Signature pedagogies for designing: A speculative framework for supporting learning and teaching in Design and Technology education

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Why focus on pedagogies for designing?

Across national and provincial borders, many versions of curricula for Technology Education, Design and Technology Education, Science and Technology Education and Technology and Engineering Education exist. Each has its own local focus, philosophy, structure and content. But there are also common, ubiquitous curriculum elements, one of which is the centrality of processes of designing. Despite its centrality, there is general recognition that teaching and learning designing is a challenge, not least because of confusion over definitions and models of designing (Kimbell & Stables, 2007; Mawson, 2003; McGimpsey, 2011; McLain 2012; Ofsted, 2002, 2008). The aim of this chapter is to provide support for developing approaches to overcome this challenge by proposing a pedagogic framework that crosses borders and enables teachers to focus on the why, what and how of teaching and learning designing in a flexible and creative way.

It is important to first consider what designing is, and why people might want to learn or teach it. What is it about designing that makes it something that is valuable to learn? Why do human beings need to be able to do it? A considerable amount has been written about the extent to which design capability is one of the defining characteristics of being human. Bronowski (1973) writes of how human creativity and imagination allows us to "visualise the future" (p.56) "not to accept the environment, but to change it" (p.19). Archer links designing with an "envisaging-what" capacity that he sees as "the third great defining characteristic of humankind" (Archer, 1992, p.9). Nelson and Stolterman (2003) remind us that "Humans did not discover fire – they designed it. The wheel was not something our ancestors merely stumbled over in a stroke of good luck; it, too, was designed." (Nelson & Stolterman, 2003, p. 9). Baynes draws directly on cognitive science "to show conclusively that designerly thinking and action are features of the mental activities of all humans. …. The highly complex skills of the professional engineer, fashion designer or CGI artist are simply the specialist development of abilities and understandings we all have. (Baynes, 2006, p.7).

Building capability in designing

Although we all have *potential* design capability, for the potential to be realised it needs to be developed through learning experiences. Baynes (1992) highlights how design learning starts as soon as a child engages with their material world, and that when a child starts formal schooling they bring their early capability with them. His concern is that these early school experiences need to go beyond conventional 'making' projects to those that "bring a deeper understanding of what we might call 'design intelligence' - that is, the particular ways in which children and adults think and act when they are designing." (Baynes, 1992, p.1)

Cross (2008) also makes a case for design being a particular kind of intelligence, a cognitive function that humans have whether they are professional designers or not. Like all cognitive functions, it needs to be nurtured. He makes a case for design in general education, developing "innate abilities in solving real-world, ill-defined problems … cognitive development in the concrete/iconic modes of cognition … development of a wide range of abilities in nonverbal thought and communication" (Cross, 1982, p 226). This case is based on his identification of what he labels 'designerly ways of knowing', particular ways of thinking and acting.

Designing: a complex activity

What Cross is describing is not a simple activity and, by definition, not an easy thing to learn or teach. Others have contributed to this view, identifying problem solving within design as being of 'wicked problems' (Rittell, 1973; Buchannan, 1995) for which there is no correct answer, just a range of different solutions that could be seen as better or worse, depending on the lens they are viewed through. Designing is characterised as solution focused (Cross, 2006). It involves cognitive and external modelling of speculative ideas, the mind and hand working together, to make models visible (to self and others) through words, drawings, physical models and prototypes (Roberts,

Archer & Baynes, 1992). There is no doubt that designing is a complex process and this complexity is what McGimpsey (2011) identifies as being at the heart of the challenge of teaching it.

Central is the procedural nature of designing and the ways in which, in developing ideas, humans iterate between thinking and doing. A focus on process in design has been increasingly present in school curricula since the 1970's as a shift in emphasis between the *product* made and the *process* this was achieved by. This shift echoed a quest amongst professional designers to create a modernist, universal approach to designing, that was made manifest through a clinical, linear set of steps to be followed – a model that was adopted in schools and re-inforced through assessment structures. Drawing on more recent design research, the linear model that persists as something often called *The* design process has been challenged, questioning whether it is either true or helpful in developing design capability. (see, e.g. Flowers, 2010; Kimbell & Stables, 2007; Mawson, 2003; Williams, 2000). This more recent analysis has provided a less simplistic, more authentic perspective, drawing together the speculative, wicked, uncertain, iterative nature of designing, negating an idea that there is one standard design process. In giving an illustration of the complexity of designing and the uncertainty inherent in such activity, Lawson (2004) exemplifies what chess might be like if it was a design activity

> "Designing then, in terms of chess, is rather like playing with a board that has no divisions into cells, has pieces that can be invented and redefined as the game proceeds and rules that can change their effects as moves are made. Even the object of the game is not defined at the outset and may change as the game wears on. Put like this it seems a ridiculous enterprise to contemplate the design process at all. To try to understand how it proceeds and what knowledge is used and develop some structure for that may seem foolhardy." (Lawson, 2004, p.20)

Lawson suggests that it would be foolhardy to create a procedural structure or knowledge base for design and, for educators, it could also be seen as foolhardy to imagine that it is possible to work out what to teach and how to teach people to develop their design capability. But if alternatives to linear models are to be embedded in school designing, then fresh and refreshed frameworks need to be established. It is critical that teachers have access to a repertoire of pedagogies that they can utilise, modify and exploit in their endeavours to develop designerly ways of knowing and doing in young people.

Design knowledge?

Focusing on what could be the specifics of knowledge for designing has received considerable attention and debate. Pinning down exactly what knowledge *is* 'design knowledge' is an attractive idea. But such specificity seems akin to looking for a holy grail – and Lawson's description of design chess gives some clues to the challenge. A concept of 'knowledge' as a fixed resource is unhelpful as, in any design situation, you can't know everything in advance. There may be a repertoire of skills – for imaging, modelling, reflecting, investigating, prototyping and so on. But the context in which designing takes place will inevitably be full of unknowns, suggesting a need for a more fluid concept of design knowledge. Take, for example, designing a learning aid for a child with cerebral palsy. A successful solution will require contextual knowledge, which in this example would include knowledge of both learning and of cerebral palsy. As a design solution begins to develop, there will also be a need for technical knowledge, for example of specific materials or mechanisms and tools that need to be used, or procedural knowledge of how to go about creating a prototype. So, in this example, the contextual, technical and procedural knowledge all become design knowledge, required in response to needs in the task. Kimbell and Perry (2001, p19) highlight the interdisciplinary nature of such knowledge and referred to this as knowledge and see it as characterising design and technology as a "restive, itinerant, non-discipline".

Cross coined the phrase 'designerly ways of knowing' and this, in itself, requires a stance that takes 'ways of knowing' beyond what could be seen as traditional Eurocentric concept of knowledge. In exploring differences between a Eurocentric concept and one commonly found in indigenous societies, Akinhead & Elliot (2010) suggest that

> the word *knowledge* is embedded in a Eurocentric epistemology and should be replaced by other expressions that more authentically capture an Indigenous worldview, such as *Indigenous ways of knowing, living, or being*. Concomitantly, the Eurocentric meaning of *to learn* becomes *coming to know* in most Indigenous contexts, a meaning that signifies a personal, participatory, holistic journey toward gaining wisdom-in-action. (p.3)

Designerly ways of knowing and doing has resonance with this broader view. Designing is an activity that constantly provokes a need for new learning, whether it is a specific skill or particular understanding, such as those suggested above in designing in the context of cerebral palsy. Gaining wisdom-in-action equates well as an underlying principle for pedagogies of designing. This broader view of designerly ways of knowing, thinking and acting is both more authentic in terms of how humans act as designers and more holistic in considering what needs to be taught and learnt.

Baynes and Norman (2017) suggest that, in the context of the English national curriculum, there has been a lack of understanding of the significance of developing designerly ways of knowing in schools. They make the point that a "'designerly way of knowing' is not an imaginary academic construct, but an everyday reality that requires appropriate consideration and weight in curriculum planning (Norman & Baynes, 2017, p.6). This, in turn, highlights its importance when considering pedagogic approaches to designing.

Signature pedagogies for teaching and learning designing

In tertiary design education, attention has been given to Shulman's concept of signature pedagogies (2005a) – pedagogies that he identifies as being those that prepare people for their profession, in ways of *thinking*, *performing* and *acting with integrity* that have their own 'signature' methods of teaching and learning, depending on the profession. Exploring this concept, Tovey (2015) suggests that, in design, there are conventional signature pedagogic elements or arenas; the studio, the design tutorial, the library, and the 'crit' (Tovey, 2015). Shreeve (2015) and Orr and Shreeve (2018) present a similar list, again highlighting the studio and the crit, but also identifying the project and brief, materiality, dialogue and research. Each of these can be readily seen to match to Shulman's concept. He identifies signature pedagogies as having pervasive and ritualistic or routine methods of learning and teaching which, in the context of the profession being prepared for, have a surface structure of "concrete, operational acts of teaching and learning, of showing and demonstrating, of questioning and answering, of interacting and withholding, of approaching and withdrawing"; a deep structure of "assumptions about how best to impart a certain body of knowledge and know-how" and an implicit structure that provides "a moral dimension that comprises a set of beliefs about professional attitudes, values and dispositions. (Shulman 2005a, pp54-55). In addition, he identifies that signature pedagogies

> "form the habits of the mind, habits of the heart, and habits of the hand … [and] prefigure the culture of professional work and provide the early socialisation into the practices and values in the field." (p.59)

Shulman goes further to draw attention to the potential similarities between educating for a profession and a general, liberal, education, such as school education, in relation to a further set of *pedagogies of uncertainty*, (Shulman, 2005b). He asks (and answers) the following question.

> How then does a professional adapt to new and uncertain circumstances? She exercises judgment. One might therefore say that professional education is about developing pedagogies to link ideas, practices, and values under conditions of inherent uncertainty that necessitate not only judgment in order to act, but also cognizance of the consequences of one's action. In the presence of uncertainty, one is obligated to learn from experience.
>
> Are there connections between these ideas and the goals of liberal education? I would say that learning ideas, practices, and values, and developing the capacity to act with integrity on the basis of responsible judgments under uncertainty, and to learn from experience, is a reasonable description of what liberal learning should be about, as well. (p.19)

Shreeve's signature pedagogies for designing (2015) link directly to the nature of uncertainty in designing. She identifies *The project* and *The brief* as signature pedagogies of project based, experiential learning. With open-ended outcomes, largely unknown at the outset by teacher or learner, these support learner autonomy. Shreeve (2015) also highlights pedagogies of critique, of the studio and of dialogic exchange as signature pedagogies of design. *The studio* is portrayed both as the site of learning and as a signature pedagogy that removes a teacher from the centre of learning, supports a student-centred approach, focuses on dialogue, peer engagement and peer learning and creates a community of practice and design culture.

Signature pedagogies for learning and teaching designing in schools?
Each of the pedagogies highlighted above also have relevance for mainstream school designing, suggesting value in identifying 'signature pedagogies for design' as a part of general education. But what might these signature pedagogies be? What are the designerly ways of knowing, thinking and acting that all learners should have an entitlement to in order for their design capability to flourish? What are the pedagogies that will support their development?

The ubiquitous linear notion of 'the' design process has been seen by some as creating a systematic process that learners can learn and then apply to design problems. Despite this not being borne out "either in reality or in the classroom" (Williams, 2000) its existence has, by default, created prescriptive approaches that could be viewed as current 'signature pedagogies' of Design and Technology Education:

- pedagogies of identifying a problem (e.g. brainstorm possible problems or 'needs', write a specification);
- pedagogies of conducting research (e.g. internet or magazine search for objects that have solved similar problems);
- pedagogies of generating an idea (draw six possible ideas then choose one);
- pedagogies of making (e.g. draw on a set of skills related to specific materials and tools that are on the syllabus for a particular age group that have been taught in advance);
- pedagogies of evaluating (e.g. write an evaluation).

A key driver in both the creation and continuation of these approaches has been the ways in which they have been linked to assessment systems that award marks for each stage. This has exacerbated a narrowness of pedagogic approaches and a consequent fixed, rather than fluid concept of knowledge as examination criteria have required evidence of each 'stage'.

An overarching pedagogic ethos?
Focusing pedagogies on producing assessment evidence creates a danger of assessment leading the pedagogic ethos of designing. It creates an atomised approach that detracts from establishing a more holistic, overarching, pedagogy for the context in which learning takes place. Shreeve (2015) proposed the *studio* as both the site for, and culture of, learning. Focusing on school education, Claxton, Lucas and Spencer (2012) explored the studio from a similar perspective. They asked

> If you were trying to create an ideal learning environment of the kind that the very best craft apprentices or artists or technologists or designers would thrive in, what would it look and feel like? How would it be different from a typical school classroom? What would the teacher do and not do? How would learner roles be different? How would the physical space be organized? (Claxton et al, 2012, p7)

Their conclusion was that this environment would be a studio, identifying seven key dimensions that would contribute to this environment.

1. The role of the teacher – facilitative or didactic?
2. The nature of activities – authentic or contrived?
3. The organization of time – extended or bell-bound?

4. The organization of space – workshop or classroom?
5. Levels of interaction – group or individual?
6. Visibility of processes – high or low?
7. The role of the learner – self-managed or directed?
(Claxton et al., 2012, p.7)

Each dimension exists on a continuum and the closer the learning environment is to being facilitative, having authentic activities, extended time, a workshop organisation, involving group interactions, high visibility of processes and self-managed learners, the more the environment would match their concept of studio teaching. The parallels with Shreeve are clear. Both approaches highlight not just a place, but the pedagogic approach that is embedded in that place. Such environments can be found in Design and Technology education learning spaces, but there is typically less emphasis on the focus of creating the pedagogy of the studio than on its physical attributes. In a highly detailed, small scale, research project exploring a studio teaching approach with Design & Technology teachers in English schools, Claxton et al. found that focusing on their seven dimensions of studio teaching brought new and challenging pedagogic approaches to a regular Design & Technology workshop but that, over time, and with the support of an intervention to develop a studio pedagogy, the majority of teachers changed their practice. Learners became more engaged, resilient, resourceful, reflective and collaborative. Almost as a by-product (rather than as the priority focus) a third exceeded predicted grades in external assessments (Claxton et al., 2012).

Kimbell and Perry (2001), in their report to the UK Engineering Council on *Design and Technology in a Knowledge Economy,* outline what they term a 'distinctive pedagogy' for Design & Technology – enriching further a perspective on pedagogic ethos. At the heart, their distinctive pedagogy is project based and 'wicked' task centred. It has a methodology that involves unpacking the wickedness of tasks, identifying values, engaging in creative exploration, modelling futures and managing complexity and uncertainty. Rather than proposing a set of pre-defined technological knowledge and skills, they focus on "the skill of acquiring task related-knowledge" and creating "new, task-related knowledge." (p.8). In a similar vein to Lawson, they don't deny that there is specialist design and technology knowledge. But they prioritise creating a climate of enquiry where learners identify what they need to know as they progress through a task, working from tacit to explicit knowledge as needs become clearer. Their vision is of an autonomous learner and of design capability as

> that combination of understanding, skill, insight, imagination and motivation that enables creative development. It provides the bridge between what is and what might be. Specifically in technological terms it mediates between human desires and dissatisfactions on one hand and technical constraints and possibilities on the other. (Kimbell & Perry, 2001, p.7)

This highlights again the range of knowledge that might be needed in any design and technological project. And it is this potential range that provides one of the biggest challenges to learning and teaching in design and technology – how to manage and balance what a teacher plans to teach and what a learner needs to know. I will return to this later in the chapter.

Pedagogies that enable designing within an overarching ethos

A pedagogical ethos of designing, as indicated by the collected ideas above, is akin to a philosophy, a stance, a particular learning 'soup' in which young designers can flourish. It lays down perspective and principles and doesn't shy away from what might make the task of enacting the ethos complex and challenging. This challenge was recognised by George Hicks, a leading innovator in the pioneer days of the nascent English Design and Technology curriculum. He also acknowledged the learning potential, when he stated

> Teaching facts is one thing: teaching pupils in such a way that they can apply facts is another; but providing learning opportunities which encourage pupils to use information

> naturally when handling uncertainty, in a manner which results in capability, is a challenge of a different kind. (Hicks, 1983, p.1)

Providing tools to support teachers meeting this challenge is critical. Many such tools (strategies, methods, activities, interventions) have been created over the years to develop designing skills. Some tools have been designed for a single purpose. For example a tool such as *user profiling* helps learners to create a tangible persona that makes it easier to think deeply about the particular needs of a client group. Like many 'single purpose' tools alternative uses might be identified. In much the same way that a screwdriver might be used to open a can of paint, user profiling might also be used as a tool to critique a developing solution. Other tools are intentionally multipurpose, for example the *design tutorial* (Stables et al, 2016), which might be used to explore early ideas, or equally to provide information about a needed skill or material, or to discuss a tricky problem that has arisen.

Exploiting a tool pedagogically is a valuable skill for a teacher, but it requires an open mind and creative thinking to see below the surface level of a tool's function. An example of this is how (and when) annotated sketching might be used. In the 1980s, our research team at Goldsmiths in the Technology Education Research Unit (TERU) had the particular challenge of assessing the design and technological capability of 10,000 UK fifteen year olds through a ninety-minute design task (Kimbell, Stables, Wheeler, Wozniak & Kelly, 1991). A major challenge was finding ways of evidencing capability of having, developing and critiquing ideas in this short time frame. The activity was structured so that, early on, the learners were asked to use annotated sketching to move initial design ideas from inside of their heads out onto paper so they could develop them in a more tangible way. This is a very common use of annotated sketching in learning and teaching designing. But the short time frame for the whole activity focused our mind on how we could extend the use of annotated sketching to gain insight throughout the activity. To do this, we turned to annotated sketching for three distinct purposes; early in the activity in initiating and develop their ideas, midway to critically annotate the strengths and weaknesses of developing ideas and finally to 'fast forward' to imagine what their outcome would look and be like as a finished product.

Not only is the purpose of the tool a consideration, but also the point in an activity when a tool might be used. Deciding when and where to use a pedagogic tool is illustrated in McLain's (2018) research exploring *demonstration* as a signature pedagogy for school teaching. In Shulman's terms, demonstration is a constant and routine approach but the term 'routine' masks a hidden depth of pedagogic value. McLain provides a detailed and deep discussion that provides insight into demonstration's underpinning educational theory and how the term encompasses teacher as expert; modelling and explaining (both physically and linguistically), gently moving learning into Vygotsky's Zone of Proximal Development (1978) and raising the need for a teacher to make judgments, consider the impact of when, if and how to demonstrate. Should it be "frontloaded", "just-in-time" or "after-failure" (McLain, 2018, p.987). His discussion emphasises the importance of going underneath the surface to expose the purpose of the pedagogic approach taken.

Speculating on a pedagogic framework for designing

The choreography of an iterative approach

Based on research conducted in the APU D&T project, (Kimbell et al., 1991), an alternative to a linear model of designing was proposed, an iterative model based on to-ing and fro-ing between thought and action as a hazy design idea develops to successful resolution (see Figure 1). Progress is driven by responding to the needs in developing the idea, rather than adhering to a set of steps prescribed in advance.

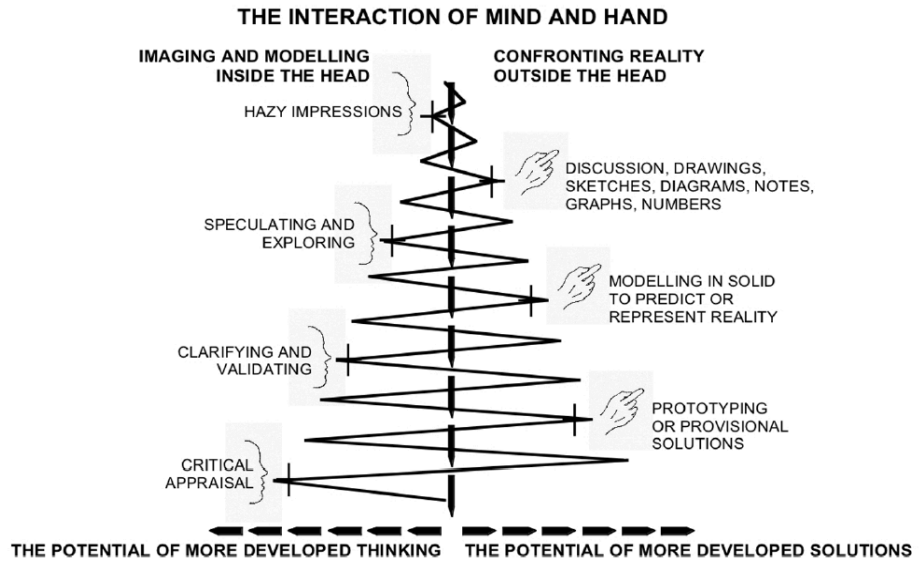

Figure 1 The APU Design and Technology Model (Kimbell et al., 1991, p.16)

This model sits comfortably with the concept of designerly ways of knowing, doing and acting, through a recognition of the 'wicked' nature of designing, of uncertainty and responding to the needs in a design task. Pedagogic purpose guides what needs to be taught and learned at a particular time to support the developing ideas. From a perspective of managing teaching learning and assessment this may be challenging. But from a perspective of designerly ways of knowing, thinking and acting it will be more authentic. The purpose forms the basis of a pedagogical choreography which may provide a pre-planned framework for an activity, but also allows for flexibility to amend a structure as need arise, either on the basis of a whole class, or on the needs of an individual project. The choreography allows a teacher to deal with the chess-like nature of a learner's designing as they "adapt to new and uncertain circumstances … [and] exercise judgment" (Shulman, 2005b pp.18-19) in pedagogical approach.

Constants and phases

The notion of an iterative model, that starts with a spark of an idea and makes a meandering design journey from that hazy starting place to a point of resolution is, in itself, a challenge of pedagogical uncertainty. How can learning and teaching be focused and structured when there are so many unknowns? From the APU project (Kimbell et al, 1991) and further research (Kimbell & Stables, 2007), certain dimensions have emerged that, pedagogically, begin to provide some form of structure. Pre-set, linear lock-steps are unhelpful, but there are other structural constants. First is a studio based pedagogical ethos of learning and teaching designing. A second is the design journey of an undeveloped idea to becoming an effective solution, from early sketchy ideas, through modelling and prototyping to a final solution. Third is the design context that a project is both embedded in and responds to. A design context provides the background to the people, places and purposes at the heart of a design challenge and the drive for Kimbell and Perry's 'task-related' knowledge requirements. It provides the impetus for a project and so is often seen as important in the early stages but then fades into the background. However, losing sight of the context can result in tokenistic and ill-developed projects, so the context needs to be a constant.

While the choreography will vary in relation to the needs of the developing idea, these 'constants' create their own structure of the rhythm of the activity. TERU projects have shown the value of recognising phases in a project which speak to the reality of the notion of a journey from hazy ideas to well developed, articulated prototypes. It can be helpful in supporting learners to recognise, explore and manage the complexity in their projects by seeing the design journey in three phases. An initial phase of *setting the scene* is important, capturing the learners' imagination, provoking initial ideas and providing insights and perspectives into a situation rich with design issues. A middle phase, when ideas are being modelled towards some visible reality, provides a heightened focus on *understanding the needs in the task* allowing learners to step back and think

about the people and places they are designing for and to develop a more rounded understanding of what they have embarked on. As their project approaches resolution, *checking the effectiveness of a prototype* allows them to consider the overall success and effectiveness of their project, identify its strengths and getting user feedback. There is an inevitable logic to these stages that provides a helpful framework for structuring a project but one that recognises that, in each phase, any or all pedagogic purposes may be present.

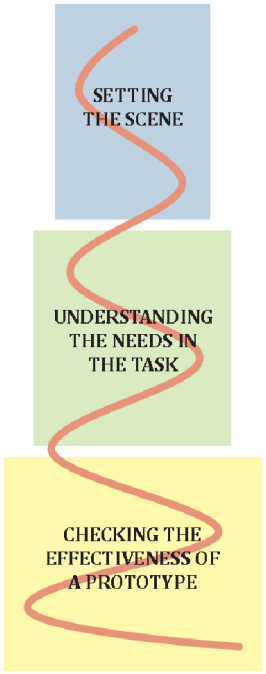

Fig 2 Three phases in a project

A pedagogic framework

In is not the intention that this chapter should provide a catalogue of pedagogic tools, but to propose a framework to help decision-making about why, pedagogically, one would choose a particular tool at any given time. Looking at this challenge in a structural way, three levels are apparent; the *purpose* of the pedagogy, the subsequent *pedagogic actions* that could be taken and, following this, the *pedagogic tools* that might be used.

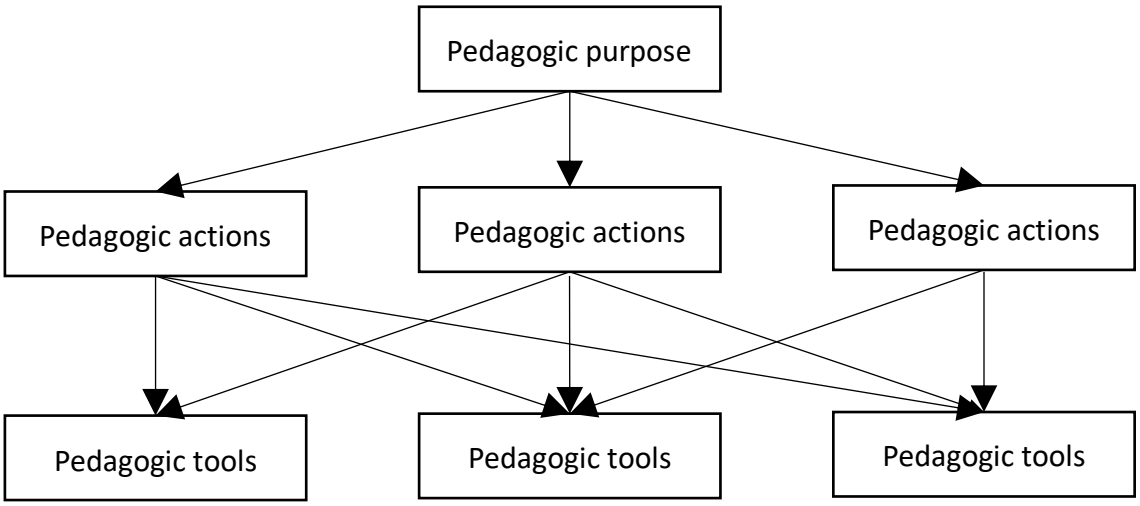

Figure 3 an outline framework

Reflecting back on higher education signature pedagogies (Shreeve, Orr and Tovey), studio learning and teaching (Claxton et al) and distinctive pedagogies (Kimbell & Perry) I propose, an overarching pedagogical ethos of studio teaching that has the following *pedagogic purposes.*

- pedagogies of *speculation*: that support learners to consider 'what if', 'what might be', 'how could'
- pedagogies of *imaging and modelling*: that support learners to test their speculative ideas by bringing them into some form of reality
- pedagogies of *materiality*: that enable learners to understand and develop knowledge and skills in bringing ideas into physical being
- pedagogies of *need-to-know*: that enable learners to have the confidence and competence to acquire knowledge, skill and understanding as the needs in their design tasks arise
- pedagogies of *critiquing*: that allow learners to make thoughtful decisions and judgements, based on values and ethics.
- pedagogies of *collaboration*: that support learners to develop skills in working with and for others.

Each of these potential 'signature' pedagogies of designing enable a teacher, and potentially a learner, to make a decision about the facet of designing that needs to be focused at any given time. Would the learner and their project benefit from speculating, finding something out, collaborating with others? Having a focus on purpose moves attention away from a linear set of steps towards a more responsive approach, led by the learning and teaching needs, to move a learner forward with their designing.

With a background of the 'constants', Identifying the pedagogic purpose at any stage is a first step. This can then be linked to the nature of an appropriate *pedagogic action* to be taken. Does the learner, for example, need to engage in creative exploration, identify values, be helped to avoid fixation, assisted in handling uncertainty, modelling futures? Once these options have been explored, a decision needs to be made about the particular *pedagogic tool, or tools,* that could achieve the purpose. Consideration needs also to be given to who is taking the decision – the teacher or the learner?

Figure 4 represents how the structure of decision making might look. At the top are the signature pedagogies – the purposes of pedagogic intervention. The middle level provides examples of the focus of actions that could address a pedagogic purpose. Following this are examples of tools that could be used to achieve the purpose and action (see appendix for glossary of tools included). Taken together, the three levels provide elements within a pedagogic choreography.

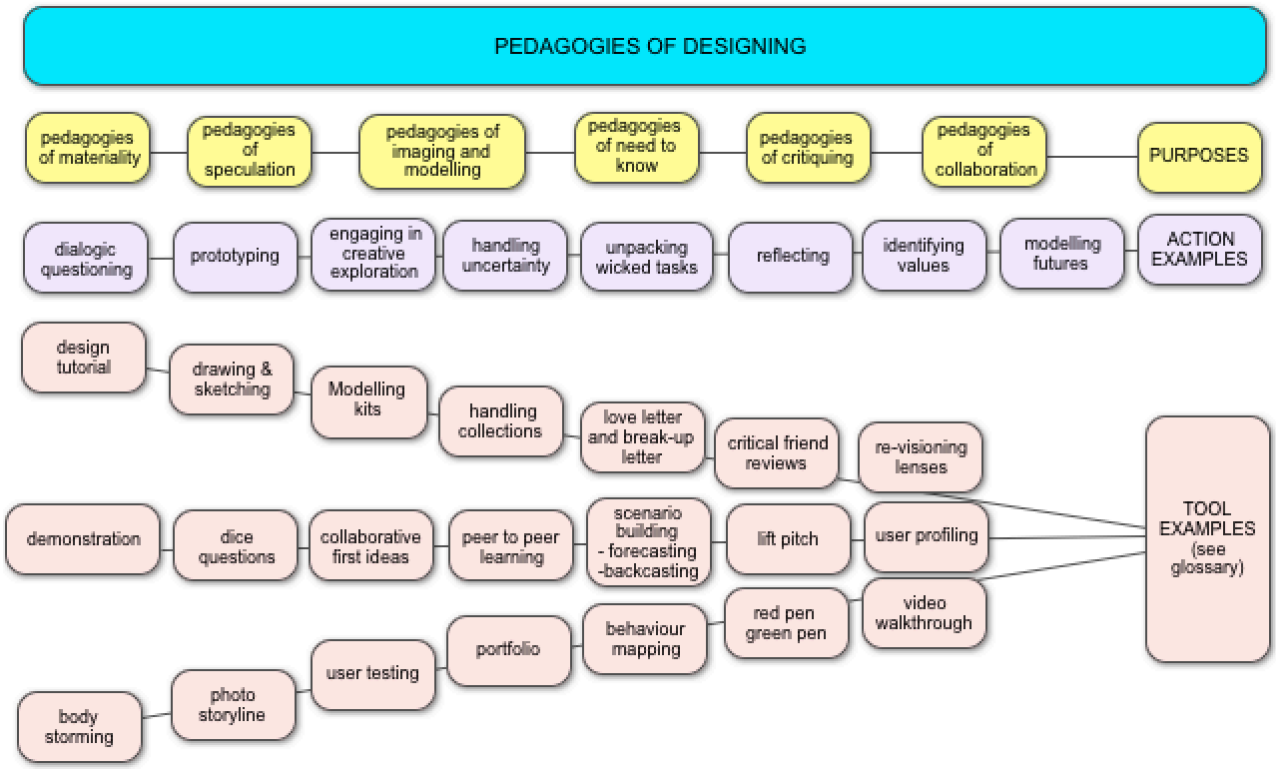

Fig 4 the pedagogic framework exemplified

The framework provides a way of considering options for making decisions. But making pedagogic decisions can be complex, both in terms of how a decision supports progression in both the learning and the learner's project and also in terms of who is making the decision – the teacher or the learner. With less experienced learners it is likely that the teacher will be the key decision maker. From a management perspective, this would likely be the same for a teacher less confident in supporting more open ended design projects. But as confidence and expertise grows, building towards greater autonomy and the pedagogic voice of the learner (Baroutis, McGregor & Mills, 2016), the balance of decision making can shift.

The following two 'vignettes' illustrate how the framework could be employed.

The first vignette (figure 5) is based on the early stages of a project with a class of 14 year olds. The topic for their project is 'design for disability'. The teacher wants to encourage the learners to be innovative so has decided that the outcomes will be working prototypes, not completely finished products. The project is due to last for 8 lessons, each 75 minutes long. In the first lesson, the teacher introduced the context for the project and learners explored different potential problems and scenarios. The vignette is drawn from the second lesson. It illustrates a structure where the teacher's initial pedagogic purpose is to support learners to engage in speculation about their developing ideas. She chooses to start this by encouraging creative exploration using a collaborative idea generation strategy before each learner uses modelling resources to begin to visualise their ideas in three dimensions. She then focuses on dialogic questioning, through small group design tutorials, initially to encourage learners to critique their developing ideas in terms of how effectively they meet the needs of their proposed user group and then to engage in further speculation of how their ideas could be developed to be more effective. The vignette illustrates the actions of the teacher and one learner, Rebecca, as she moves through her project.

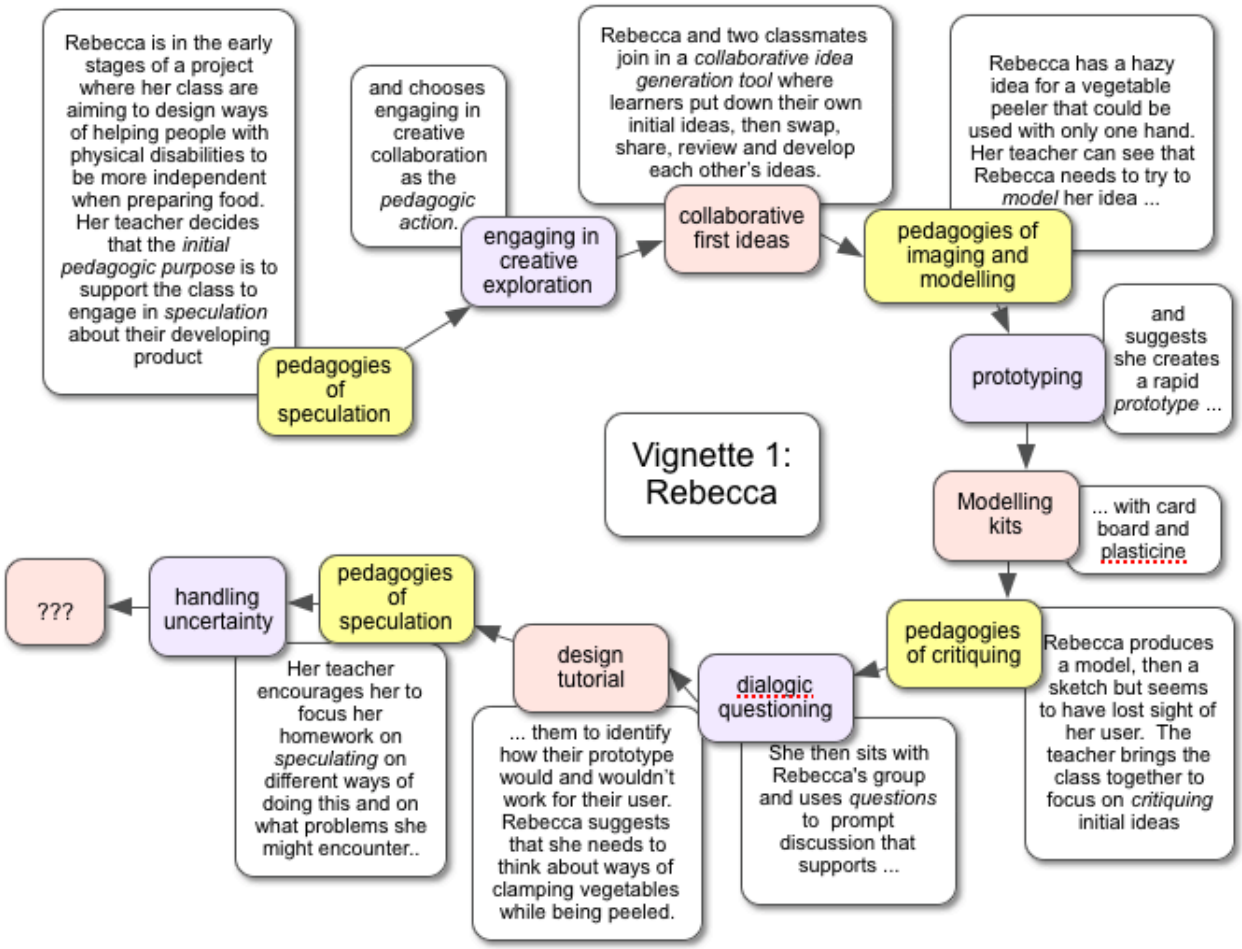

Figure 5: Vignette 1 - a potential route through the early stages of a project

In this vignette the majority of the pedagogic decisions are made by the teacher as the learners are less experienced in prototyping ideas and she wants to maintain control of the overarching lesson structure. But through collaborative work and dialogic questioning, she is shifting some responsibility to the learners to and by the end of the lesson is prompting Rebecca to make her own procedural decisions on how her design might function and what technical knowledge she might need to learn to achieve this.

The second vignette (Figure 6) is set in the middle stage of a project with 16 year olds who are working on projects related to displaced people. It illustrates a structure where the teacher's pedagogic purpose is to support learners to critique their developing ideas by creating user profiles to check out their current ideas. The purpose then shifts to identifying what they need to know in order to address issues raised through their critique. The pedagogic purpose then shifts again to supporting material skills needed to create a prototype, both through demonstration and peer-to peer collaborative learning. Again, the vignette illustrates the approach by focusing on one learner, Abdul.

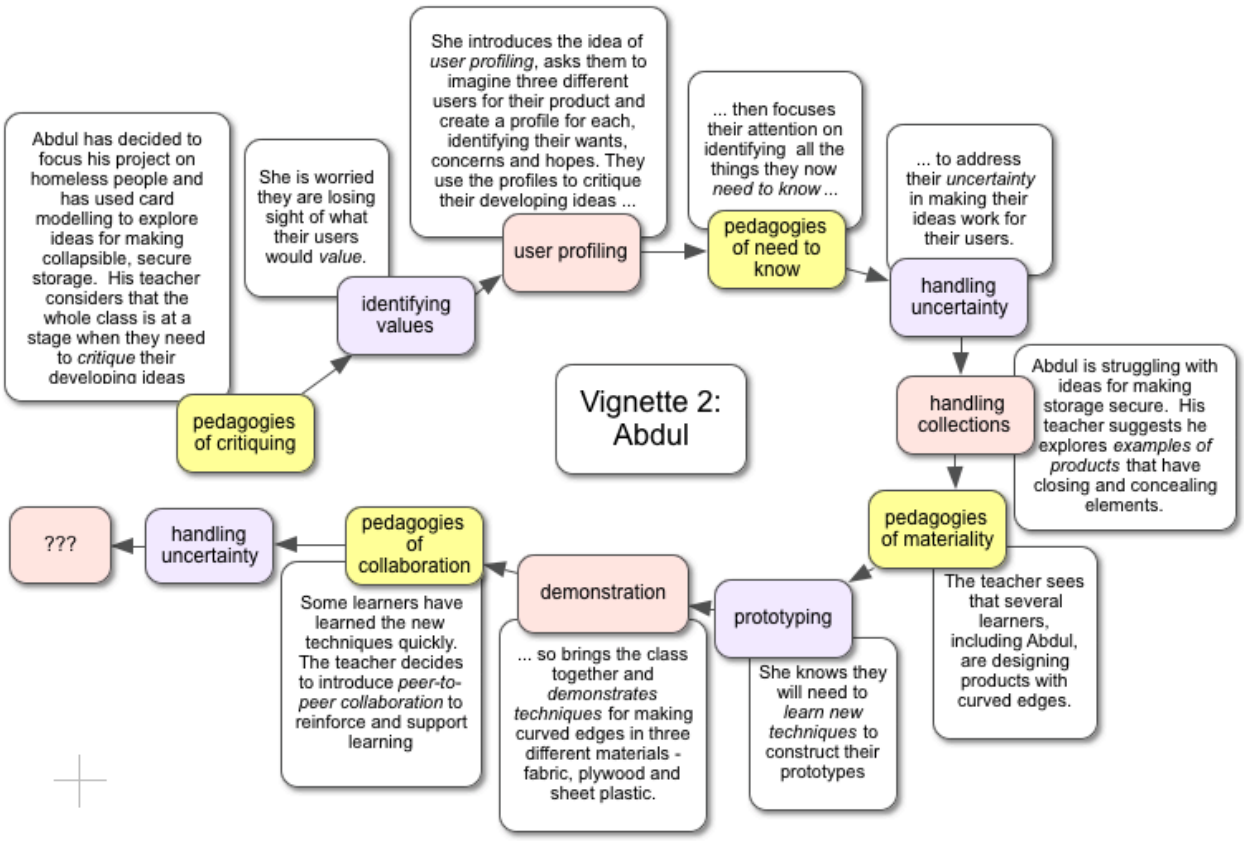

Figure 6: Vignette 2 - a potential route through the middle stages of a project

In this second vignette the teacher is shifting most decision making to the learners. Abdul has decided on his own project focus. Through creating user profiles further decisions will be made by the learners about task related issues and identifying what they need to know encourages them to make decisions about technical and procedural knowledge. To help Abdul his teacher suggests product analysis so that he can build some technical understanding of security systems. When she sees a construction issue that is affecting several learners she makes the decision to teach specific skills. Seeing how some learners have quickly learnt the skills, she sees an opportunity for supporting 'pedagogic voice' by having the newly established 'experts' support others in learning the skills they need.

These examples illustrate just two of multiple ways in which purposes, actions and tools could be combined in any project.

Concluding comments

This chapter has set out with an ambitious target, ambitious in both the aim of speculating on a fresh way of considering the nature of a pedagogic framework for learning and teaching designing and with an ambition for teachers to implement the approach proposed. Design capability is at the heart of technological activity but teaching and learning designing in the context of mainstream schooling is challenging. By moving from a prescribed approach, following a linear set of steps, to a responsive approach, where there is recognition that, as a project and its needs become clearer, the ground will shift, a teacher's pedagogic practices will inevitably be unsettled. An alternative structure is needed, and one that has the potential to scaffold both a teacher and their learners. By identifying key distinctive, potential signature pedagogies, and proposing a framework of pedagogic purpose, actions and tools, this chapter offers an alternative. In considering the proposed framework, teachers will want to reflect on their existing practices and the successful tools they already employ. Equally, more formulaic practices may need to be critiqued. This chapter aims to provide approaches to refresh, energise and provide opportunities to create new

pedagogic approaches that, in time, will be seen as signature pedagogies for designing that result in a flourishing of design capability in learners.

Initial points for a reader reflecting on current practice could include the following

- What is your view of design capability? How do you develop this through your current perspective on design process? What drives your current approach?
- What would you identify as your current 'signature pedagogies? How do these relate to those proposed in this chapter? How and why might you modify your curriculum stance to refresh your pedagogic approach?
- What would you currently see as the range of pedagogic purposes, actions and tools in your learning and teaching repertoire? How might the proposed framework extend your repertoire?
- How would you critique the speculative framework presented in this chapter? What do you see as the major challenges and benefits? How could you overcome the challenges and take advantage of the benefits?

References

Aikenhead, G., & Elliot, D. (2010). An Emerging Decolonizing Science Education in Canada. *Canadian Journal of Science, Mathematics and Technology Education, 10*, 321-338.

Archer, B., & Roberts, P. (1992). Design and technological awareness in education. In P. Roberts, B. Archer, & K. Baynes (Eds.), *Design Occasional Paper No. 1, Modelling: the language of designing* (pp. 3 - 4). Loughborough: Logughborough University of Technology.

Baroutsis, A., McGregor, G., & Mills, M. (2016). Pedagogic voice: student voice in teaching and engagement pedagogies. *Pedagogy, Culture & Society, 24*(1), 123-140.

Baynes, K. (1992). *Children Designing. Learning Design: Occasional Paper No 1*. Loughborough: Loughborough University of Technology.

Baynes, K. (2006). Design education: what's the point? *Design and Technology Education: An International Journal, 11*(3), 7-10.

Bronowski, J. (1973). *The ascent of man*. London: British Broadcasting Corporation.

Buchanan, R. (1995). Wicked problems in design thinking. In V. Margolin & R. Buchanan (Eds.), *The idea of design* (pp. 3-20). Cambridge, Massachusetts; London, England: MIT Press.

Claxton, G., Lucas, B., & Spencer, E. (2012). *Making it: Studio teaching and its impact on teachers and learners*. Winchester: Centre for Real-World Learning.

Cross, N. (1982). Designerly ways of knowing. *Design Studies, 3*(4), 221-227.

Cross, N. (2006). *Designerly ways of knowing*. Germany: Springer.

Flowers, J. (2010). The Problem in Technology Education (A Definite Article). *Journal of Technology Education, 21*(2), 10-20.

Hicks, G. (1983, Autumn 1983). Another step forward for design and technology. *APU Newsletter, 4*.

Kimbell, R., & Perry, D. (2001). *Design and technology in a knowledge economy*. London: Engineering Council.

Kimbell, R., & Stables, K. (2007). *Researching design learning : issues and findings from two decades of research and development* (Hardback ed.). Berlin: Springer.

Kimbell, R., Stables, K., Wheeler, T., Wozniak, A., & Kelly, A. V. (1991). *The assessment of performance in design and technology*. London: SEAC / HMSO.

Lawson, B. (2004). *What designers know*. Oxford: Elsevier.

Mawson, B. (2003). Beyond "The Design Process": An alternative pedagogy for Technology Education. *International Journal of Technology and Design Education, 13*, 117-128.

McGimpsey, I. (2011). A review of literature on design education in the National Curriculum. In (pp. 23). London: RSA.

McLain, M. (2012). An (auto)ethnographiic narrative of the teaching of designing within Design and Technology in the English curriculum. *Procedia Social and Behavioural Sciences, 45*, 318-330.

McLain, M. (2018). Emerging perspectives on the demonstration as a signature pedagogy in design and technology education. *International Journal of Technology and Design Education, 28*(4), 985-1000.

Nelson, H. G., & Stolterman, E. (2003). *The design way: intentional change in an unpredictable world*. Englewood Cliffs, NJ: Educational Technology Publications.

Norman, E., & Baynes, K. (Eds.). (2017). *Design Education and curriculum planning*. Rothley, Leics.: Loughborough Design Press Ltd.

OFSTED. (2002). *A Report of the OFSTED Conference for Secondary Teachers of Design and Technology 'Teaching Designing'*, Jaguar Cars Limited, Birmingham.

Ofsted. (2002). *Secondary Subject Reports 2000/01: Design and technology*. Retrieved from London:

Ofsted. (2008). *Education for a technologically advanced nation Design and technology in schools 2004 -07*. Retrieved from London:

Orr, S., & Shreeve, A. (2018). *Art and Design pedagogy in higher education*. Abingdon, New York: Routledge.

Rittel, H., & Webber, M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*, 155-169.

Roberts, P., Archer, B., & Baynes, K. (1992). *Modelling: the language of designing. Design: Occasional Paper No. 1*. Loughborough: University of Loughborough.

Shreeve, A. (2015). Signature pedagogies in design. In M. Tovey (Ed.), *Design pedagogy: Developments in art and design*. London, New York: Routledge.

Shulman, L. (2005a). Pedagogies of uncertainty. *Liberal Education, Spring*, 18-25.

Shulman, L. (2005b). Signature pedagogies in the professions. *Daedalus, 134*(3), 52-59.

Stables, K., Kimbell, R., Wheeler, T., & Derrick, K. (2016). *Lighting the blue touch paper: Design talk that provokes learners to think more deeply and broadly about their project work*. Paper presented at the PATT 32: Technology Education for 21st Century skills, Utrecht, Netherlands.

Tovey, M. (Ed.). *Design Pedagogy: Ddvelopments in art and design education*. London, New York: Routledge.

Vygotsky, L. S. (1978). *Mind in society; the development of higher psychological processes*. Cambridge, Mass: Harvard University Press.

Williams, P. J. (2000). Design: the only methodology of technology? *Journal of Technology Education, 11*(2), 48 - 60.

Appendix 1: Pedagogic tool glossary

Below is a brief overview of pedagogic design tools mentioned in this chapter. Some have been developed through research undertaken in the Technology Education Research Unit (TERU) at Goldsmiths, University of London, some have been 'borrowed' from elsewhere, some are common, ubiquitous approaches.

Where possible and helpful, links to further information are provided.

Annotated sketching	*Annotated sketching* is an approach that enables the thoughts behind a developing idea to be made visible. The annotations can be both descriptive and evaluative and should be made 'in the moment' to capture the iterative relationship between thought and action. In encouraging learners to verbalise their thoughts in an informal way, they make their thinking more visible to both themselves and others.
Behaviour mapping	Behaviour mapping is a tool that allows learners to focus in detail on how a user interacts with and uses a product, system or environment. It involves then in closely observing a user (or a series of different users) for example, peeling vegetables, using a self-service supermarket checkout. Using words, drawings, photos and/or vidoes, learners capture the detailed actions of the user in ways that they can then analyse when designing. See also • Martin, B., & Hanington, B. (2012). *Universal Methods of Design: 100 ways to research complex problems, develop innovative ideas, and design effective solutions*. Beverly, MA: Rockport Publishers.
Body storming	*Bodystorming* is a user-centred tool that is a subset of user testing, that is a bit like physical brainstorming. It involves creating a physical situation through which a learner can experience specific needs, such as poor vision, lack of mobility, such that they can gain insights and inspiration to design for people who have these needs. It allows learners to develop empathy with a user group and then simulate user testing of models and prototypes as their design ideas evolve. See also • Martin, B., & Hanington, B. (2012). *Universal Methods of Design: 100 ways to research complex problems, develop innovative ideas, and design effective solutions*. Beverly, MA: Rockport Publishers. • Stanford D school https://dschool-old.stanford.edu/groups/k12/wiki/48c54/Bodystorming.html

Collaborative first ideas	Collaborative first ideas is an approach where, early in a project, learners work in groups of three as 'critical friends' to review and develop each other's ideas. The activity starts with each spending a short time (e.g. five minutes) quickly putting down (drawing and/or words) any initial ideas they have. The ideas are then swapped and each learner reviews and develops the ideas in front of them (more drawings and/or words). After the same time frame. The swap is repeated. Finally, the ideas return to their owner, who reflects/acts on the ideas and comments as they continue with their designing.
Critical friend reviews	In a similar way to *collaborative first ideas*, the 'critical friends' come together at appropriate times during the length of a project to review each other's ongoing work. This can usefully be structured by each learner providing three comments on what they think is working really well and three comments where they consider that more work is needed – effectively giving a 'thumbs up' to the good bits and a 'thumbs down' to bits needing attention. See also: • Iterative design in action https://www.data.org.uk/resource-shop/iterative-design-in-action/
Demonstration	*Demonstration* is effective when a teacher decides that an individual, small group, or the whole class need to 'see' and understand how something works. This might be a physical piece of equipment, such as a pillar drill, or equally an action or strategy, such as providing feedback on a learner's work. It can be the teacher demonstrating and/or learners taking the demonstration role. Critical in the endeavour is observing the impact of the demonstration as learners then practice for themselves and, where necessary, correcting any mistakes or misunderstandings before continuing. See also: McLain, M. (2018). Emerging perspectives on the demonstration as a signature pedagogy in design and technology education. *International Journal of Technology and Design Education, 28*(4), 985-1000.
Design tutorial	In a *design tutorial*, a teacher discusses project work with an individual or small group of learners. The teacher encourages learners to explain their work and critique it, and follows this by encouraging them to speculate on how they could improve it. Finally a discusses takes place on what the next steps could be and how to proceed. Small group tutorials have the added advantage of involving peer to peer discussion and feedback. See also: Ward, M. (2013). Design tutorials: the basics*2015*. Retrieved from http://sb129.com/2013/11/08/design-tutorials-the-basics/
Dice questions	*Dice questions* or *Left field questions* is a tool developed by TERU as a way of disrupting learners' thinking by asking random questions about their designing that encourages them to think differently. The first iteration of the tool involved rolling a dice that was linked to a set of questions. The idea was developed further using an on-screen avatar to ask random questions. Other ways could be used to provide questions randomly, e.g. a set of cards. Central to the tool are the questions themselves – and teachers can devise these. Examples include "would your product work under water? "… in the dark?" "… be made from custard?" See also: Stables, K. (2017). *Talking with avatars: the potential and impact of design dialogue with an on-screen avatar on the development of a learner's design and technology project work*. Paper presented at the PATT 34 Technology and engineering education: fostering the creativity of youth around the globe, Philadelphia.
Handling collections	A *handling collection* is a set of carefully chosen objects that learners can pick up, examine and fiddle around with in order to stimulate design thinking. They can provide creative inspiration throughout a task. They can familiarise learners

	with ideas, concepts and issues within a task; help learners understand how features of a product function; inspire learners to explore unexpected, novel and provocative ideas; and 'unstitch' a concept from one product to use in a new way in their own designing. See also: • Iterative design in action https://www.data.org.uk/resource-shop/iterative-design-in-action/
Lift pitch	Creating a *Lift pitch* is a way of presenting all of the positives of a designed outcome in a short, snappy way. The idea is that the designer steps into a lift in a very tall building and realises that they have a potential manufacturer or retail manager who they could 'sell' the idea of their design outcome to. They have less than a minute (when the list reaches the top of the building) to present a 'pitch' for their idea. The tool can be used both as a final evaluation of a learner's project or earlier on when they are speculating on the qualities of the product they are designing.
Love letter and break up letter	The *Love letter and break up letter* is a novel design tool for helping learners to analyse and evaluate an object (or service/system/environment) – typically an existing one but possibly the one they are designing. The *Love letter* allows for everything good about a 'relationship' with an object to be describe – physical and emotional, providing an analyse of all the positives. The *Break up letter* does the opposite, including providing insights into why the learner has fallen out of love with the object. Originally created as a design strategy by Smart Design, they advocate writing the letters individually and then sharing them with a group to initiate discussion. Teachers will want to customise this approach for use in classrooms. See also • Smart Design's video at http:// www.vimeo.com/ smartdesign/ breakupletter for an example of Love and Breakup Letters. • Martin, B., & Hanington, B. (2012). *Universal Methods of Design: 100 ways to research complex problems, develop innovative ideas, and design effective solutions*. Beverly, MA: Rockport Publishers.
Modelling kits	A modelling kit is a diverse collection of plentiful, cheap, easy to use materials and a range of basic tools that enable learners to rapidly mock-up whole or parts of design ideas – what are sometimes called 'sketch' models. The kits allow learners to explore ideas at speed and without wasting expensive materials. They need to include tools and materials that allow for 'box', 'skeletal' and 'organic' shapes to be modelled. See also: • Iterative design in action https://www.data.org.uk/resource-shop/iterative-design-in-action/
Peer to peer learning	*Peer to peer learning* involves less experienced learners being, for example, taught a skill, given advice or gaining needed understanding by working with a more experienced learner. It can be formally structured – such as when a learner is given a 'mini expert' label for something they have mastered, or used informally, for example by a teacher encouraging learners to ask a peer for help before they ask the teacher. It requires a teacher having a well-developed understanding of the abilities of learners in the class. It has the potential to support metacognitive development – as the 'expert' has to externalise their knowledge or understanding; increase self esteem of the 'expert'; increase collaboration; and help a teacher confirm the level of understanding of those on both sides of the exchange. See also: • Make design thinking visible (ref to be added)

Photo storyline	Creating a *photo storyline* as a project progresses involves periodically taking photos of work as it progresses in order to quickly capture each stage, particularly when ideas are being modelled and prototyped, including things that didn't work and were discarded or re-modelled. The photos can be annotated to provide further reflection and insight into how the designing is developed. Creating the storyline has benefits for both formative and summative assessment, as both thought and action can be captured throughout a whole project or as a detailed 'cameo' of a particular stage in a project. See also • Iterative design in action https://www.data.org.uk/resource-shop/iterative-design-in-action/ • Make design thinking visible (ref to be added)
Red pen, green pen Review and development	Red pen, green pen is a tool developed by TERU to be used for onging evaluation throughout a project. Learners are asked to pause and review their work to identify what is and is not working well. They are asked to directly annotate their portfolio with a red pen or pencil to identify what isn't working and a green pen or pencil to identify successes. The use of coloured annotation directly onto work aims to break the mould of neat, tidy, after-the-event annotation, thus promoting portfolios as working documents, not presentation pieces.
Revisioning lenses User focus	*Revisioning lenses* is a tool created by pi-Studio at Goldsmiths UoL to provide a physical artefact that focuses a designer on different facets of their design. Each lens is a card that has images relating to the focus, such as materials, environment, culture, disposal. It has a circular hole cut in the card that the designer looks through to focus on their design. Used with learners, it raises their awareness of a breadth of issues that affect the success of a design, whilst also allowing them to focus on a specific perspective at any one moment. Cards can be made that are generic, or specific to a particular context See also: • Iterative design in action https://www.data.org.uk/resource-shop/iterative-design-in-action/
Scenario building, forecasting, backcasting	Scenario building is a tool that allows learners to speculate on a future design situation in a way that is manageable and realistic without becoming pure fantasy. It allows learners to think about what the near future might be like and how this can create a focus for their designing. *Forecasting* allows them to think about positive and negative future scenarios, for example a world where, by 2025, there are no plastic bags or a world that has been overtaken with plastic bags. *Backcasting* allows them to think about how design can work incrementally towards the positive scenario – to hit the 2025 deadline, where do we need to be by 2021, 2023. See also • Mathilda Tham getting people to speculate on future clothing habits by asking simple 'What if' questions http://www.wowtalks.tv/mathilda-tham/ • Martin, B., & Hanington, B. (2012). *Universal Methods of Design: 100 ways to research complex problems, develop innovative ideas, and design effective solutions*. Beverly, MA: Rockport Publishers.
User profiling, personas	User profiling involves creating personas for the people that are being designed for to help learners focus on the needs their designs should address. They can be created by teachers or the learners can create them in groups or on their own, possibly using a template created by their teacher. Details of the personas include lifestyle, behaviour patterns, likes and dislikes, special interests, special needs etc. See also:

	• Personas in Martin, B., & Hanington, B. (2012). *Universal Methods of Design: 100 ways to research complex problems, develop innovative ideas, and design effective solutions*. Beverly, MA: Rockport Publishers.
Video walkthrough	Towards the end of a project, before the design outcome is finalised, ask the learners to make a video walkthrough of their design that explains all of its features, how it works etc. Partner them with another learner who can ask questions, critique and provide feedback to identify any final changes or developments that can be made.