Dismantling Feminist Biology through the Design of eTextiles

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Abstract: We present the design of a toolkit that explores textile materials with electronics as interaction material for intimate health literacy, and method for engaging women in self-care. This toolkit includes a series of artefacts designed for research. A range of design and craft techniques were used, and materials explored, as medium to engender conversations between communities of women on practices of intimate care. The toolkit consists of a set of materials for the following two activities 1) body mapping and 2) do-it-yourself (DIY) wearable eTextiles. We present findings from our case study that included iterations with the toolkit within four discrete workshops, and a total of 22 women and girls age range 15-52.

Our approach draws from feminist biology to assimilate notions of embodiment and bodily functions in ways that are conducive to knowledge production. Within this study we put a focus on interweaving aesthetics with the material landscape of electronic textiles and the body; making with and through DIY artefacts supported by technology-enabled materials, to shape and strengthen knowledge of processes within and between bodies. We contribute a designerly approach to creating bodily awareness through hands-on engagement with crafting technology.

Keywords: Intimate care; toolkits; eTextiles; feminist biology; woman-centred design

Introduction

The bodies through which we produce knowledge matter (Haraway 1988; Harding 1991), and how we know what we know is conditioned by systems of inclusion and exclusion from the communities that configure knowledge (Schiebinger 1993). Traditionally, women have been a group of people ignored in the production of knowledge (Tuana 2006), even so when knowledge is directly related to them and their bodies. Historically, it was the professionalisation and medicalisation of women's health that, in detriment of women's traditional knowledge, was instrumental in establishing "women as objects of knowledge, but not as authorised knowers" (ibid 2006). In light of this, we contend that design, as an effective tool for social change (Prado de O. Martins 2014), is uniquely situated to withstand what previously has hindered women's development in, and access to, health and care. In our work, we aim to make accessible topics of the body, such as those that are intertwined with taboo and misinformation in connection to biological knowledge. In doing this, we challenge traditional forms of engaging women in understanding their bodies, and propose renewed approaches to designing materials that promote bodily awareness, value care, and invite women to become embodied knowers. As argued elsewhere, knowledge, or lack thereof, is actively produced (Tuana 2006), and we explore notions of the body in relation to its biology to disentangle novel approaches conducive to create self-awareness through interaction with (technology-enabled) materials and activities.

We position our approach in that making design-as-inquiry enables tackling sensitive topics and engagement with varied communities within workshop settings. This designerly approach contends that thinking through making is integral to knowledge and understanding (Durrant et al. 2017), and it views research through design as a resource for the production of new knowledge (Storni 2015). Hence, we draw from a conceptualization of feminist biology, one that accounts for the processes within the biological body and is removed from gender bias, to explore biological knowledge and biological embodiment in legitimate ways that are useful to the production of knowledge. Put into practice, we designed a toolkit that combines tangible visual media and on-body interactions to support learning about intimate body parts and their functions. This toolkit consists of a set of materials for the activities of body mapping and DIY wearable eTextiles, and it was used in four workshops and 22 women and girls in total, from 15 through to 52 years old. This paper introduces findings from this case study to highlight qualities that merge knowledge-generating activities with the design of artefacts. The designerly approach engages with crafting technology and uses aesthetics and the materiality of a toolkit to enable the development of intimate body knowledge and awareness in a 'public' setting.

Bodies and Technologies

Throughout history, the female body has been associated with taboo, a restriction that to this day continues to hinder the development of women's intimate health and care, e.g. across geographies (Tuli et al. 2018) and devices (Rossmann 2008). Whereas the biological body has long been a problem for feminism (Birke 1999), or feminists arguing that there are no 'women's bodies' at all (Frost 2011), new approaches that look at the body as a living organism explore how processes involved in the materiality of the body, e.g in its anatomy and physiology, can actively matter and contribute to social and cultural constructs (ibid 2011). Similarly, we advance that biological processes and behaviour are shaped by the social and the cultural, but also that of the material. Bodies hurt, bleed, and are made of flesh.

We shift the focus to that of processes and activities within and between bodies. In health, we might take for granted our bodily functions and the way our bodies manage themselves (Birke 1999). While the biological body might be a part of the great unmentionable (ibid 1999), the biology of the body "is crucial – and a vital ally – in terms of how we understand both embodiment (our own and others) and the subtly sociopolitical dimensions of scientific knowledge production" (Åsberg and Birke 2010). Biology is also what includes bodily functions, and this study was aimed at using novel interactive materials as tools to open dialogues within communities of women in understanding biological processes such as those involved in pelvic health care.

Whereas the design of eTextiles as interactive materials that generate knowledge has mainly focused on learning and teaching computation and engineering, (Buechley and Perner-Wilson 2012) also note that "the experience of making things by hand is an important part of being human" and different ways of doing can engage different kinds of people in creating technology. Moreover, approaches that apply eTextiles as artefacts to facilitate and mediate knowledge of the body vary from making and designing wellbeing, e.g (Briggs-Goode et al. 2017), through anatomy and physiology (Norooz et al. 2015), the latter using computational textiles to deliver an interactive experience of unseen "body organs" to children. In a similar way, the research introduced in this paper combines making and wearable eTextiles as a form of raising awareness of the body. Specifically, we

explore such an approach as catalyst for discussion around sensitive, embarrassing, taboo topics as described earlier.

'Doing' enables different concerns for embodiment, emotionality, and situated enquiry otherwise overlooked (Rosner et al. 2016), and the experience of engaging with the making of material objects can contribute to engage in more intricate issues (Ratto 2011). Generally defined, experiences are far more effective tools for provoking estrangement, discomfort and, ultimately, reflection (Prado de O. Martins 2014). In exploring ways for technology to contribute to creating bodily awareness around intimate pelvic health, the interactions that took place between the toolkits and women in the workshops opened up the space for 'knowing'. Such generating activities led to conversations around experiences of care and revealed how qualities of body knowledge can be affected by topics of taboo, misinformation, and lack of self-awareness.

The eTextile Toolkit

The eTextile Toolkit introduced in this paper combines technologies to explore novel ways to promote bodily awareness around pelvic health (figure 1). It aimed to bring to the foreground research in a sensitive topic and to challenge lines of inquiry that continue to be absent. In generating artefacts that tackle bodily functions and body organs that are intimate, the set of materials available during the workshops invited participants to recall existing body knowledge, and to expand on that same knowledge through a hands-on process of DIY discovery of and 'on' the body. To do this, we integrated two research methods to making and working with tangible materials 1) body mapping: Body maps have a history of facilitating conversations around sensitive topics (Solomon 2007; Zablotny 2014), and we used body mapping as a creative method to talk about bodily taboos that are problematised by touch (Suvilehto et al. 2015), specifically the anatomy of the pelvis and the female perineum. Moreover, the difficulty associated with researching 'troublesome' topics and the "social codes that dictate that we do not talk about our 'private parts' with strangers or acquaintances" as it were a transgression of boundaries between public and private is explored in (Braun 1999). In this sense, body mapping was positioned as an alternative approach that employs clothing as embodied experience to express knowledge of the body and to facilitate conversations around these anatomical private parts; 2) DIY wearable eTextiles: In engaging with clothing as embodied experience, the focus remains in the anatomy. However, by introducing eTextiles, we focus on the morphology of the pelvic floor muscles, which is an unexplored, albeit crucial, topic in intimate health education. We review the use of the toolkit in the section that follows.

Figure 1. eTextile Toolkit: Components for Activity 2, DIY Wearable eTextiles. Underwear with sewn soft circuit; screen-print on fabric of pelvic floor muscles; a semi-assembled pattern with soft circuit on back; prototypes of detachable soft electronics; various hand-outs. Photo: Teresa Almeida.

The Design Workshops

The design workshops described in this section functioned as a collaborative field site in which 'making things' and working with materials aimed to generate knowledge and understanding. By combining an interdisciplinary approach and inventive methods to making, the workshops provided hands-on insights into the intimate body and anatomy. The two hours workshop was structured around a toolkit composed of two activities, firstly a body mapping exercise with the duration of (average) 30 minutes and secondly, a DIY wearable eTextile consisting of materials to explore the anatomy of the pelvic floor. A total of 22 women and girls aged 15 - 52 used our eTextiles toolkit within four workshops. We summarise four themes that emerged during the sessions:

Making connections to knowledge

The body mapping activity invited women to work in pairs and recall knowledge they may have of the reproductive system and associated external organs (figure 2). The knickers, a piece of white cotton classic briefs, served as a visual guideline and to steer the conversations amongst them. Moreover, as an ice-breaker, it was there to help them getting comfortable with each other and the workshop setting, one that involved discussing and drawing what remains a taboo: sex related organs. *"Do you want me to draw a vagina?"*, asked a 16 years old participant causing all others to laugh. The discussions across the different sessions centred around the women' perceptions of intimate parts of the body, and combined both the use of biological and colloquial language.

Mapping out in and around the body varied between women's experiences, e.g first-person knowledge in relation to childbirth or the use of lingo that was acceptable and relatable among some. Nevertheless, this activity enabled open conversations among them, informal discussions between them and the researchers, and it served both as a conversation starter and a guide to the activity that followed, an introduction to the pelvic floor (figure 3).

Figure 2. An initial sketch of pelvic floor muscles on underwear *(top)*. Illustration: Sophie Fernandez. Pelvic organs: Body mapping on the body; on underwear. Stills from workshop. Photos: Ko-Le Chen.

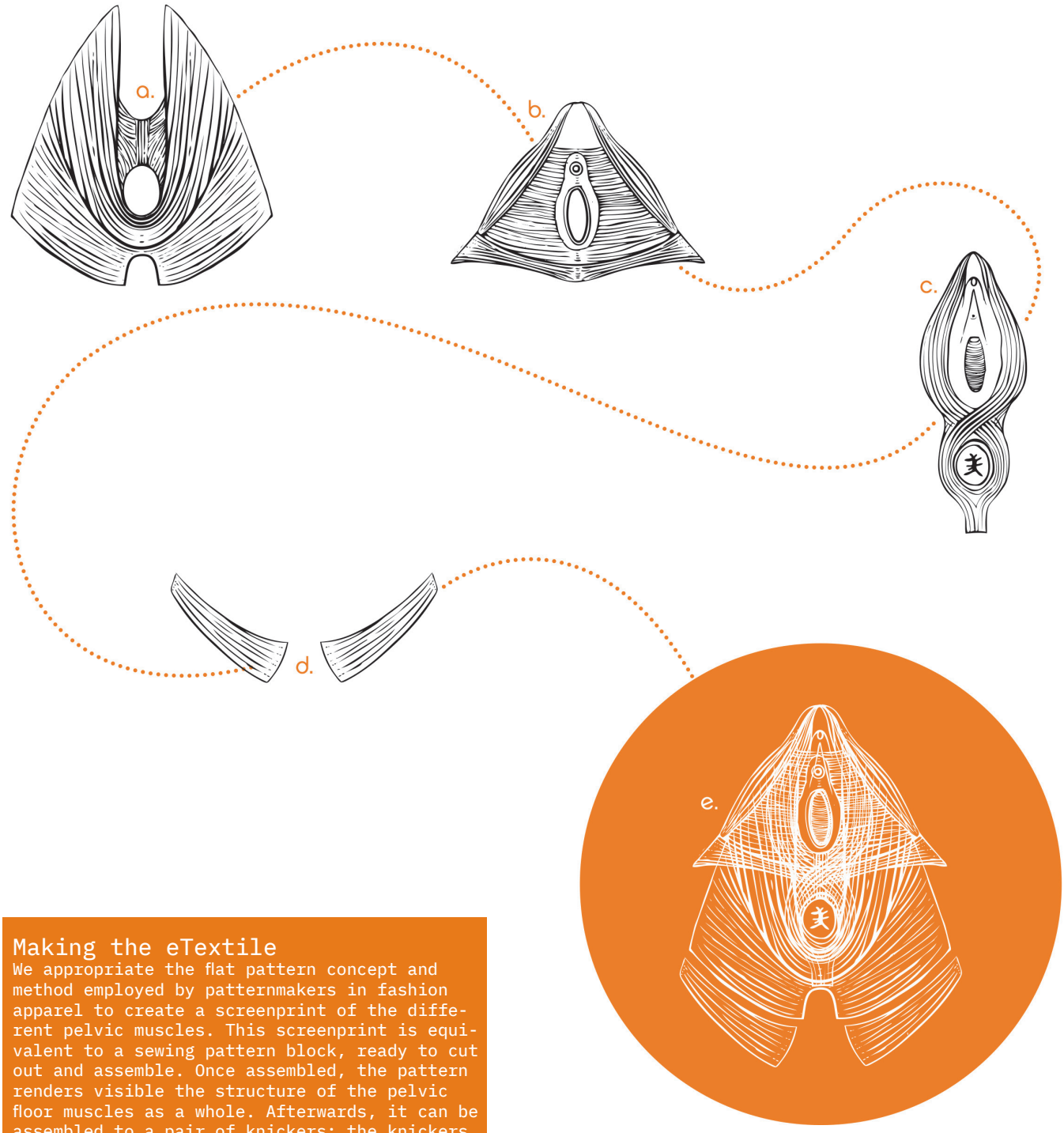
Pelvic floor muscles are important for lifelong well-being. They have a significant role in continence prevention, sexual pleasure, and core stability, being the only muscle group in the body capable of giving structural support to the pelvic organs.

<Figure 3. (Clothing) Tag, part of the toolkit. This tag introduces a short description of the pelvic muscles and exercise. Visual Design: Ephrat Seidenberg.

INSIDE OUT PELVIC FLOOR

Use fabric scissors to cut out all the pattern pieces.
(1) Assemble the pieces according to the diagram.
(2) Use the snap fasteners to attach one piece to the other.

1. CUT AND LAYOUT



Making the eTextile

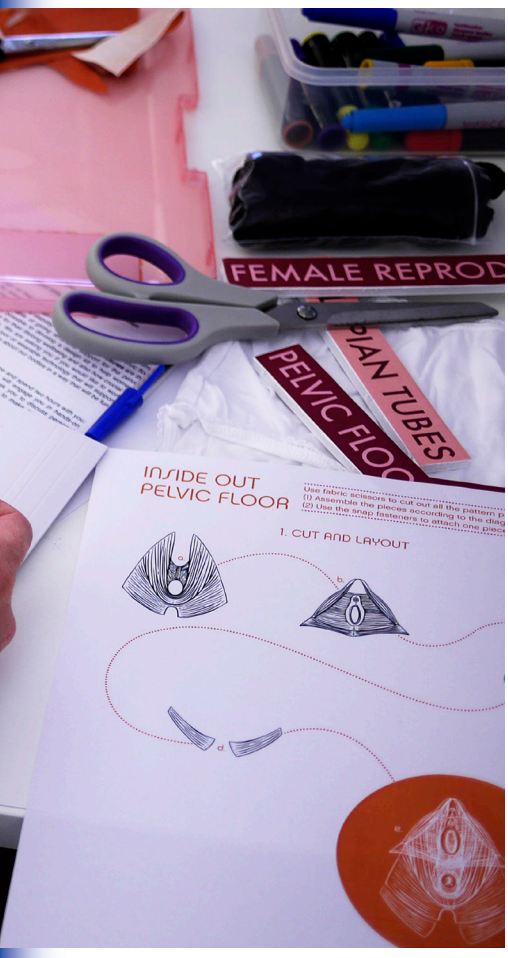
We appropriate the flat pattern concept and method employed by patternmakers in fashion apparel to create a screenprint of the different pelvic muscles. This screenprint is equivalent to a sewing pattern block, ready to cut out and assemble. Once assembled, the pattern renders visible the structure of the pelvic floor muscles as a whole. Afterwards, it can be assembled to a pair of knickers: the knickers have a hand-sewn circuit of conductive thread and paired halves of metallic snaps to attach the pattern to. Once the pattern has been correctly attached, a detachable soft circuit board can be connected to the circuit threaded on the knickers. This task completed, 3 LED lights on the soft circuit board light up in a sequence, 1) all the way up 2) all the way down, in order to simulate a 'contraction' and 'relaxation' movement. Repeat 10 times.

Figure 4. Handout: A component of the toolkit, it demonstrates how to assemble the pelvic floor muscles once pattern pieces have been cut out *(Body Inside Out)*. Illustration: Sophie Fernandez. Visual design: Ephrat Seidenberg.

Body Inside Out
In cutting out the flat pattern of the pelvic floor muscles provided in the toolkit, women and girls engaged in exploring the materiality of the fabric at hand. The touch and feel of the material was valued by them and the detail of the illustration was intriguing. They were curious whether the researchers had designed it and how it had been produced. Some of their remarks included the illustration, the choice of colours and printing techniques, through the tactile nature of the material and the tasks of cutting and assembling as prone to engage in learning. Moreover, they found that the assembly of the flat pattern was useful when thinking about the body in ways that using a mobile application may not have done, or have been so engaging or appealing. Finally, they commented on the fact that, by including the piece of underwear, they could relate the activity (and body part) to their own body more easily.

Figure 5. Body inside out: (female) pelvic floor muscle pattern pieces assembled on underwear *(page 8)*; plugging a soft circuit to the piece of underwear with muscle print *(page 9)*. Photos: Ko-Le Chen.

Figure 6. DIY Wearable eTextiles: Making connections to knowledge *(top)*; exploring the anatomy of the pelvic floor with and through making in a workshop *(bottom)*. Photo: Ko-Le Chen/Teresa Almeida.



The ultimate goal of the workshop was to understand pelvic fitness, and the final activity was to attach a soft wearable piece of electronics that would complete the knickers as an eTextile (figure 5). This eTextile provides a visual simulation of the muscles contracting and relaxing, a representation intended to stress awareness of the morphology and alert to the biomechanics of the female pelvic floor. This last step on making the eTextile involved connecting the small bespoke soft circuit board to the circuit threaded on the knickers. This task completed, the LED lights on the soft circuit board would light up in a sequence with one second interval inbetween all the way up and then all the way down to simulate a 'contraction' and 'relaxation' movement. As awkward as the eTextile might have looked, it granted a space to laugh and make fun of oneself, as in the case of two participants who decided to try on the knickers: *Squeeze what...? Squeeze down there! (laughs)*, but also to reflect on personal experience and ask related questions, such as 'what is normal', incontinence, organ prolapse, or whether or not men also have a pelvic floor.

Awareness and Outreach

In general, women appeared to have a genuine interest in the topic and the workshop granted them an opportunity to (re)discover an integral part of their bodies: they not only had never heard about the pelvic floor before, or pelvic floor muscle exercises, but also had varied knowledge about their own intimate anatomy. Whereas the reproductive system and genitalia are topics that are part of the national (UK) curriculum to be delivered in the classroom, topics of taboo as such, which may bring about embarrassment, are topics people 'don't talk about'. Nevertheless, the need to keep this part of the body fit, or why it is relevant for general health and wellbeing, was surprising to them and something they had never thought about, despite concerns and questions regarding sex or childbirth. It might have been an awkward subject to bring up in these workshop settings however the prevailing openness to learn new things that relate to their bodies appeared to be appreciated.

Reflecting in Uncharted Territory

The learning generated through the designs supported an understanding of what the pelvic floor looks like or being aware of the reasons why the pelvic floor should be kept fit. The women easily engaged in discussion and related to their own personal experiences. Furthermore, the experience of cutting out the printed pattern was meant to observe the body from an unlikely viewpoint. The action of cutting out was an approach that required material interaction to build body perceptions. In the absence of suitable knowledge about their female body, many participants sought to learn more during the workshop. The new knowledge about their own anatomy caused surprise, sparked curiosity, and prompted humour and laughter - a common response throughout all the workshops. Whether prompt by embarrassment, self-doubt, or nervousness, to feeling comfortable and supported when talking about and asking about their genitalia and related pelvic floor issues, most women seemed to be at ease after starting the session. A willingness to blend humour with the discussion was present most of the time and in a variety of situations, from speculating possible designs for the technology through being 'suspicious' of the woman demonstrating how to do pelvic floor exercises on a video shown during the workshop.

Figure 7. The eTextile Toolkit showing in *Attempts, Failures, Trials and Errors*, group exhibition organized by 2580 Association and coordinated by Tincuta Heinzel and Hillevi Munthe. Salonul de Proiecte, Bucharest, Romania. Photo: Teresa Almeida.

Discussion

Designing for the female body, its health and care, continues to be troublesome, thus reframing knowledge and experiences of such bodies is paramount. With the eTextiles toolkit, we attempt to ignite conversations and promote new knowledge that is "freed from the confines of traditional frameworks" (Tuana 2006). Moreover, the shift of focus to processes and activities within the body, and "how the body's materiality – for example, its anatomy and physiology – and other material forces actively matter to the processes of materialization" (Barad, cited in Frost 2011) is entwined in our exploration. The eTextile Toolkit shares this feminist view of the body as a living organism, while recognizing the agency of biology.

Envisioned as a way of encouraging women to learn about their intimate bodies, the approach considers design and its artefacts as mediums to highlight the prospect of knowledge creation and action. To the same extent, the body map was framed for intimate care with a pair of knickers, having women to exercise knowledge and share perceptions of their bodies by illustrating reproductive organs on the cotton textile material. Furthermore, through making eTextiles, they experienced computational textiles as an interactive material to learn with, and critical making as method to bridge the gap between traditional education and learning on the body. We suggest that it is an awareness of this materiality of the body as an ever-changing organism (with its e.g. organs) that prompts women to take charge and self-care. Moreover, body literacy of intimate parts of the body can have an impact on, e.g. managing

menstruation or sexual health. In combining innovative methods and hands-on engagement with relatable (textile) and surprising (interactive, technology-abled) materials, the toolkit and the workshop setting serve as unconventional devices for breaking the taboo on the topic and as catalysts for conversation. In this regard, insights provided by this making design-as-inquiry approach show that sensitive topics as those of the intimate body can benefit from thinking through making and engagement with creative resources as a resource itself, when it comes to enquire and deconstruct existing knowledge in pursuance of producing new one.

The content of this toolkit enabled women to gain renewed understanding of, e.g anatomy and lived experiences such as childbirth. Whereas surprised that an event they might not have had the lexicon for before, e.g. incontinence, concerned by an ongoing condition on the body or simply curious, women engaged in discussion and related to their own personal experiences. In reflecting on, and relating to, their bodies through the materials at hand, they observed the body from an unlikely viewpoint, e.g. in drawing organs on knickers or in cutting out the screenprinted pattern on fabric. Moreover, these activities involved material interaction to build body perceptions, the act of cutting and assembling (the pattern) becomes a method to engage in learning. This mediated knowledge of the body through artefacts and social engagement, within a community of women, seeks to highlight disparate concerns for embodiment or situated knowledge (Rosner et al. 2016). Considering that each and every woman may find themselves in a wide-ranging and varied circumstances, or have a distinct range of subjective experiences, this toolkit was manifold in that it aimed to tackle a topic that traverses biology and health, by exploring tangible interactive materials, communication and reflective (self-) awareness.

Body Matters

The possibilities afforded by the toolkit within the design workshops included the opportunity for women to talk about topics that are usually not shared, or if shared are generally done so in a joking manner between peers, or seriously if within a consultation. Creative methods, such as the body mapping explored during the first half of the group activities, helped the participants in these workshops to share (and challenge) their knowledge, while thinking with and through the materiality of the body itself, and with each other. The DIY wearable eTextile activity that followed the body mapping experiment contributed further to materialise this ‘out of touch, out of sight’ body part (the pelvic floor and its muscles), offering the women and girls, through a combination of crafting materials, tools and techniques, the time and opportunity to discuss and converse among themselves.

All in all, the eTextile toolkit and the design workshop format were an attempt in practice at exploring methods that may support women’s bodily knowledge in health and (self) care. In addressing the challenge of such a sensitive topic, we aimed to design a technology (set of activities) that could help bringing awareness and destigmatise the conversation around the intimate female body. We did this through imbuing the materials of interaction with qualities that merge knowledge-generating activities with the design of eTextiles. This approach combined aesthetics and the materiality embedded in a toolkit that explored the anatomy and physiology of the intimate body. Emerging from a design inquiry into the making with and through DIY artefacts within intimate care, the toolkit enabled the development of intimate body knowledge and for each woman to shape the content to their own bodies.

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