Digital Touch: Towards a Novel User-Experience Design Pedagogy

Abstract

HCI and Industrial Design are both disciplines that are currently experiencing radical transformation in terms of their identity and scope. HCI has moved beyond its origins in human factors and cognitive psychology towards the proactive and generative design of experience. Industrial Design has similarly evolved from a concern with physical form and function-giving solutions to the holistic design considerations of the user's experience. Given the complexity and scale of this shifting design landscape, the response of design education must shift in methods and learning and teaching objectives. This paper provides the Design and Technology Education community with a research case study of innovation within HCI education, here situated within the broader context of Industrial Design education. We present a novel pedagogy for designing digital touch communications, developed through an interdisciplinary collaboration of HCI, Industrial Design, and Social Science academics, and advanced through a coursework assignment for 64 undergraduate Industrial Design and Technology students undertaking a User-Experience Design module at the [AUTHOR] (UK). We discuss the role of low-fidelity experience prototyping of digital touch interactions beyond screens, and the limitations of such an approach when engaged with by novice designers with entrenched material science understanding. We conclude the paper with a call for new educational '*tools*' to support and scaffold both the learning and teaching of design for digital touch experiences within a User-Experience Design context, and we offer our development of a Designing Digital Touch Toolkit as one such tool.

Keywords

Digital Touch; HCI; Experience Prototype; Design Pedagogy; User Experience; Multidisciplinary.

Introduction

This paper explores what happens pedagogically when we move '*digital touch communication*' to the centre of a Human Centred Design (HCD) design process. Advances in haptics, virtual reality, and bio-sensor applications are re-shaping what can be touched as well as how it can be touched, shifting digital communication from '*ways of seeing*' to '*ways of feeling*' (Price et al., 2018; Jewitt et al, 2020). While technological frontiers continue to be pushed, there is scope for innovation regarding the kinds of meaningful communication experiences and activities that these technologies might enable or support. We reflect on the ways in which current pedagogical experiences with design 'materials' and rapid prototyping shape design students' engagement with the design of digital touch experiences, and suggest an emphasis on the speculative, social, and sensory aspects of how touch experience might enhance their engagement.

The paper presents an ongoing interdisciplinary collaboration between the authors, academics in Human Computer Interaction (HCI), Industrial Design, and the Social Sciences, in the form of a case study on the design of digital touch. The case study explores this design space in the context of a User-Experience Design module at [AUTHOR], part of the BA Industrial Design and Technology (ID) programme. We outline the case study site and methodology and discuss how the study findings concerning the students' processes and outcomes led us to consider ways to bring more social and sensory-experiential sensitivities to their design process. In order to enhance students' consideration of the social and sensorial aspects of touch in the Experience Design process, we suggest educational design tools are needed to encourage consideration of touch, the fuller exploration of opportunities to design new ways of feeling, and situated reflection regarding the meaning and value of touch, and outline the early stages of our development of the Designing Digital Touch Toolkit as one such tool.

First, we contextualise the case study in relation to recent changes in HCI, ID, and HCD education, with attention to experience prototyping and storytelling as core to design pedagogy.

The Shifting Backdrop of HCI Education

The boundaries of the disciplines of HCI and ID are undergoing rapid change. We have seen the expansion of HCI beyond its roots within human factors and cognitive psychology where efficiency and usability were paramount, through a time where the hedonic aspects of interaction were acknowledged but still bolted on (Blythe & Monk, 2018), to today where design of experiences is now the '*central and explicit*' object of design (Harrison, Sengers, & Tatar, 2011; Hassenzahl, 2018). This has coincided with similarly seismic shifts within ID practice from form giving to consideration of form and function, through Interaction Design (Moggridge, 2007), User-Experience Design (UXD) (Hassenzahl, 2005), and now Experience Design. Today's Experience Designers draw on both disciplines to not only deliver products that are useful, usable, and satisfying to use (Bevan, Carter, Earthy, Geis, & Harker, 2016), but also to operate within contexts where the boundaries between business and design are increasingly blurred (Mitchell & Melinkova, 2018), and to design systemically across multiple physical and digital touchpoints, taking the needs of diverse stakeholders into account. The materials available to designers from which to craft experiences have never been so diverse, particularly at the intersection between physical and digital materiality (Pink, Elisenda, & Lanzeni, 2016) where digital touch communications reside.

Education of tomorrow's professional designers is also taking place against a backdrop where the relationship between designers and the people they are designing for is fundamentally changing. In response to the increasingly unbounded and complex societal problems that designers are called upon to address (Sanders & Stappers, 2008), co-creation

with people rather than designing for people is emerging as part of the shift from designing isolated products to designing connected and meaningful experiences. This is leading to new strategic roles for professional designers as the owners and facilitators of the design process and creators of tools and methods that allow all to participate in design. This role has been further amplified by the emergence of '*design thinking*' (Brown, 2009) which has led to HCD methodologies becoming central to technology innovation and business transformation processes, thus further democratizing design as a discipline.

UX Design Teaching

ID education has, in many national and international contexts, a signature pedagogy as students are predominately motivated to learn for a particular profession, rather than to acquire domain knowledge (Shreeve, 2015). Teaching of UXD to ID undergraduates has a similar emphasis on developing professional practice alongside the qualities needed for critical enquiry and independent learning. In the mid to late 2000's in the UK and USA, HCI teaching tended to reside predominately within computer science or psychology departments. However, the paradigm shift of HCI towards experience (Harrison et al., 2011) within industry and academia required a holistic, visual, problem-based way of thinking (Buxton, 2007) that has much in common with ID practice, with many students going on to careers within the fast growing UXD industry.

The UK Design Council '*Double Diamond*' (Design Council, 2005) is a framework that is used internationally by many within UXD teaching (and beyond) to structure student design practice. The Double Diamond describes four key stages of design common to any design practice focused on product- and service-centred innovation: Discover, Define, Develop, and Deliver (see Fig. 1.). This framework communicates the need for both divergent and convergent thinking within an HCD process. Equal emphasis is given to strategically identifying the '*right thing*' to design and then, once a vision for the future product has been established, designing the '*thing right*' (Wilson & Mitchell, 2018) through iteration of product concepts in collaboration with representative users. This is consistent with the representation of design as overlapping processes of elaboration (divergent opportunity seeking) and reduction (convergent decision making).

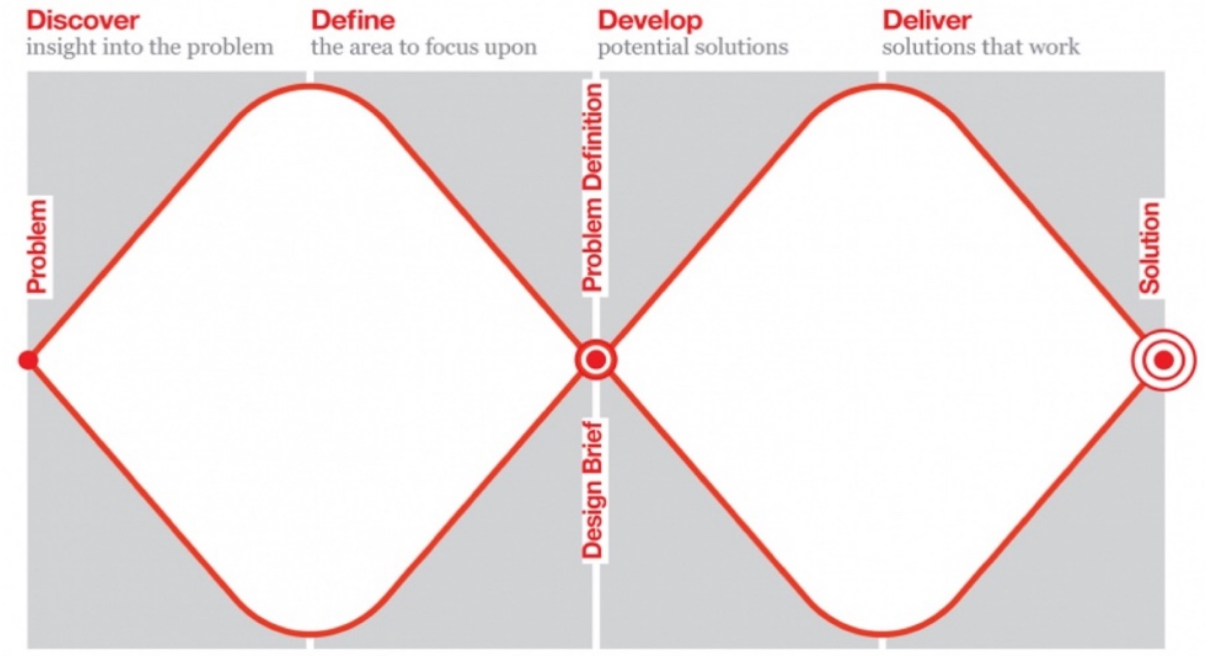

Figure 1. The Design Council 'Double Diamond' model (Design Council, 2005).

This framework underpins UXD teaching at [AUTHOR], the site of the case study presented in this paper.

The Role of Experience Prototyping and Storytelling in UXD

The value of prototyping is well established within international design education and practice in both ID (Youmans, 2011) and HCI design (Lim, Stolterman, & Tenenberg, 2008). The benefits of prototyping within design education include increased creativity, innovation, and design synthesis skills, with a review of world leading design school curricula showing an orientation towards active learning and extensive use of prototyping (Berglund & Grimheden, 2011). Prototyping within UXD practice is often orientated towards tactical evaluation of design ideas (Hinman, 2012) with a focus upon usability, although its generative role as a tool for creation of meaning has been recognized and championed for many years (Lim et al., 2008). Buchenau and Fulton Suri (2000, p.425) first introduced the concept of '*Experience Prototyping'*, defining an experience prototype as "*any kind of representation, in any medium, that is designed to understand, explore or communicate what it might be like to engage with the product, space or system*". They describe its use as a way to capture the contextual, physical, temporal, sensory, social, and cognitive factors that should be considered during the exploratory generative stages of design. Whereas Buchenau and Fulton Suri describe the technique as a way for designers to immerse themselves within a design space, largely by simulating what it would be like to be the user (also known as '*bodystorming*'), others have developed experience prototyping as a participatory design technique. This involves the acting out of scenarios within realistic contexts of use using low-fidelity props to enable the meaning of future products to be explored unconstrained by representations or concerns about how future enabling technologies may work (Iacucci & Kuutti, 2002).

The use of low-fidelity experience prototyping has been core to the development of pedagogy for UXD, providing a means to help student designers to understand that user experiences are situated and constructed by the context of use (Kankainen, 2003), and that their design and meaning should be negotiated collaboratively by designers and users (Muller, 2003). Theoretically, this approach is underpinned by the notion of embodied interaction (Dourish, 2004) at the heart of 3rd paradigm HCI (Steve Harrison, Sengers, & Tatar, 2011). In particular, with attention to grounding the meaning and nature of interaction in the context within which it takes place and the ways that embodied meaning of interactions unfolds over time. Accordingly, user experiences should be designed and evaluated within the context within which they will be used (Sengers, Boehner, & Knouf, 2009). This requires the student designer to locate their generative and evaluative design activities out-side of the safety of the studio and collaborate with their target users '*in the wild*'.

Storytelling is a medium for constructing and conveying meaning in relation to the context of use that has become central to UXD pedagogy (Kolko, 2011). Students use narrative form to make sense of the problem space with users; to create temporal based abstractions of reality, such as experience maps, to then generatively explore future experiences, using contextual scenarios. In doing so, they move from understanding '*the world as it is now*' to exploring the '*world as it might become*' (Dubberly, Evenson, & Robinson, 2008). These scenarios then form the basis for experience prototyping (Buchenau & Suri, 2000) with target users, using constructed props and prototypes to act out choreographed scenarios within a realistic context of use. Finally, students create video-based prototypes (Yliris & Buur, 2007) of their final concepts to convey their visions for future

experiences, with storytelling used explicitly to convey the '*hero's journey'* and to manifest how their future product enhances the experience of their target user.

Case Study Design and Method

The case study presented in this paper is an illustrative case study (Yin, 2009) which describes and explores the pedagogy of HCD for digital touch communication. It addresses the question, what happens pedagogically when we move '*digital touch communication*' to the centre of a HCD design process? More specifically it asks, how might current pedagogical experiences with design 'materials' and rapid prototyping shape design students' engagement with the design of digital touch experiences? And how might the speculative, social, and sensory aspects of touch experience enhance design student engagement with touch?

The case is bounded by a design brief on digital touch communication in the context of a UX Design module within the BA Industrial Design programme. It is the result of an interdisciplinary collaboration between the authors, academics in HCI and ID, and Social Science researchers on the [AUTHOR] project (a 5-year research project exploring digital touch communication).

Case Study Site and Participants

The case study is situated in the [AUTHOR] - a leading UK Design school. Specifically, a cohort of second-year students on the User-Experience Design (UXD) module, an optional module on the BA Industrial Design and Technology (ID) programme. This year was selected to provide a shared understanding and competency in UX design. Students were recruited via a face-to-face introduction to the project, they were given a detailed information sheet, and their consent was sought for participation in the study (i.e. to be observed, audio and/or video recorded). Participation was voluntary, students were able to opt in or out at any stage, and it was made explicit that refusal to participate would not affect their course experience or grading. A total of 64 full-time undergraduate students enrolled on the module participating in the study and all participated in the study. The cohort comprised of 46 students that identify as male, and 18 that identify as female.

Case Study Pedagogic Approach

The UX Design pedagogical approach at [AUTHOR] is briefly outlined here as it provided the structure for the case study design. The approach is underpinned by project-based learning (Capraro, Capraro, & Morgan, 2013) where students address over extended periods of time complex tasks based on challenging questions or problems, culminating in iterated and refined design outcomes (Koutsabasis & Vosinakis, 2012; Thomas, 2000), within the Double Diamond Design framework, outlined earlier. Low-fidelity experience prototyping is a core pedagogic method used, which has evolved over the last 8 years at [AUTHOR], to scaffold the learning process within the storytelling medium. Studio-based workshop activities are used at key stages of a project to enable '*learning by doing*' and support cycles of experimentation and reflection (Kolb, 1984; Nilson & Dewey, 2006). Throughout the design-project, the student is on a learning pathway towards the reconciliation of two states – from the problem towards the solution (Checkoway & Schon, 2006; Tovey, 2015). By reflecting upon phenomena and their own understanding, reconciliations (concepts) are made and further reflected and iterated upon. The signature nature of this UXD pedagogy motivates the lecturers to seek out challenging assignment briefs that push students to engage with themes at the forefront of UX professional practice and societal trends. The design space of digital touch experiences and the emergence of digital touch for communication is one such theme. It is of particular relevance to the ID students because of the related intersections of

physical and digital materiality, and the landscape in which their future professional careers are likely to be situated.

Case Study Activities

The case study design included three activities: 1) A lecture on digital touch; 2) A project brief on digital touch design; and 3) A series of three experience prototyping workshops. Each of these activities is described below.

1) *An introductory lecture* by one of the [AUTHOR] academics introduced the students to the notion of '*digital touch'*. Through the (45 minute) lecture, students were shown examples of a wide range of digital touch communication devices and environments, and the kinds of technologies that may facilitate digital touch communication now and in the near future. They were encouraged to consider how the digital mediation of touch had the potential to change who, what, and how people (and machines) were going to be able to touch, how they might relate to each other, and how people may come to know and experience the world differently through touch. Digital touch was broadly defined as touch that is '*digitally mediated*', and could involve a range of technological domains, including haptic devices, virtual touch applications, wearables and bio-sensing, within co-located and remote communication contexts. Communication was broadly defined as the sharing of information, feelings, sensations, skills, thoughts or ideas between humans, humans and machines, or humans and other objects. The scaffolding of students' learning and design process through the supporting lecture helped to build student confidence whilst leaving space for creativity and innovation.

2)A project brief on digital touch communication design was devised collaboratively between [AUTHOR] and the [AUTHOR] team and set as an assignment for the 64 second-year ID students taking an optional module in UXD. The students' assignment brief was:

> *'…to develop an innovative, future-facing digital product or service that enhances communication through touch in one of three sectors: personal relationships, leisure, or health and wellbeing. To do this, students need to first research a specific communication context that would benefit from the introduction of touch technology, for face-to-face or remote interaction. Students then need to identify specific user needs and, in collaboration with target users, develop and refine a product or service that will respond to those needs that includes an element of digital touch.'*

The brief for the product or service concept was framed by constraints that required students address a real-world problem identified through research activity and be iteratively refined through experience prototyping; define their target user group; move beyond touch screens and mobile apps; incorporate other forms of tangible interaction, existing or emerging technologies tapping into current trends, the '*weak signals*' of possible touch developments. While they could draw on other senses or modalities, touch was to be central to their design. They were also constrained by ethical considerations of safety and wellbeing, reflecting on what might be appropriate contexts and boundaries of touch. Students were introduced to the brief by the Design educators in the class, and given a paper and digital copy of it.

3) *A series of three workshops* were facilitated across the module to support the students' concept development and experience prototyping in relation to digital touch communication. Low-fidelity experience prototyping workshops were structured around 4 prompts: Question, Plan, Test, Reflect (QPTR), which the students situated in the context of digital touch communication. Students first needed to decide the question(s) that the digital touch experience prototype would be used to explore with consideration of the '*user*', '*task*',

and '*environment*' (proxies for the '*motivation*', '*action*', and '*context*' of an experience (Kankainen, 2003)). Students then created a plan of how to address their question(s), guided by narrative structure, for the touch experience they wished to create through a compelling scenario using storyboards (Kolko, 2011) from the point of view of the target user. To do this they considered the roles and scenes, data required, protocols and ethics established and found the tools, props, and actors to design and produce a low-fidelity digital touch experience prototype. In the Test phase, students worked in small groups and built on the theatrical method of investigative rehearsal (Stickdorn, Lawrence, Hormess, & Schneider, 2018), a more staged variation on the bodystorming (Stickdorn et al., 2018). The format followed a watch (act out the scene without interruption), understand (act out the scene again but call '*stop*' to question aspects of the experience), and change and iterate structure (act out the scene again, but this time make changes to enhance aspects of the experience). The iterated version of the scenario was captured as rough video using the students' smartphones for future development and reflection. In the final Reflect phase, students engaged with cycles of experimentation and reflection (Nilson & Dewey, 2006).

Through the above QPTR process students are not only '*doing*' but also making criteria-based judgements towards the generation of insight and original knowledge (Krathwohl, 2002). This process was rehearsed through three, three-hour studio-based workshops designed to guide the students though the experience prototyping process including: the construction of a meaningful narrative to convey their emerging touch experience design; encouragement towards touch experimentation to develop empathy with the user and their desired experience; and supportive resources for transitioning to independent learning and practice when they take their prototypes out '*into the wild*' to evaluate with users in context.

The prototyping was led by [AUTHOR] academics and supported by the [AUTHOR] team. These drew on rapid prototyping workshops facilitated by [AUTHOR] elsewhere [AUTHOR], which provided participants with a range of sensory materials and touch words. This expansion of materials aimed to bring to the fore sensory-experiential sensitivities and to support consideration of the sociality of touch experiences, rather than focusing on only functionality, was in line with embodied interaction thinking. '*Body scaffolding*' materials, such as plain white socks, white catering hats, and white face masks (developed as an element of [AUTHOR] experience prototyping process, and partly inspired by the all-in-black invisible '*Kurogo*' assistants of Japanese '*Kabuki*' (Cavaye, 1993)) were also provided to encourage experimentation of touch interfaces that go beyond the hand.

Data Collection and Materials

In the prototyping sessions students worked in 10 groups (of 6-7) and each researcher focused on the activity of 3-4 groups in a particular section of the room; while the lecturers worked with all groups - providing an overview of the workshops. Brainstorming activities were observed and post-it notes photographed to capture the process. Whole class discussion and demos were video-recorded using one camera. Three [AUTHOR] researchers used roaming video cameras to record the interaction of student prototyping with the materials and one another. They moved and occasionally 'felt' with participants, in an effort to gain insights into their experiences, and where their design processes were not clearly articulated they asked questions to probe for them. These were supplemented by researcher observations (recorded in field notes) and text-based data generated by the participants was also photographed (e.g. post-it notes, storyboards, and flip-chart notes). A total of 14 hours of video data was collected. In addition, the students' course work responses to the brief in the form of individual concept boards (64 PDF documents), and group concept videos (12) were collected.

Analytical Frame and Process of Analysis

The prototyping session observations and field notes provided a background and thematic insights for the analysis of the students' final concept boards and videos. The [AUTHOR] team reviewed and conducted a thematic analysis of the 64 student storyboards and video prototypes. We reflected on the kinds of design concepts that had emerged and how the digital-touch-centred brief shaped the design process and located the students' concepts in the emerging landscape of digital touch. Our approach to the analysis was guided by both multimodal and sensory ethnographic sensitivities. This led us to explore how students engaged with the materials made available to them and the potentials of experience prototyping to speculate and engage with the social and sensory aspects of touch experience design. Through team discussion of the workshop experiences, and preliminary analysis of the students' concepts boards and videos a set of analytical categories were developed with which to review the students' work: a) the overall design concept – the problem space of touch; b) the technology type and features used (e.g. bio-sensing, wearable solutions); c) the character of the touch communication supported by the design – the what, who, when and why of digital touch; d) the character of the communication afforded via digital touch – its temporality, spatiality, share-ability etc.; e) how the body was brought into the interaction – where was touch located on or in the body; f) how touch was related to other senses or modes; g) an overall assessment as to whether the designed digital touch served to supplement, heighten, extend, or reconfigure touch experiences. Through these questions, we explored the touch narratives underlying the student designs.

The analysis of the concept boards provided a route back into relevant video recorded episodes of prototyping to explore the case study research questions through attention to the interactions between students and materials and the design of digital touch communication.

Findings and Discussion

The focus of this paper is on the pedagogy of '*digital touch communication*' within HCD design processes, however, we first provide an analytical overview of (64) students design concepts to situate the discussion of how pedagogical experiences with design 'materials' and rapid prototyping might shape and enhance design students' engagement with touch, notably its speculative, social and sensory aspects, and our call for new educational '*tools*' for the learning and teaching of design for digital touch experiences within a User-Experience Design context.

Overall the students' design concepts imagined a functional problem space for touch. The majority centred around touch (mainly as vibration) as a means to convey connection and/or presence. These designs entered existing 1-2-1 relationships (e.g. parental, romantic), or professional-care to provide support with anxiety, homesickness, loneliness or health and well-being (including sports injury). Some example concept devices included, a touchable-bed-side lamp, set out to managing the emotion of adult child –parent separated using touch as non-verbal presence/connection; the social potential of touch to enhance connection including, a virtual-reality environment that haptically connected remote players; several devices enabled a tactile sense of connection (mainly via a phone app) with pets, as well as animals in the zoo. Touch was strongly linked to ameliorating the anxiety of being connected and providing a sense of control over self and your touch-environment (e.g. the management of claustrophobia, reducing 'first date' anxiety, creating a touch-free 'your personal bubble' in a busy workplace, to alerting cyclists of approaching cars). This notion of digital touch as control and 'solution' was extended to safety, and the provision of touch feedback and monitoring as reducing risk (e.g. in relation to the elderly 'falling'; cycling and motorbike riders; personal safety on nights-out; and accidents and injury more generally).

Touch (in the form of bio or motion-sensing, and vibration) was used by students as a kind of tactile corrective punishment and to promote Kinaesthetic awareness. For instance, many of the students' design concepts imagined the use of digital touch feedback to re-shape the body or a bodily-technique, sensing feedback, or temperature re-calibration, disciplining the body through touch into an idealized body. For example, a device worn on the user's wrist would vibrate if they spent too long on their phone or to encourage the correct grip of a tool. Vibration featured in many designs to enhance navigation, for instance, a device for visually impaired people warn behind ears which change pitch according to the degree change in direction; a tactile smart cane with vibration; and a motorbike helmet with vibration alerts. Finally, touch was brought into the domain of efficiency and convenience in many of the design concepts for instance making the controls of an electronic guitar more accessible in a timely way that made bodily movement more efficient, or health analysis in time-efficient ways.

Digital touch was generally conceptualised as touch between a monitoring device and the wearer. The types of technology and digital features used by students in the concept designs were strongly shaped by those 'preconditioned' prototyping: mobile phones, Apple watches, digitally imagined auxetic materials, heat pads, VR, AR, smart textiles, connected devices, bio-sensing, GPS, environment sensors, a wide range of digital wearables, smart socks, and other pre-existing garments. Despite this wide range of technologies, most concepts limited digital touch to some kind of vibration, and the role of touch to functional aspects - activation, feedback, and sensing. The student concepts suggested that they also grappled with the notions of input/output and sending/receiving in relation to touch, and how this happened was not always clear.

The what, who, when and why of digital touch was thus limited, often tied to the mobile 'screen' – reimagined onto the body, or another device, with buttons and alerts a constant feature. The difficulty of moving beyond standard digital touch forms, swiping, tapping, vibration, and the use of touch as 'activating a feature' dominated the case study. Even when digital touch was degraded and reduced to a vibration, however, touch was talked of as gentle, weak, firm, too strong, holding, caressing, nice, unpleasant, a stroke, or a hug. It was attributed with some social meanings, such as caring touch, comforting, playful, rejecting, loving, supportive, or controlling touch. Digital touch was seen as having the potential to fulfil social needs, with 'the right amount of touch' being key, understanding when pressure and duration moved from supportive to 'too much' through to 'aggressive or violent'. For some participants, interpretations of touch involved gendered associations and the creation of masculine and feminine touch, which attributed technology itself with a gender.

The character of the communication afforded via digital touch, its temporality, spatiality, and share-ability was a feature of some student design concepts. Participants in the case study explored technological, social, and emotional temporal features of touch to structure communication experiences through their prototypes. These were shaped through their experiences of mobile media/apps in terms of communicational time-effort, spontaneity and managing response time, and obligations and expectations. The student concepts also raised issues regarding the temporalities of touch including on/off touch, always on touch, being triggered by specific touch, and some afforded synchronous touch, while others enabled asynchronous touch.

The sense that the body is vulnerable through touch communication resonated across the case studies. The student design concepts reflected the social norms of touch, with over a half locating touch on the hand or arm. While some engaged with other body parts, only a few engaged touch with the whole-body. Bodily feedback along particular digital-material parameters was key in students' imagination of digital touch concepts; here, bodies were

nudged into specific positions and kinds of movements, and bodily feelings, states and symptoms were reinterpreted through numbers, vibrations, and emotion displays. More broadly, the concepts primarily situated touch in relation to ideal normative bodies, that is fit and healthy (though some temporarily injured through sport), available, and (with a few exceptions) able-bodied. The dominance of mobile apps and wearables (often the two were linked) also suggested a design conceptualisation of the body as a future touch interface.

The student concepts primarily engaged with touch in the context of the visual, and aural senses. Overall, their designs of digital touch served to supplement or heighten and amplify existing touch experiences, rather than designing digital touch possibilities that extended or reconfigured touch experiences in new ways.

Towards a UXD Pedagogy for Designing with Digital Touch

In reflecting on the students' workshop activities, storyboarding, prototyping, and subsequent concept development, we were struck by the relative conservatism with which the design students approached the brief. The quest for technological solutions appeared to override considerations of the sensory-experiential and social aspects of the products and services they designed for. We illustrate this below by focusing in on one example typical of the students' relationship with prototyping materials, before turning to the broader pedagogical implications.

The materials were introduced to the ID students in the first of three workshops (see Fig. 2.), designed to support ideation of initial '*sketchy*' concepts, before experience prototyping one or more of these concepts using the QPTR process. The premise was that at this divergent and creative stage of the UXD process (the 'Develop' stage of the Double Diamond) exposure to a wide variety of sensory materials would provoke the students to consider a broad range of touch-mediated communication experiences.

Figure 2. Sensory materials used within the workshop.

The student participants were, however, unexpectedly '*hands off*' and uninquisitive about the sensorial qualities of the materials. This was despite being encouraged by the lecturers and the brief to explore and play with them and consider their affordances as they collaboratively progressed their early concept ideas. Whilst the students enthusiastically

engaged in the experience design process, scaffolded with the QPTR framework and storytelling activities (described earlier), their engagement with the sensory materials was predominately in the context of seeking out and constructing props to support acting out and exploration of concept ideas through storytelling. Their final concepts created in response to the brief similarly foregrounded application of digital touch technologies to deliver novel product features, with less reflection on the social meaning, ethics, and role of touch interactions within their imagined future experiences.

The markedly low-level of engagement with the sensory workshop materials was surprising (as compared to those with speculative design students led by [AUTHOR], for example, see [AUTHOR]). This led us to reflect more broadly on the role of prototyping materials within UXD and the implications for HCI teaching. This issue is particularly relevant where the current signature pedagogy of Experience Design is evolving to meet market demands for graduates equipped to think systemically whilst designing at the intersection of digital and physical product design.

The ID students undertaking the optional UXD module had developed a relationship to physical, solid materials (wood, metals, plastics etc.) in line with the traditional teaching of their discipline, where knowledge about material properties is developed somewhat separately from their application. Students are encouraged to understand material science data, such as the Young's modulus of steel or the thermal properties of silicon, or possible finishes, treatments, and coatings towards the technical and visual resolution of their proposal, rather than the social and sensorial qualities of these materials. In response to exploration of the problem space (Discover) and generation of key insights and opportunities (Define), concepts are typically sketched on paper, with rapid ideation encouraged to explore a variety of forms and functions before moving to low-fidelity prototyping using blue foam or card, and then switching to CAD and increasingly 3D prototyping to further refine the design. In that scenario, whereas consideration of the feel and properties of materials may be encouraged, it is subservient to considerations of form and function within this iterative but ultimately reductionist process of moving from problem to solution. This case study, and [AUTHOR] UXD pedagogy more generally, although prioritizing the design of experiences over products and more divergent exploration of problem and solution spaces, appears to lead to a similarly reductionist relationship with materials and technologies. Similar to the refinement of sketches and prototypes from low- to high-fidelity, within UXD, scenarios are used to mediate between problem and solution with increasingly detailed narratives and visualizations used to advance the fidelity of ideas towards the final solution. Students are initially encouraged to ideate concepts using sketchy contextual scenarios to narrate experiences at a behavioural level, deliberately omitting the details of user interfaces to keep the story focused on conveying the desired experience, undistracted or constrained by the detail of specific interactions.

At the concept ideation stage where we introduced the sensory materials, the students' pedagogic training therefore led them to prioritize rapid and divergent ideation of solutions as they acted out different contextual scenarios and questioned aspects of the experience through bodystorming with quickly constructed experience prototypes. Although the role of mediated touch communication was often central to their bodystorming experiments, the sensory nature of the interactions was not fully utilised as a design resource, as students focused on crafting the narrative of their proposed future experience. For example, Fig. 3. and Fig. 4. show students exploring the role of digital touch communications within an experience designed to help amateur golfers adopt the correct posture when practicing their swing.

Figure 3. [AUTHOR] students experience prototyping.

Figure 4. Exploring the role of digital touch within a golfing context.

Experiments with different forms of digital touch are apparent (a surgical glove is being used as a prop to signify a smart glove that senses the golfer's grip on the club; string and a balloon are being experimented with to explore how pressure on the back and/or shoulders could be used to direct the golfer into the correct posture as part of a shirt-based wearable). Although the nature of the sensations conveyed was discussed and negotiated amongst the student designers, this was '*broad brushed*' typically at the level of '*inputs*' and '*outputs*' (e.g. the thumb of the glove could vibrate to alert you [the golfer] that the grip is correct and you can begin to swing). Digital touch here was mainly concerned with the translation of binary information towards a yes/no user relationship with the concept. Are my shoulders

situated correctly in relation to the activity? Is my arm positioning correct? Touch in this concept becomes a mechanism to convey objective correctness – an extension of the designer's intent to make a perfect solution to a problem - as opposed to enhancing the experience with subjective quality (e.g. wrong but with a reaffirming touch vs wrong with an aggressive touch). An experience is present and can be refined and iterated, but its parameters are narrowed to the experience of engaging with the information, not the qualities of touch *per se*.

The sensation of touch or situated meaning of touch in this context, and as seen across this workshop, was not articulated (e.g. a '*sharp touch*' or '*angry touch*'), touch was not foregrounded or its meaning critically explored. Reflection was present in the action and iteration of the ID students, however, the character of problem reconciliation narrowed the scope of the students so as to omit directions and ideas that did not support a tangible direction forwards within the safe confines of their training-to-date. Reflection here became a tool for goal-orientated resolution within the parameters of a more novice comprehension of meaning and criteria-based judgements (Krathwohl, 2002). Judgements were not made in light of an expansive '*what if...*' proposition that would indicate higher order understanding and an ability to deal with ambiguity. The students were trying to emulate the processes taught to them, with learning objectives concerned with being able to consolidate and replicate the procedures and display the level of comprehension expected of a second-year undergraduate ID student, not to innovate and create new knowledge.

This emergent UXD practice for designing with touch is in line with established UXD pedagogy, particularly how contextual scenarios are used to explore behaviour and the narrative of experiences before the details of user interfaces and (typically screen based) interactions are resolved. How students go on to articulate the sensory interactions once the overall narrative of the experience has emerged has yet to be resolved. Nonetheless, it is significant that studio-based and staff-supported experience prototyping provided the ID students with the knowledge and confidence to take these prototyping techniques out into the wild to further resolve their designs with target users later in the assignment (for example, Fig 5.).

Figure 5. Later experience prototyping of iterated touch technology concept in context with a user.

Future Work: Educational 'Tools' for UX Design Learning and teaching of Digital Touch Experiences

This case study gives a sense of the complexity of engaging novice designers in the task of imagining digital touch futures. It can bring forth utopic and dystopic visions, and easily reproduce cliché and stereotypical visions of digital touch that fail to engage with its nuanced social and sensory aspects or speculative futures (Dunne and Raby, 2013) of extended and reconfigured digital touch. The case study, tracking and observing the students' design process (ideation, experience prototyping, and concept development), highlighted the difficulty of imagining the sociality of digital touch and moving beyond the constraints of dominant digital forms in the current landscape (e.g. mobile phone apps, and on-the-wrist-wearables).

The case study suggests that a need for new educational 'tools' to support and scaffold both the learning and teaching of design for digital touch experiences within a User-Experience Design context. Design students need support to approach digital touch technology as a way of enabling novel user experiences that significantly extend or enhance existing ones and move towards a socially orientated reconfiguration of digital touch. More specifically, resources are needed to support students to: go beyond technology-driven solutions and stereotypical touch sensations (vibration); place more emphasis on the sensory and communicative properties of touch throughout the design process; encourage greater critical awareness, discussion, and investigation of touch at different stages of the design process; reflect on what touch could mean within user experiences, different types of touch, what touch might mean and feel like in different contexts; and to engage with the whole body, bodily sensations and social and cultural boundaries of touch.

In response, we have used the case study findings to inform the development of a prototype Designing Digital Touch toolkit - with specific reference to the sticking points students experienced in their engagement with materials and the process of prototyping touch, and analytical themes that emerged across the student design concepts, and the case study more generally. The toolkit is a card-based resource designed to open up and articulate the sociality and sensorality of touch into the UX design space, and guide the user by providing new and divergent routes into their imagining of digital touch futures. It draws on and extends the Double Diamond Design model by proposing a 'Pre-Discover' phase which focuses on explorations of and sensitisations towards 'touch' as it manifests itself in a range of social and embodied contexts. There are three types of cards for each design stage which aim to put touch and its possible digital mediation at the forefront of students' thinking and making. 1) *Filters*, that is, contextual questions to help participants reflect on their own and others' experiences (e.g. When does it matter who touches? How do you touch to communicate? How visible is your touch?). 2) *Activities*, that is, structured exercises and explorations (e.g. List and discuss five objects you touched today; Find some materials you wouldn't usually work with and explore how each would change your design; Map how touch has appeared and disappeared in your design process). 3) *Wild Cards*, that is, abstract provocations for thought or action (e.g. Touch meaningfully; Amplify the touch; or Make it soft). The toolkit prototype is currently being tested and evaluated by design students across a range of design courses.

Conclusion

We have described how we moved '*digital touch communication*' to the centre of a UX Design module and what happened pedagogically. We have shown how current pedagogical experiences with design 'materials' and rapid prototyping shaped design students' engagement with the design of digital touch experiences, with attention to how they

conceptualised the problem space of touch, touch-based technologies, the potentials and character of digitally mediated touch for communication, and how the sensing body was brought into their experience prototyping and design concepts. The case study workshops confirmed the potential of using low-fidelity prototyping to rapidly explore and prioritize considerations of experience, rather than the capabilities of technologies as part of a UXD process unfettered by the time taken to construct technology prototypes or knowledge of how to do so. However, we found the students' design approach to digital touch was at times constrained by an orientation to the functional and technological aspects of touch, rather than with the speculative, or social and sensory aspects of touch experience. This limited the design of digital touch to mimicking, supplementing or amplifying existing touch experiences. Whilst the ID students did not fully embrace the opportunity to explore different social and sensory experiences or to consider their meaning within future digital touch communications, their engagement in the workshops does reflect their expected knowledge of ID and UXD practice at the expected point in their education. This highlights a gap in knowledge raised by this work that can be broadly framed around how to consider the sensory meaning of interactions within a structured design process and points to an area worthy of further development within these signature pedagogies.

Finally, we have made the case for educational tools for designers which would enhance the construction of meaning at all stages of Experience Design (broadly framed by the Double Diamond) and to encourage further situated reflection regarding the meaning and value of touch. We have proposed one such tool in the form of the Designing Digital Touch Toolkit, a research-based resource in development by the authors. By seeding understanding of the nature and meaning of touch in an accessible and relevant form, we argue that students can be scaffolded and encouraged within the learning and teaching of the HCD process to more fully explore opportunities to design new ways of feeling rather than '*bolting on*' considerations of touch once the problems to be solved have been defined. The related intersections of physical and digital materiality, and the emergence of digital touch in the design landscape in which students' future professional careers are likely to be situated makes this paper particularly significant for the UX and ID pedagogic community.

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