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On the Misappropriation of Spatial Metaphors in Online Learning

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Abstract
In online educational systems, teachers often replicate pedagogical methods, and online institutions replicate systems and structures used by their in-person counterparts, the only purpose of which was to solve problems created by having to teach in a physical environment. Likewise, virtual learning environments often attempt to replicate features of their physical counterparts, thereby weakly replicating in software the problems that in-person teachers had to solve. This has contributed to a vicious circle of problem creation and problem solving that benefits no one. In this paper I argue that the term 'environment' is a dangerously misleading metaphor for the online systems we build to support learning, that leads to poor pedagogical choices and weak digital solutions. I propose an alternative metaphor of infrastructure and services that can enable more flexible, learner-driven, and digitally native ways of designing systems (including the tools, pedagogies, and structures) to support learning.

Keywords: online learning, learning environment, learning management system (LMS), Next Generation Digital Learning Environment (NGDLE), personal learning environment (PLE), learning infrastructure

Introduction

For those with Internet access, online learning is likely more prevalent than its in-person counterpart, as at least the first port of call and, often, as the primary means through which it occurs. From Google Search to Wikipedia, from YouTube tutorials to Twitter exchanges, we learn online without complaint. However, many academics and students still see online *education* as a poor second-best to in-person education (e.g., Protopsaltis & Baum, 2019; Bouygues, 2019; Tichavsky, Hunt, Driscoll, & Jicha, 2015). I will argue in this paper that this is often the result of institutional online teaching inadequately attempting to replicate features and forms of in-person teaching, many of which:

1. Exist to solve problems caused by the distinctive physical, temporal, psychological, and economic limitations of material spaces, and
2. Are successful mainly as a result of the features and forms of the physical setting, not as a result of intentional teaching.

Consequently, the online systems we develop rarely take full advantage of the medium, seldom exploit the physical context of the students, and often attempt to solve problems that should not exist at all. Frequently, online teaching may therefore actively militate against effective learning. Some issues may be solved using pedagogical adjustments in teaching and organizational changes at an institutional level. However, many emerge from the electronic systems that we use to teach, that (I will argue) poorly mimic the functions of their in-person counterparts in software. I will suggest that this is, to a significant extent, due to the misappropriation of spatial metaphors that should not be applied to online systems. I propose a different approach to the construction and conceptualization of tools for online learning, that better utilizes the affordances of online learning, and that more fully supports the needs and circumstances of both online students and online teachers. I conclude by putting the pieces together and suggesting ways that, in combination, pedagogical, organizational, and digital changes may co-evolve to achieve the potential transformation of education that is afforded by digital networked devices.

Blurred Boundaries

Virtually all of what we describe as in-person education is also at a distance. Some actually occurs *inside* a classroom: textbook authors, say, or curriculum designers are also (distance) co-teachers. However much of the learning itself occurs outside the classroom, from assignments and homework to personal sense-making reflection, to conversation and interaction with others in spaces such as corridors, common rooms, cafes, libraries, and computer labs, all of which may make material contributions to guiding activities leading to learning (Ellis & Goodyear, 2016). Physical institutional environments are active participants in this distributed learning process, enabling, structuring, connecting, and guiding (Dron, 2022). As Goodyear & Carvalho (2019) put it, “matter matters”. Learners see others learning around them, and inhabit spaces designed to support learning, whether through conversation, reflection, or study. Libraries are rich distance teaching technologies, in organization, furnishings, tools, and content, but so too are student kitchens and smokers’ areas, where countless learning conversations occur. Even something as simple as walking to a classroom adds salience to an event that clicking a link on a web page never can, due to (at least) the greater effort needed to get there, the change in environment and consequent cues to memory, the inherent spacing it entails, the time for reflection it affords, and the benefits to recall of the physical activity involved (Salas et al., 2011; Skulmowski & Rey, 2017). Institutional structures and processes teach, too. Credentials and grades, for example, though antagonistic to

persistent intrinsic motivation (Blum & Kohn, 2020; Ryan & Deci, 2017) encourage students to make use of whatever means they can – including those many other teachers as well as cheating or satisficing – to succeed. Physical spaces can only support a finite number of students, so competitive selection processes result in students who have already proven that they are proficient learners, and can play at least some of the teaching role themselves. Consequently, in-person teaching does not always *have* to be great, because much of the teaching is done by others, mediated through the powerful and well-evolved learning technologies of physical institutions.

In the classroom itself, however, the in-person teacher is, by default, expected to be the locus of control of each second of what happens, albeit that there may be significant complexity in this exchange in real life (Goodyear & Carvalho, 2019), and there are many things that the teacher may do to delegate control to students along the way (Dron, 2007). There is a strong implied expectation that, if a teacher has a timeslot to fill, they should fill it, and everything about the structure and process, from the placement of podia to timetabling and rules contrives to emphasize their dominant role. Students therefore have limited autonomy if (as is usually the case) they are required to attend and conform to rules and norms. They are typically expected to learn much the same things at the same time, so some will be bored and some will be confused, making it difficult to meet their competence needs. Autonomy and competence are two of the three necessary foundations for intrinsic motivation, the third being relatedness (Ryan & Deci, 2017). There are many ways to deal with this, and so the emblematic pedagogies of in-person teaching have therefore evolved to address the fundamental motivational problems the context creates, including ways of avoiding inherent learner disempowerment, ways of supporting personal needs and interests, and ways of exploiting the huge social benefits of many people sharing the same place at once. Equally, many approaches have evolved that are 'good enough' given the broader learning context, from rewards and punishments for attendance or compliance, to lectures.

On the whole, and notwithstanding counter-examples of online proctoring and some immersive systems, the online teacher *cannot* so directly control the minute-by-minute activities of an online student, any more than a writer of a book can control a reader. Except in synchronous simulacra of online classrooms, the student can usually choose when, where, and at what pace they learn. However, many online teachers assume that (despite the absence of physical constraints that required it) they should dictate the learning process as much as their in-person counterparts and so adopt coercive methods like frequent grading, draconian scheduling, and tests. They struggle to find workarounds for the affordances of physical, that the learner is going to follow the path that they have determined for them. To make matters worse, educational institutions often impose other structures that result from constraints of teaching in physical classrooms, such as fixed-length courses, deadlines, semesters, timetables, cohorts (Dron, in press; Dron, 2016) and, perhaps most perniciously, the concept of failure. Failure is a critical part of learning (Alfi et al., 2004). It only becomes a terminal outcome thanks to the need to manage limited time, space, and resources in physical environments, with consequent needs for schedules with beginnings *and* ends.

When all such factors are combined, the online student may have little more independence than their in-person counterpart, may suffer many of the same disadvantages but, at the same time, may lack the countless structures, forms and processes of physical institutions that provide much of the teaching for in-person students.

The Promise of Online Learning Environments

In-person, classrooms present non-negotiable problems that our pedagogies have to solve, and/or opportunities that they can exploit. Online, there are countless tools available and, if none are suitable, it is not so difficult or expensive to build them or to modify them to suit our needs. The literature in the field of online learning provides at least hundreds of thousands of examples of teachers experimenting successfully with countless digital technologies across the educational landscape. During the COVID-19 pandemic, a vast proliferation of different technologies was used by emergency online teachers, from Facebook to virtual reality systems (Zhang et al., 2022). These are, however, anomalies. In a Canadian national survey conducted in 2019, 84% of online courses made extensive use of learning management systems, while the next most popular tools (streamed lectures) were extensively used in only 23% of cases (Johnson et al., 2019). Many other tools are used, but the numbers suggest limited uptake: social media are extensively used in only 6% of institutions, adaptive learning in 4%, while AI and extended reality (XR) are widely used in less than 1% (ibid). There are many possible reasons that explain this highly skewed pattern, such as:

- Teachers' lack of knowledge of the options;
- Teachers' lack of skill in using them;
- Lack of time and/or money for development;
- Institutional mandates or student demands to standardize tools;
- Costs and difficulties in management of the digital systems;
- Cognitive load involved for learners in adapting to the metaphors, signposts, and methods needed to use the tool itself.

These are consequences of the same diversity that would make us want to use different applications in the first place. It is a classic Faustian Bargain (Postman, 1998) in which a technology that solves one problem creates new problems to solve. Every digital system must establish rules of engagement that its users must learn, such as the ways that navigation occurs, the ways to make it perform its functions, the terminology it uses, and so on. In effect, every application invents its own metaphorical physics. That makes virtual systems harder to find out about, harder to learn, harder to develop, costlier to manage, and more difficult to navigate than the static, fixed facilities found in particular physical locations. They are all different, there are few if any universals, and any universal today may become a conditional tomorrow.

The LMS

Learning management systems (LMSs) partly address such issues by automating the functions, though not exactly the form, of traditional classrooms. Indeed, they are typically seen *as* environments. In some parts of the world, they are called 'managed learning environments' (MLEs), and the LMS/MLE is the most dominant representative of a larger category of virtual learning environments (VLEs) that also includes things like multi-user dungeons, immersive learning environments, and simpler web-based tools like Google's or Microsoft's Classroom. While many other metaphors might be used instead (Farrelly et al., 2020), the almost ubiquitous use of spatial metaphors for the names of such systems reflects a tacit assumption that the

virtual systems can provide the boundaries within which learning activities occur, in ways that are broadly analogous to those of physical spaces. Creators of early LMSs and VLEs back in the 1990s (including the author) incorporated the entities found in the traditional institutions from which they sprang and chose organizational metaphors to match. Metaphors matter, shaping how we think (Lakoff & Johnson, 1980) and, perhaps, how we *may* think (Hofstadter & Sander, 2013).

The LMS is, however, an unusual school. It has no metaphorical corridors, halls, common rooms, canteens, yards, libraries or any of the other parts of a typical university environment where students gather to learn or, if it does, they are weak shadows of their physical counterparts. Students rarely get to even be aware of other classrooms beyond those they are in. Some teachers may give classrooms informal-sounding names like 'the learning café' but they work like the rest. Students teleport from one classroom to the next, with none of the rich learning spaces between them.

When physical classrooms are modified, the effects are local to that particular space. In LMSs, every course gets its own instantiation of a single centrally hosted codebase, so changes or errors in that code affect everyone. Worse, one set of features must suit all. If, say, a teacher wants a discussion component that does things the default discussion component does not support, then it has to be installed or integrated in the centralized code base. Wise system administrators usually do not allow this, because component is another potential source of failure or (often) security holes, incurs significant management costs, uses system resources, and increases the complexity of the system for everyone. They are averse to technical debt (Kruchten et al., 2012) and wary of the inevitable escalation of counter-technologies (Dubos, 1969), each bringing its own additional burdens. Consequently, most available features must be compromises that are rarely ideal for anyone.

Software is inherently non-rival, but cloud-based and closed systems create artificial scarcity that is worse than its physical counterpart, that can be withheld at any time, but that locks institutions in, due not just to the data imprisoned in the system but also to investments in training and integration with other systems, the costs of which usually dwarf that of the software itself. Open source LMSs reduce the data lock-in concerns but do not eliminate other forms of lock-in, while introducing new problems of maintenance of their own (Giera & Brown, 2004).

LMS users typically have programmatically enforced, inflexible hierarchical roles. In a physical classroom a teacher *may* lead, but many choose to at least share leadership with their students, often fluidly and in response to how students are learning. In an LMS, a teacher (or someone with that role) *must* lead. Even in more egalitarian discussion forums, teachers may delete unwanted messages, prevent replies, stop discussions, and do much that would take superhuman capabilities in a physical space. In principle, the teacher's power is confined to a small part of the learner's *own* environment, not to a whole classroom. In practice, however, teachers still tend to treat the forum as an analogue of the classroom and, recognizing the value of dialogue in such contexts, often resort to coercion to make it happen online, giving marks for discussion contributions. Most LMSs directly support such marking. This ill-conceived combination of hard, role-based digital authority and hard, reward-based pedagogy creates a power distance that compounds what is already a less immediate relationship between student and teacher.

Within the LMS the teacher sees things that students cannot, and controls things that the students may not. It can be made to behave differently, but it almost never is, because doing so usually involves subverting the role hierarchy, with all its associated risks and management

complexity. Risks to every user of the system must be considered, so everyone suffers. It is also an embodiment of a necessarily centralized system (Weller, 2009) so, often, the thought of changing these defaults does not even arise.

The LMS classroom metaphor is imprecise, inasmuch as its fundamental units of organization are rarely called classrooms: they are called *courses* (or sections, modules, units, papers, etc.), speaking to the fact that computer systems embody processes as much as they embody structures. LMS functions are mostly based on loose, superficial observations of the things that teachers and students seem to *do* in physical classrooms, analysed to their component parts, such as presenting, discussing, assessing, guiding, and so on. For instance, if you want to talk with someone, you normally need to go to a separate discussion area. Equally, if you want to take a test, or to share your work with others, it normally involves navigation to a different page.

Similarly, lectures are either literally that (video recordings of lectures) or text and images to be read on screen that replicate lectures' information transmission function, which is perhaps their least useful role (Greene, 1928). In-person lectures can and do have value as physical and temporal signposts, as events that gain salience from attendance, and as opportunities to engage with others, at least outside the lecture hall. Online, there is seldom a chance for students to even put up a metaphorical hand to question the teacher, and 'joining' a lecture is no more salient than clicking any other link. It may as well be unpopulated, given the little students see of one another. Learning resources are typically static and designed in advance, and so the teacher cannot nimbly adjust to student reactions to them. Classroom timetables are embodied in software despite the fact that a rigid and unforgiving timetable makes little sense in a medium that supports learning anywhere, any *time*.

The LMS is full of metaphorical robots. Adaptive systems act as gatekeepers that prevent students from moving on to the next section of work before completing the current one, or they prevent students from submitting work before or after a specified date (Martin, Chen, Moore, & Westine, 2020). Other systems might even mark your work (Keuning, Jeuring, & Heeren, 2018). Human beings have grown up with other humans and therefore understand the context of the work, the motivations of the students, and the many different ways that things can go wrong, as well as creative and unexpected ways they can go right. Robots – even those that are employ deep learning and similar AI approaches - do not and, as many have argued, cannot (e.g.Goertzel, 2014). While hard, mechanistic systems may be useful for providing feedback when students must play their role correctly in hard, mechanistic systems (in hard, 'right answer' subjects), such hard skills are seldom the most important part of what they learn (Dron, in press). Human teachers do not (or *should* not) just judge success or failure: they should model practice, remedy misconceptions, provide encouragement, and so on (Lunenberg et al., 2007). Robots make poor role models, whether because of their imperfections or their inhuman, tireless, over-timely, relentlessly cheerful perfection (Goel & Polepeddi, 2019).

There are metaphorical surveillance cameras everywhere, recording students' every move (in *very* low, error-prone resolution), often only accessible to those with more powerful roles, though sometimes a robot or two might give them a filtered view of it, such as through learning analytics traffic-light interfaces (Verbert, Duval, Klerkx, Govaerts, & Santos, 2013). The perpetrators of these tools may claim to have student interests in mind, and will often talk of 'personalization' by way of justification, but it is not personalization at all: it is system-enforced customization done *to*, not *by* the students (Kohn, 2015). It is often an attempt to embody in software the same kind of control that is demanded of an in-person teacher due to an accident of physics (Dron, 2016), not for any pedagogical purpose.

A student can rarely go back and visit when their course is over because most online courses have opening and closing enrolment dates. Again, this is because physical classes are scheduled and terms come to an end because they *must*, not because it makes pedagogical sense. Like almost everything, it is possible to override this default, but hardly anyone does, partly because it brings back those Faustian bargains, but mainly because most people accept defaults (Kelly, 2009, Dron, 2006). LMSs embody enrolment technologies as much as they do teaching technologies and, in the process, they unnecessarily limit potential for learning, and make failure a possible outcome.

Classroom metaphors work poorly for ways of teaching that have no classes, such as self-paced courses, or individual projects. Odd phenomena follow, such as students engaging in discussions with 'classmates' who are no longer there, and the impossibility of collaboration when every student is at a different point in the course (Anderson & Dron, 2018). More challengingly, and unlike teacher-paced courses in which the teacher can modify almost any aspect of the content or curriculum at will, knowing that the whole class will be affected in the same way, confusion may arise when changes are made to materials that may already be in use by existing students.

In brief, most LMSs normally provide an automated set of metaphorical classrooms that harden many side-effects and assumptions of in-person teaching in software. Often, they create new laws, new kinds of structure, and new kinds of hardened process that can be embodied in code. Classrooms solved problems of physics for in-person teaching and form part of a much larger structure that has evolved to teach reasonably well. LMSs focus primarily on teaching roles and functions. They empower the teacher in ways that caricature their already excessive dominance in the classroom, that are largely a consequence of the nature of the physical space and the constraints it imposed.

In their favour, the metaphors on which LMSs are based bear enough resemblance to physical reality to be readily understood by teachers and students. They usually provide just enough configurability and flexibility to provide adequate teaching tools, for everyone, almost regardless of digital proficiency. They more or less address the Faustian bargains listed earlier, albeit by stifling what we wanted and should have been able to do in the first place with online tools. In the process they create new and quite extensive problems, as well as failing to replicate most of what makes physical universities work in the first place. Virtual learning environments are only ever *parts* of physical environments. They occupy space within the learner's own physical environment, but it is rare for pedagogical designs to even acknowledge this, let alone to consider it in the design. It is possible to subvert or bypass most of their failings (at the very least, hyperlinks can lead to other systems) and for learning designers to make productive use of their constraints, but it goes against their grain and increases the cognitive and management costs to do so.

Making the LMS More Like a Classroom

An obvious solution to such problems would be to make the LMS more closely resemble the physical environments on which it is modeled. However:

1) physical environments create constraints and problems to solve that are unnecessary and avoidable in virtual systems; and

2) it is not practical nor is it within our technical reach to replicate all the many incidental benefits of physical environments.

Most notably, virtual spaces are not *just there*: students will not pass one another in a corridor on their way to somewhere else or be there for other reasons, like a need for rest or refreshment. They must intentionally visit, with a purpose in mind. That said, there are lessons to be learned from physical spaces. Among many improvements that *could* fruitfully be made to existing LMSs would be:

1) To make every part of the system at least potentially social: to allow synchronous and/or asynchronous dialogue to occur on every page or screen of the system. This is the default in all physical spaces: talking has to be prohibited if it is not wanted. It would not be difficult to create plugins, modules, or building blocks to provide this.

2) To allow at least some parts of the system to be free of roles, or with more flexible roles, allowing all members of the system to create and share posts and resources using discretionary access control (so it is the poster's responsibility to choose who can see it, and who can change it). Even in highly controlled physical environments, we choose what we reveal and to whom. This difficult to achieve due to the hierarchical security model on which almost all LMSs are based. A deliberately 'demilitarized' area, however, akin to Drupal's Organic Groups feature, in which roles no longer apply, might offer a partial solution, albeit constrained to one course or course-like space.

3) To support the blurring of boundaries between areas, tools, and features of the site, so that courses are just one of many kinds of organizational unit, with selectively permeable boundaries through which others can pass, or with which they can overlap. Again, this is a default in physical spaces, that leak information through walls, floors, windows, and doors, that exhibit continuity of engagement when people enter or leave classrooms, that allow teachers to open doors to others, that admit a multiplicity of primary uses. This is the among the most difficult of problems to solve, due to the combination of role-based security and the architectural centrality of the course in almost all LMSs

However, though the LMS can be made to more closely resemble its physical counterpart, it is important to remember that educational systems, as we know them, have evolved over millennia as a set of solutions to problems and opportunities created by the constraints and affordances of physical spaces (Dron, 2016). Rather than recreating those constraints and affordances so that existing solutions work better with them, it may be more fruitful to rethink those solutions altogether.

Improving the metaphor

Systems designers naturally look to existing practices, and ask existing practitioners about the spaces they need and the stuff they do in them, or observe them doing stuff in those spaces. 'Space' and 'stuff' are, as it happens, what Stewart Brand (1997) describes as inevitably being the fastest-changing, most volatile parts of any physical building, after site (its physical limits), structure (what holds it up), skin (mainly the external walls), and services (electricity, gas, network wiring, etc). More abstractly, this structural principle applies as much to ecosystems and educational systems as it does to buildings. As Brand himself observes, drawing from O'Neill, DeAngelis, Waide, & Allen (1986), the larger, slower-changing elements of any system affect the smaller, faster-changing more than vice versa. In physical spaces, these naturally tend to be bigger and/or more difficult to change. Size seldom matters that much in virtual spaces, but hardness (inflexibility, brittleness), often resulting from aforementioned issues with centralization, roles, and investments in content and training, has the same effect. The more difficult it is to make changes, the more an element of the system determines the behaviour of

other elements that interact with it, especially when it also acts as a container. The structure, skin and services of the LMS were designed based on needs determined by the physical environments from which they sprang, with all the inherited baggage that occurred as a result of mediaeval monks' solutions to effective dissemination of doctrine (Dron, 2016). Consequently, they not only replicate but reinforce the same patterns of teaching and learning. However, because the metaphor is so loose and there are none of the highly evolved counter-technologies and supports that make in-person learning successful despite itself, the results are often disappointing.

Some students do succeed because they are always the most important teachers in any learning transaction, and they can often fill in the many gaps left by intentional teaching. However, too many drop out, too many do not even start, and distance education continues to be seen as a poorer (if more convenient) cousin to its in-person counterpart.

In order to break out of this vicious cycle, a good starting point would be to disaggregate the space and stuff from the structure and skin that surround it, so that what we do is no longer constrained by a single ossified hierarchy but can be made to fit different environments and structures.

Stripped to their essentials, digital systems for education provide services, consisting of tools that may be used to support learning, teaching, accreditation, and other roles and functions of an educational system. There is no good reason that these services should be confined to loose approximations of their physical counterparts, nor is there any good reason that teachers or system administrators should be the only ones to control them. Microservice digital architectures that support such systems are quite mature, and widely implemented in different fields, if not so much within the educational sector. From the point of view of end users, these can be thought of as assemblable components, and the assemblies can be performed by anyone, including students. Ideally, it should be possible to integrate them with other applications and services offered beyond an institution, including on students' desktops. Such components should be assemblable into units with value in the system, that can themselves be assembled into other components. This provides a path for evolution from existing approaches because some of those assembled units might include courses.

Such services are not environments but infrastructure that exists within and between the different environments that learners, teachers, administrators, and technicians occupy both virtually and in person. Non-exclusively, such infrastructure may minimally support needs such as:

- Dialogue and interactions between participants
- The presentation and curation of content
- Assessment, formal and informal
- Sharing of words, images, video, audio, and other document types
- The formation of groups, networks, and sets (social gatherings around shared interests or other commonalities)
- Sharing of tools and resources
- Etc.

What matters most is that all of these services can be combined in indefinitely many ways, by anyone.

This is not a new idea. In the early 2000s, the ELF (e-learning framework) and OKI (Open Knowledge Initiative) both attempted to provide ways to assemble services (ELF) or components (OKI) in many different ways to build a flexible learning environment (Dagger et al., 2007). However, for the most part, both of these initiatives were firmly focused on building centralized systems that replicated the functions of an LMS, so they carried forward the assumption that what would be built from the components would be teaching environments; a better LMS, but still an LMS.

Driven by similar intents, the concept of the personal learning environment (PLE) also became popular in the early 2000s, though with very many quite radically different interpretations (Martindale & Dowdy, 2010), ranging from institutionally controlled systems that were often described as 'platforms' (Yen et al, 2019) to collections of applications and services assembled by a learner on their own desktop in an ad hoc fashion (Wilson, 2008). Though some of the promoters of the concept saw the environment as extending beyond virtual systems, most saw the PLE as only digital tools. Again, the 'environment' metaphor was misleading. The PLE was also, for the most part, a concept, not a technology, though efforts were made in some circles to create standards for mashing up those tools, most notably through work on ELF which was, by some, seen as the VLE of the future (Wilson, 2005, cited in Martindale & Dowdy, 2010), and a number of systems were built that were described as PLEs, but that were essentially another kind of institutionally managed server. A more promising set of standards, that focused on the development of standards-based widgets that could be assembled by individuals as well as within an LMS or other system (Wilson, Sharples & Griffiths, 2008), failed to gain momentum, despite endorsement of the widget specification by the W3 Consortium, and implementations within all major operating systems. Meanwhile, the term 'PLE' itself became such an amorphous concept that even conversations about it were difficult to sustain, let alone useful implementations.

In recent years, the Educause organization has promoted the Next Generation Digital Learning Environment (NGDLE), which is essentially very similar in purpose and approach to the earlier ELF initiative, but that:

1) Takes into account the possibility of learners assembling their own digital toolsets;
2) Incorporates developments in analytics and artificial intelligence, and
3) is largely agnostic to standards used for its implementation, although it does recommend standards and protocols such as xAPI, LTI, learning record stores, and Caliper to help bind services together (Brown, Dehoney, & Millichap, 2015).

Combining the best ideas from service-based systems and work on PLEs, the initiative shows promise. While, again, the 'environment' metaphor fails to extend into the actual spaces that it is intended to be deployed, the initiative is a genuine move beyond the teacher-centric, classroom-inspired models of the LMS and towards a student-oriented service-provision model. There are now some implementations of the concept. For example, the OERu aggregates a wide assortment of open source tools systems providing services such as discussion, microblogging, blogging, wikis, social bookmarking, and so on, that can be used independently by students or as part of the university's own system (Lane & Good, 2019). While these are still largely

perceived as an environment composed of environments, the potential for such a design approach is to eventually free us from the traditional classroom metaphors of the LMS.

Institutional Teaching Beyond Virtual Environments

Although distance teaching and distance education are possible, there is no such thing as distance or online *learning*: it all occurs where the learner is situated. A distance learner's environment is never digital, though digital tools and services can comprise important parts of it. An infrastructure is not just the digital tools but also the human-enacted methods (including pedagogies), rules, protocols, and standards that accompany it. It is not just what we use, but the ways that we use it. And there are other people in that environment, virtually mediated and not. It is natural to focus mainly on the software and hardware when designing an online system to support learning, and thus to come to think of it as providing the learning environment itself. If, instead, we remember that we are only building tools to use in the learner's own environment, that they are parts of rich, complex, social systems, and that we are just providers or curators, not controllers or managers of the environment, then a critical and oft overlooked design principle becomes clear: that online students are always the primary orchestrators of their own learning (Dron, 2022). How, therefore, should teachers in institutions teach, when they are just parts of someone else's environment, and what kinds of digital tools and systems are needed to support that?

As I observed earlier, traditional classrooms and surrounding educational infrastructure (most notably credentialling demands) are inherently antagonistic to intrinsic motivation thanks to the innate limitations on autonomy and support for competence needs that they entail and embedded extrinsic motivation they rely upon. Much of what we traditionally recognize as good pedagogy is thus concerned with restoring such motivation through careful and caring learning design and practices, or, too often, replacing it with extrinsic motivation, which assures compliance at the cost of being even more antagonistic to intrinsic motivation (Ryan & Deci, 2017). A learning infrastructure should therefore not mindlessly attempt to replicate the form and structure of a traditional classroom, nor should it solely support teachers in assembling the tools needed for their teaching. The focus – both digitally and pedagogically – *can* (and, I think *should*) be on making it possible for learners to assemble the services into their environments themselves, in order to avail themselves of the support they need, when they need it, for the purposes they intend, at their own pace. The processes, methods, techniques, tools, and structures that students bring with them into that place are at least as important as those created by their teachers. A learning infrastructure needs to support these aspects at least as much as the interconnections between software tools.

Pedagogically as well as digitally, there may be a need to support students in making the best use of all of that, for instance to search well, to find people that can help them to learn, or to organize their own learning process and environment. This is, again, a service on which students may draw, not (unless students wish it) a teacher-determined obligation. Pedagogies that assume a classroom context may be counter-productive. For example, those that rely on rewards and punishments to enforce compliance, from grades to attendance rules serve no useful purpose outside a classroom context and, more often than not, actively inhibit effective learning (Kohn, 2011). New pedagogies are needed that acknowledge the many teachers in a learner's environment, that help them to traverse the complexity of it, to leverage the advantages and to avoid the pitfalls.

Teachers need to let go, but find ways of staying close. While, to a large extent, much of a student's own environment may be unknowable to their designated teachers, there is much

value to those who seek to support student learning in discovering *how* they are learning, and what constitutes their learning environment. Learning – the process, the tools, and the ways of learning, and not just the products – must be made visible if teachers (including other learners, friends, and colleagues) are to help learners to learn (Hattie, 2013). Much use can be made of pedagogical approaches such as shared reflective learning diaries, and some cautious use may even be made of automated systems that indicate presence, or that record traces of activities, as long as their role is to provide support for understanding student learning, and not to provide the teacher with means of control. Beyond individual courses, there may be pedagogical value in encouraging learners to share their learning experience through media such as blogs, microblogs, and other online tools, which may (as long as means are available for the student to control their privacy as needed) be aggregated and shared across their whole distributed, diffuse environment. Connectivist MOOCs (e.g. Downes, 2008) provide a useful model for this. Rather than replicating the necessarily closed and time-limited nature of the classroom, the artefacts of learning and the relationships that are developed in the process may persist indefinitely. For example, Cormier (2014) talks of 'Zombie MOOCs' in which learning and interaction persist long after the course itself is over. The temporal boundaries of courses may thus be blurred. It is important to note that the success of such approaches is not in terms of course completion or attainment of teacher-determined outcomes within a predetermined timeframe, but in the accomplishment of what learners' wish to achieve in accordance with their own schedules.

Social interaction is critical to many forms and topics of learning, demanding tools that provide the means to share, discuss, work together, schedule meetings, and so on. However, providing such tools as a service demands coordination: all participants have to be using the same tools, or at least those that can interoperate. Where possible, therefore, open protocols or standards such as SMTP, Jabber, iCal, WebMention, or ActivityStreams should be used to provide maximal freedom to all participants. Standards like RSS or Atom, proprietary APIs offered by tool providers, or mailing systems to collect what students have shared elsewhere can be used for aggregation of diverse systems. One benefit of such approaches is that they can support both diversity and manageability, inasmuch as the management burden may be shared by the participants rather than taken on by a single teacher or institution. Students, not just teachers, may choose which tools they use.

Institutional change demands both bottom-up and top-down support. Teacher's pedagogies are normally more malleable than digital tools, because they can adapt rapidly to any tools: they are, in Brand's terms (Brand, 1997), the 'stuff'. However, they are therefore also the most constrained by the structures into which they must slot, and the least able to significantly impact things at structural level. A single teacher, or even a small group of teachers is thus unlikely to sway either institutional policy or the design of the LMS because, as we have seen, one LMS must address the needs of all. The LMS was, though, originally designed not just to replicate classroom behaviours but to fit into the larger, slower-changing structures and systems of institutions, so significant changes in how we teach will not occur unless those structures and systems also evolve. However, this will not happen as long as digital systems replicate and reinforce their boundaries. From the top down, therefore, disaggregating the services of an LMS is a first step towards breaking out of the vicious loops that inhibit digitally native pedagogies and structures from evolving. At first, such a disaggregated service infrastructure will naturally resemble the LMS it replaces, because its boundaries will continue to be largely determined by the institutional forms and structures such as courses, credentials, teachers' employment contracts, and so on above it. However, once these are decoupled from the design of the tools, these larger structures may change without major retooling.

Conclusion: Beyond the Institution

The opportunities for change may not be taken, at first, at least in part because the signals (such as qualified students, their credentials, and so on) that pass in and out of the boundaries of the university will go to and from governments, employers, and other institutions that may not be prepared for radical change, even if the institution itself is committed to it. If, say, other institutions insist on grade point averages for standardized courses, then it will be difficult to completely avoid providing them, or something that is recognizably equivalent. However, the adjacent possible empty niches (Kauffman, 2019) that a decoupled infrastructure supports will inevitably be filled by those who see the opportunities it entails, from courses whose lengths are pedagogically determined, to integration of lifelong and workplace learning, to new forms of credentials and learning. Perhaps, if enough institutions start to adopt such practices, we may eventually break free of the insular single-institution model of education (itself a product of physical constraints and their consequences) altogether. Out of this may grow a truly learner- and learning-driven future, in which learners draw on services from multiple educational providers, leading to a vast participative system in which institutions meld or blend to offer support for learning not just *any* time and *any* place, but *every* time and *every* place.

Author's Contributions

All contributions by Jon Dron.

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