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In medias res: reframing design for learning

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Our goal in this article is to set out some important elements of a useful theory of *design for learning*. We aim to help understand what it means to design something, or some assemblage of things, to help other people learn. In offering what we believe to be a useful framework for thinking about design for learning, we address a number of key issues, including: how it is that something designed by one person can help other people learn; what kinds of things can be designed; how these things might also need to support the work of people (like teachers) whose job it is to support other peoples' learning; how learning usually has multiple layers and multiple goals – each of which may place different requirements on design – and how people who are learning can also be expected to modify that which has been designed.

Keywords: design for learning; indirection; sustainable design

Why it is important to have a theory of design for learning

This theoretical work is important because *practical* work on design for learning is growing quite quickly. Design is becoming a more recognisable and significant part of the work of teachers generally (Beetham and Sharpe 2013; Conole 2012; Goodyear and Retalis 2010; Laurillard 2012; Luckin 2010). Moreover, research and development in the field of design for learning is producing some useful insights, tools and methods. Before these become too engrained, it is worth considering whether the fundamental conceptions underpinning this practical work are strong enough for the growing loads being placed upon them. In short, it is time to check whether work is moving in the right direction, and with a sufficiently comprehensive idea of the challenges that need to be addressed.

We think this theoretical work is important for the following reasons.

(1) While the last decade has seen a flowering of tools and methods for design for learning, it is not clear that these are firmly grounded in contemporary understandings of how people come to learn what they need to know to thrive in modern life – some approaches might be seen as offering more efficient ways of designing for obsolescent forms of education (Pellegrino and Hilton 2012).

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(2) Some work on design for learning blurs the distinctions between (a) that which has been designed and (b) the activities in which people engage, through which they learn. For example, most classic accounts of instructional design assume a compliant learner – someone who will do what they have been asked to do, in and through the design (Goodyear 2000).
(3) Some conceptions of the new circumstances in which teachers find themselves working portray the complex choices teachers face as essentially design choices – helping students pick among an over-abundance of information resources, gadgets and tools. We do not think that this kind of pedagogical decision-making is necessarily *design* work (Beetham 2008).
(4) Rather, we think the word "design" is best reserved for a kind of working practice that has particular, distinctive qualities – and that failure to recognise what is special about design will (in the end) reduce the repertoire of educational practices available to teachers. For example, design typically involves both problem-formulation and problem-solving, using early candidate solutions to help achieve a better understanding of needs. It often involves reframing the presented problem, seeing it as an instance or a symptom of some larger problem. It often involves reconciling competing forces, rather than optimising on a single goal.
(5) Theorisation of design for learning is complicated by a few unhelpful prejudices: such as (a) design work is normally aimed at producing something brand new (on a "greenfield" site); (b) design for learning really only makes sense if the people who are meant to be doing the learning can be assumed to be compliant (i.e. that they will do what the design says they should do); (c) if, in contrast, people are seen as free agents who can (and should) take charge of their own learning activity, then design becomes irrelevant or an unwarranted intrusion. (For an extended discussion, see Duffy and Jonassen 1992; Goodyear 2000; Tobias and Duffy 2009).

Clearing the ground: clarifying some ideas about design for learning

Learning cannot be designed – it can be designed for

For those who work in this field, "design for learning" may seem an awkward phrase. We prefer it to "learning design" for what may seem a trivial reason, but is actually crucially important. "Learning design", like "experience design", can be read as meaning that it is possible to design other people's learning. This is not the case (Beetham 2008). One cannot design someone else's experience. One cannot design their happiness. One cannot design their learning. Only the person who is learning can learn. Someone involved in the design for learning can design *things* that help other people learn. We say that this is crucially important for two connected reasons. First, recognising that there is a gap between:

(1) that which has been designed; and
(2) the activities in which people engage (through which they learn)

means that one can then try to analyse the *relations* between (a) and (b). Second, it is very rare for (a) to *determine* (b). One can argue that classical work in instructional design assumes (quietly) that (a) determines (b). In which case, there is no reason to try to see the relations between (a) and (b) as involving anything subtle or complex.

Understanding the relations between (a) and (b) mirrors a central problem in the human sciences – how to relate structure and agency. How should we understand that people make history, but not in circumstances of their own choosing? When thinking about design for learning, how should we consider the ways in which learners are influenced and supported by artefacts (etc.) in their learning environment, and at the same time, how their activity changes that learning environment (for themselves and others)? Design for learning often involves the creation of scaffolds, scripts and other supports for parts of learners' activity – how should we think about the functioning of these scaffolds (the way they shape activity) and about the ways in which activity marks, erodes and rebuilds the landscape in which it is set?

Design needs to emerge as a core part of on-going educational practice, not as something that is always protected within the safe walls of a funded project

If design for learning is to be part of a sustainable educational practice, then it should not routinely be thought of in time-limited, *project*-based terms. So large a proportion of innovation in education, especially where new technology is involved, is funded through short-term projects, that we do not have a shared professional sense of how design would look if it was a core part of the mainstream work of education. There are three consequences of this limited vision. First, it means that we tend to see design as something that begins with a fresh project. We do not so often think of design as a natural part of on-going cycles of educational provision and enhancement. Second, the imperatives of projects are such that people involved in them work hard for success. Among other things, they create a niche for the project, to protect it from the complexities of everyday educational life. This is one of the reasons that things, which work well, in the project's niche, tend to fail when the project funding ends and the innovation has to prosper (or not) among the unpredictable exigencies of the real-world. Third, and connected to this, it means that projects typically fail to plan adequately for life after the project's funded period ends. Crucially, the design work that dominates the life of a project tends to under-prepare for: (1) the complexities of embedding or enacting the design in new contexts, (2) the customisation or co-configuration that is done by learners and teachers to make the innovation work in new contexts, (3) supporting the work of teachers who have to make the innovation function, after the end of the funded project, and (4) periodic review, modification and/or redesign of the innovation.

Design work and design thinking characteristically start "In medias res"

We have picked this phrase for two reasons. Classically, it refers to a literary device, through which a narrative begins "in the middle of things," rather than at what one might take to be the logical start of a story. (In Horace's *Ars Poetica*, *in medias res* is contrasted with *ab ovo* – literally "from the egg"; from the very start.) Most of the classic texts of instructional design start *ab ovo*. Agreed, they will often structure the process as a sequence of Analysis, Design, Development, Implementation, Evaluation (ADDIE), within which there are meant to be multiple feedback loops, but they nevertheless sit best within a project-based framework. We use *in medias res* to try to normalise design – as something that should have value, and be understood, within the regular on-going flow of educational activities. This is one of our key messages. But we also use the phrase for some secondary resonances – that design creates *things* and these things influence the activity that results in learning. In short, design needs to be understood from a socio-materialist perspective (Fenwick, Edwards, and Sawchuk 2011).

The role of the teacher needs explicit treatment in design

Understanding the relations between (a) that which has been designed and (b) the activity that results in learning is complicated (one might say confounded) by the uncertain role of teachers. The best way we can make this point is to ask you to imagine design for learning that takes place in situations where there *is* no teacher – just the learner and whatever the design process has helped create, and whatever else the learner brings to hand. Without the realtime (learntime) interventions of a teacher, the relations between (a) and (b) become clearer.

One of our concerns is that many approaches to "learning design" assume that a teacher will be around at learntime and that they (the teacher) will be able to improvise remedies to shortcomings in the design – filling in gaps, explaining details, etc. In some cases, what purports to be a design for learning is actually just a design for a teacher to enact: a lesson plan.

Now we need to make a subtle point. In our view, a comprehensive theory of design for learning needs to include the ability to describe a role for a teacher at learntime. A teacher can, of course, play a crucial role in making a success of a lesson. The distinction we want to make is between: (1) situations in which designs are (unconsciously) incomplete or underspecified, *assuming* that a teacher will be on hand to fill in details and make repairs on the fly, (2) situations in which designs explicitly treat the teacher as a knowledgeable, helpful actor, but with bounded capabilities. We think that many (weaker) examples of designs for learning are of type (1). We think that designs of type (2), which some call "design for orchestration", represent an important subclass of designs for learning (Dillenbourg *et al*. 2012).

Design should look forward – further forward than convention supposes

A comprehensive, coherent, defensible view of design for learning therefore needs to pay careful attention to a number of major issues that are not uniformly well-handled in the existing literature. A related issue, which we examine more closely in our companion paper (Dimitriadis and Goodyear, 2013), is that design thinking and design practice would benefit from being even more forward-looking. By this, we mean that design work should not just focus on what students are expected to do (in their learning activities), it should also include *design for configuration* (what students and other agents do, to prepare, customise or otherwise modify that which has been designed, to suit specific needs), *design for orchestration* (providing support for the teacher's work at learntime), *design for reflection* (ensuring that actionable data is gathered at learntime, to inform system evaluation) and *design for redesign* (consciously making design choices at time t, to make modifications at time $t+1$ easier).

Theorising design for learning

R&D in the field of design for learning tends towards the practical rather than the theoretical. This is not a problem in itself, but the skimpiness of theorising can make it unnecessarily hard to achieve a shared understanding of the key (grand?) challenges and opportunities in this complex area. It can also make it harder to evaluate the theoretical contributions made by practice-based R&D. So in the next part of this article, we offer some sketches of what it means to have a theory of design for learning.

In talking about "design as a discipline", Nigel Cross (2006) distinguishes between "scientific design" and a "science of design." "Scientific design" is the attempt to apply scientific methods to the practices of design – most often interpreted as an attempt to replace craft methods with automatised, industrial methods. The "science of design" is the systematic study of design – that is its goal is to study how people design, what they design and what knowledge is drawn upon during design work. Cross identifies three broad sub-fields in the science of design: *design epistemology* (the study of "designerly ways of knowing"), *design praxiology* (the study of the practices and processes of design) and *design phenomenology* (the study of the form and configuration of artefacts).

There are many theories of learning. The activity theorist, Yrjö Engeström (2001) provides a useful, deceptively simple checklist of what a theory of learning should cover. We use it here, partly because it echoes Cross: who is doing the learning, why do they learn, what do they learn and how do they learn?

Combining Cross and Engeström, a theory of "design for learning" should focus on:

- Who is doing the designing? Who is doing the learning? Who else is involved?
- Why is the design work being done? Why are the learners doing what they do?
- What is designed? What is learned?
- How is the design work undertaken? How does the learning activity occur?

And of course it also needs to account for any significant relationships between the entities (people, places, artefacts, etc.) implicated in the design and the learning activities.

We do not have enough space here to explore all of these elements, let alone their inter-relationships. But we do want to make the following key points about reframing design for learning.

The focus should be on what the student does: activity-centred design

The nature of the students' activity is what affects whether or not they succeed in learning, and what they actually learn. Outcomes are dependent on activity. Different kinds of knowledge are acquired in different ways (Biggs and Tang 2007; Ohlsson 1995). It therefore makes sense to put student activity at the heart of things: to embrace "activity-centred design." As Lehtinen (2011) has pointed out, many of the things we ask students to do involve (and result in) complex learning – in which multiple forms of knowledge and ways of knowing, at various grain sizes, have to harmonise when needed (Pellegrino and Hilton 2012). This means that activities and their outcomes are rarely simple or singular. Most designs for learning need to deal with two or more learning goals. If there is only a single learning goal, then optimisation of a design around that goal can be quite algorithmic/formulaic. Design acquires some of its complexity (wicked problems are the norm) because designs for learning are often trying to balance multiple desired outcomes. For example, a learning task might have the goals of: (1) learning to apply a specific Physics principle, (2) developing teamwork and communication skills, and (3) enhancing the learners' ability to regulate their own learning. Optimising for (1) may make the achievement of (3) very difficult, and vice versa. (Some of the heated, but rather ill-conceived, debate about direct instruction vs. "minimally guided" learning can be brought into focus here. Direct instruction *may* turn out best for objective (1) but not necessarily for objective (3); self-managed learning *may* usually be better for objective (3) than (1).) As different sub-fields of the learning sciences have focussed on different aspects of learning, designers need to be able to integrate multiple, ostensibly competing, accounts of learning in order to map outcomes to activities to design.

It is necessary to have a clear view of "that which has been designed"

A downside of our use of terms like "teaching-as-design" (Goodyear and Retalis 2010) or "teaching as a design science" (e.g. Laurillard 2012) is that it can erase some important distinctions between design and interactive teaching. For example, if the same person is designing and teaching, they can fill holes or repair flaws in the design at "learntime". This ability to make repairs "on the fly" can be of great practical (educational) value, but it also makes it harder to see where the design work stops and the interactive teaching work begins. It can make it harder to see exactly what has been designed, and how the realised form of what has been designed actually functions in practice. This, in turn, makes it harder to re-use designs in other contexts.

A clear view of "what has been designed" is easier to obtain if one places definitional limits on what *can* be designed. As mentioned earlier, we prefer to avoid implying that behaviour, activity, experience or learning can be designed. Rather, design activity results in the creation of *things* which can influence behaviour, activity, experience and learning.

Design for learning has three main components: design of tasks and design of the physical and social architectures for learning

The most important kind of designed things (with respect to learning) are *tasks*: suggestions to the learner of good things to do. Learners' activity can be strongly influenced, though rarely determined, by the tasks they are set. Design can also result in the creation of, or, more commonly, the bringing into place of already existing, tools, artefacts and other material/digital objects that constitute the "learnplace" – also known as the "learning environment" or the "setting" for learners' activity (Carvalho and Goodyear 2013). When we say that "learning is physically situated," we mean that what can and cannot be done, what is easier and harder to do, is often influenced by the *stuff* that comes readily to hand in the learnplace. As learning is also socially situated, design can also have an effect when it creates things that influence whether and how learners work together – for example that suggest they should work in pairs, or in jigsaw groups, or consider themselves active, legitimate, albeit peripheral members of a community of practice.

Among the multitude of things that can be designed, texts have a special role and character

Some designed things are influential because they work as/through texts. Tasks are often communicated through written specifications, for example "please write a 5000 word essay on the history of instructional design." The material form in which the task specification is inscribed is not (of course) the same as the task itself. Usually, it is the characteristics of the task, rather than the medium in which it is inscribed, that most influence the learning activity and its outcomes. But the material form is not unimportant. If a teacher communicates a homework task to students verbally, those who were not present that day may fail to do the work; those who were there may misremember what was asked for; those who were given the task on a piece of paper may lose it. A task inscribed in a course website has a more robust existence.

The ideas of "affordance" and "interpretation" help capture the relations between things that have been designed and activities that result in learning

Interpretation of texts is not the only way that students' activity is influenced by designed stuff – far from it. The tools, artefacts and other resources that come to hand are influential. The qualities of the learnplace can be influential.

The fields of educational technology and human–computer interaction make much use of the concept of "affordance" in explaining how the material world can be said to have an effect on human activity (Ingold 2000; Laurillard 1987; Norman 1999). More recently, both Collins (2010) and Oliver (2011) have questioned the coherence and explanatory power of "affordance" – preferring to stress the interpretative powers of human agents. As Goodyear and Carvalho (2013) argue – theorising the relations between the material world and human activity needs *both* concepts (interpretation and affordance).

Activity-centred design benefits from distinguishing between "fast" and "slow" thought

Some activity proceeds smoothly without much conscious thought. Some kinds of learning task work best if they demand hard thinking – if they invoke "desirable levels of difficulty" (e.g. McDaniel and Butler 2011). Design for learning is likely to have best results if it helps learners deploy their mental efforts where they are most needed. For example, if successful completion of a task depends upon both hard thinking and the use of an unfamiliar computer-based tool, it would be best if use of the tool did not also require hard thinking. The same applies to the design of learning environments, whether virtual, material or hybrid. The affordances of a learning environment should help students focus mental effort where it is most needed.

Two related theoretical perspectives help with this kind of design challenge. Kahneman (2011) distinguishes between two systems that are involved in human cognition. "System 1" is intuitive, fast and emotion-laden. "System 2" involves deliberation, is slower and more rational. In a similar vein, Sweller (2008) draws on David Geary's evolutionary psychology to distinguish between "biologically primary" and "biologically secondary" forms of knowledge. "Biologically primary" knowledge is knowledge that we have evolved, as a species, to acquire (e.g. our mother tongue). "Biologically secondary" knowledge is culturally important and taught in educational institutions through formal instruction. Sweller argues that proponents of discovery learning are making the mistake of assuming that biologically secondary knowledge can be learned through the "natural" methods our species has evolved for acquiring biologically primary knowledge.

These distinctions – fast and slow thought; biologically primary and biologically secondary knowledge – can help understand how to approach the design of *scaffolds* for learning (including *scripts*, which we take to be a special kind of scaffolding). More generally, they help distinguish between areas of design where the goal is to invoke "System 2" and areas of design where success is measured by the extent to which "System 1" supports smooth navigation of a learning environment. Mapping this onto Sweller's terms, design cannot always rely on the automatic invocation of biologically primary learning processes. "Natural" learning methods will not always be adequate to solve the challenges at hand.

Returning to our account (in the previous subsection) of affordance and interpretation, we might now say that *affordances* are what connect designed materials to System 1 and *interpretation* is what connects designed materials to System 2.

Design needs to take into account shifts in locus of control

An additional key aspect or dimension to be considered is the locus of control – with the teacher/designer, with the student/learner, with devices/materials/virtual agents in the learning environment. This is not a simple matter, because learning activity can be thought of as nested and the locus of control can vary between levels/layers at any one time (Jones, Asensio, and Goodyear 2000; Laurillard 1988). For example, one can imagine a course within which there is a tight specification of the learning goals and of the ways in which students will be assessed, but where the students themselves are given a high level of freedom over *how* they learn. The degree of structuring, or the locus of control, can be seen as applying to each of the design components in design for learning. For example, a teacher might specify the learning goals, but give the students freedom to choose the tools they want to work with; or students may be told who they have to work with (e.g. in teams of four, or in a jigsaw group) but allowed to pick their own learning project. The existence of such complicated freedoms means that design for learning usually needs to be considered as an *indirect* practice (Goodyear 2000). Only where the locus of control is firmly with the teacher/designer does this indirection become of marginal importance. In most other circumstances, there is necessarily an *uncertain relationship* between what gets designed and set in place for the learner and what they actually end up doing – and how, and with whom. For example, learners will often construct their own interpretations of the requirements of a designed task and work accordingly. Or a certain kind of virtual space for learning may be designed, involving a number of different tools, and then one finds that the actual spaces of interaction are "contingent and locally inhabited" (Jones and Dirckick-Holmfeld 2009). Similarly, designs proposing certain kinds of divisions of labour will sometimes be taken by students as suggestions rather than commands – the students' subsequent activity, with its various acts of communication, collaboration and coordination may result in very different social arrangements. (It is worth noting that many areas of design, outside education, have learned to live with such uncertainties.)

Design should be shaped by anticipation of the capabilities of the key agents who work together at learntime

There are various ways of thinking about, or discriminating between, the key agents – designers, teachers, students and technological agents. It is important to pay careful attention to the goals and capabilities of these agents. For example, a designer may or may not be involved as a teacher at learntime. Whether they will be able to provide extra guidance at learntime can have a significant effect on how and what they design. As another example, avoiding cognitive overload of the teacher at learntime is one of the starting points for talking about *design for orchestration*; the ability of the teacher to monitor and intervene is part of the rationale for orchestration (Prieto *et al*. 2011). Yet again, students often need to experience an appropriate combination of self-management (autonomy) and just-in-time support. If a teacher or technological agent is able to help them balance autonomy and guidance at learntime, then designs may not need to pay such careful attention to reconciling these forces.

Two key aspects of reframing design for learning: lifecycles and granularity

In the final section of this article, we bring together a number of the design considerations sketched above. Our goal is to identify conditions in which design can flourish as an element of *sustainable educational innovation* (Ellis and Goodyear 2010).

Design for learning involves creating *things,* providing more favourable conditions for effective learning. Design practices also have to be able to flourish outside the confines of time-limited funded projects, recognising the needs and capacities of the agents involved, as they unfold in on-going cycles of innovation.

Our reframing of design for learning emphasises two key considerations: (1) adopting an extended design lifecycle and (2) dealing with design issues at various degrees of granularity. The extended lifecycle for the design process is non-linear, with multiple entry points and feedback loops. It considers configuration, orchestration, reflection and redesign as its main phases, with a forward-oriented design focus (Dimitriadis and Goodyear, 2013). Though recognising the specific characteristics of these phases is important, we also see that some decoupling of the phases can help deal with the multiple loci of control among the agents involved in the process and with the indirect character of design.

In terms of *agents* that are involved in the design process, we can make a distinction between the main *human agents* (designers, learners and teachers), the other stakeholders (e.g. administrators of educational institutions, policy makers or providers of technological tools and learning environments), and the *software agents* that may intervene in order to personalise or adapt the designed activities or tools. The main human agents have to solve non-trivial (“wicked”) problems, aiming to satisfy multiple learning goals. The artefacts created by the designers involve various *design components,* which may be grouped together as tasks and the physical and social architectures within which learning activities are set.

As learning cannot be *determined* by design, we have to see that the *locus of control* can vary. Such a locus can be distributed among various agents and may span the continuum from “direct instruction” to “minimally guided learning”. For example, a teacher may be the designer of the tasks and she can script or “hardwire” the flow of sub-tasks to be followed by the learners. Thus, the designer provides structure and may delegate running of the script to a software agent, which will scaffold the set of tasks. In this case, the locus of control is external to the student, while a certain delegation to the software agent may decrease the cognitive load on the teacher at learntime. In contrast, in a more open, project-based learning environment, students may interpret the definition, goals and suggested milestones of a project. Then, students may proceed and self-regulate activities, environment and levels of social organisation, that is the locus of control is internal to the students. In any case, it is the designer's responsibility to set the design components, and *design for* the desired locus of control at one or multiple nested levels, as mentioned in the previous section.

The concept of *time* is also intrinsic to the design process and to the broader *lifecycle*. For analytical purposes, different *phases* can be distinguished, though there is little consensus about how phases should be named and delimited. For example, the terms "instantiation", "deployment" and "development" are used to refer to the actions of *configuring* the design components for a specific teaching and learning setting. On the other hand, terms like "enactment" or ""operationalisation" are used to refer to learntime, i.e. when the aforementioned agents *orchestrate* learning. Finally, interaction analysis is typically performed in order to increase awareness and enable regulation, scaffolding, evaluation and *reflection*. Such an evaluation phase is further employed in order to realise a partial or complete *redesign.*

We want to contrast this conception with some over-simplified versions that can be found in the literature, of which the best known is ADDIE (Molenda, Pershing, and Reigeluth 1996). ADDIE follows a cascade mode of operation, that is a linear process with isolated phases, in which each phase feeds the next. Although this model allows for feedback loops, they are reduced to a connection between evaluation and an eventually enhanced design (redesign) phase. We also note in passing that in time-limited project-based innovations, this evaluation–redesign loop is actually very rare.

In contrast, a designer of a successful *existing* course may find herself reconfiguring the environment for a new cohort of students. However, significant variations in the student enrolment may influence her in changing the group-formation policies, or the adoption of a new institutional learning management system may influence the availability of learning tools and therefore oblige her to modify her design decisions in relation to the tasks themselves.

We also need to revisit the notion of *granularity* in terms of time and design knowledge and actions. However, major design decisions may be taken in a "formal" initial design phase, which may be followed by long phases of configuration, orchestration, reflection and eventual redesign running over an academic year. Alternatively, smaller loops of redesign may occur, typically in response to unanticipated problem situations. Then, a *forward-oriented design process* may be beneficial, in which accumulated design knowledge is exploited, and important decisions may be taken that influence downstream phases.

Grain size can also be dealt in terms of level of concern (e.g. micro, meso and macro – Jones, Dirckinck-Holmfeld, and Lindstrom 2006) or time (session, week, unit, curriculum), or in multiple types and levels of patterns (Prieto *et al*. 2013), which encapsulate design knowledge.

We should also mention the need for *decoupling* of the different lifecycle phases. However, such a decoupling supports the "indirect" character of design and emphasises the importance of shorter and more agile loops for redesign. Also, more reusable design artefacts can be produced, while different agents may be involved in each one of the phases of the lifecycle.

The agents involved in design, may be different from those in charge of configuration (instantiation, deployment) or orchestration at learntime. For example, in many open and distance-teaching universities, professional course designers or e-learning designers may take care of the initial global educational or technological design. Then, teachers (or learners) instantiate, adapt and fine-tune the designs provided to them. In contrast, there are other cases in which a teacher is the single agent in charge of all phases, from conception to evaluation. While the latter case is not uncommon, it would be much more beneficial to consider decoupling from a conceptual point of view, since it is more general and it allows us to understand more clearly the requirements of design for learning.

In other words, there are different requirements depending on the agents who create the design artefacts and those who subsequently work with them. The amount of effort and the eventual gains vary in each case. We can think of a group of teachers/designers who may design ahead of time in more abstract, de-contextualised terms, and focus more on bringing in sound pedagogical ideas. The resulting artefact might be used by them or by other teachers, in the short term, in a concrete course, or across several courses at different times. The effort, the gain and the focus differ a lot. And so does the importance of design.

Concluding points

We have sketched some ways of reframing design that considers a *generalised lifecycle* and takes into account the aforementioned elements. We suggest a *forward-oriented design* approach (i.e. design for the different phases and elements of the framework) so that sustainable integration can be achieved, advocating for *adequate technologies* that either form part of the learning environment (e.g. a learning tool that provides adequate instrumentation for learning data collection) or support the main function of a phase (e.g. a dashboard for a teacher may enable adequate orchestration during learning time). One key idea is that *design and redesign are intimately related, and occur at various grain sizes, in terms of time and design knowledge and actions.* Thus, in order to be successful in a sustainable way, support should be provided so that redesign may be performed as easily and fluently as possible. Good design acknowledges the fact that redesign is the norm, not the exception, and that it is a correlate of sustainability, not of failure.

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