Design, learning networks and service innovation

Lucila Carvalho, Institute of Education, Massey University, Auckland 0636, New Zealand

Peter Goodyear, Centre for Research on Learning and Innovation, School of Education and Social Work, The University of Sydney, NSW 2006, Australia

This paper has three main aims. It argues that education is a surprisingly neglected sector of activity in research on service design and innovation and that greater attention to education as a service can shed new light on theoretical and methodological issues in service design and innovation research. It shows how a novel reframing of education activity — as networked learning — can enrich some critical areas of thinking about the analysis, design and evolution of co-produced services more generally. Finally, it identifies a family of participatory design approaches that are particularly well-tuned to the needs of service innovation. The paper shows how contemporary ideas on individual, group and network-wide learning can benefit research on services and service innovation. © 2017 Elsevier Ltd. All rights reserved.

Education plays a vital role in society. When it works well, it is a vehicle for social mobility, social inclusion and cultural reproduction. It provides foundations for the development of a skilled, innovative workforce and is both a major area of public investment and a substantial employer of highly trained workers (OECD, 2016). But education does not always serve everybody well, and in a rapidly-changing world, there are doubts about the ability of education to adapt in timely, evidence-informed ways. In short, education is a crucial but problematic service sector. Education is also an under-explored 'Cinderella' sector in many branches of research in the human and social sciences, including in research on organisations, services and design. Its neglect by researchers in these fields is a missed opportunity both for the researchers concerned and for the improvement of education (Furlong, 2012).

In this paper we use some recent research in the field of education and the learning sciences to provide a number of insights that can question, extend or add significant nuances to existing (mainstream) thinking about service design and service innovation. We start by providing a high-level sketch of contemporary education as a site for research on services and service

Corresponding author:
Lucila Carvalho
l.carvalho@massey.ac.nz

innovation (Section 1). We explain that education can be broadly considered to include formal and informal learning, and life-long as well as life-wide learning, and we then summarise established approaches to the design and analysis of educational services (Section 2). We illustrate some of the advantages of analysing educational services as learning networks (Section 3). In Section 4 we introduce Activity Centred Analysis and Design (ACAD). ACAD is an *indirect* approach to design for learning which distinguishes carefully between what can be designed ahead of time and the real-world activity that subsequently emerges. We draw on our experiences of applying the ACAD framework to complex examples of networked learning (Carvalho & Goodyear, 2014; Carvalho, Goodyear & De Laat, 2017) in order to reconsider a selection of salient conceptual issues in (mainstream) research on service design and service innovation (Section 5). We focus on four main areas in Section 5:

- the objects of service design
- the nature of (educational) exchanges between providers and clients, within a learning network
- relationships between learning infrastructures and learning interfaces, and
- the social, digital, material and epistemic entanglements that constitute the service interface — in networked learning and more generally.

Innovation is very unevenly distributed in educational practices (Fullan & Hargreaves, 2009). Some kinds of innovation — particularly where government policies are being mandated — sweep across the whole system, with very variable effects on actual practice. Other kinds of innovation are typically small-scale, locally managed and iterative: often on tight timescales. Successful educational innovation is almost always *participatory* (Bang & Vossoughi, 2016). Indeed, one of the goals of formal education is to help students become autonomous lifelong learners. It turns out that learning how to co-configure one's learning environment is an important part of gaining such autonomy. This can be seen as an interesting special case of co-configuring a service interface (Secomandi & Snelders, 2011, 2013; Secomandi, 2013). So a subsidiary aim of this paper, informing the last part of our text (Sections 6 and 7), is to identify and pull together a cluster of approaches to participatory design that are particularly well-aligned to endogenous (insider-driven) service innovation. This family includes design anthropology, formative intervention, and second order cybernetics (Engeström, Sannino, & Virkkunen, 2014; Gunn, Otto, & Smith, 2013; Sweeting, 2016). In Section 7, we also draw another set of connections between learning and service innovation by focussing on how effective participatory design depends upon fluent articulation of group sense-making and decision-taking processes.

1 Education as a field in which to study service design and innovation

Research in innovation originally focused on technological innovation, having historical roots in the manufacturing sector: in the aerospace and automotive industries, for example (Carlborg, Kindstrom, & Kowalkowski, 2014; Djellal, Gallouj, & Miles, 2013; Drejer, 2004). From this perspective, scholars were interested in the products and the production systems related to innovation, but they hardly acknowledged services. Once the services sector gained momentum and recognition for its economic significance, and its relevance for global economic development and growth (OECD, 2016), research on service innovation started expanding and diversifying (Toivonen & Tuominen, 2009). Similarly, service design as a domain of practice and research has been making progress in a number of human services fields, including healthcare, social work and crime prevention. Surprisingly, education is almost invisible in research on service design and service innovation. Very few of the studies that explicitly take a service design or service innovation perspective have used education as their field of inquiry or action (Baranova, Morrison, & Mutton, 2010; Ng & Forbes, 2009; Oplatka, 2004; Radnor, Osborne, Kinder, & Mutton, 2014). Moreover, most existing studies of educational services focus on ancillary services, such as student administration or catering, rather than on core processes of learning. Oplatka (2004), Felix (2011) and Kuzmina (2014) can be cited as rare exceptions.

What makes this gap even more striking is that education has its own strong tradition of design-based practice (van den Akker, Branch, Gustafson, Nieven, & Plomp, 1999; Goodyear & Retalis, 2010; McKenney & Reeves, 2012; Hokanson & Gibbons, 2014; Svihla & Reeve, 2016). But, for the most part, this tradition is pragmatic and looks inward. It has not shown much interest in theoretical ideas from the mainstream design literature, nor has it yet made a substantial contribution to that literature.

If properly framed, ideas and methods associated with service design have the potential to be very beneficial for both practical and theoretical work on educational innovation. Conversely, the field of innovation in educational services offers fertile ground for the (broader) design research community — for example, as a relatively neglected domain in which to test the applicability of existing and emerging theories and methods.

Among all the major areas of employment in developed economies, the education sector stands out as being dominated by highly-skilled workers (Miles, 2008). The *best-paid* workers in health, finance and business services may have higher skill levels and/or longer training than their equivalents in education, but those sectors also employ larger numbers of people with only medium levels of skill. High skill levels tend to be associated with innovation, yet

education has a widespread reputation as a risk-averse field in which practices seem immune to change (Cuban, 2001). Chalk and blackboards may have given way to Powerpoint and Prezi, but the image at the core of education is still the teacher at the front of the class, lecturing and directing the students.

In actuality, that core image no longer represents the scope and variety of *students' work*. It is when we look at the range of diverse activities in which school or university students actually engage that we see how some significant trends have been reshaping what students do (Johnson, Adams Becker, Estrada, Freeman, & The New Media Consortium, 2015, 2016). Acknowledging the changing realities of their work is a prerequisite for understanding students as co-producers of the services of education. The main trends are (1) a pedagogical shift towards more student-centred, project-based and inquiry-based forms of learning activity, in which students − whether individually or in groups − are expected to take greater control of, and responsibility for, their own learning (Beetham & Sharpe, 2013), (2) the growing affordability and ubiquity of networked devices (smartphones, tablets, laptops etc.), allowing access to virtually infinite online resources, and (3) reshaping and expanding traditional spaces for learning in schools, universities, libraries, museums and elsewhere − in part, to enable better use of digital technologies and more flexible self-managed learning.

2 Design and analysis of educational services

People engage in educational activities − broadly understood − from a very early age, and they continue to do so throughout life. In western societies, most people spend 10 or more years in formal education settings, with an increasing proportion also going on to higher academic or vocational studies. Formal education settings, however, are not the only sites for learning. In one way or another, people also engage in less formal learning activities, such as when visiting museums or libraries, and in their work environments. People learn through personal interactions with family, friends and work colleagues, when reading books and other text-based materials, by exploring the web, when using mobile devices or taking part in more structured learning activities: people learn in *many* different situations.

In most cases, educational services are highly heterogeneous and are produced by networks of multiple institutional and individual actors, operating at a variety of scale levels. The work entailed in the provision of formal education ranges across such diverse areas as architecture (e.g. school buildings, university learning spaces), information technology (e.g. virtual learning environments, computer-aided instruction), teacher supply, curriculum and assessment design, quality assurance and certification. All these provide a sociotechnical infrastructure for the core activities of education: namely, the

interactions between learners and teachers (educators) and the creation and use of educational artefacts.

Although some educational services are driven by a profit motive, it would be fair to categorise the vast majority of designerly work in education as a sub-class of 'Socially Responsible Design' (Cipolla & Bartholo, 2014; Margolin & Margolin, 2002; Papanek, 1985). It is more concerned with the satisfaction of fundamental human needs — opportunities for lifelong, lifewide learning — than responding to wants that are expressed through the market and inflamed by advertising.

Design activity in education has fragmented into two rather separate areas: macro-level work on educational planning and administration and micro-level work on instructional design. These have very different labour forces and methodologies. While there is a growing acknowledgement of the need for *services that integrate around the learner*, there is — as yet — very little awareness of how service design and innovation strategies can be used to tackle the complex problems thereby entailed, and to connect macro, meso and micro levels (Goodyear et al., 2015; Jones, Dirckinck-Homfeld, & Lind-strom, 2006).

Operating mostly at the micro-level of educational activity can be found the designerly sub-field known as instructional design, educational design or learning design (Gagné, 1965; Gibbons, 2013; Hokanson & Gibbons, 2014; Romiszowski, 1981). Practice here is methodologically broad-based and it has deep roots. Indeed, it could be argued that it is one of the oldest sub-fields of service design, even though the term 'service design' is barely recognised in educational discourse.[1]

The origins of instructional design date back to WWII, and are associated with the work of psychologists and educators in creating training materials for the US military and for industrial production (Reiser, 2001). By applying instructional principles based on theoretical understandings of learning and behaviour, sets of systematic procedures were generated, creating models or approaches to guide instructional designers through the analysis of educational, training and performance problems, and through key steps in designing, developing, implementing and evaluating learning procedures and materials.

The outcomes of educational design and innovation activities often involve mixtures of products and services. Some work leads to the creation of educational artefacts — such as a video portraying astronomical or sub-atomic phenomena in physics education, or a worksheet used to provide structure for a group learning activity. Other work results in less tangible outputs — such as a specification for a learning task. As scholars analysing service design often

remark, it can be very hard to tease apart products and services. Service enactment depends upon mobilising material resources of one kind or another. Products may have knowledge (intellectual services) inscribed in them, and such things as videoclips may be digital 'crystallisations' of services provided through the speech and gestures of talented teachers.

Since the early days of instructional design in the mid 20th century, the range of circumstances in which human learning takes place and the types of tools used for learning have evolved and multiplied in complexity. Consequently theorizing and scoping 'design for learning' requires (re)thinking at a level of abstraction that escapes the particularities of schools and classrooms, or the training materials devised for the US military in the WWII period. For example, it is possible to frame the analysis of educational services more abstractly in terms of learning *spaces*, *systems, communities and/or networks* (Harrison & Hutton, 2014; Greeno & Engeström, 2014; Wenger, 1998; Carvalho & Goodyear, 2014.)

Spatial models are useful when the affordances of particular places, and/or geographical proximity are dominant features in the co-production of a service (Harrison & Hutton, 2014). Systems models can be useful in understanding how components of a functioning service (or of a complex product) nest inside each other — with lower level subsystems generating effects at higher levels (see e.g. Crilly, 2013, 2015; Greeno & Engeström, 2014). Community-based models are particularly valuable where an understanding of habitual social practices and human relationships is a necessary part of seeing how a service works and is reproduced (Wenger, 1998).

Spatial, systems and community-based models each have their strengths. Our own recent work takes a different tack: we approach the analysis and design of complex learning situations in terms of *networks* (Carvalho & Goodyear, 2014; Carvalho, Goodyear, & de Laat, 2017). Since the early 1990s, analytical ideas about networked learning have evolved rapidly, in a bid to capture the changing nature of the learning activities afforded by new technologies, emerging social practices, and the fluid ways of collaborating and participating in networks (Goodyear, 2014; Hodgson, de Laat, McConnell, & Ryberg, 2014; Jandric & Boras, 2015; Jones, 2015; Ryberg, Sinclair, Bayne, & de Laat, 2016). A networked learning perspective offers a powerful and flexible way to conceptualize and represent relationships between people, tasks, tools and other artefacts. Its focus is on understanding the use of technology to connect people and resources, irrespective of time and physical location, to promote collaborative engagement in processes of knowledge co-creation and knowledge sharing. A network perspective offers analytical tools to address the complexity of situations involving many possible combinations of heterogeneous elements. It allows us to delve into the interconnected elements, and to abstract part-whole relationships that may affect human activity, with a view

to identifying what works well, and what does not work, in diverse learning situations.

3 Taking a network perspective

Our interest in network-based models arises from a desire to be able to represent the operation of educational and other services in situations where:

- Interactions between individuals are not constrained by distance but reflect and create a topology of relationships — as is the case with digital/Internet based services. (Spatial models are not so helpful here.)
- Service effects and opportunities are not constrained by the nesting of firm systems, or the solidity of established communities, but can be flexibly configured through connecting new sets of people and resources. (Systems and community-based models are not so helpful here.)

We suggest that network modelling may also be useful for representing service co-production in situations where neither market models nor models based on hierarchical organisations are suitable (Barabási, 2016; Borgatti & Foster, 2003; Borgatti, Everett, & Johnson, 2013). They may also be very good for representing service co-production that involves complex assemblages of digital, material, social and informational entities — networks and meshworks of people and things (Hodder, 2012; Knappett, 2011).

For example, in recent research we have analysed the network of material and digital objects and human actors involved in a mountain rescue training exercise for people who are learning to become paramedics (Goodyear & Carvalho, 2013). This multi-day activity is an instance of an educational service that requires careful design in advance, but which is then co-produced by multiple human actors interacting with each other, with and through a multiplicity of devices, taking into account contingencies of changing weather, terrain, stamina and information about casualties. As we discovered, a satisfactory representation of how the service is co-produced needs to capture a network of people in various roles — novice paramedics, mountain rescue experts, 'casualties' to be triaged and evacuated — who are also looking after and depending on heterogeneous material and digital things — such as boots, compasses, whistles, maps, bandages, smart phones and iPads. (While spatial relations, such as proximity, and community relations, such as trust, are relevant here, space and community models capture only a small subset of the diverse kinds of relationships to be found in the exercise when it is functioning successfully.)

The design of this training exercise is modified each year it is run. Changes in the design may reflect lessons learned: what worked well and what went badly. Changes may also be required when new tools become available (e.g. handheld

GPS units), when new medical or rescue protocols are introduced or because of other contingencies (e.g. the training site has to move to a different mountain range). It turns out that representing the diverse things and humans and their relationships in network form rapidly draws attention to the profound repercussions of apparently simple changes to individual elements — as when a notebook is replaced by an iPad and provision has to be made for recharging batteries.

We should make one further point before leaving this example. The dynamic, heterogeneous network of humans and things is implicated in the enactment of a *complex* service: or, one might say, there are three distinct layers or levels to the service. (1) There is a service of medical treatment and rescue being enacted here: even though the 'injured' are pretending, they have to be found and brought out with proper care. (2) There is an educational service being co-produced. The main purpose is to train student paramedics through their participation in the simulated service of rescue. (3) The team designing and managing the event learns from evaluating how each exercise turns out: a self-improving dynamic is built into the service design. The exercise serves to help the educational designers learn how to modify parts of the network to improve the service(s) in subsequent years.

We suggest that service enactment in and through heterogeneous networks of people and things often has these 'layered' qualities: even with services that are not explicitly 'educational' one can expect to find significant instances of individual, group and network-wide learning and change. Understanding part-whole relationships, and how multiple elements connect, in a complex mix, is crucial for successful (re)design of such services.

4 Activity-centred analysis and design for networked learning
Our research into the architecture of formal and informal learning networks has led us to the view that networked learning is best understood as involving the co-configuration of heterogeneous tasks, activities, roles, relationships, artefacts and spaces (Carvalho & Goodyear, 2014; Carvalho et al., 2017).

We can use Figure 1 to make the following points. Learning cannot be designed. People learn in and through their own (emergent) activity, including through thinking, making, arguing, writing and reflecting. Learning outcomes are very varied in kind. They include the acquisition of skills and factual knowledge, understanding the principles that explain a class of phenomena, gaining confidence in one's own abilities, becoming better at managing one's own learning, and so on. Different kinds of activity tend to result in different kinds (or combinations of kinds) of outcome. One cannot master the skill of
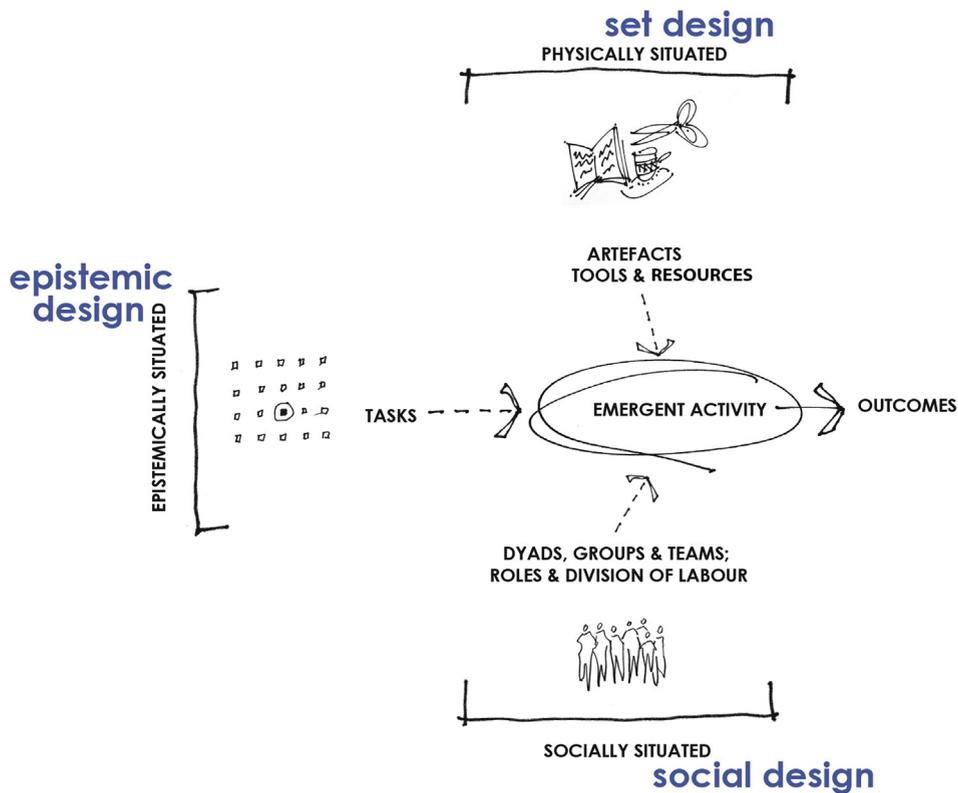
set design
PHYSICALLY SITUATED

epistemic design
EPISTEMICALLY SITUATED

ARTEFACTS
TOOLS & RESOURCES

TASKS

EMERGENT ACTIVITY

OUTCOMES

DYADS, GROUPS & TEAMS;
ROLES & DIVISION OF LABOUR

SOCIALLY SITUATED
social design

Figure 1 Activity centred analysis and design (ACAD)

drawing a building or hitting a ball by listening to a description of how it should be done.

Other than in a very narrow set of circumstances, activity cannot be designed in advance. What human beings actually do — which is what we mean by activity — emerges. However, activity can be *influenced* by its setting: activity is physically and socially *situated* and the course it takes is partly shaped by the qualities of the situation. How one hits a ball is influenced (but not determined) by the shape of the bat and by whether anyone else is around to retrieve the ball. So while learning cannot be designed, some of the physical and social components of the situation in which learning activity unfolds *can* be designed. Design affects learning indirectly. We refer to design of the physical (digital and material) elements of the situation as set design (by analogy with the theatre) and we refer to the design of roles and divisions of labour as social design (Figure 1). In educational services, activity is most strongly shaped by *tasks* — that is, by non-deterministic specifications for worthwhile activities; suggestions of things that are worth doing. We can say that tasks result from

epistemic design, and that learners' activity is therefore triply situated: physically, socially and epistemically.[2]

We call the approach to thinking about design for learning represented in Figure 1 'activity centred'. When we couple it with the forms of analysis described earlier, we arrive at Activity Centred Analysis and Design (ACAD): where the main reason for doing the analysis is to inform future design work on service enhancements. Although the ACAD model was developed as a way of guiding analysis and design for learning — in other words, for educational services — we now suggest that it has more general applicability across the broader field of service design and service innovation. Focussing on what service users/co-producers *are actually doing* (i.e. their emergent activity), and tracing the networks of people, tasks, tools and other things coming together in the activity, helps clarify what is designable in advance, and what is not.

5 Insights from ACAD and networked learning research that strengthen and extend existing concepts in service design

Service design scholars are understandably preoccupied with a number of slippery conceptual issues, such as the roles of tangibles and intangibles, things and services, 'touchpoints', servicescapes and lines of sight (see e.g. Secomandi & Snelders, 2011, 2013). In this section, we use some insights from our ACAD/networked learning research to reconsider a selection of salient conceptual issues on the core topic of the object(s) of service design. We then address some interlocking issues about the nature of exchanges in service provision, relations between infrastructures and interfaces, and the constitution of service interfaces.

5.1 The object(s) of service design

Theoretical consideration of design principles and methods is no longer tightly tied to enhancing the appearance and functionality of material products. Design practices have spread out to encompass different areas of business, administration and social innovation (Brown & Wyatt, 2010; Bucolo & Matthews, 2010; Dong, 2014; Dorst, 2015; Manzini, 2015; Secomandi & Snelders, 2011; Verganti, 2008).

This raises complicated questions about the nature of the *object* of service design (Sangiorgi, 2009; Secomandi & Snelders, 2011, 2013). Object has a dual meaning in everyday discourse. It can mean either an artefact or a purpose. In product design, both meanings are implied: the purpose of design is to create a new or improved artefact to satisfy a specific function. Scholars writing about service design have sometimes sought to distinguish it from product design by banishing the material and tangible, only to trip over

problems about how services can be experienced, if not through the mediation of material objects (as with 'service touchpoints' and 'service evidence'). Shostack's (1977) notion of 'tangible evidence', for example, argues that services are 'experienced [and] cannot be stored on a shelf, touched, tasted or tried on for size' (p. 73). At the same time, Shostack also suggests that in order to deal with the intangibility of services, consumers still search for 'tangible evidence', or clues which are identifiable through the five human senses.

Pacenti builds on Shostack's work, merging concepts from interaction design, service economics and service management, thus bringing an interaction perspective to service design (Pacenti & Sangiorgi, 2010; Sangiorgi, 2009; Secomandi, 2013). Using an analogy that combines the ideas of a 'front-office' with the 'interface of a digital artefact' (Pacenti & Sangiorgi, 2010), Pacenti describes a service interface as an 'area' or the 'scene' where interactions between a user and the service occur. Her perspective embraces a temporal dimension and characterises the nature of a service interface as including its 'potential' for becoming an event. Sangiorgi further elaborates on ideas about the nature of service interaction, suggesting that a service interface involves 'the tangible and visible part of a service that a user can experience […]. It is made up of people, products, information and environments that will support the user experience' (Sangiorgi, 2009, p. 416). Sangiorgi's interpretation conceptualizes service interfaces beyond the interface itself, that is, beyond a scenario composed by a human and a thing (user-interface), to one that also includes the socio-cultural phenomena embedded in this interaction (Secomandi, 2013). The literature on service design uses different terms when referring to this 'area' or 'scene', including for example 'service interactions', 'service encounters', 'touchpoints' − all involving 'users' and 'service interfaces'.

We suggest that the ACAD model can help here, through its insistence on conceptual separation between (a) what can be designed ahead of time, and (b) the activity that emerges at 'run-time'. This is a strongly materialist perspective. For example, it asserts that activity − what service users actually do − cannot be designed, but one can design tasks: the specifications for which need to be inscribed in physical (material, digital or hybrid) artefacts if they are to persist into the 'run-time' service environment and have an effect on emergent activity. Or in network terms, the activity of a human being can be influenced through a relationship with a physical thing that bears a task inscription or affords a particular kind of action.

The ACAD framework resonates with aspects of some existing conceptualisations of service design. For example, Sangiorgi (2011) argues that service design has a complex and relational nature and services in general cannot be entirely designed nor pre-determined. Maffei and Sangiorgi (2006) propose an approach to service design that incorporates concepts from situated action (Suchman, 1987) and Activity Theory (Engeström & Sannino, 2010).[3]

Their approach refers to purposeful action which is both physically and socially situated, and a 'service space' that encompasses at the same time an 'action space' − where targeted actions are facilitated through interactions mediated by physical artefacts (e.g. material and cognitive artefacts) − and an 'encounter space' − where interactions are renewed and performed over time. Extending Maffei and Sangiorgi's approach, the ACAD framework refers to emergent activity as also *epistemically* situated. *Tasks* (proposals for things worth doing) are key structural elements, and task design may involve different considerations about ways of knowing and choices related to task sequencing, pacing, selection of information and ways of structuring knowledge. For example, in a museum scenario, task design might involve considerations about how visitors might be invited to experience an object or an exhibition. This might involve sequencing and pacing of information related to objects, in a way that brings the overall topic of the exhibition together − how do we present key ideas related to objects or the exhibition theme? What objects do we choose to display information? Where do we display the information − next to objects or in a portable device? How might we invite interactions with an object? Should we make information available to visitors to be revealed on demand or just displayed? What about the length of the information displayed? Nevertheless, whatever design elements result from our decisions, visitors will still exercise agency to decide what objects they may stop at and read about or interact with.

An indirect approach can also be found in the ecologically-oriented work of Margolin and Margolin (2002), who see the design of physical and spatial surroundings and products as affecting 'the safety, social opportunity, stress level, sense of belonging, self-esteem, or even physical health of a person or persons in a community' (p. 26). The indirect approach is also echoed in what Cipolla and Manzini (2009) call 'meta-design' − when they argue that relational services cannot be directly designed, though they can be enabled. Cipolla and Manzini (2009) make a useful distinction between 'standard services' and 'relational services'. In the standard service model, providers and clients perform predefined roles; the focus is on the 'how' rather than the 'why' of the service; they take an industrial, mass-produced or production-line approach to service delivery. By contrast, relational services are reciprocally produced in ways that foreground and strengthen human relationships. They are convivial rather than alienating. Design for standard services can involve such things as scripting what should be said, proscribing and prescribing certain forms of behaviour, etc. However, '… *relational services* can only be "enabled," i.e., they need to be designed in such a way as to start up, support, and continuously sustain interpersonal encounters between the participants …' (Cipolla & Manzini, 2009, p. 50; emphasis in original).

In recent years scholars in the field have provided a rich array of ideas about the objects of service design in terms of the nature of exchanges between

providers and clients, relations between the service interface and service infrastructure and the complex (socio-) materiality of the service interface (e.g. Secomandi & Snelders, 2011, 2013; Secomandi, 2013; Snelders, van de Garde-Perik, & Secomandi, 2014). In the next three subsections, we visit each of these in turn, identifying some resonances with the ACAD/networked learning perspective and suggesting some further elaborations of concepts in service design.

5.2 The nature of exchanges between providers and clients

Education is an area in which socially responsible design, informed by a sense of what people *need*, has a great deal of support. Moreover, part of the purpose of education is to help people become more aware of their own needs, better able to diagnose and articulate them and to find and/or design services that better meet those needs. If we think of (formal) education — particularly education in schools — as being an instance of service provision, it quickly becomes apparent that the 'consumers' of the service are not always enthusiastic. Economic analyses of service provision tend to assume that what is provided is meeting a set of consumer *wants* — that services are created and evolve in relation to market demand. This is not an accurate representation of how (many) young 'consumers' of educational services interpret the situation.[4] And this scenario becomes even more complicated when we take other related 'consumers' — such as parents, care givers, social workers and others — into the equation. These people also interact with instances of the services created on behalf of the young 'consumers'.

Even when one looks at areas of informal education and lifelong learning, the exchanges are not best characterised as 'service for fee'. It is rarely the case that there are providers who devise and market services and clients who purchase and use them.[5] Instead, educational services are co-produced through a variety of forms of exchange, often involving multiple stakeholders in different roles (Ng & Forbes, 2009).

5.3 Interface and infrastructure

Secomandi and Snelders (2011) distinguish between two domains in service design — the interface and the infrastructure. The interface (or front-office) refers to interactions between users and providers (Sangiorgi, 2009; Pacenti & Sangiorgi 2010); while the infrastructure (or the back-office) relates to the socio-technical resources that support and enable such interactions. In later work, Secomandi and Snelders (2013) further develop these ideas using a phenomenological perspective, highlighting the role of interfaces in mediating people's experiences of the world. Secomandi (2013) argues that only within an experiential, relational and situated framing does it become possible to understand service interface and infrastructure. Snelders et al. (2014) remind us that:

'service designers are left with little decision-making power, since many of their decisions at the level of interface will have already been made by others in order to create an efficient and effective infrastructure' (Snelders et al., 2014: p. 3).

Similar issues have been recognised, though not always clearly articulated, in the provision of educational services. In traditional classrooms, much of what is done is constrained by a relatively inflexible, slow-to-change infrastructure, comprised of epistemic, physical and social components. (For example, a national curriculum, school buildings and grouping students into age-based classes.)

However, once we look at interface:infrastructure relations from a networked learning perspective, the analysis becomes a little more complicated and service design possibilities become freer. Service infrastructure is sometimes distinguished from service interface by virtue of (1) infrastructure having to exist prior to actualisation of the service, and (2) the service interface being tangible to the user (available to their senses), whereas the infrastructure is typically 'hidden from sight' (Snelders et al., 2014).

Where the actualisation of a service interface involves the co-configuring — the temporary, intentional drawing together — of a network of physical, digital, human and other resources, infrastructure and interface are no longer so clear cut. Recognising this dynamism and reconfigurability reminds us of Susan Leigh Star's dictum: that infrastructure is relational.

'It becomes infrastructure in relation to organized practices. Within a given cultural context, the cook considers the water system a piece of working infrastructure integral to making dinner; for the city planner, it becomes a variable in a complex equation. Thus we ask, *when*—not *what*— is an infrastructure.' (Star & Ruhleder, 1996: p. 113, emphasis in original).

When service co-production is seen as emerging in and through a network of people and things, infrastructure is probably not best understood as something that can be defined in terms of essentialist or absolute characteristics. It is not inevitably prior, pre-requisite or uncontrollable. Innovative practices can change what infrastructure *is*. For example, many universities provide their students with online tools for collaboration and discussion. These are usually set within an approved enterprise learning management system (LMS), which is backed up and password protected. Nevertheless, when students are set a groupwork task, it is quite common for them to ignore the official infrastructure, turn to social media and set up a Facebook group, or its equivalent. If their collaborative work turns out to need other online facilities, they will often incorporate other platforms, distributing their activity quite

fluently, on-the-fly: thereby dynamically reconfiguring the infrastructure they need, as they need it (Donlan, 2014).

5.4 Materiality of the service interface

'… for the production of services, intangible resources must be actualized through an interface that is material and available to bodily perception … service exchange relations between providers and clients are grounded on the materiality of their interfaces, even in the case of interpersonal encounters' (Secomandi & Snelders, 2011: p. 31−2).

We also take the view that it is not the materiality, or conversely the intangibility, of the service interface that is important: it is the *material heterogeneity* that needs proper acknowledgement. As Ingold (2007) argues so well, insights flow from recognising the *distinctive qualities* of materials and their relations with human practices.

For example, in many of our instances of networked learning, interactions between participants are mediated by online technologies, and thereby become reified: creating artefacts that embody experience and other forms of knowledge. Imagine a university course, where students participate in an online debate about a given topic. Their contributions are added to a threaded discussion, and the medium of communication becomes a co-created knowledge artefact. The tangibility and persistence of these knowledge-laden artefacts loosen the temporal and spatial bonds between people engaged in learning with/from each other and challenge some of the more rigid distinctions between products and services (Boder, 1992; Goodyear & Steeples, 1998; Wenger, Trayner, & de Laat, 2011).

So the service interface can be thought of, and mapped in detail as, a dynamic network of diverse humans and things co-producing a nested set of services. It may, therefore, be better to approach design for service innovation *indirectly*, in the following sense. Rather than aiming to design the service interface directly, creating richer opportunities for co-production entails combinations of task, set and social design that modify the situation in which co-production unfolds.[6]

6 Learning and the co-production of innovative services

Many accounts of service innovation underscore the importance of the role of the client in co-producing services (e.g. Cipolla & Bartholo, 2014; Gallouj & Weinstein, 1997; Osborne, Radnor, Kinder, & Vidal, 2015; Secomandi & Snelders, 2011; de Vries, 2006). When a client becomes involved in co-producing a service, some learning processes are also often entailed. For example, when a patient is receiving medical advice, both the patient and their

doctor are likely to be involved in a joint learning process. In the education sector, however, service co-production is *crucial* since learning is the primary purpose. Education fails completely if the student is not actively constructing their own understanding during educational transactions. Most models of effective learning give the learner a central role in co-configuring their actual learning activities, learning relationships and learning environment (Buchanan, 2001; Carvalho & Goodyear, 2014). Education as an important field of human activity can therefore also provide compelling examples of how service design needs to include active clients. Moreover, it can provide theoretical tools that service design researchers can use to analyse *how* and *what* service clients need to *learn* in order to co-produce effective services, and contribute to service innovation.

The services research literature recognizes knowledge as a key resource in modern economies. The importance of knowledge exchanges, production of new knowledge, and codification of knowledge for innovation have been highlighted, as well as their impact on knowledge-intensive business services (KIBS) (Drejer, 2004; Miles, 2005; Toivonen, 2004). However, the nature of learning is still rather 'taken-for-granted' in accounts of innovation in service provision — learning tends to be treated as merely the transfer of information and know-how, whether by providers or clients, individuals or organisations (e.g. Gallouj & Weinstein, 1997; Osborne et al., 2015; de Vries, 2006). In contrast, recent research in the learning sciences offers richer explanations of what is involved in such situations — going well beyond individualistic cognitive learning to include embodied learning, collaborative knowledge creation and participation in the development of new social and epistemic tools and practices (see e.g. Greeno & Engeström, 2014; Markauskaite & Goodyear, 2017; Moen et al., 2012; Paavola, Lakkala, Muukkonen, Kosonen, & Karlgren, 2011; Sannino, Daniels, & Guti, 2009).

We can apply this more expansive sense of 'learning' to reconsider approaches to service design and innovation more broadly. In short, we argue that the design of novel services is more likely to succeed if service design makes it easier for all participants to see what they need to learn in order to effectively, efficiently and enjoyably co-produce better service practices and outcomes. In other words, a good service interface includes affordances for *co-learning* as well as co-production.

Secomandi and Snelders (2013) draw on the work of Gui Bonsiepe in exploring the idea of 'interface transparency'. In general terms, Bonsiepe argued that the interface should always be transparent to the user: that as soon as the user becomes aware of the tool they are using then something has gone amiss in the process. On this reading, a well-designed tool should never draw attention to itself. Secomandi and Snelders (2013) take a different line. They argue that designing for transparency is sometimes appropriate, but not universally so.

For example, redesigning some component of an interface may be done with the explicit purpose of drawing the user's attention to that component in order to nudge them into adapting their behaviour – learning something new.

We can extend this argument a few steps further. Imagine a workplace in which a group of people collaborate to provide a service. A new employee starts. The more transparent the interface, the less available are work processes and work objects to the new employee's senses. The less able they are to perceive, copy and learn autonomously, the more has to be explained to them. The same applies to a new client: their ability to partake of the service and be proactive in co-producing it will be impeded. Then consider a situation in which joint participation, by 'providers' and 'clients', has the primary object of creating a shared understanding of some complex problem, sufficient to agree on a course of action. (Examples from other service sectors would include such things as a physiotherapist and patient working out a viable exercise regime, or a residential home manager and client designing a care plan for the client's elderly parent.) The challenge necessitates collaborative sensemaking. Here, it is even more beneficial, sometimes necessary, to *represent* – to bring anew into the present and to visualise – the phenomena, tools, methods etc that are implicated in analysing the problem.

This scenario is exactly what one finds in examples of collaborative inquiry-based learning (Aditomo, Goodyear, Bliuc, & Ellis, 2013; Spronken-Smith et al., 2011). And one can see at least three kinds or levels of service interface (cf. the example of the mountain rescue exercise in Section 3). At a base level, one can think of a service interface constituted to afford opportunities to learn about some phenomena by a process of group inquiry. However, inquiry-based learning also has the goal of helping students become better at self-managing inquiry processes – not just learning about one set of target phenomena. Constituting a service interface so that tools and methods of inquiry become more visible and therefore more available for the learner's reflection, offers better opportunities for them to improve their inquiry skills and techniques, and to appropriate and even improve the tools they are using. And then a third kind or level of interface can be constituted where the goal is not (just) to learn about the target phenomena, or improve individual students' inquiry techniques, but to enable the whole activity system to improve: that is, to evolve to be a better service for inquiry-based learning. Through interaction with, and feedback from, students involved in such inquiry-based learning activities, teaching staff can create shared representations of the network of tasks, tools, people *et cetera* that are implicated in the learning activities. They can agree on what needs changing and can anticipate some of the consequences of proposed changes. In short, they can engage in informed, collaborative redesign.

This multiplicity of goals — some immediate, some more expansive — and these recursive relations between service interfaces, is not a peculiar feature of education. Many areas of service co-production involve individual and organisational learning and change, accompanied by the reconfiguring of material and social arrangements in worksites. Our point is that analysing such examples from a learning perspective provides some sharper insights into the dynamism of the objects of service design.

7 Service innovation and (re)design from the inside

In the last part of this paper, we take a closer look at design processes for innovations in educational services where a strong role is taken by learners and others who co-produce educational services. We identify an emerging, loosely related, family of approaches to service innovation and (re)design that are particularly appropriate for this kind of service evolution. These share the following characteristics. Most importantly, they involve a commitment to action by a group of people. Secondly, they are 'insider' approaches, which place a high value on the active participation of people close to the service interface — including service users and service providers. This contrasts with 'outsider' approaches in which analysis and/or (re)design are done 'top down' by people who are not closely or personally involved in the service itself.[7] Thirdly, these approaches acknowledge the complexity of analysis and design: members of the group do not take for granted a shared understanding of the current state of affairs, or assume that the next steps to be taken are simple or self-evident.

In other words, all the approaches involve a commitment to group inquiry (individual and group learning), to the construction of a shared representation of the current state of affairs, and to making plans for action.

The approaches listed in Table 1 share many commonalities. They also contain some interesting variations. Firstly, there are variations in the extent to which analysis of the existing state of affairs is acknowledged to be complex: requiring special tools and/or representational methods to create a shared understanding of how things work, where the problems and opportunities are, what should be done next, etc. In some (simpler) situations, participants can rely on direct, everyday experience and sense-making to provide them with actionable insights into how things work, and what might be worth improving. Consensus depends on shared, taken-for-granted, understandings. In more complex situations, important elements and/or relationships are not so directly available to the senses, and investigative techniques may be needed to establish how the current state of affairs (system, network) is maintained. It may also be necessary to use representational techniques to create a shared description of the structure and functioning of the system (network) — to show important causal connections and dependencies, for example.

Table 1 A family of approaches to endogenous service innovation

	Approach	Sources
E	Action learning	Pedler, 2011
	Action research	Lewin, 1952
E	Community-based design research	Bang, Faber, Gurneau, Marin, & Soto, 2016
	Creative communities	Manzini, 2005
	Design anthropology (emic; etic)	Gunn et al., 2013
E	Design-based implementation research	Fishman, Penuel, Allen, Cheng, & Sabelli, 2013
E	Design-based research	Kelly, Lesh, & Baek, 2008
E	Expansive learning	Engeström & Sannino, 2010
E	Formative interventions	Engeström et al., 2014
	Formative/developmental evaluation	Patton, 2010
	Lean startup	Gong & Janssen, 2015
	Participatory design	Schuler & Namioka, 1993
E	Participatory design research	Bang & Vossoughi, 2016
	Participatory action research	Whyte, 1991
E	Practice-based research	Levy, 2003
	Rapid prototyping	Connell & Shafer, 1989
	Second order cybernetics;	Sweeting, 2016
E	Self-managing learning ecologies	Ellis & Goodyear, 2010
	Soft Systems Methods	Pries-Heje, Venable, & Baskerville, 2014;
E	Social design experiments	Gutiérrez & Vossoughi, 2010
	Theory-based/driven evaluation	Coryn, Noakes, Westine, & Schröter, 2011
	Transformation design	Burns, Cottam, Vanstone, & Winhall, 2006

Note: E in column 1 denotes an approach originating in, or best exemplified by, research and practice in education.

A second dimension of variation concerns the extent and complexity of the design and implementation work that may be involved in changing the system. Sometimes, steps are simple and obvious. In other situations, detailed plans may need to be developed, evaluated and modified before changes can be agreed and made.

A third dimension concerns the locus of power or control: whether it is more with service users or service providers.

Some of our own recent work includes an exploration of Soft Systems Methods by groups of people who are key stakeholders in the evolution of a learning network — though the approach is also of interest to other situations in which people need to collaborate to analyse and help improve the design of an educational, or other, service (Goodyear & Carvalho, 2016; Markauskaite & Goodyear, 2017). Neither Soft Systems Methods nor Second Order Cybernetics are new, but they are enjoying a resurgence in both education and design (Checkland & Poulter, 2006; Glanville, 2007; Ison & Blackmore, 2014; Pries-Heje et al., 2014; Sweeting, 2016).

In this type of approach, the people involved in collaboratively analysing and (re)designing a service observe and act from *within* the system of concern.[8]

Acknowledging that real-world systems and services are complex — that their components, inter-relationships, functions and emergent properties are not self-evident — means that the group needs to construct shared representations of the system/service. (There is a promising line of research to be pursued here into lay-people's visual representations of co-produced services. Segelström (2010) has researched service designers' uses of visualisations, but there is no vernacular equivalent.) Processes of systematic and systemic group inquiry are entailed in creating and testing such representations, which have a *pragmatic* function: they need to be good enough to support structured discussion and the making of design commitments.

Participants in a learning network, in contrast to those who are 'merely' consuming a well-understood, stable service, have a vested interest in understanding how the network functions. Its complexity means that neither the architecture nor the functioning of the network are self-evident: tools and processes are needed to render them comprehensible. Our closing claim — addressed to the wider service design community — is that finding ways of rendering complex services more visible and comprehensible to those who co-produce them can make a valuable contribution to service enhancement and innovation.

8 Concluding comments

This article has identified a number of connections between (a) ideas and methods in research on service design and innovation and (b) practical and theoretical developments in educational design and innovation. It has argued that education is a rich but neglected site for service design and innovation. The article has shown how some key developments in design for learning, and the learning sciences, question and extend conceptions of learning and co-production in service design and innovation. Our analysis of the architecture of productive learning networks shows how contemporary learning entails an entanglement of tasks, activities, roles, artefacts and spaces, illustrating ideas that can be applied in the co-learning and co-production of better service interfaces, practices and outcomes.

Notes

1. Masters programs specifically to train instructional designers date back to the late 1960s/early 1970s and there has been a steady stream of methodological texts and empirical studies of designers' activity running from the 1970s onwards. For a review of empirical research on the activities of educational designers, see Ertmer, Parisio, and Wardak (2013).

2. The concept 'situated' needs careful handling. In a learning network, a person can interact with digital resources and other people irrespective of their locations. The person's activity can be shaped remotely, one might think. However, a person's activity − including their perception and cognition − depends on a physically situated body. Interactions with remote others are mediated through local artefacts (screens, keyboards, phones, etc). So both local place and networked space(s) are important in understanding situated activity (Carvalho, Goodyear & De Laat, 2017). This is true of 'digital' services in general.

3. Although the ACAD framework also builds on Activity Theory, there are some important distinctions between the approaches. Activity Theory (Kaptelinin, 2005) insists that activity is always goal-oriented, while in ACAD, activity is defined as 'what the learner actually does' whether the action is goal-oriented or not. (Learning can be incidental as well as intentional.)

4. Once one makes this observation, it also soon becomes apparent that some other services are experienced in a similar way. Going to the dentist is a good case in point. Further reflection suggests that many instances of service provision are best thought of as sites for the resolution of conflicting forces: the work of traffic wardens, judges and jailers offering further food for thought.

5. 'Transmissionist' models of how education and learning occur come closest to the classic provider:client model. On this view, teachers transmit knowledge, which fills the students' (otherwise empty) heads. This model no longer commands much favour in educational research and practice, though it persists in some public and policy discourse about education. Learning is now more broadly understood as a set of processes in which students actively construct their own knowledge, drawing on resources − including but not limited to teachers − in their environment (Beetham & Sharpe, 2013). On this socio-constructivist view of learning, educational services are *always* co-produced.

6. This kind of design thinking involves careful consideration of likely functions of what can be designed and offered: a process made more uncertain, but also more worthwhile, by human predilections for improvising novel uses and practices (Crilly, 2010, 2013, 2015; Krippendorff, 2006; Vardouli, 2015).

7. People with special expertise in service analysis, service design, and/or the facilitation of group inquiry processes can, of course, play a useful role here. One thinks, for example, of Manzini's descriptions of productive interactions between 'diffuse' and 'expert' design − Manzini (2015). The key point concerns the quality of participant engagement and control.

8. This echoes the sentiment that socially responsible design means 'acting where you are' (Cipolla & Bartholo, 2014, p. 1). One also thinks of Latour's advice to designers to take an insider's perspective (Latour, 2008).

References

Aditomo, A., Goodyear, P., Bliuc, A.-M., & Ellis, R. A. (2013). Inquiry-based learning in higher education: Principal forms, educational objectives, and disciplinary variations. *Studies in Higher Education, 38*(9), 1239−1258.

van den Akker, J., Branch, R., Gustafson, K., Nieven, N., & Plomp, T. (Eds.). (1999). *Design approaches and tools in education and training*. Dordrecht: Kluwer.

Bang, M., Faber, L., Gurneau, J., Marin, A., & Soto, C. (2016). Community-based design research: Learning across generations and strategic

transformations of institutional relations toward axiological innovations. *Mind, Culture, and Activity, 23*(1), 1−14.

Bang, M., & Vossoughi, S. (2016). Participatory design research and educational justice: Studying learning and relations within social change making. *Cognition and Instruction, 34*(3), 173−193.

Barabási, A.-L. (2016). *Network science*. Cambridge: Cambridge University Press.

Baranova, P., Morrison, S., & Mutton, J. (2010). *Service design in higher and further education: A briefing paper*. CETIS, University of Derby.

Beetham, H., & Sharpe, R. (Eds.). (2013). *Rethinking pedagogy for a digital age: Designing and delivering e-learning*. RoutledgeFalmer.

Boder, A. (1992). The process of knowledge reification in human-human interaction. *Journal of Computer Assisted Learning, 8*(3), 177−185. https://doi.org/10.1111/j.1365-2729.1992.tb00402.x.

Borgatti, S., Everett, M., & Johnson, J. (2013). *Analyzing social networks*. London: Sage.

Borgatti, S., & Foster, P. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management, 29*(6), 991−1013.

Brown, T., & Wyatt, J. (2010). Design thinking for social innovation. *Stanford Social Innovation Review, 8*, 31−35.

Buchanan, R. (2001). Design research and the new learning. *Design Issues, 17*(4), 3−23.

Bucolo, S., & Matthews, J. H. (2010). Using a design led disruptive innovation approach to develop new services: Practising innovation in times of discontinuity. In *Paper presented at the proceedings of the 11th international CINet conference: Practicing innovation in the times of discontinuity, Zurich, Switzerland*.

Burns, C., Cottam, H., Vanstone, C., & Winhall, J. (2006). *Transformation design, RED paper 2*. London: Design Council.

Carlborg, P., Kindstrom, D., & Kowalkowski, C. (2014). The evolution of service innovation research: A critical review and synthesis. *The Service Industry Journal, 34*(5), 373−398.

Carvalho, L., & Goodyear, P. (Eds.). (2014). *The architecture of productive learning networks*. New York: Routledge.

Carvalho, L., Goodyear, P., & de Laat, M. (Eds.). (2017). *Place-based spaces for networked learning*. New York: Routledge.

Checkland, P. B., & Poulter, J. (2006). *Learning for action. A short definitive account of soft systems methodology and its use for practitioners, teachers and students*. Chichester: Wiley.

Cipolla, C., & Bartholo, R. (2014). Empathy or inclusion: A dialogical approach to socially responsible design. *International Journal of Design, 8*(2).

Cipolla, C., & Manzini, E. (2009). Relational services. *Knowledge, Technology & Policy, 22*(1), 45−50.

Connell, J., & Shafer, L. (1989). *Structured rapid prototyping*. Englewood Cliffs NJ: Prentice Hall.

Coryn, C. L., Noakes, L. A., Westine, C. D., & Schröter, D. C. (2011). A systematic review of theory-driven evaluation practice from 1990 to 2009. *American Journal of Evaluation, 32*(2), 199−226.

Crilly, N. (2010). The roles that artefacts play: Technical, social and aesthetic functions. *Design Studies, 31*(4), 311−344.

Crilly, N. (2013). Function propagation through nested systems. *Design Studies, 34*(2), 216−242.

Crilly, N. (2015). The proliferation of functions: Multiple systems playing multiple roles in multiple supersystems. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing, 29*(01), 83−92.

Cuban, L. (2001). *Oversold and underused: Computers in the classroom*. Cambridge MA: Harvard University Press.

Djellal, F., Gallouj, F., & Miles, I. (2013). Two decades of research on innovation in services: Which place for public services? *Structural Change and Economic Dynamics, 27*, 98−117.

Dong, A. (2014). Design x innovation: Perspective or evidence based practices. *International Journal of Design Creativity and Innovation, 3*(4), 148−163. https://doi.org/10.1080/21650349.2014.943294.

Donlan, L. (2014). Exploring the views of students on the use of Facebook in university teaching and learning. *Journal of Further and Higher Education, 38*(4), 572−588.

Dorst, K. (2015). *Frame Innovation: Create new thinking by design*. Cambridge, MA: The MIT Press.

Drejer, I. (2004). Identifying innovation in surveys of services: A Schumpeterian perspective. *Research Policy, 33*, 551−562.

Ellis, R., & Goodyear, P. (2010). *Students' experiences of e-learning in higher education: The ecology of sustainable innovation*. New York: RoutledgeFalmer.

Engeström, Y., & Sannino, A. (2010). Studies of expansive learning: Foundations, findings and future challenges. *Educational Research Review, 5*, 1−24.

Engeström, Y., Sannino, A., & Virkkunen, J. (2014). On the methodological demands of formative interventions. *Mind, Culture, and Activity, 21*(2), 118−128. https://doi.org/10.1080/10749039.2014.891868.

Ertmer, P., Parisio, M., & Wardak, D. (2013). The practice of educational/instructional design. In R. Luckin, S. Puntambekar, P. Goodyear, B. Grabowski, J. Underwood, & N. Winters (Eds.), *Handbook of design in educational technology* (pp. 5−19). New York: Routledge.

Felix, E. (2011). Learning space service design. *Journal of Learning Spaces, 1*(1). Retrieved from. http://libjournal.uncg.edu/jls/article/view/284/162.

Fishman, B., Penuel, W. R., Allen, A.-R., Cheng, B. H., & Sabelli, N. (2013). Design-based implementation research: An emerging model for transforming the relationship of research and practice. *Yearbook of the National Society for the Study of Education, 112*(2), 136−156.

Fullan, M., & Hargreaves, A. (Eds.). (2009). *Change wars*. Bloomington IN: Solution Tree.

Furlong, J. (2012). *Education − an anatomy of the discipline: Rescuing the university project?* London: Routledge.

Gagné, R. (1965). *The conditions of learning*. New York: Holt Rinehart & Winston.

Gallouj, F., & Weinstein, O. (1997). Innovation in services. *Research Policy, 26*, 537−556.

Gibbons, A. (2013). *An architectural approach to instructional design*. New York: Routledge.

Glanville, R. (2007). Try again. Fail again. Fail better: The cybernetics in design and the design in cybernetics. *Kybernetes, 36*(9/10), 1173−1206.

Gong, Y., & Janssen, M. (2015). Demystifying the benefits and risks of lean service innovation: A banking case study. *Journal of Systems and Information Technology, 17*(4), 364−380.

Goodyear, P. (2014). Productive learning networks: The evolution of research and practice. In L. Carvalho, & P. Goodyear (Eds.), *The architecture of productive learning networks* (pp. 23−47). New York: Routledge.

Goodyear, P., & Carvalho, L. (2013). The analysis of complex learning environments. In R. Sharpe, & H. Beetham (Eds.), *Rethinking pedagogy for a digital age* (2nd ed.). (pp. 49−63) London: Routledge.

Goodyear, P., & Carvalho, L. (2016). Activity centred analysis and design in the evolution of learning networks. In *Tenth International Conference on Networked Learning*. Lancaster: Lancaster University.

Goodyear, P., & Retalis, S. (Eds.). (2010). *Technology-enhanced learning: Design patterns and pattern languages*. Rotterdam: Sense Publishers.

Goodyear, P., & Steeples, C. (1998). Creating shareable representations of practice. *Association for Learning Technology Journal, 6*(3), 16−23.

Goodyear, P., Thompson, K., Ashe, D., Pinto, A., Carvalho, L., Parisio, M., et al. (2015). Analysing the structural properties of learning networks: Architectural insights into buildable forms. In B. Craft, Y. Mor, & M. Maina (Eds.), *The art and science of learning design* (pp. 15−29). Rotterdam: Sense.

Greeno, J., & Engeström, Y. (2014). Learning in activity. In K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (2nd ed.). Cambridge: Cambridge University Press.

Gunn, W., Otto, T., & Smith, R. (Eds.). (2013). *Design anthropology: Theory and practice*. London: Bloomsbury Publishing.

Gutiérrez, K., & Vossoughi, S. (2010). 'Lifting off the ground to return anew': Documenting and designing for equity and transformation through social design experiments. *Journal of Teacher Education, 61*(1−2), 100−117.

Harrison, A., & Hutton, L. (2014). *Design for the changing educational landscape: Space, place and the future of learning*. London: Routledge.

Hodder, I. (2012). *Entangled: An archaeology of the relationships between humans and things*. Chichester: Wiley-Blackwell.

Hodgson, V., de Laat, M., McConnell, D., & Ryberg, T. (Eds.). (2014). *The design, experience and practice of networked learning*. Springer International Publishing.

Hokanson, B., & Gibbons, A. (Eds.). (2014). *Design in educational technology: Design thinking, design process, and the design studio*. Dordrecht: Springer International Publishing.

Ingold, T. (2007). Materials against materiality. *Archaeological Dialogues, 14*(01), 1−16.

Ison, R., & Blackmore, C. (2014). Designing and developing a reflexive learning system for managing systemic change. *Systems, 2*(2), 119−136.

Jandric, P., & Boras, D. (Eds.). (2015). *Critical learning in digital networks*. Springer International Publishing.

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., & Hall, C. (2016). *NMC horizon report: 2016 higher education edition*. Austin, Texas: The New Media Consortium.

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2015). *NMC horizon report: 2015 K-12 edition*. Austin, Texas: The New Media Consortium.

Jones, C. (2015). *Networked learning. An educational paradigm for the age of digital networks*. Springer International Publishing.

Jones, C., Dirckinck-Homfeld, L., & Lindstrom, B. (2006). A relational, indirect, meso-level approach to CSCL design in the next decade. *International Journal of Computer-Supported Collaborative Learning, 1*(1), 35−56.

Kaptelinin, V. (2005). The object of activity: Making sense of the sense-maker. *Mind, Culture, and Activity, 12*(1), 4−18.

Kelly, A., Lesh, R., & Baek, J. (Eds.). (2008). *Handbook of design research methods in education: Innovations in science, technology, engineering and mathematics learning and teaching*. Mahwah NJ: Lawrence Erlbaum Associates.

Knappett, C. (2011). Networks of objects, meshworks of things. In T. Ingold (Ed.), *Redrawing Anthropology: Materials, movements, lines* (pp. 45−63). Ashgate.

Krippendorff, K. (2006). *The semantic turn: A new foundation for design*. Boca Raton FL: CRC Press.

Kuzmina, K. (2014). *Investigating opportunities for service design in education for sustainable development*. PhD thesis. Loughborough University.

Latour, B. (2008). A cautious Prometheus: A few steps towards a philosophy of design. In *Proceedings of the international conference of the design history society*. https://hal-sciencespo.archives-ouvertes.fr/hal-00972919/file/112-design-cornwall.pdf.

Levy, P. (2003). A methodological framework for practice-based research in networked learning. *Instructional Science, 31*(1−2), 87−109.

Lewin, K. (1952). *Field theory in social science*. New York: Harper & Bros.

Maffei, S., & Sangiorgi, D. (2006). From communication design to activity design. In J. Frascara (Ed.), *Designing effective communications: Creating contexts for clarity and meaning* (pp. 83−100). New York NY: Allworth Press.

Manzini, E. (2005). Enabling solutions for creative communities: Social innovation and design for sustainability. *Design Matters, 10*(1), 45−52.

Manzini, E. (2015). *Design, when everybody designs: An introduction to design for social innovation*. Cambridge MA: MIT Press.

Margolin, V., & Margolin, S. (2002). A 'social' model of design: Issues of practice and research. *Design Issues, 18*(4), 24−30.

Markauskaite, L., & Goodyear, P. (2017). *Epistemic fluency and professional education: Innovation, knowledgeable action and actionable knowledge*. Dordrecht: Springer.

McKenney, S., & Reeves, T. (2012). *Conducting educational design research*. Abingdon: Routledge.

Miles, I. (2005). Knowledge-intensive business services: Prospects and policies. *Foresight, 7*(6), 39−63.

Miles, I. (2008). Patterns of innovation in service industries. *IBM Systems Journal, 47*(1), 115−128.

Moen, A., Mørch, A., & Paavola, S. (Eds.). (2012). *Collaborative knowledge creation: Practices, tools, concepts*. Rotterdam: Sense.

Ng, I. C. L., & Forbes, J. (2009). Education as service: The understanding of university experience through the service logic. *Journal of Marketing for Higher Education, 19*(1), 38−64.

OECD Centre for Educational Research and Innovation. (2016). *Trends in education*. Paris: OECD.

Oplatka, I. (2004). Marketing informal education institutions in Israel: The centrality of customers' active development in service development. *The International Journal of Educational Management, 18*(6/7), 417−424.

Osborne, S. P., Radnor, Z., Kinder, T., & Vidal, I. (2015). The SERVICE framework: A public service dominant approach to sustainable public services. *British Journal of Management, 26*, 424−438.

Paavola, S., Lakkala, M., Muukkonen, H., Kosonen, K., & Karlgren, K. (2011). The roles and uses of design principles for developing the trialogical approach on learning. *Research in Learning Technology, 19*(3), 233−246. https://doi.org/10.1080/21567069.2011.624171.

Pacenti, E., & Sangiorgi, D. (2010). Service design research pioneers. An overview of service design research developed in Italy since the '90s. *Design Research Journal, 1*(10), 26−33, Ges Ut Av Svid, Stiftelsen Svensk Industridesign, from http://www.svid.se/upload/Forskning/Design_Research_Journal/Design_Research_Journal_nr_1_2010/DesignResearchJournal_nr_1_2010.pdf.

Papanek, V. (1985). *Design for the real world: Human ecology and social change*. Chicago: Academy Chicago Publishers.

Patton, M. (2010). *Developmental evaluation: Applying complexity concepts to enhance innovation and use* (3rd ed.). New York: Guilford.

Pedler, M. (Ed.). (2011). *Action learning in practice* (4th ed.). London: Gower.

Pries-Heje, J., Venable, J., & Baskerville, R. (2014). Soft design science methodology. In J. Simonsen, C. Svabo, S. Strandvad, K. Samson, M. Hertzum, & O. Hansen (Eds.), *Situated design methods* (pp. 77–95). Cambridge MA: MIT Press.

Radnor, Z., Osborne, S. P., Kinder, T., & Mutton, J. (2014). Operationalizing co-production in public services delivery: The contribution of service blueprinting. *Public Management Review, 16*(3), 402–423.

Reiser, R. A. (2001). A history of instructional design and technology: Part 1: A history of instructional media. *Educational Technology Research and Development, 49*(1), 53–64.

Romiszowski, A. (1981). *Designing instructional systems*. London: Kogan Page.

Ryberg, T., Sinclair, C., Bayne, S., & de Laat, M. (Eds.). (2016). *Research, boundaries, and policy in networked learning*. Springer International Publishing.

Sangiorgi, D. (2009). Building up a framework for service design research. In *Paper presented at the 8th European academy of design conference, Aberdeen*.

Sangiorgi, D. (2011). Transformative services and transformation design. *International Journal of Design, 5*(2), 29–40.

Sannino, A., Daniels, H., & Gutiérrez, K. (Eds.). (2009). *Learning and expanding with activity theory*. Cambridge: Cambridge University Press.

Schuler, D., & Namioka, A. (1993). *Participatory design: Principles and practices*. Hillsdale New Jersey: Lawrence Erlbaum Associates.

Secomandi, F. (2013). Thinking through the service interface: A study of Philips Direct Life. *Design Philosophy Papers, 11*(1), 65–88.

Secomandi, F., & Snelders, D. (2011). The object of service design. *Design Issues, 27*(3), 20–34.

Secomandi, F., & Snelders, D. (2013). Interface design in services: A postphenomenological approach. *Design Issues, 29*(1), 3–13.

Segelström, F. (2010). *Visualisations in service design*. PhD. Linköping: Linköping University, The Institute of Technology. Retrieved from. http://liu.diva-portal.org/smash/record.jsf?pid=diva2:354845&rvn=1.

Shostack, G. L. (1977). Breaking free from product marketing. *American Marketing Association, 41*(2), 73–80.

Snelders, D., van de Garde-Perik, E., & Secomandi, F. (2014). Design strategies for human relations in services. In *Paper presented at ServDes 2014: Fourth service design and innovation conference, Lancaster UK*.

Spronken-Smith, R., Walker, R., Dickinson, K., Closs, G., Lord, J., & Harland, T. (2011). Redesigning a curriculum for inquiry: An ecology case study. *Instructional Science, 39*(5), 721–735. https://doi.org/10.1007/s11251-010-9150-5.

Star, S., & Ruhleder, K. (1996). Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information Systems Research, 7*(1), 111–134.

Suchman, L. (1987). *Plans and situated actions. The problem of human-machine communication*. Cambridge MA: Cambridge University Press.

Svihla, V., & Reeve, R. (2016). *Design as scholarship: Case studies from the learning sciences*. New York: Routledge.

Sweeting, B. (2016). Design research as a variety of second-order cybernetic practice. *Constructivist Foundations, 11*(3), 572–578.

Toivonen, M. (2004). *Expertise as business: Long-term development and future prospects of knowledge-intensive business services (KIBS)*. Unpublished PhD thesis. Finland: Helsinki University of Technology.

Toivonen, M., & Tuominen, T. (2009). Emergence of innovations in services. *The Service Industries Journal, 29*(7), 887−902.

Vardouli, T. (2015). Making use: Attitudes to human-artifact engagements. *Design Studies, 41*, 137−161.

Verganti, R. (2008). Design, meanings, and radical innovation: A metamodel and a research agenda. *Journal of Product Innovation Management, 25*, 436−456. https://doi.org/10.1111/j.1540-5885.2008.00313.x.

de Vries, E. (2006). Innovation in services in networks of organizations and in the distribution of services. *Research Policy, 35*, 1037−1051.

Wenger, E. (1998). *Communities of practice: Learning, meaning and identity*. Cambridge: Cambridge University Press.

Wenger, E., Trayner, B., & de Laat, M. (2011). *promoting and assessing value creation in communities and networks: A conceptual framework*. *Heerlen*.

Whyte, W. F. E. (1991). *Participatory action research*. Thousand Oaks, CA: Sage Publications, Inc.