, with one other discipline represented (English Literature and Creative Writing). Various levels of study, cultural and international backgrounds are represented. Understanding learner experience of these kinds of activities may help to support today's growing culture of learning cities, to "promote lifelong learning opportunities for all" (Unesco SDG4), within a context of the European Commission 2018 Digital Competence Framework for Citizens.

Keywords: phenomenography, smart learning, smart pedagogy, connectivism, participation, learner experience

Introduction
This paper discusses pedagogical factors of interest relating to smart learning and smart learning environments. Research investigated how participants experience a smart learning journey, that is, a smart learning activity comprised of a series of hyperlocal (Carroll et al. 2017) authentic locations connected by a topic of interest that together form a journey of learning in the real world, mediated by digital augmentation interactions. Areas of interest were in possible measurement of effective learning and the potential usefulness of connectivist principles in these types of smart learning activities. Research was devised as a complementary pedagogical investigation to the COST funded CyberParks[1] research project (Bonanno et al., 2019).

Smart learning in this paper is considered as a ubiquitous computing immersive learning environment (Dunleavy, Dede & Mitchell, 2009), where technology and environment act to enhance and support participatory and collaborative learning. Autonomous connectivist-inspired learning strategies were considered most appropriate as a basis for this kind of learning experience (Lister, 2018, p. 3). Connectivism, as a 'theory for the digital age' (Siemens, 2005), is referred to by Henning as the "first genuine 21st century model of learning" (2018, p. 281), and attempts to account for the processes and behaviours that are present in the agency, mode and mediation of learning in new digitally connected spheres. The interpretation of connectivist-inspired learning strategies in the context of this research was of technological solutions that did not rely on

[1] CyberParks project http://cyberparks-project.eu/

enterprise level smart city technology implementations, rather, were free and available to anyone with a smartphone, and would provide the autonomy that connectivism envisages. HP Reveal[2], Edmodo[3], together with the free mapping app Google MyMaps[4] permitted the author and others involved as creators and implementers of these learning experiences to have control over what was developed. The approach was therefore connectivist for both the learning facilitators as well as the learners themselves.

Literature Review

Smart learning and smart environments

Smart learning is intertwined with smart learning environments, with key texts nominated here to outline these concepts for the purposes of discussion in this paper. Spector's (2014) description of a smart learning environment that "might include features to promote engagement, effectiveness and efficiency" (2014, p. 2) of learning is a useful benchmark, without associating specific technological implementation to it. He describes further aspects concerning collaboration, knowledge and learning, the importance of place and the role of technology to indicate elements that form support for this environment which in turn help to indicate 'critical aspects' (Edwards, 2005) of a smart learning activity in this study. Dron (2018) emphasises the purpose of smart learning environments to learn and teach effectively, discussing how intrinsic and extrinsic motivation (2018, p. 11) play a crucial role in any learning participation. Motivation is further investigated here as part of a pedagogical 'structure of relevance' (Marton & Booth, 1997) for smart learning, considering the experiences of participants in smart learning journeys and the engagement of young people towards smart learning as a concept. Motivational relevance is argued as potentially integral to any connectivist pedagogical autonomy in smart learning design and planning.

Future-Present Smart Learning and Teaching

Learning journeys set in real world places are not new, as location based and mobile learning pedagogies testify (e.g. Brown, 2010, Cook, 2010). These pedagogies are loosely concerned with 'anytime anywhere' learning, often focusing on learning at work, or citizen informal learning based inquiry. Smart learning journey activities build on these earlier investigations, to further constitute pedagogies for learning in digitally augmented real world environments, attempting to offer the "better, faster learning" of Koper (2014). Digital augmentation of local features can accurately provide context-aware content and learning, yet are controlled by the learner autonomously, so are more able to respond to learning opportunities and interactions at that time and place, in the "bottom up, piecemeal manner" that Dron alludes to (2018, p. 3). While digital personalisation of content and interactions are often considered vital components of smart learning (e.g. Koper, 2014, Hwang, 2014), this might not always benefit the learner, as "the presence of smartness within an environment does not necessarily or even normally lead to smartness of that environment" (Dron, 2018, p. 3). Additionally, acknowledging drawbacks of intelligent content delivery based on simple commercial models (e.g. Kop, 2012), or issues of data privacy and governance (e.g. Williamson, 2015) are relevant to the use-case experiences of learners in smart learning, these are not

[2] HP Reveal (formerly Aurasma) app https://www.hpreveal.com/
[3] Edmodo app https://www.edmodo.com
[4] Google MyMaps https://www.google.com/mymaps

emphasized in this paper. Here, focus is on supporting learner experience through emerging pedagogies.

As technological capability develops, augmentation of real world spaces to access contextually relevant information is becoming more standardized, with new functionality like Google Lens[5] already being added to standard camera functions in smartphones[6]. Investigating these kinds of autonomous augmented reality interactions with real world surroundings is therefore considered a timely investigation of *future-present* (Husman & Lens, 1999) learning, building understanding for what might be 'just around the corner' as commonplace functionality in personal smartphone devices. Ireland & Johnson (1995) argue that investigating the future in the present can be achieved by 'Applied Exploration', "(t)o anticipate future needs, researchers must create conditions in which designers and developers can *observe the future in the present*" (their emphasis) (1995, p. 59). This study seeks to achieve this, even though it is acknowledged that technology used is somewhat rudimentary, it achieves the idea of interacting digitally with real world location features by providing augmented triggers to access context-aware content. Ireland & Johnson provide a complementary perspective to the phenomenographic approach (Marton, 1981, Bowden, 2005) of stepping into the lifeworld (Ashworth & Lucas, 2000, p. 307) of the learner. By investigating this lifeworld, we gain understanding of individual learner experiences of an activity, which are further examined at collective level.

Methodology and research design

As examining learner experience was central to the investigation, phenomenography (Marton, 1981) was chosen as the methodology of the research. Two related fields of inquiry demonstrate the benefit of phenomenography in similar territories: technology enhanced learning (e.g. Edwards, 2005, Booth, 2008, Koole, 2012, Souleles et al., 2014, Cutajar, 2017), and user experience (e.g. Kaapu & Tiainen, 2009, 2010, Zoltowski et al., 2012). These fields have increasingly looked to phenomenography to understand more about what users and learners do and why they do it. Phenomenography analyses learner experience at collective level, looking at experience variation itself rather than the individual context, though context is retained. Phenomenography draws on Gurwitsch's (1964, 2010) ideas about theme, thematic field and margin to analyse experience using a 'structure of awareness' analytical framework (Cope, 2002). Known as a second order perspective (Marton, 1981, p. 2), phenomenography is non-dualist in nature, making an epistemological assumption that there is only one world as experienced by the learner, "where there is an internal relation between the inner world and the outer world" (Ireland et al., 2009). Here we are not concerned with ontological discussions of reality, or of the essence of a phenomenon (Marton & Booth, 1997, p. 117), but rather only the reality concerning phenomena of interest to the research as experienced by individuals being researched.

Sample

The sample was purposive and convenience (Reed, 2006, p. 6, Edwards, 2005, p. 22, Souleles et al., 2014, p.4), recruiting 24 undergraduate and postgraduate participants on a voluntary basis, including cohorts from several education-related degrees based at University of Malta, and an additional cohort from London Metropolitan University studying English Literature and Creative Writing.

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[5] Google Lens https://lens.google.com/
[6] Google Lens development and reach https://en.wikipedia.org/wiki/Google_Lens

Smart learning in this study

Smart learning in this study is conceptualized as a smart learning journey, that is, as a learning activity designed to mainly take place *outside* in the real world. Employing digital augmented reality technology to augment specific features of locations, context-aware learning content, participative learning tasks and opportunity for location-based interactions can be effectively provided to the learner at that time and place. Within a connectivist inspired scope, HP Reveal, Edmodo and Google MyMaps were used to mediate learning interactions and a route of locations that together form the journey. Learning content is hyperlinked from knowledge sources such as Wikipedia[7], Wikimedia Commons[8] or specialist websites, with some content created by tutors and hosted on independent webpages[9]. Two location settings were used for smart learning journeys: London, UK and Valletta, Malta. 'Literary London', approximately 2.5 kilometres long, focused on locations around St Paul's Cathedral and the City of London, and 'Malta Democracy', around 600 metres long, focused on locations along Republic Street, the main thoroughfare in the centre of Valletta. These locations are rich in cultural history and heritage, permitting a tutor to provide a learning experience supported with multiple authentic sites. This gives the learner real-world examples that encourage a direct, creative and critical participation within an autonomous activity largely controlled by them. This attempts to support Dron, who "consider(s) smartness as an emergent consequence of dynamic interactions between the environment's constituent parts, including those of its human inhabitants and the artefacts and structures they wittingly or unwittingly create." (2018, p. 3).

Participating in a smart learning journey was autonomous, learners could decide when, where and how much of the journey they participated in. Tasks involved were informal, using a creative participatory pedagogy to encourage full interactivity at time and place, as well as afterwards or even before going on the journey. Learners were required to create content – photographs or videos, comments and commentary – and post them in an Edmodo class area, relevant to tasks and locations. None of the participation or content was formally assessed in any way.

Emerging categories of experience variation

Adopting the methodology of phenomenography (Marton, 1981), emerging categories of variation for an outcome space (e.g. Reed, 2006, p. 8, Larsson & Holmström, 2007, p. 56) of 'experiencing a smart learning journey' were formulated. This outcome space looked for units of meaning (Reed, 2006, Marton & Pong, 2005) for the activity *as a whole*, noting commonalities and difference variation across the collective set of experience transcripts. These develop a set of relational, inclusive categories that may have some hierarchical relationship to each other. Of a total of 24 interview transcripts (duration 35 to 60 minutes), initial analysis was carried out for the first 15 participants so that additional analysis of a further 9 transcripts can confirm or challenge the initially formulated categories of variation (Taylor & Cope, 2007). Phenomenography does not require large amounts of data, only sufficient to permit the widest possible (or likely) variation of experience to be found (Yates et al., 2012, p. 8). In this study, taking into account practical limitations as well as iterative estimation for different variations to emerge, 24 participants were

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[7] Wikipedia https://www.wikipedia.org/
[8] Wikimedia Commons https://commons.wikimedia.org/
[9] Smart Learning research website http://smartlearning.netfarms.eu/

considered sufficient, giving a snapshot of variation (Trigwell, 2000, Jarrett & Light, 2018) that included different demographics and subject disciplines.

Phenomenographic analysis began with simple open coding of transcript data, including almost all utterances, allowing data to be managed more efficiently for utterances to be further categorised. Edwards (2005), Cope & Taylor (2007), Cope (2002) and Sjöström & Dahlgren (2002) act as guide to find units of meaning and dimensions of experience variation, using factors such as frequency and significance for levels of presence and complexity. Selecting units of meaning is achieved by repeated reading of the transcript data, attempting to find the meaning of experiences for each individual that might be reflected in the collective as different dimensions of the same thing.

Exploring early categories of experience variation

Emergent relational, partially inclusive categories are shown in Table 1. These indicate explicitly different ways that a smart learning activity might be experienced, as a structure of awareness for the activity as a whole. (For the sake of space here, transcript quotes demonstrating these categories are not included but are included in other reporting of this research.)

Examining primary 'Dimensions of Variation' (PDoV) for structural (internal and external horizon) and referential (meaning) aspects within each category, a 'pedagogical relevance structure' is emerging. Factors range from closely related to coursework requirements of the study unit, motivation and relevance to topic area of study and future working life, a range of personal interests, interest in the topic of the journey, the significance of place and time to participate, perception of the activity itself, and other social and collaborative factors that are sometimes disconnected from study factors. Some of this focus indicates Marton & Booth's 'global aspects of learning' (1997, p. 141), with issues such as 'having to do it', role or direct impact in assigned and assessed coursework, or implications for future life.

Table 1 Experiencing a smart learning journey, structure of awareness category descriptions

CATEGORY OF DESCRIPTION	**STRUCTURE OF AWARENESS**		
Primary Dimension of Variation *Indicated by collective frequency/ position/ pregnancy, denoting 'category status'*	**REFERENTIAL:** meaning, reasoning, focus (theme)	**INTERNAL:** the theme; 'near' thematic field	**EXTERNAL:** further thematic field into the margin
PDoV A Obligation Obligation Requirements	'What we had to do'; what is required	Doing the tasks; obligations, requirements, assignment, coursework	Relevance to own work, 'being marked', usefulness, reason to do it, time needed or set aside
PDoV B Social Discussing Helping Working together Being social	Discussing tasks, things associated with tasks, other things about the location	Working together, help each other, discussing technology, 'who was going to do what', sharing technology, memories	Collaboration to help learning, other social aspects, getting to know each other, other passers by, fun, enjoyment with friends
PDoV C Being there Being there In the place There at that time	Being 'in the place', 'being real', 'living it', 'living in the picture', walking in their shoes, at that time, in that moment	Close context, knowledge 'immediately' at the place, not wasting time, 'doing it now', not being like a book or online, discovery, feeling in a place	Mood, atmosphere, weather, light, sounds, wider context, surroundings, knowing the locations on a map (the route), being like a tourist, taking notice of surroundings, inspiration, *Imagination, Visiting/exploring other locations for learning and/or inspiration*
PDoV D Knowledge & Place value Knowledge, place as gaining benefit, as value, for own sake	Personal research, motivation, own experience, being of benefit, the journey as value for learning,	Personal reasoning, imagination, creativity, curiosity, own interest in topic(s), inspiration, learning	Potential, purpose, future practice, preparedness, prior or post research, additional knowledge construction or discovery, exploration

		something new	

Understanding experience complexity in a smart learning journey

Significant discussion in phenomenographic literature concerns hierarchical, relational inclusivity of categories of variation (e.g. Cope, 2002), so transcript data was repeatedly examined to see whether any hierarchy was present. Key to developing this understanding was Cope's table of 'comparisons of levels of understanding' (2002, p. 74), and Kaapu & Tiainen's table 'summary of the categorization of consumer information and privacy conceptions in e-commerce' (2009, p. 10), that can be read vertically or horizontally. Their tables inspired further reflection to devise a table of multiple levels of understanding experience complexity for a smart learning journey, with both vertical and horizontal interpretations of relational inclusivity (see Table 2). This table appears to indicate hierarchical aspects in terms of experience complexity progression. By then considering a further diagonal relational inclusivity (Table 3), one can see a developing concept for a potential pedagogical framework structure to support deeper levels of participation, engagement and learning in a smart learning journey activity.

Table 2 Understanding experience complexity of a smart learning journey

	Category A **Doing the tasks**	**Category B** **Discussing**	**Category C** **Being there**	**Category D** **Knowledge and place as value**
Level 4	Research tasks and topic beforehand, take time doing and reflecting on tasks	Share tasks and content, do additional learning, discuss related experience and knowledge	Live it, being in the picture, live the atmosphere, take more time, seeing the whole and related parts	Knowing and seeing knowledge and place as valuable, personal experience, deeper engagement and 'possibilities'
Level 3	Tasks indirectly related to coursework or assessment	Discuss tasks and topic in relation to time and place	Experience in the place relating to other people, aspects and memories. Make connections between places and knowledge	Engage further with knowledge in topics, create upload content for tasks and at locations
Level 2	Do the tasks of interest, directly related to coursework or assessment	Discuss the tasks, help each other with tasks and tech	Locations are of some interest, potential for learning, creativity or inspiration	Click a few content links, save links 'for later', make screenshots of augmentations or tasks
Level 1	Do the tasks, go home	Discuss who does the tasks, how technology works	Go to locations, do tasks, go home	No engagement with content or knowledge, don't create or upload content

Considering this diagonal progression as being inclusive of each level it progresses through (1A, 2B, 3C, 4D, shown in Table 3), it is possible to consider multiple strands of participatory pedagogy to support the learner in this kind of activity. Further reflection of these diagonal levels of progression shows a hierarchy of learning becoming apparent, supporting a phenomenographic concept of surface to deep learning approaches (Marton & Säljö, 1976). This hierarchy is emergent, not predetermined, thereby maintaining integrity for the importance phenomenography places on analysis 'discovery' (Ashworth & Lucas, 1998, p. 420).

Table 3 utilises Hounsell's (2005) concepts of 'arrangement', 'viewpoint' and 'argument' to help describe learning complexity in these contexts and further shows Bloom's Revised (Anderson &

Krathwohl, 2001) and SOLO (Biggs & Collis, 1982) learning evaluation taxonomies as equivalent level interpretations. This provides ways of evaluating different aspects of this kind of learning with relevant equivalences.

Table 3 Surface to deep learning approach, evaluating learning across categories of variation

	Cat A	Cat B	Cat C	Cat D	Surface to deep learning relationships	Bloom's Revised	SOLO
Level 4	4A	4B	4C	4D	DEEP APPROACH shows intentionality for tasks, topic, knowledge and locations to contribute to argument; to understand further potential interpretation (inter/intra); ideas, application	5/6	4/5
Level 3	3A	3B	3C	3D	SURFACE TO DEEP #2 moving towards 'argument' concepts; tasks and journey begin to be seen as indirectly relevant to wider settings; more reliant on imagination, creativity, inventiveness, inspiration	4	3/4
Level 2	2A	2B	2C	2D	SURFACE TO DEEP #1 some engagement with 'viewpoint', building elements of meaning and connection resulting from the journey participation	3	3
Level 1	1A	1B	1C	1D	SURFACE APPROACH shows intentionality of doing tasks as fact, 'arrangement' only. The bare minimum required.	1/2	1/2

Defining effective learning

As we have considered whether (and what type of) learning may or may not be occurring, it is useful to clarify how effective learning might be defined. In this study, effective learning is framed in terms of broad interpretations, considering the reflections of the learner, what they might regard as learning or perceive as an effective learning experience. Within this framing, smart learning is best summed up by Liu et al.'s (2017, p. 209) definition of "learning to learn, learning to do and learning to self realisation". Dron describes smart environment learning as "a complex conversational process that can and usually does lead to much that is of value beyond what is planned", (2018, p. 3). This asks us to reflect on what effective learning is within contexts of smart learning, and what might be involved in teaching pedagogical approaches to facilitate that learning. The emerging hierarchies of surface to deep levels of experience complexity previously described go some way to answering these questions.

Situating smart learning in a pedagogical relevance structure

Learners may be ill equipped to participate in autonomous learning activities, yet in contexts of connectivist inspired learning, autonomous motivation and empowerment of the learner are imperative. Whether or not learning is assessed, mandatory, formative or supportive may potentially all be powerful mitigators in the mind of the learner to initiate and sustain participation in learning. Marton & Booth's 'relevance structure' comes into play: the 'global aspects of learning' (1997, p. 141) into which a smart learning journey activity is situated determine how the phenomenon of the smart learning journey might be experienced. In a structure of awareness analysis, the focus of the learner may be as much on these hidden learning agendas as on any aspect of the journey itself. This 'hidden agenda' awareness experience variation can be seen in participant interview transcripts, and in the emerging categories of variation for the phenomenographic outcome space for the journey as a whole. Perhaps part of the understanding of pedagogies for smart learning is to acknowledge this, adopting an approach that learning activity situated-ness is of prime importance, and that the empowerment and engagement of the learner begins well before participation in any specific learning activity, and considers a variety of participatory factors. This may be a consideration in creating smarter learning environments, by explicitly acknowledging this pedagogical relevance structure.

Conclusions

The categories of experience variation and levels of experience complexity for a smart learning journey point towards some indicators of a pedagogical relevance structure for learning activities that might be partially or wholly mediated by 'future-present' technologies and characterized by "connectivist generation of pedagogies" (Anderson & Dron, 2011) such as those found in smart learning. In terms of the smart learning journeys that this study investigates, a pedagogical relevance structure might be positioned for activity relevance, purpose and interactions most encouraged and supported within connectivist inspired learning. Utilising experience variation as an articulation of how different emphasis can be placed on activities in a connected environment, we can see an emergent pedagogical guide for smart learning, which can be further supported by key related pedagogies and pedagogical relevance structures. Further analysis builds on these conceptions for developing a pedagogical guide for smart learning based on learner experience in connectivist style activities. Additional aspects of pedagogical interest will be investigated, and relationships to existing related current pedagogical discourse such as Henning's (2018) Learning 4.0 and the Digital Competences DigComp 2.1 framework (Carretero et al., 2017) in the context of Sustainable Development Goal 4 targets (Unesco).

This paper is one of a number in a series to report and reflect on these findings.

Declarations

Availability of data and material

Not applicable

Competing (conflict of) interests

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