Empathy Thresholds in Transport Design Students

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Abstract

Threshold concept models offer a useful way of understanding aspects of design education. A threshold concept represents a gateway, or portal, to a more developed understanding and level of capability (Meyer, Land & Davies, 2008). Passing through a threshold can be transformative, irreversible, integrative and troublesome. Key transformations for design have been identified, such as gaining sufficient confidence in design thinking to enable solution concepts to be generated which are crucial to achieving capability as a designer.

Empathy has been recognised as a key skill by practicing designers, but one which is seldom formally taught in classrooms. Drawing on the experience of five workshops held with transport and engineering design students which aimed to broaden their empathic understanding, the authors discuss the extent to which empathy may be considered as a threshold capability.

Key words

empathy, design thinking, design education, threshold concepts, learning interventions.

Introduction

Designer Responsibilities
Designers' responsibilities can be characterized as covering two main roles:

- To represent the market and user requirements in determining the ergonomics, appearance and brand identity of the product.
- To integrate the market, user and engineering requirements into a whole design solution.
  (Tovey, 1992)

The former implies an alignment with user needs which requires an empathic approach where empathy may be defined as the ability 'to think outside of themselves and think of others' (Osmond & Turner, 2008). The latter requires the ability to synthesize a design solution as an overall concept. Both of these can be regarded as threshold capabilities which student designers need to achieve.

Design thinking capability

The ability to solve problems through creating designs is a fundamental design capability involving the movement from an initial brief through a mix of activities at the end of which there is a credible new design proposition.

Designing is often described as inherently creative, and as a poorly understood cognitive process which is difficult to teach (Lawson & Dorst, 2009). It is unpredictable, and there are many ways of designing well and successfully, with much variation between projects. A distinct aspect of designing is that it features solution-led thinking (Lawson, 2005), making it fundamentally different from the processes of social or scientific analysis central to other disciplines. The solution led approach can be applied to ill defined, or wicked problems (Buchanan, 1992), in which designers may not have all the information needed to solve a problem. As such they have to learn to tolerate uncertainty, and have the confidence to develop draft solutions, which may redefine and reshape the problem-as-given (Cross, 2006).

Design involves developing parallel lines of thought (Lawson & Dorst, 2009); one concerns the shape of the problem, its clarification and framing; the other focusses on developing ideas about its solution. Experienced creative designers are able to sustain several parallel lines of thought, even if they are incompatible or apparently irreconcilable, for extended periods in a design project. The creative reframing of the situation allows for new views and understanding, in which the various lines of thought can be incorporated in a higher-level set of ideas. Thinking along parallel lines, maintaining a sense of ambiguity and uncertainty and not being concerned with a single answer too quickly seem to be essential design skills.

Conceptual design can be described as the art of seeing the design situation in multiple ways to facilitate (Lawson & Dorst, 2009) the existence of ambiguity and uncertainty. Experienced designers are used to performing this 'little dance around the problem', taking stabs at it from different sides mixing rational, analytical thinking with intuition and creativity. This fundamental 'schizophrenia' is a defining characteristic of design which may explain the peculiar way of working that is a common trait of practice throughout the design professions. A principal skill of the experienced designer is getting the balance of activity right. Confronted with a design problem which can be tackled in either a problem-focussed (analytical) or a solution-focused (creative) way is a difficult choice for a designer and the project can fail if the balance is wrong. Being too analytical can lead to an unnecessary limitation of the solution space, while being too creative and generative can launch a journey into nothingness.

The ability to blend thinking styles is a fundamental part of being a designer (Tovey, 2015). The experienced designer, will keep switching between analysis and creativity, between 'problem' and 'solution' without any effort. This process has been identified in a number of contexts, for example, by Dorst (2003) and Cross (2006), in Tovey's (1984) notion of dual process thinking involving an incubation period, in Wallace's (1992) leaping between problem bubbles, and sometimes having to start again, and Daly, Adams & Bodner (2012) proposal of a progression through a hierarchy of capabilities. However, for young student designers this can be an uncertain threshold/liminal space.

Threshold concepts and liminal spaces

Osmond (2015) used the threshold concept framework to gain further insight into teaching design. A threshold concept is defined as being:

> 'akin to a portal, opening up a new and previously inaccessible way of thinking about something. [It] represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress. As a consequence of comprehending a threshold concept there may thus be a transformed internal view of subject matter, subject landscape, or even world view.' (Meyer & Land 2003, p. 1)

Thus, a threshold concept represents a gateway, or portal, to a more developed understanding and level of capability (Meyer et al. 2008). A threshold is:

- transformational,
- irreversible (once learnt, impossible to forget),
- integrative (enables conceptual leaps within and outside the discipline field), and
- troublesome (uncomfortable, with resistance only accepted after some resistance).

Progressing through a threshold can be impeded by rigid ways of thinking including ritual, and inert (disconnected) knowledge, conceptually difficult knowledge (which relies on mimicry), alien (or counter intuitive knowledge) and tacit knowledge (Perkins, 1999). This can leave students struggling within a liminal space, where they flail, as they search for understanding. In new spaces, where technologies are being brought together, new user experiences are being designed, or new products created, the designer has to re-educate him/herself, breaking from traditional educational conditioning. The threshold concept can be seen as a process or moment in time when the designer acknowledges a shift in their understanding.

As a transformational process, passing through this liminal space (or gateway) can be uncomfortable for students who may be required to shed old forms of knowledge and 'ways of knowing and doing'. In educational practice, the gateway portal is viewed as having four stages:

1. Sub-liminal stage, which concerns student knowledge of the existing rules of engagement in the subject. Depending on their previous educational background and life experiences there will be variations of understanding on entry.
2. Pre-liminal stage associated with how confident students are as they approach the threshold concept portal.
3. The portal where there will be variations in how well they handle an unsafe space, and whether or not they can pass through it.
4. Post-liminal stage where students emerge with new capabilities.

For educators, such moments can be crucial, enabling curriculum design by pinpointing diagnostic points for tutors as the waypoints to be navigated, where the key transformations they wish to bring about take place (Meyer et al, 2008).

The tolerance of design uncertainty: how to uncover a threshold concept
Osmond & Tovey (2015) used the threshold concept framework to identify tolerance of design uncertainty as being crucial for design, where tolerance of design uncertainty is defined as:

> '…the moment when a student recognizes that the uncertainty present when approaching a design brief is an essential, but at the same time routine, part of the design process.' (Osmond & Tovey 2015)

This threshold concept emerged from a study undertaken to understand how Coventry University (UK) undergraduate design students negotiated their way through this threshold. Eighty-nine students took part, most of whom were interviewed twice a year from entry to graduation, over a 5-year period. The analysis showed that some students experienced a significant problem during their first year of study, characterised as a lack of confidence in making the creative leap to producing design concepts. This insecurity might be explained through their previous experience in educational systems that fostered a mind-set of 'tell us what do we need to do to pass'. Their undergraduate design course required them to employ new levels of creativity, which they found to be troublesome and anxiety-provoking. Held back by their previous experiences and unable to embrace new ways of working and trust in themselves or the educational process they remained stranded in a sub liminal space. Unfortunately, this proved to be too much for some students who subsequently left the course. For others, the process they went through instilled in them the confidence and techniques to deploy a combination of intuitive and analytical design thinking and thus produce solutions. Crucially they reached the point where they could debate and defend their designs with industrial design staff.

This ability to think holistically backed by analysis is a fundamental part of designing, which requires an approach to teaching design to provide an appropriate environment and a sympathetic curriculum to support designerly understanding.

Table 1. Toleration of uncertainty mapped against Meyer and Land's characteristics (Osmond & Tovey 2015)

Characteristic	Description as applied to toleration of uncertainty
Transformative	Students accept that the toleration of design uncertainty is the jumping off point to innovative design
Irreversible	This transformation incurs a cognitive shift in terms of students' design confidence
Integrative	Students recognise that everything they learn and experience is a legitimate source of inspiration (for example, accepting that surfacing around thinking about subjects that are not directly related to their task may turn out to be the most important part of the process).
Troublesome	Students accept that they will constantly experience and re-experience this 'surfacing around' as they hunt for a solution, even when they attain the status of professional designer.

During the initial study of threshold concepts, it was hypothesised that the development of empathy might be a threshold concept (Osmond & Mackie 2012). This was noted during an ergonomic module which emphasised a link between design and user needs (Osmond & Turner 2008). It was clear that students were experiencing difficulty in moving beyond the 'I methodology'.

Most undergraduate design students tend to be able-bodied 18-24-year olds with 'limited life experience' (Moody, Mackie & Davies, 2011). They begin by basing their design decision-making on their personal perspective (e.g. designing for themselves). They may continue to want to design exciting, innovative products for people like themselves. However professional designers are required to design for 'the other'. Limited opportunities exist within the curriculum to enable students to engage with or research about different populations. This lack of experience combined with a lack of empathy and a high toleration of uncertainty may lead to design which fail to address the needs of the 'other'.

Teaching empathy using Discrete Learning Interventions (DLIs)

In this research, Discrete Learning Interventions (DLIs) are used to enable students to pass through, or gain insight into, key thresholds required by their profession. If DLIs can be used to identify the difficulties students experience in attempting to gain capabilities in certain areas, they have potential as useful pedagogic and diagnostic tools when linked to formative evaluation and reflection. Key here is integrating the DLI and the wider curriculum, so that a DLI does not exist in isolation, but its value is extracted, and students/staff can see and recognize their expertise of design skills.

For the purposes of this paper a DLI is one which is delivered by expert tutors external to the course for a fixed amount of time. Any design exercise in which the students engage is bounded in time and may not necessarily feed directly into the curriculum. Participation in the DLI in this research was voluntary, and provided students with experiences which they would not normally be offered on their courses. Where the DLI was offered above and beyond normal teaching and learning activities, students were offered financial incentives to take part.

The research draws on five DLIs with different cohorts over 2 years. The main objective was to perfect the DLI and show its benefits in increasing the empathic capability of students. All activities were supported by a grant from the Frank Jackson Charitable Trust. Although the key concepts and methods remained, the implementation of the DLI varied between groups as a function of time, resource and student availability. Owing to these variations separate medium – high level ethical clearance was given for each instantiation of the DLI. Unless stated otherwise all activities took place at Coventry University (UK).

Table 2. Summary of cohorts

Ref	Discipline	Cohort details	DLI experience
DLI1	Transport design	5 undergrads (2017) undertaking final assessment	Students self-selected following a lecture on design for the elderly and empathy and were supported with tutorials, classroom based and real-world experiential simulations during the concept design phase of their project involving design of transport for older users. This ran over 2 terms
DLI2	Engineering design	30 undergraduate engineers enrolled on a humanitarian engineering module (2017),	2-hour low fidelity classroom based experiential simulation workshop to encourage them to develop a more empathic understanding of older transport users
DLI3	Transport engineers	20 Serbian undergraduate engineers attending the 6th Humane Cities Conference (2017)	2-hour low fidelity classroom based experiential simulation workshop to encourage them to develop a more empathic understanding of older transport users
DLI4	Transport planners /professionals	10 delegates enrolled for an interactive workshop at the IPATH conference in US (2018)	90-minute low fidelity classroom at the IPATH conference in US (2018) based experiential simulation workshop to encourage them to develop a more empathic understanding of older transport users
DLI5	Transport design	5 MA transport design students participating in challenge to design products to support companionship	This involved low and high-fidelity simulation in and out of the classroom, group tasks and design critique over a 3-day period.

The approach used was to evoke the designer's own experiences in a domain relevant to the user, with designers trying to simulate the user's condition through ideation. Any type of representation designed to understand, explore or communicate what it might be like to engage with the product, space or system may be described as 'experience prototyping' (Buchenau & Fulton Suri, 2000). Students engaged in short individual and group activities related to mobility and travel - in a classroom setting (e.g. route finding, using a phone, eating and drinking, playing games (cards and word search) and removing outer garments)

and out of the classroom (DLI1 and 5) where they used different forms of transport while having restricted mobility and sensation. In relation to this, a technique which is gaining attention is the use of whole-body simulation suits in design and transport research to provide designers with an immersive empathic experience [e.g. Schmidt & Kekel 2013; Armstrong, Stone, Immel & Hunter-Zaworski, 2015). An ageing SUIT was used with DLI5.

The DLIs were designed to take the students through staged of discovery, immersion, connection and detachment (Kouprie & Visser, 2009).

Discovery

In this stage participants were provided with small classroom immersive experiences to raise their curiosity and to start to expand their empathic horizons. Materials provided included

- Glasses: simulating a variety of conditions, such as macular degeneration and cataracts
- Ear plugs: to reduce hearing in one or both ears
- Masking tape used totape thumb and forefinger together on dominant hand, and bind three fingers together on non-dominant hand
- Thin gloves to reduce sensation in hands
- Bandages to restrict movement

Immersion

Typically at this stage the designer moves out of his/her office and explores the user's world. DLI1 and DLI5 were able to do this using simulated suits. DLI1 students took part in a 'walkabout' where they were required to perform all activities involved in travelling from the university to the main rail station, boarding a train to a local station and returning. To support this 'experience prototyping', low fidelity simulations were used, including a range of visual impairment glasses (to simulate glaucoma, macular degeneration and cataracts), mobility impairments (crutches, wheelchair, tape to stiffen legs) and hearing loss.

We evolved a number of strategies to help students make the leap from personal experience to relating this to real people. For example:

- DLIs 1 and 3 were given semi-structured interviews and prompts to help them capture mobility experiences of older people. This was shared with others through a video repository and posters
- DLI4 consisted of transport planners and academics who were attending a transport conference in a particularly inaccessible location (Mackinac Island). They were asked to draw on this experience and relate how they had felt during the simulated exercises to the problems elders might have experienced if they undertook a similar journey.
- DLI5 participants were asked to create mind maps of grandparents on Day 1 and revisit these/consider their grandparents as end users of their designs. This was reinforced by asking them to draw their grandparents once they had produced initial concepts, to refocus them on the end users. On the last day they were asked to produce moodboards which captured how they felt when wearing the simulation suit. Moodboards provide designer with opportunities to express their understanding of the design problem utilising images rather than being restricted by words.

Connection

This requires students combining the information they had been provided on empathy and ageing, their own experiences and relating this to real world situations and people. This process was supported in the debrief sessions where students were given 'quick note' sheets to record their thoughts before, during and after the experience. They shared these with the rest of the class. Although they have a felt experience, they still may not be able to transfer this feeling into design activities.

Detachment

This involves the student or participant stepping back into the role of designer, to deploy the new insights into the current design task. Our participants were a convenience sample, all except the engineers in DLI3 had elected to attend our DLIs and were aware that we were trying to improve transport for older people, by increasing their empathy towards elders in whatever capacity they encountered them. As it was not possible to include a design activity in all groups, at the end of the session, participants were asked to step back and think how they would employ what they had learnt e.g., through brainstorming in groups (DLIs 2-4) or creating individual pieces of work DLI5, or showing how their broader empathic horizons effected their designs.

Results

The overall aim of the research has been to develop a DLI which could increase the participants' empathy towards older transport users as reading statistics on ageing populations and user requirements does not necessarily mean that students understand the felt experience. We would argue that simulations can have profound and unexpected effects in how one feels, and that this can also be transformative if it is acknowledged and brought into play.

If designers, engineers and transport planners apply empathic thinking to urban and transport planning, design of vehicles and transport infrastructure then it is hypothesized that more age friendly transport will start to emerge.

Participant feedback suggested that there had been a change in some in level of empathy and they backed this up by suggesting how they would apply this new understanding in their work and everyday experiences. For example, the Serbian engineering students in DLI3 had never experienced such a method and were keen to use it in their classes. They felt that they focussed too much on the mathematics of construction and forgot about the people who would use their designs. They wanted to champion the users in their activities. Their feedback included 'the workshop is a great practice for all people to accept disabled person and much more to understand these people. Our responsibility is to help them to have as much normal world (normal means accessible, like for non-disabled people, Thank you for this opportunity.'

DLI3 students reflected on how they would be more thoughtful and tolerant of older people using public transport. This transference out of the classroom was also noticeable in one of the participant's comments in DLI1 who started to interpret things in a new way, for example he commented that he found himself watching an old lady struggling down

some steps in Coventry, and for the first time understood why she was moving so slowly – because it was painful for her. This could be directly attributed to the binding up of limbs to restrict mobility and walking with stones in the shoes to simulate diabetic nerve pain.

Engineering students in DLI2 considered how they might change their everyday behaviour by being more patient and helpful, show more understanding towards people in traffic, and by educating others about the effects of disability.

A student from DLI1 experienced unknown levels of anxiety when walking in a busy street with vision restricting goggles. He relied on reading people's faces to judge their moods and feelings. With restricted vision he could not do this and became fearful of the mood of a crowded high street. All students felt very vulnerable – which they had not expected – and were glad to remover their encumbrances

DLI2 was the shortest intervention. After each group activity they were asked to reflect on their experience of group tasks e.g. socialising, wayfinding and doing a shared task. Of key significance was how quickly they became isolated from the group (because they could not see or hear the activities) were left behind (or ignored) and simply gave up trying because it was too difficult.

This was also reflected in the comments of a participant DLI1 who embraced the method, experimenting with low level simulations at home. He saw the benefits of the method, asserted that he would use it as part of his future practice, concluding that the mobility, hearing and visual restrictions made getting shopping into and out of the car

> "… a mountain of a task, it made multitasking very difficult and delayed every task"

From an analysis of individual quick notes and group discussions most of the engineering students in DLI2 and DLI3 expressed deeper empathy for older people and those with age related disabilities and started to realise how difficult everyday life was for them. In terms of changes to their practice, they agreed for the need to champion and consult with differently abled users, and not design transport systems for the fittest. They could point to design features that they could improve e.g. lighting, size of fonts, acoustic signals.

DLI4 was conducted with transport professionals and academics from fields related to transport and health. They were somewhat sceptical of the approach, buy-in was difficult in this non student groups, and providing an immersive experience for them in 30 minutes was challenging. However, once they sensory and mobility restrictions they saw the potential of this approach. Their reflections and transference back into real life included ideas for discrete support for everyone at airports, where support staff are trained to look for people who might be having a problem, not necessarily just the elderly. Also, they wanted quiet space for themselves as carers with dependents and support so that they could take time out from being a carer e.g. to leave someone with a trusted member of staff while they went to the toilet, bought food or took time out during the journey.

The concept idea developed by one of the students in DLI5 revealed a more empathic understanding of the needs of elders and a more thoughtful approach. These are shown in figures 1 and 2 below. The first image shows a design for a walking stick handle, which is based on a handshake – representing trust, companionship, and human feeling. Although the design remained unresolved, it showed a more empathy and sensitivity to users than the initial functional designs.

The second concept was for shoes which opened up, like a clam, so they were easier to put on and take off. This could be traced to the difficulties the students experienced in the low fidelity simulation when they experienced difficulty removing their own shoes and putting on someone else's. This task was designed specifically to show the problems elders have with putting on shoes, and the problems' older partners may have in helping their loved one, when they might also have a disability.
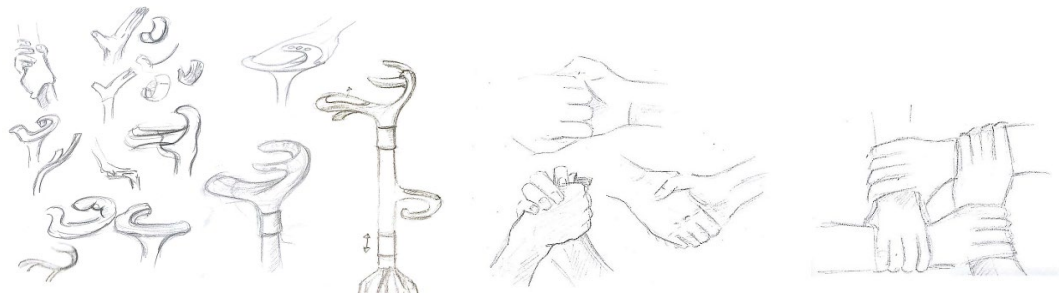

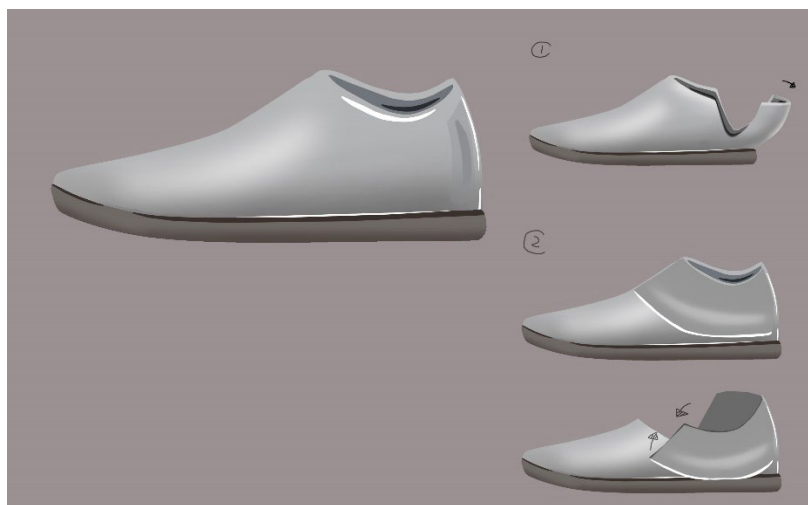*Figure 1. Movement in design direction following empathic modelling*

Figure 2. Initial designs for the 'opening shoe'

The evidence for empathy as a threshold concept

The research which established that the toleration of design uncertainty is a threshold concept did so through providing convincing evidence of its operation and efficacy. This was achieved through both identifying the nature of design uncertainty as a block for students and then developing pedagogic strategies which enabled the block to be overcome. The work was mapped onto the stages of the threshold concept theory as transformational, irreversible (once learnt, impossible to forget), integrative (enables conceptual leaps within and outside the discipline field), and troublesome (uncomfortable, with resistance to acceptance).

In the studies reported here we argue that achieving an empathic understanding of users as a crucial element in understanding user needs. Designers will not produce products which are properly attuned to their users, if they lack it. The empathic horizon (Woodcock, McDonagh & Osmond, 2018) is real and travelling over it is an essential journey for designers. We can thus map this against threshold concept characteristics as shown below.

Table 3. Empathy Horizon mapped against Meyer and Land's characteristics

Characteristic	Designing for others is fundamental to design
Transformative	Design students accept that the empathic understanding is essential to understanding user needs.
Irreversible	This transformation incurs a cognitive shift in terms of students' design approach.
Integrative	Students recognise that an empathic approach should give direction to their solution concepts and frame their evaluation of proposals, thus providing the overall shape for their design process.
Troublesome	Students accept that they will constantly experience and re-experience this empathic struggle to understand and connect with users, even when they attain the status of professional designer.

Thus, we can argue that empathic understanding is a threshold capability for design students. It is a very similar capability portal to the Toleration of Design Uncertainty with which it overlaps, but is separate from. However, although we have mapped empathy against Meyer and Lands' characteristics, we cannot speak to the longevity of the experience delivered through this pedagogic model: to this end the development of a future pedagogic framework should align with the four stages identified earlier:

1. Sub-liminal stage, which concerns student knowledge of the existing rules of engagement in the subject. Depending on their previous educational background and life experiences there will be variations of understanding on entry.
2. Pre-liminal stage associated with how confident students are as they approach the threshold concept portal.
3. The portal where there will be variations in how well they handle an unsafe space, and whether or not they can pass through it.
4. Post-liminal stage where students emerge with new capabilities.

Conclusions

In this article we have summarised previous work which established the relevance of the Threshold Concept model to design education. In that work, the key role of the designer as the creator of the draft solution which synthesised requirements was highlighted. This is normally achieved through proposing a design concept. Students who found they struggled to do this were at a considerable disadvantage. This has been labelled the toleration of

design uncertainty and surmounting it is both essential and transformational. It thus conforms to the Threshold Concepts model.

We have also sought to summarise thinking on the importance of empathy as a component in understanding user needs and wants from designs. The empathy horizon represents the threshold of understanding the end-users which designers should aspire to achieve. Representing users in the design process is a key role for designers.

The studies we report on have clearly shown just how difficult design students found this to be. When confronted with the need to understand and put themselves in the position of users who are radically different from themselves, such as those with sight-impairment or mobility restrictions, they were shocked by how unfamiliar and difficult this is. This is of course good for their souls. But it is also a challenge for design educators.

We believe that we have shown clearly that achieving empathy represents a threshold of understanding which is essential in designing for others. In the work we have reported here we show that it conforms to the Threshold Concepts model and that it is similar to the Threshold of Design Uncertainty. The Empathic Understanding forms part of the pre-liminal space, which students approach as a portal of uncertainty. In order to develop the confidence and capability to pass through this portal they need to develop genuine and effective empathic skills. We are claiming that we have established the relevance of the model in this area, and that this Empathic Understanding represents a threshold capability. What needs further work is the development of a pedagogic framework that incorporates Meyer and Lands' four liminal stages (sub/pre/portal/post) as a baseline in order to bring design students to a level of confident capability in handling empathic design.

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