Journal of International Development
Special issue Engineering and Development

# Challenges for interaction design education in the South: a case study of Botswana

## Abstract

In a long-term partnership between a university in the UK and one in Botswana teaching interaction design, the Botswana cohort of students consistently performed less well than their UK counterparts. To investigate this, we conducted a pair of design protocol studies: one in the UK and one in Botswana. Our findings show that designer behaviour differs in the two contexts in terms of process, use of ideation techniques, and solution and problem focus when approaching the task. More specifically, UK students follow the approach taught in the module, while this process conflicts with Botswana students' behaviours. However, we also find that Botswana students prioritise the external context of the designed product rather than its interaction characteristics, which is problematic as interaction is the key feature of interactive products. These results are significant because without leveraging indigenous knowledge to design interaction that supports local user characteristics and context, sustainable and equitable development through technological innovation will be suppressed. In this paper we highlight challenges for interaction design education in Botswana, which include how to recognize and support a diversity of design approaches while providing suitable pedagogic scaffolding.

## 1 Introduction

Interaction design is the process of "designing interactive products to support the way people communicate and interact in their everyday and working lives" (Preece, Sharp, & Rogers, 2015). It is a relatively young academic discipline, but it has spread rapidly, leveraging an increasing demand for interactive products around the world. Interaction design is taught globally (Gross, 2014), but the variations in how it is learned and how it is practiced in different contexts are just starting to be understood (Abdelnour-Nocera, Clemmensen, & Guimaraes, 2017). Teaching and learning in interaction design that meets global standards and integrates indigenous knowledge and processes is a recognised challenge for international development (Lazem & Dray, 2018). The development of contextually relevant technologies requires indigenous knowledge and practices to be integrated in the design of interactive products. Products that achieve this integration are more likely to be accepted and adopted to meet users' needs, products that don't are not (Chavan, Gorney, Prabhu, & Arora, 2009). Developing designers' capacity to design for interaction that supports indigenous user characteristics and context is therefore of relevance to international development.

In this context, The Open University in the UK and Botho University in Botswana formed a teaching partnership to deliver the BSc (Hons) Computing and its Practice top up degree in Botswana. One of the level 3 modules in this programme was *Fundamentals of Interaction*

*Design*, which was also taught in parallel to students in the UK. Throughout the partnership, Botswana students consistently scored around 20% lower than their UK counterparts. For example, in 2010 the UK cohort's average assessment scores were at 72% while the average scores for the Botswana cohort were at 52% with a similar standard deviation for both cohorts. The UK cohort had a larger ratio of higher performing students than the Botswana cohort. In particular, no Botswana student reached more than 80% for their work (Figure 1).

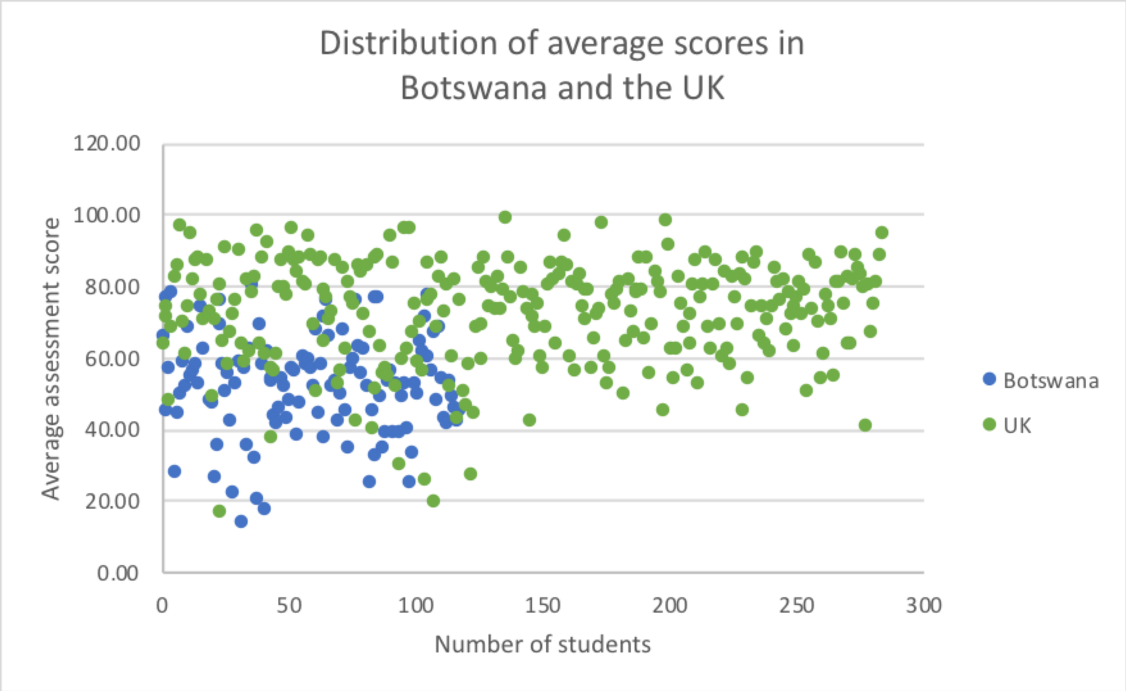


*Figure 1 the distribution of average assessment scores in Botswana (n = 118) and the UK (n = 284) in the 2010 cohort. Cohort sizes in other years differed but showed a similar distribution.*

Recognising the differences, the teaching team localised case studies and examples to include in the teaching materials. For example, together with the local tutors, they developed design problems which would be familiar to both cohorts, e.g. replacing a Garden Centre example with a market example. This did not affect student performance. Preliminary analysis of submitted design assignments indicated that the students in Botswana approached design tasks differently from UK students, even though they are taught the same design approach in the module.

One possible explanation is that the behaviour is influenced by a variety of factors, e.g. design process, cognitive or socio-cultural factors, that are not being adequately accounted for in the pedagogical approach. The analysis of the differences visible in the student's assignments did not sufficiently explain the results. A more detailed investigation of students' behaviours, and factors affecting their behaviour, was therefore instigated to understand how to support their learning more appropriately.

This led to a research relationship between the UK and Botswana staff which was initiated in 2011 to understand local pedagogy and design behaviours and to better tailor learning and teaching of interaction design in Botswana. This partnership involved several staff members based in Botswana and four in the UK.

The results from this teaching and research partnership have suggested several challenges to interaction design education across contexts. This paper represents a synthesis of results from previous research papers (Lotz & Sharp, 2017; Lotz et al., 2014; Sharp et al., 2013) and an in-depth discussion of the implications of this body of work for interaction design education in Botswana.

# 2 Background

## 2.1 Interaction design

Interaction design grew out of a range of other disciplines, and is sometimes referred to as human-computer interaction (HCI) design, web design, interface design, and user experience design, to name but a few. Academic disciplines that contribute to interaction design include information systems, graphic design, software engineering and psychology (Gross, 2014). The main aim is to design computer-based systems that support people's goals, and the field of interaction design promotes a range of different methods, techniques, and frameworks, with some proponents viewing interaction design as a creative design activity and others viewing it more as a scientific engineering activity (Winograd, 1997; Wolf, Rode, Sussman, & Kellogg, 2006). Accounting for user characteristics and the context of use for an interactive product is fundamental to interaction design and HCI, and there are many approaches and techniques to support this. User-centred design, which suggests that potential users of the product under development should be involved in their design and evaluation, is a cornerstone of interaction design.

A key feature of interaction design, however, is the need to design the *interaction* between a product and its human user. This leads to the need for a range of aspects to be designed or chosen including the product's interface (e.g. voice, wearable or virtual reality), interaction styles (e.g. instructing or exploring), and dialogue structures between the user and the product. These activities require a combination of design skills such as aesthetics and graphic design, and engineering skills such as programming and construction, as well as an understanding of human psychology and abilities.

Like other designers, interaction designers draw on a diverse set of skills and knowledge, and use analytical and abductive ways of thinking to shape solution-focused strategies that address real world problems (Cross, 2007). Interaction designers seek to resolve difficult, ill-defined problems that do not have one answer or solution. Interaction designers then suggest potential solution ideas in the search for one that satisfies the problem, knowing that this is not the only possible solution to the problem. This is a creative process, while other parts of the process of designing interactive products are seen as more scientific, core engineering activities.

## 2.2 Interaction design in a global context

This work takes place in a context where interactive products such as mobile phones, and software apps such as social media platforms are being used around the world and in different contexts. The implications of this for software development, interaction design and education are under scrutiny, and the approach to education and design in a global setting is being questioned. Specifically, in interaction design, this has led to a desire to reframe the discipline through local and indigenous perspectives (Abdelnour-Nocera et al, 2013), in both educational and practical contexts. Because of the focus on involving users in design, this takes on a particular importance and focus in interaction design.

From their experiences in India and China, Smith, Bannon, & Gulliksen (2010) note that there is "a considerable appetite to learn about Western HCI case studies in the expectation that these can be implemented locally". They argue, however, that differences between countries and cultures have the potential to affect both the product and the process of Interaction Design, and they call for a holistic understanding of HCI within the local practitioner community, and localization of methods and tools to meet local requirements. Studies provide evidence of this, both for the design of a product (Moalosi, 2007, when studying designers in Botswana) and the process of design (Marsden, Maunder, & Parker, 2008, reporting on South African design cases). For example, Gautam & Blessing (2009) found differences in the design process between industrial designers from Germany, China and India. Huang & Deng (2008) demonstrate how a local traditional activity (a tea ceremony) could influence the design of interaction with modern products, indicating that local tradition impacts upon the designed product. Others have found that a tendency to develop designs that are sensitive to local contexts and characteristics is evident even in novice designers. For example, Razzaghi, Ramirez, & Zehner (2009) studied industrial design students' design concepts and identified links between their cultural characteristics, i.e. whether they were born, lived and were educated in Australia or Iran, and their sketches of design concepts. Faiola & Matei (2005) found that American and Chinese website users performed better on information-seeking tasks when using web content that was created by designers from their own country.

Deininger et al. (2019) looked at how far Ghanaian engineering students followed prototyping best practice, which they argued mainly originated from the West. They found only limited evidence that Ghanaian novices followed this practice. Lack of skills in prototyping was cited as one reason, but we would argue that lack of appropriate prototyping techniques to suit the users, their context, and the background of the students might be another.

## 2.3 Interaction design and education

Due to its inter-disciplinary nature, interaction design is taught in many different education programmes including software engineering and computer science, information systems and tailor-made degrees focused only on Interaction Design. Traditionally HCI has been taught mostly in computer science curricula and this has influenced the design process promoted. But several scholars argue that the field of HCI will continue to diversify, and with it comes a diversification of interaction design education (Gross, 2014; Winograd, 1997).

Interaction design education was discussed in a workshop (called Baraza!) at the first African Conference for Human-Computer Interaction (AfriCHI, http://www.africhi.net/) which was held in Nairobi in November 2016 (Lazem & Dray, 2018). This workshop identified roles for HCI educators, including to understand how techniques from developed countries work in other contexts (Lazem & Dray, 2018). It also built upon a key output from a four-year project (2011 to 2014) involving HCI educators around the world to explore the future of HCI education (Churchill, Bowser, & Preece, 2016). The key output was the need for a *living* *curriculum*, which refers to a frequently refreshed curriculum that focuses on “connecting people and resources, and on the collaborative creation and maintenance of resources” (ibid). They concluded that there is no universal standard for HCI education, and that the curriculum should be flexible and diverse, offering locally relevant content to the students.

Fendler & Winschiers-Theophilus (2010) highlighted the issue of locally-relevant content in software engineering. They suggest that software engineering is heavily influenced by techniques from developed countries, and that software engineering education be localised. In addition, Smith et al. (2007) point out that principles underlying the user-centred approach to software development are derived from USA and Northern Europe. They propose a framework that challenges the notion of “universally transferable” education and takes account of specific software development contexts. Their work emphasises the way forward as being to examine a range of methods and knowledge to assess similarities, differences and local influential factors rather than to take established approaches and tailor them to developing nations.

Sari & Wadhwa (2015) report results of a survey of HCI curricula across Asia-Pacific, Respondents from developing nations in South East Asia, such as Indonesia or Malaysia, pointed out that HCI is not considered as a priority compared to the more developed nations in the region. Developing nations focused on transferring the basic concepts using any available resources, but usually in one direction - teacher to student. The learning in more developed regions included students actively constructing their knowledge and skills beyond the basic concepts. The emergence of participatory approaches to interaction design in many developing regions was pointed out as promising. But the authors warn that interaction design students need to be empowered first to actively construct their own HCI knowledge before they can empower their users by involving them in the design process. These issues are echoed in Ghana (Deininger et al., 2019).

# 3 The case study

Between 2008 – 2017, the School of Computing and Communications at the Open University, UK, partnered with Botho University, Botswana to deliver a degree programme of Computing and its Practice. This programme included the level 3 undergraduate module *Fundamentals of Interaction Design* which was concurrently delivered in the UK using the same teaching materials. In order to complete their studies, students from Botho continued to study with the OU until 2017.

The module is based on an internationally best-selling textbook Interaction Design (www.id-book.com) and the materials consist of the main textbook, a DVD of videos and online activities, examples and assessments, and around 800 pages of extra material which reinforces and complements the teaching in the textbook.

The module takes a process-oriented approach to interaction design, with a strong emphasis on producing and evaluating sketches and prototypes. It teaches three key techniques: storyboard, card-based prototype and interface sketch. Storyboards are a series of sketches showing how a user might accomplish a task using the product. Card-based prototypes consist of several index cards, each of which represents one interface element. Interface sketches show the product’s detailed interface design. See Figures 3 and 4 for examples of these sketch types. The module teaches a structured and iterative approach which builds from a scenario (a text-based description of one use of the product) to storyboards, from storyboards to card-based prototypes and from cards to interface sketches.

The students in Botswana and in the UK were allocated a local tutor who marked student assignments and answered their queries, and any one module employed several tutors so that the tutor:student ratio is kept low (about 1:20). Tutors in Botswana were supported by the module team and by experienced tutors in the UK who had been teaching the module for several years. They were given specific classroom suggestions and exercises to run with the students, they were trained using marking exercises, including a board game, and the module team carried out tutorial visits and mentoring sessions. The local tutors' marking was initially monitored by UK tutors with experience of teaching on the module. Tutors who received good monitoring for their own work by UK monitors were then appointed as local monitors. There were monthly review meetings held via Skype.

In order to ensure that student learning was as consistent as possible across tutors, the learning materials were designed to be independent and self-contained. This means that each of several hundred students learned from the same materials and followed the same assessment and practice exercises. In our context, this meant that students in the UK and in Botswana received as closely as possible a comparative exposure to interaction design techniques and methods.

# 4 Methodology

The research built on the teaching partnership described above. A two-year Leverhulme funded collaborative project involved OU and Botho University staff and students in a mixed methods research to investigate novice interaction designer behaviour in these two contexts. A mix of protocol studies, a cognitive styles test, diary studies and educator workshops was employed to gather data in this project. This paper focuses on the findings from the protocol studies and cognitive styles assessment. Findings from the educator workshops are not conclusive. The diary study and its results are discussed in (Sharp, Lotz, & Woodroffe, under review)

## 4.1 The protocol study

Protocol studies ask designers to verbalise their thoughts while designing and have been used extensively in design research (Cross, Christiaans, & Dorst, 1997). During protocol studies, participants are asked to "think aloud" as they complete the given task (Ericsson & Simon, 1980). In the study reported here, data collection sessions took place just after the participants had completed the module's design assignment. Each session lasted 2 hours, with about one hour devoted to the main design task. No time limit was set but participants were told that they could stop at the end of this hour. After the main task, participants presented their designs to the facilitator. Sessions were audio- and video-recorded; all sketches and other artefacts produced during the study were collected.

The protocol studies were designed together and data collection was adjusted for each country. In the UK, students study individually, at a distance, and only occasionally work in groups. UK participants therefore worked individually and were asked to think-aloud throughout the two-hour session. In Botswana, students usually work in groups on campus.

Individual think-aloud was not used in Botswana because of possible influences of "cultural cognition" in concurrent protocols (Clemmensen, Hertzum, Hornbaek, Shi, & Yammiyavar, 2009). Instead, students were paired using constructive interaction, in which students talk together in pairs while completing the task (O'Malley, Draper, & Riley, 1985). This approach, and a role-play approach to the presentation at the end, was advised by local Botswana colleagues to overcome participants' inhibitions.

Figure 2 shows the study room layout in both locations. On the table is a set of module materials, paper, pencils and a participant booklet that was available in three languages (Setswana, Kalanga or English). Also, on the table is the Towers of Hanoi game, used as a warm-up activity to get participants used to talking out loud. The participant booklet contained a study background document, consent form, warm-up activity instructions and design brief: a medication system for home-based patients. Participants were given no direction regarding the techniques to use or how to address the design problem. Local staff members facilitated the sessions, and a facilitator was present throughout. For consistency, facilitators all worked from a common guide. Refreshments were also available in the room, to be taken as desired.

*Figure 2. The study room set-up in (a) Botswana and (b) UK*

Seven UK participants (UKPs) were recruited; one session was not usable. In Botswana, 30 participants were chosen from 70 volunteers, making 15 pairs (BPs); two sessions were too quiet to be usable. All participants were educated in their country of residence.

## 4.2 GEFT cognitive styles test

Previous research points to evidence that cognitive processes (including ideation and creativity) are not universal (Nisbett, 2003), so to assess participants' cognitive style, we asked them to complete a Group Embedded Figures Test (GEFT). GEFT is a measure of field-independence, which indicates how much participants are influenced by context. We chose an instrument based on images rather than language in order to avoid any translation-related issues between and within the groups. Field-independence assesses the "ability to break up an organized visual field in order to keep a part of it separate from that field" (Witkin, Oltman, Raskin, & Karp, 1971, pp 2). Field-independent thinking encourages focus on one object and goals with respect to it. Field-dependent thinking fosters attention to relationships and context. In GEFT, participants need to locate a familiar figure within a more complex figure. The better participants can locate the figures, the higher their field-independence. Higher field-independence enables minimal cognitive load and maximal working memory efficiency and is correlated positively with visual perceptiveness.

The reliability and validity of GEFT scores is generally supported (Panek, Funk, & Nelson, 1980), but others question their interpretation in measuring field-dependence. Evans, Richardson, & Waring (2013) argue that GEFT can only be used reliably to measure field-*in*dependence.

### 4.3 Analysis of data

The audio and video recordings were transcribed in English (translated by local translators if appropriate). These transcripts were analysed using a modified and extended version of Valkenburg and Dorst (1998)'s notation to identify the processes in Schön (1983)'s design and reflection cycle: naming, framing, moving and reflecting[1]. Our extension introduced a more detailed notation to distinguish between the designers' thinking and actions in the problem space and in the solution space and includes frame signatures to more clearly identify frames (Blyth et al., 2012; Sharp et al., 2013). The coding was completed by two researchers independently and challenged by two others on a regular basis. Using this extended notation allowed the analysis to uncover the detailed process followed by the designers. In particular it identified and visualised the focus of participants' designing – when were they focusing on the problem space and when on the solution space. It also highlighted the use of different interaction design techniques.

A second analysis focused on the video recordings, and the paper-based sketches produced during the study. This analysis identified the ideation techniques used and for how long they were used. To achieve this, the researchers immersed themselves in the video and the beginning and end of ideation technique use was marked in a spreadsheet aligned with the transcribed data. The significance of any differences found was investigated using the Mann-Whitney U-test. Through this analysis we were looking for repeating patterns of behaviour within sessions, within cohorts or across sessions or cohorts. The GEFT data was analysed using descriptive statistics.

## 5 Findings

Our findings highlight differences between UKP and BP in four main areas: cognitive styles, design process used, the development of solution ideas, and the use of ideation techniques.

### 5.1 Designers' cognitive styles

Tables 1 and 2 show participants' GEFT scores. The surveyed interaction design students in Botswana had on average relatively low GEFT scores. Lower GEFT scores indicate a field-dependent cognitive style while high GEFT scores indicate a field-independent style. This means that the Botswana cohort are more likely to emphasize relationships and context, while the UK cohort are more likely to focus on one object and goals. According to the Mann-Whitney U-test ($p<0.05$) UKP GEFT scores and BP GEFT scores were significantly different.

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[1] Designers *name* factors in the problem space and solution space, *frame* a problem by creating a context for viewing it in, take actions to *move* towards a solution and *reflect* on those actions.

*Table 1 Individual GEFT scores and Mean for Botswana designers. Participants 6, 32, 46 and 48 indicated they did not fully understand the GEFT instructions, Participant 21 could not attend.*

| ***BP*** | ***1*** | | ***2*** | | ***3*** | | ***4*** | | ***5*** | | ***6*** | | ***7*** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Participant | 1 | 44 | 2 | 11 | 3 | 6 | 13 | 33 | 14 | 22 | 15 | 48 | 19 | 46 |
| Gender | F | F | F | F | F | F | F | M | F | F | F | F | M | M |
| GEFT Score | 3 | 3 | 7 | 7 | 4 | 0 | 4 | 4 | 4 | 1 | 11 | 3 | 9 | 0 |

| ***BP*** | ***8*** | | ***9*** | | ***10*** | | ***11*** | | ***12*** | | ***13*** | | ***Mean*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Participants | 21 | 65 | 25 | 70 | 29 | 34 | 32 | 38 | 37 | 50 | 39 | 63 | |
| Gender | F | F | F | F | F | M | F | F | F | F | F | M | |
| GEFT score | x | 0 | 0 | 3 | 3 | 5 | 0 | 5 | 0 | 7 | 2 | 7 | ***3.6*** |

*Table 2 Individual GEFT scores and Mean for UK designers.*

| ***UKP*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***Mean*** |
|---|---|---|---|---|---|---|---|---|
| Gender | F | F | M | M | F | F | M | |
| GEFT Score | 4 | 9 | 18 | 18 | 16 | 15 | 15 | ***13.6*** |

## 5.2 Design process

Analysis shows that each protocol in both cohorts has a unique design process signature, but all protocols showed a mixture of problem-focused and solution-focused behaviour, and episodes where the problem space and the solution space were considered at the same time (called co-evolution). As design is generally a solution-focused activity, it is not surprising to find that both UKPs and BPs focused on producing solution ideas. Although all designers also consider the problem they are asked to solve during designing, the approaches to this vary (Lotz et al., 2014; Sharp et al., 2013).

The module teaches students to explore the design problem and its context first and develop a conceptual design before suggesting solutions. Once a prototype can be built, then the design can be evaluated with users and iteratively developed into a final product. UK designers nearly exclusively used the taught approach, exploring the problem space before suggesting solutions, and then proceeding in episodes of co-evolution of both solution and problem spaces. In most of the design conversations in Botswana, an approach different to the one taught was observed. The majority of students in Botswana chose a “solution-first” approach, in which a solution is initially suggested and then problem and solution spaces are investigated together. Only a few BPs deliberated the problem context in more depth before bringing in solution ideas. For example, these were the first lines in the conversation between two designers in Botswana (BP2):

| Protocol | Interpretation |
|---|---|
| *B. The main topic here is time, isn't it?* | |
| *A. Yes, It is* | |
| *B. Then we should design something like an alarm.* | The designers jump straight to their first solution, an alarm. |
| *A. An alarm!* | |
| *B.  An alarm can be set to remind some patients. If patients are pensioners, then an alarm might not be that effective due to their slight deafness* | The designer name the users of the alarm in parallel and refine who the users are (pensioners and hearing impaired) |

The favoured approach to interaction design that was taught and assessed in the teaching and learning materials is a "problem-first" approach, in which the designers explore the problem before suggesting a solution. For example, this UK designer (UKP4) showed a problem first approach in the first lines of their design protocol:

| Protocol | Interpretation |
|---|---|
| *I am just going to re-read the problem, just to make sure I have got it in my head.*<br>*The problem is to remind people to take their drugs.  For all age groups, to be set up by the doctor or patient and gives a clear, drug specific reminder.  A variety of drugs. You are going to have busy people, times of day, different dose, every four hours.  Could be night time, day time.* | Analysis of problem criteria, such as the goal (remind people to take medication) and tasks (medication specific reminder) including task frequency and complexity, user groups (doctor, patient), including age. |
| *They are taking drugs for set periods and it could be night time or day time.  Potentially it would need to wake them up, or attract their attention.* | Task frequency and complexity and back to the goal (attract attention) |
| *Metaphor for that would be an alarm clock.  A reminder... alarm clock... or a pager.* | Solution of alarm clock, pager… |

See Table 3 (second column) for differences in solution first behaviour between UKP and BP.

*Table 3. Behaviours in Botswana and the UK*

| BP | Solution first | Multiple outline solutions | Simple off-the-shelf designs |
|---|---|---|---|
| 1 | x | 1 | ✓ |
| 2 | ✓ | 5 | ✓ |
| 3 | ✓ | 5 | ✓ |
| 4 | ✓ | 2 | x |
| 5 | ✓ | 4 | ✓ |
| 6 | ✓ | 3 | ✓ |
| 7 | x | 3 | ✓ |
| 8 | ✓ | 3 | ✓ |
| 9 | x | 1 | x |
| 10 | ✓ | 2 | ✓ |
| 11 | x | 5 | ✓ |
| 12 | ✓ | 4 | ✓ |
| 13 | x | 6 | ✓ |

| UKP | Solution first | Multiple outline solutions | Simple off-the-shelf designs |
|---|---|---|---|
| 1 | x | 2 | x |
| 3 | ✓ | 1 | x |
| 4 | x | 3 | ✓ |
| 5 | x | 3 | ✓ |
| 6 | x | 3 | x |
| 7 | x | 2 | x |

## 5.3 Design solutions

Designers in Botswana start with several simple, off the shelf solutions, such as a mobile phone or watch, develop multiple outline solutions for different user groups, and produce solutions that are a mixture of product and service. Designers in UK produce a few outline solutions, hardly ever build on simple off-the-shelf solutions, and focus primarily on the interactive product being developed without considering any additional services.

Our analysis has shown that BP produce several outline solutions or concept designs. They also come up with a mixture of product and service design solutions appropriate to their local context. For example, one designer pair (BP3) initially developed two very different and separate ideas in parallel: a counselling service for vulnerable patients, and a mobile phone reminder for the youth. The pair switches between these solution ideas and considers the problem context in parallel as their design progresses. Having discussed the counselling service idea further including its educational role, the designers bring an education flavour to the mobile phone reminder, and merge the two into one frame of thinking. In this example, the designers' shift in thinking between solution ideation and problem reconsideration influences their ideation process.

Other BPs similarly discuss several outline solutions which sometimes merge into an integrated product-service solution appropriate to their local context. However, this kind of solution lacks detail of the concrete user interaction with the service-product. The product remains similar to the simple off the shelf solution they had started the ideation process with. On the other hand, UKP do develop detailed user interaction, but keep to the scope of interactive products, not considering other solution components, such as services.

The lack of attention given by BPs to designing the interaction elements of their solutions is a concern for interaction design educators as this is a key element of interaction design. Conversely, BPs consideration of contextually appropriate services as part of the solution beyond the individual interactive designs is currently not supported well in interaction design curricula.

## 5.4 Design ideation techniques

Designers in Botswana and the UK use techniques taught in the course, but in different ways (Lotz & Sharp, 2017), and with different levels of engagement with the techniques. Ideation techniques can be broadly divided into text-based and sketch-based. Text-based techniques are for example scenarios or personas, in which a textual description of users and the product's context of use is given. Sketch-based techniques integrate graphical representations with textual annotations; examples are storyboards, card-based prototypes or interface sketches.

BPs used textual ideation equally as much as sketch-based ideation and their scenarios and storyboards described the design in detail. UK designers used more graphical ideation (statistically significantly different at $p \leq 0.05$). They used storyboards and scenarios to describe the context of a solution, such as how a phone could be used by illiterate users.

BPs focused on using known devices in a new problem context but did not necessarily consider the interaction implications of doing so. For example, several BPs suggested using the phone alarm to signal that it's time to take medication. The interaction to set a phone alarm is well-known and does not need complete re-designing, but it does need to be considered from a usability perspective, especially where some users may not be confidently able to set a phone alarm, for example through disability, or if they are unfamiliar with the interaction styles. For example, BP2 considered using a flashlight in their phone reminder storyboard to consider (elderly) users with hearing impairment (see Figure 3). UKPs did not adapt existing solutions to context, instead they tended to design a new product dedicated to the specific purpose, such as UKP4's specialised mobile reminder device kept within a pouch, shown in Figure 4.

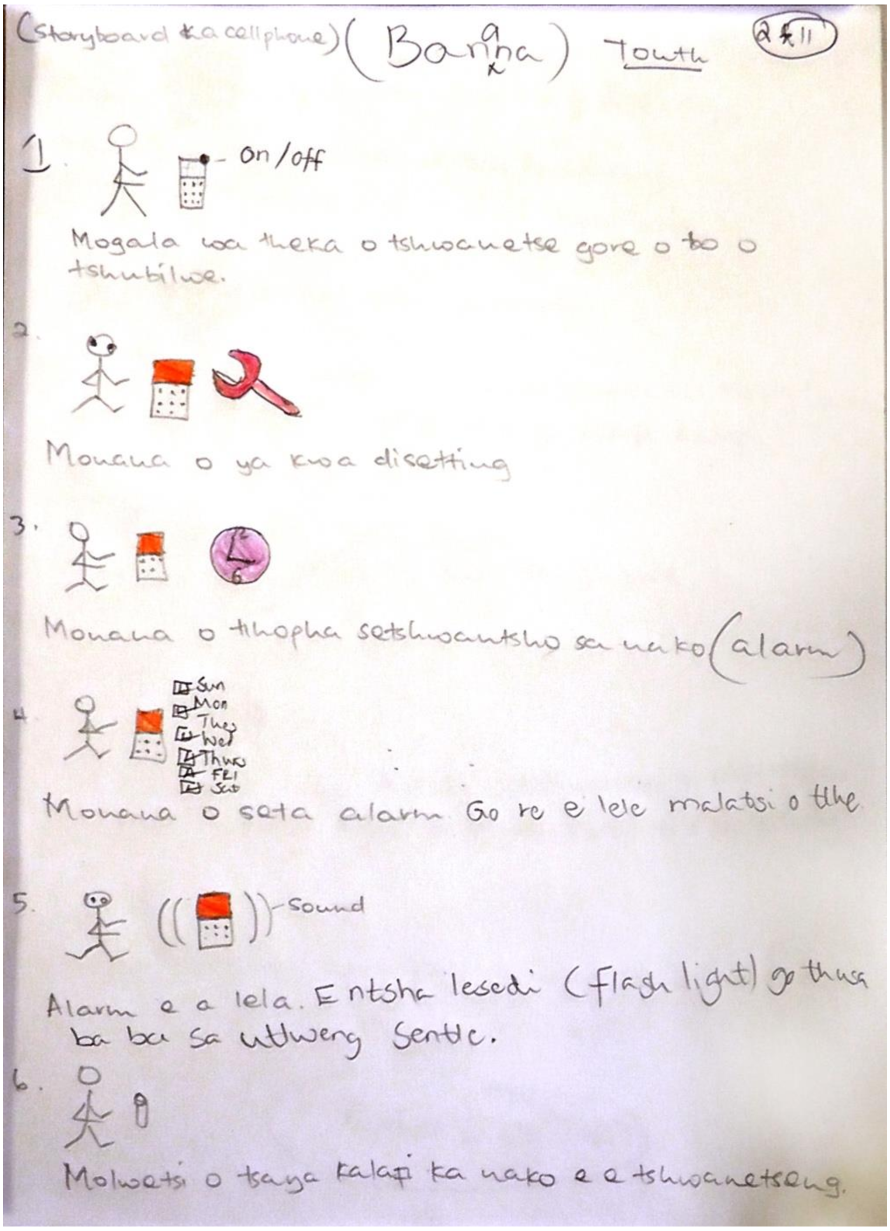


*Figure 3 BP2 storyboard for a mobile phone reminder using Flashlight for hearing impaired users*

BPs make more use of interface design sketches than UKPs (although statistically not significant). An interface sketch is a static view of the interface of the interactive product. BPs rarely create card-based prototypes, which is a technique taught in the module to draw out user interaction and detailed interface elements. The difference was significant at $p \leq 0.01$. The low use of card-based prototypes in Botswana suggests that either detailed user interaction is not considered an important ideation task or the technique itself is not appropriate for our BPs.

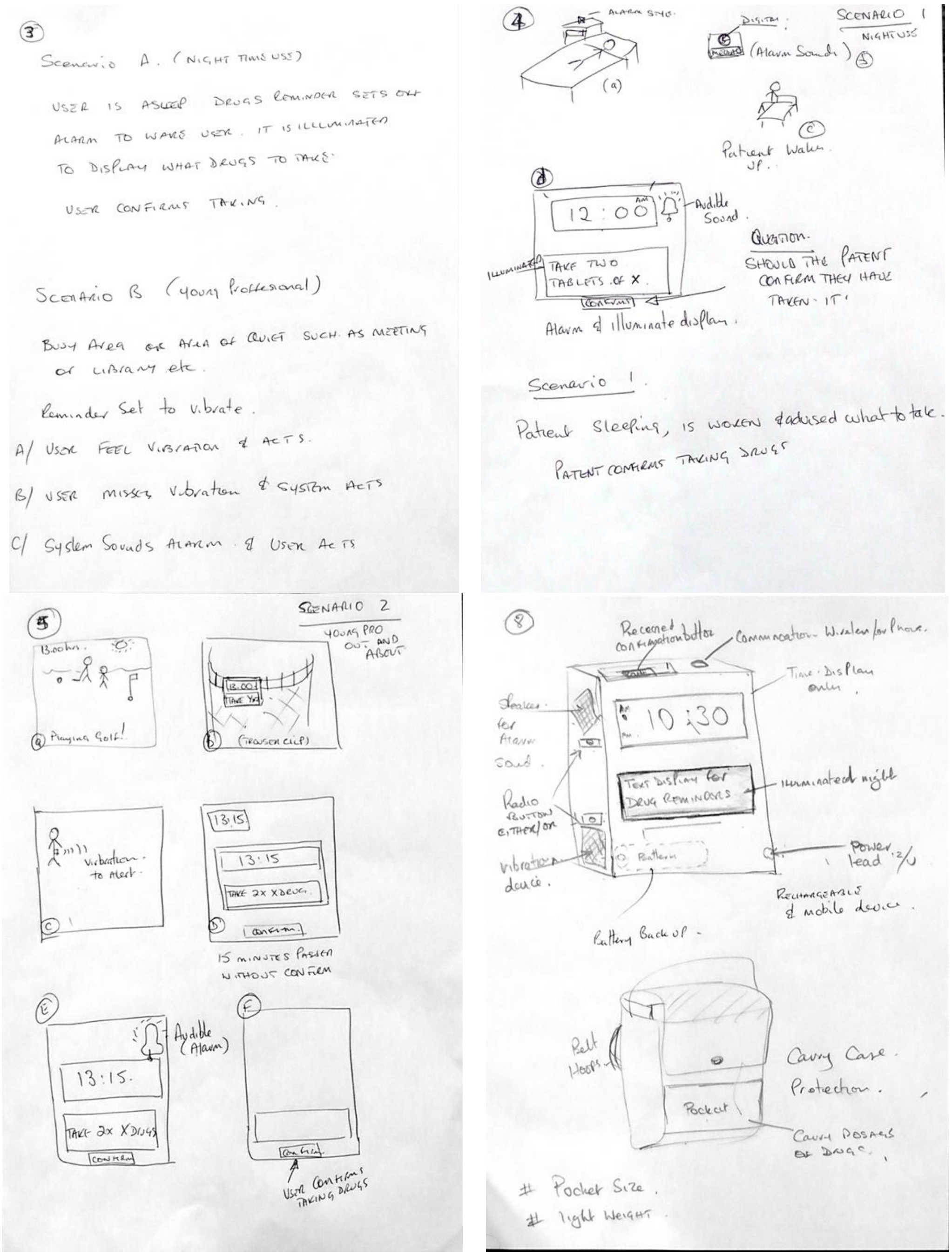


*Figure 4 UKP4 use of (a) written scenario, (b) storyboard, (c) card-based prototype and (d) interface sketch of a mobile reminder device for young professional user*

UKPs used all the ideation techniques. They left much more uncertainty in storyboards, and drew them more quickly, using them as just one step in a series of ideation moves. UKP gradually reduced this uncertainty and developed detail in their design ideas through card-based prototypes that describe detailed user interaction, followed by an interface sketch. This is closer to the approach taught in the module: start with a storyboard, move to detailed card-based prototypes for interaction detail, and then produce a concrete interface sketch. The use of several ideation techniques, each with a different focus, gradually solidifies ideas and reduces uncertainty with each step.

# 6 Discussion: challenges for interaction design education

The two cohorts (UK and Botswana) were similar in terms of their exposure to interaction design techniques but they differed in terms of their background, education and socialisation: the UK students had been educated and lived in the UK while the Botswana students had been educated and lived in Botswana. The interaction design course they had studied used the same materials, processes, techniques and activities, and the studies were conducted at comparable points in their interaction design education. During the protocol studies, both cohorts produced credible design ideas. Yet their behaviours showed marked differences, and in particular BPs did not focus on designing the interaction of their products.

These findings have implications for interaction design education. The structured and guided approach taken to introducing techniques and approaches in the course was not followed by the majority of BPs, while UKPs followed this approach more closely. In fact, the protocol analysis provides evidence that this structured approach, including the use of particular design techniques at specific times in the process, may be counter to the BPs' design behaviour. In addition, BPs' use of techniques that support the design of interaction was limited. What challenges to interaction design education might these findings imply?

## 6.1 A universally structured design process

One significant question faced by all design educators is whether novices benefit from being given a structured process to follow at all. Cross (2007a) argues for a more explicit pedagogical approach, especially in the light of distance study of design (p46/47). He maintained that following an ideally sequenced, efficient and systematic design process helps novice designers:

> *"Designing is a form of skilled behaviour. Developing any skill usually relies on controlled practice and the development of technique. The performance of a skilled practitioner appears to flow seamlessly, adapting the performance to the circumstances without faltering. But learning is not the same as performing, and underneath performance lies mastery of technique and procedure." (Cross, 2007:47)*

This thinking is based on the emergence of phased design process models in the 90s, which treat design as a problem-solving activity. Dorst (2006) argues that design may be problem-solving in some cases, but that view doesn't describe all design activities and designers' behaviours. In particular it diminishes the idea of designing as an evolutionary process, characterised by the continuous learning of the designer through trial and error. This learning utilises cycles of a parallel consideration of problem criteria and solution ideas, as we have seen in our data. Dorst (2006) observes:

> *Design problems are also something like a moving target: they are usually very vague at the beginning of the design project. As the designer acquires more knowledge about the problem and about the possibilities for solving it, the design problem also evolves during the design project.*

Instead of looking at designing as a pure problem-solving activity, Dorst suggests to look at design tasks as learning opportunities. We agree. But we have seen differences in how designers evolve their knowledge through designing.

We would argue that, in line with what Peters (2013) proposes for distance education in general, we need to achieve the right balance between structure (a phased problem-solving process), dialogue and autonomy in interaction design education. Adhering to structured learning (for example through set activities using particular techniques in phases) is important, but interaction designers also need to engage in dialogue with their peers and with more experienced designers who work as part of the education process. This would help to develop more autonomy in devising contextually appropriate processes and techniques for designing. Peters maintains that materials designed for distance study, such as the materials used in the OU's interaction design module, are more explicitly structured than would be found in universities that teach face-to-face. This is because the educators want to assure a good general standard of teaching throughout. However, suitable encouragement and incentives may be needed for students to feel comfortable to divert from the given structure, through dialogue or autonomy. A different balance of structured design process, dialogue and autonomy in designing may need to be adopted depending on the situation and context.

BPs diverted much more from the structured design process advocated in our module than UKPs, including using a solution-first approach, using off-the shelf designs to ideate in context and developing multiple outline solutions rather than fewer, detailed interactions. This may have been due to a more dialogic engagement with the process or because there was a large cognitive dissonance between the structure of the learning materials and students' preferred approach. Developing a design process through the pairs' dialogue may have diverted BPs from following the structured process given in the learning materials more closely. In addition, designers with low field-independent cognitive styles prefer a less structured design approach and the GEFT results indicated a low field-independent cognitive style in BPs. Even though BPs were taught a structured approach, they chose not to follow it. The higher GEFT scores for UKPs might also explain their behaviour, including a problem-first approach and working designs through in detail.

These findings call for flexibility in providing a balance between structured, dialogical and autonomous learning and professional development for interaction designers with varying field-independent styles and in different settings.

## 6.2 Contextually appropriate design techniques

BPs emphasised the context of the design and its use, the use of existing off the shelf products, and static representations of interfaces. UKPs used a wider range of techniques, gradually developing the detail of interaction with a product. BPs suggested interactive product-service solutions, but did not develop detailed steps of interaction with these, while UKP designed the interaction with a novel product and did not consider any services. Developing service solutions calls for different techniques to develop detail of interaction, such as Touch Point maps or Customer Service journeys (Stickdorn & Schneider, 2011). While such techniques were present in the textbook, the service design was not in the scope of the module. But designing the interaction for a product was in scope, and BPs focused on ideation techniques that emphasise the product's context and a holistic but static view of it. They did not use ideation techniques that support the development of detailed, dynamic interaction, yet designing interaction is key. So, what might have led to this?

Previous research suggests a relationship between cognitive style and sketch-based ideation behaviour. Witkin (1964) observed that field-independent individuals drew figures with more detail and differentiation than field-dependent subjects. Pei-Shan, Dengchuan, & Yao-Jen, (2009) found that analytic individuals (similar to field independent) prefer ideation with words and intuitive individuals prefer images. Abdelnour-Nocera et al. (2017) studied the performance of HCI undergraduate students in 5 different countries (China, UK, Mexico, Namibia and India), and related the students' performance to their cognitive styles. They found that students with a higher analytical cognitive profile are more likely to provide a richer analysis in a heuristic evaluation (analytical) task, but no significant correlation was found in a persona creation (creative) task.

Although the findings in this research are not consistent with some of the work cited above, i.e. that field independent participants provide more detail and prefer words, while field dependent participants prefer images and provide less detail, the differences in behaviour and technique choice may be due to differing cognitive styles. Taking this argument further, Miyamoto & Wilken (2013) summarized the literature on cognitive styles and concluded that several factors, including age, gender, professional discipline and cultural context affect cognitive style. They also suggest that Collectivism is linked to field-independence. Botswana has been assessed as high on the family Collectivism scale while England has a relatively low score (House, Javidan, Hanges, & Dorfman, 2002). Together, these points imply that BPs might be less field-independent because they lived and were educated in Botswana.

However, Sealetsa & Moalosi (2012) produced results that appear to contradict this implication. They studied freshman engineering students in Botswana and found the majority of them ranked higher on field-independence than our cohort. But their students were mostly male, while in our groups we had more female BPs (16/21) and a balanced UKP cohort (4/7). Scholars maintain that gender influences ideation processes, although to what degree is still largely unknown (Bratteteig, 2002), and that may explain the difference in our findings. In addition, Sealetsa and Maolosi studied engineering students who tend to rank more highly on field-independent scores no matter which country they come from, while our students were not studying an engineering degree but a Computing and Practice degree. So, discipline and gender may have influenced their results more than the cultural context.

So there is an argument that our participants' cultural background and their gender may have influenced their cognitive style and hence their design process and sketch-based ideation. But socialization and education filter new knowledge and strengthen a particular cognitive style. The continued socialisation of a specific discipline of study will influence how ideation techniques and processes are developed further through designers' practice. It seems therefore that cultural background, cognitive style and socialisation are related factors that impact on the similarities and variations we saw in the design behaviours in UKPs and BPs.

Taken together, these discussion points indicate a challenge for interaction design education to be the identification or development of techniques that support a range of cognitive styles, and which are sympathetic to the background and socialisation of the designers as well as the users' characteristics and the context of use.

## 6.3 What to teach

Although there are well-established textbooks in interaction design and HCI that are used around the world, e.g. Preece et al (2015) and Shneiderman, et al. (2016), their use in a global context has been questioned. For example, Bidwell & Winschiers-Theophilus (2010) highlight that such texts are often “founded on non-African values and practices”, and that “while African IT professionals and teachers” may notice gaps related to local contexts, students’ high regard for textually-published knowledge together with a drive for consensus often works against alternative perspectives.

Researchers have also questioned the effectiveness of standard HCI tools and techniques from developed countries (e.g. Smith et al, 2007). The need to involve users in the design of interactive products – through co-design and evaluation of designs and products – is well-established in the interaction design field, but how to do that, and how to integrate indigenous knowledge into the designs and the design process is a focus of active research (Abdelnour-Nocera, Clemmensen, & Kurosu, 2013). For example, Winschiers-Theophilus & Bidwell (2013) call for more critical research into the tensions between local contexts, practices and characteristics, and HCI principles.

In the study reported above, BPs used several of the taught techniques successfully in producing their designs. However, it is also clear that some of the techniques commonly used to work with users and designers in identifying requirements and evaluating prototypes are not so comfortable for novice designers in Botswana (Sharp, Lotz & Woodroffe, in review).

Interaction design educators in Botswana face a challenge of deciding which techniques and tools to teach, and what resources to draw upon. While existing interaction design textbooks are likely to remain a central focus for such programmes at least in the short term, the bi-annual AfriCHI conferences (e.g. AfriCHI ’16 and ’18) (Awori & Bidwell, 2016; Winschiers-Theophilus et al., 2018) offer a solid resource for examples and techniques that are centred on communities in different parts Africa.

# 7 Conclusion

Everyone should benefit from technological innovations, but they need to be designed with the user characteristics and contexts of use in mind. Products that integrate indigenous knowledge and practices into their design are more likely to be accepted by the user community and to support users’ goals. Interaction design education that develops designers’ capacity to produce such designs is therefore of relevance to international development.

Challenges for interaction design education in Africa were discussed at the AfriCHI Baraza! workshop mentioned above, and reported by Lazam and Dray (2018). They include the lack of HCI faculty members in African universities, the focus on theoretical aspects of HCI rather than practice, and the need for local pedagogical models. Others have also identified challenges in a global setting such as the need to develop curricula for intuitive-adaptive students, and to support diversity in HCI education delivery (Abdelnour-Nocera et al, 2017). The work reported here has identified a complementary set of challenges for interaction design educators in Botswana, grounded in an empirical study of student behaviour:

1. *Designing a pedagogical model that provides a flexible balance between structured, dialogic and autonomous learning and professional development for interaction designers with varying field-independent styles and in different settings*. In particular, the challenge is whether and how to accommodate a range of design processes and behaviours to encourage students’ intuitive approaches. This has implications for assessment as well as delivery of materials because design process may be used as a

framework for assigning grades, as it was in the case study reported here. The findings gained from this collaborative research project help to explain the differences in assessment scores in the cohorts from Botswana and the UK in the teaching partnership with Botho University.

2. *Identifying techniques that support a range of cognitive styles, and which are sympathetic to the cultural background of the designers as well as the users*. In particular, this challenge highlights the need for design techniques that support field dependent students to design the detailed interaction between products and their human users.

3. *Locating and selecting suitable resources to support a localised curriculum*. The lack of resources is a challenge identified by others, but the work here implies an additional challenge of choosing resources that exemplify indigenous knowledge, practices and characteristics. This may involve choosing a core textbook and supplementing it with examples of interaction design, and ideation techniques or user involvement methods that have been used successfully by designers from similar backgrounds and with similar user groups. Alternatively, this may involve dedicating resource to support more dialogic tasks between designers with different cognitive styles and perspectives, such as through international or interdisciplinary collaborations.

The main implications of our findings for interaction design education are the need to embed greater flexibility and contextual sensitivity in the curriculum. Beyond this, learners need to challenge the *status quo* of what is a good design, what techniques are needed to create a good design, and what makes a good design process. One approach to achieving this would be to develop the capacity for reflective practice in designers (Schön, 1987). Starting from the understanding that there is a multiplicity of possible design processes, one approach would be to apply a process and a set of techniques, and at the same time, develop the capacity to critically reflect on this experience. Reflective practice will help to uncover which techniques work in the designers' own contexts and what resources to use during designing. Teaching critical reflective practice while also critically engaging with the effectiveness and shortcomings of techniques and process, will help designers based in developing nations to challenge non-indigenous processes.  This will lead to more autonomy and empower designers to challenge the *status quo* in the long run.

## Acknowledgements

We thank all our study participants, and other members of the research team without whom this paper could not have been written: Mark Woodroffe, Dino Rajah, Ranganai Turugare and Richard Blyth. This work was supported by the Leverhulme Trust under Grant RPG-257.

# 8 References

Abdelnour-Nocera, J., Clemmensen, T., & Guimaraes, T. G. (2017). Learning HCI across institutions, disciplines and countries: a field study of cognitive styles in analytical and creative Tasks. In R. Bernhaupt, G. Dalvi, A. Joshi, K. D. Balkrishan, J. O'Neill, & M. Winckler (Eds.), *Human-Computer Interaction – INTERACT 2017* (pp. 198–217). Springer, Cham. https://doi.org/10.1007/978-3-319-68059-0_13

Abdelnour-Nocera, J., Clemmensen, T., & Kurosu, M. (2013). Reframing HCI through local and indigenous perspectives. *International Journal of Human-Computer Interaction, 29*(4), 201–204. https://doi.org/10.1080/10447318.2013.765759
Awori, K., & Bidwell, N. J. (Eds.). (2016). *Proceedings of the First African Conference on Human Computer Interaction.* ACM, New York, NY, USA.
Bidwell, N. J., & Winschiers-Theophilus, H. (2010). Beyond the benjamins: toward an African interaction design. *Interactions, 17*, 32–35. https://doi.org/10.1145/1649475.1649483
Blyth, R., Schadewitz, N., Sharp, H., Woodroffe, M., Rajah, D., & Turugare, R. (2012). A frame Ssgnature matrix for analysing and comparing interaction design behaviour. In *Proceedings of BCS HCI12*. Birmingham. Retrieved from http://hci2012.bcs.org/programme.html
Bratteteig, T. (2002). Bringing Gender Issues to Technology Design. In *Feminist Challenges in the Information Age* (pp. 91–105). Wiesbaden: VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-322-94954-7_8
Chavan, A. L., Gorney, D., Prabhu, B., & Arora, S. (2009). The washing machine that ate my sari---mistakes in cross-cultural design. *Interactions, 16*(1), 26. https://doi.org/10.1145/1456202.1456209
Churchill, E. F., Bowser, A., & Preece, J. (2016). The future of HCI education. *Interactions, 23*(2), 70–73. https://doi.org/10.1145/2888574
Clemmensen, T., Hertzum, M., Hornbaek, K., Shi, Q., & Yammiyavar, P. (2009). Cultural cognition in the thinking-aloud method for usability evaluation. *Interacting with Computers*.
Cross, N. (2007). *Designerly ways of knowing*. Birkhäuser.
Cross, N., Christiaans, H., & Dorst, K. (1997). *Analysing design activity*. Wiley.
Deininger, M., Daly, S. R., Sienko, K. H., Lee, J. C., & Kaufmann, E. E. (2019). Investigating prototyping approaches of Ghanaian novice designers. *Design Science, 5*(6). https://doi.org/10.1017/dsj.2019.5
Dorst, K. (2006). *Understanding design: 175 reflections on being a designer*. Amsterdam: BIS Publishers. https://doi.org/90-6369-149-1
Ericsson, K. A., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review*. https://doi.org/10.1037/0033-295X.87.3.215
Evans, C., Richardson, J. T. E., & Waring, M. (2013). Field independence: reviewing the evidence. *British Journal of Educational Psychology, 83*(2), 210–224. https://doi.org/10.1111/bjep.12015
Faiola, A., & Matei, S. (2005). Cultural cognitive ctyle and web design: beyond a behavioral inquiry into computer-mediated communication. *Journal of Computer- Mediated Communication, 11*(1). Retrieved from http://jcmc.indiana.edu/vol11/issue11/faiola.html.
Fendler, J., & Winschiers-Theophilus, H. (2010). Towards contextualised software engineering education: an African perspective. *2010 ACM/IEEE 32nd International Conference on Software Engineering, 1*, 599–607. https://doi.org/10.1145/1806799.1806888
Gautam, V., & Blessing, L. (2009). How cultural characteristics influence design process - an empirical study. In U. Norell Bergendahl, M.; Grimheden, M.; Leifer, L.; Skogstad, P.; Lindemann (Ed.), *ASME 2009 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference IDETC/CIE 2009* (pp. 115–122).
Gross, T. (2014). Human-computer interaction education and diversity. In M. Kurosu (Ed.), *Human-Computer Interaction. Theories, Methods, and Tools. HCI 2014.* (pp. 187–198).

Springer, Cham. https://doi.org/10.1007/978-3-319-07233-3_18
House, R., Javidan, M., Hanges, P., & Dorfman, P. (2002). Understanding cultures and implicit leadership theories across the globe: An introduction to project GLOBE. *Journal of World Business*, *37*(1), 3–10. https://doi.org/10.1016/S1090-9516(01)00069-4
Huang, K., & Deng, Y. (2008). Social interaction design in cultural context: a case study of a traditional social activity. *International Journal*, *2*(2), 81–96. Retrieved from http://www.ijdesign.org/ojs/index.php/IJDesign/article/view/341/168
Lazem, S., & Dray, S. (2018). Baraza!: human-computer interaction education in Africa. *Interactions*, *25*(2), 74–77. https://doi.org/10.1145/3178562
Lotz, N., & Sharp, H. (2017). The Influence of Cognitive Style, Design Setting and Cultural Background on Sketch-Based Ideation by Novice Interaction Designers. *Design Journal*, *20*(3), 333–356. https://doi.org/10.1080/14606925.2017.1301039
Lotz, N., Sharp, H., Woodroffe, M., Blyth, R., Rajah, D., & Ranganai, T. (2014). Framing behaviours in novice interaction designers. In *Proceedings of DRS 2014: Design's Big Debates* (pp. 1178–1190.). Umeå: Umeå Institute of Design, Umeå University.
Marsden, G., Maunder, A., & Parker, M. (2008). People are people, but technology is not technology. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *366*(1881), 3795–3804. https://doi.org/10.1098/rsta.2008.0119
Miyamoto, Y., & Wilken, B. (2013). Cultural differences and their mechanisms. In D. Reisberg (Ed.), *Oxford Handbook of Cognitive Psychology*. https://doi.org/10.1093/oxfordhb/9780195376746.013.0061
Moalosi, R. (2007). *The impact of socio-cultural factors upon human-centred design in Botswana*. Queensland University of Technology.
Nisbett, R. E. (2003). *The geography of thought : how Asians and Westerners think differently and why*. New York, NY: Free Press.
O'Malley, C. ., Draper, S. ., & Riley, M. . (1985). Constructive interaction: a method for studying human–computer interaction'. In *Human-Computer Interaction* (pp. 269–274). London: Elsevier.
Panek, P. E., Funk, L. G., & Nelson, P. K. (1980). Reliability and validity of the Group Embedded Figures Test across the life span. *Perceptual and Motor Skills*, *50*(3 Pt 2), 1171–1174. https://doi.org/10.2466/pms.1980.50.3c.1171
Pei-Shan, T., Dengchuan, C., & Yao-Jen, F. (2009). A study of cognitive style on design performance. In *Proceedings of IASDR*. Korean Society of Design Science. https://doi.org/ISBN 978-89-963194-0-5
Peters, O. (2013). *Learning and Teaching in Distance Education*. London: Routledge. https://doi.org/10.4324/9780203046029
Preece, J., Sharp, H., & Rogers, Y. (2015). *Interaction Design: beyond HCI* (4th ed.). Chichester: John Wiley & Sons. https://doi.org/10.1016/S0010-4485(86)80021-5
Razzaghi, M., Ramirez, M., & Zehner, R. (2009). Cultural patterns in product design ideas: comparisons between Australian and Iranian student concepts. *Design Studies*, *30*(4), 438–461. https://doi.org/10.1016/j.destud.2008.11.006
Sari, E., & Wadhwa, B. (2015). Understanding HCI education across Asia-Pacific. In *Proceedings of the International HCI and UX Conference in Indonesia on - CHIuXiD '15* (pp. 65–68). New York, NY, USA: ACM Press. https://doi.org/10.1145/2742032.2742042
Schön, D. A. (1983). *The reflective practitioner: how professionals think in action*. Basic Books.
Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching*

*and learning in the professions.* San Francisco: Jossey-Bass.
Sealetsa, O. J., & Moalosi, R. (2012). Cognitive and learning styles of the Faculty of Engineering and Technology students : University of Botswana. *World Transactions On Engineering and Technology Education*, *10*(2), 138–143.
Sharp, H., Lotz, N., Blyth, R., Woodroffe, M., Rajah, D., & Ranganai, T. (2013). A protocol study of sovice interaction design behaviour in Botswana: solution-driven interaction Design. In *Proceedings of the 27th International BCS Human Computer Interaction Conference* (pp. 18:1--18:10). Retrieved from http://dl.acm.org/citation.cfm?id=2578048.2578074
Sharp, H., Lotz, N., & Woodroffe, M. (n.d.). Socio-cultural factors and Interaction Design in Botswana: results of a video diary study. *Submitted to International Journal of Human-Computer Systems*.
Shneiderman, B., Plaisant, C., Cohen, M., Jacobs, S., & Elmqvist, N. (2016). *Designing the User Interface: Strategies for Effective Human-Computer Interaction* (6th ed.). Pearson.
Smith, A., Bannon, L., & Gulliksen, J. (2010). Localising HCI Practice for Local Needs. In *Proceedings of the 2010 International Conference on Interaction Design and International Development* (pp. 114–123). Mumbai, India: BCS Learning & Development Ltd. Swindon, UK. Retrieved from https://dl.acm.org/citation.cfm?id=2227362
Smith, A., Joshi, A., Liu, Z., Bannon, L., Gulliksen, J., & Li, C. (2007). Institutionalizing HCI in Asia. In C. Baranauskasv, P. Palanque, J. Abascal, & S. D. J. Barbosa (Eds.), *Human-Computer Interaction – INTERACT 2007* (pp. 85–99). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-74800-7_7
Stickdorn, M., & Schneider, J. (2011). *This is service design thinking : basics, tools, cases*. BIS Publishers.
Valkenburg, R., & Dorst, K. (1998). The reflective practice of design teams. *Design Studies*, *19*(3), 249–271. https://doi.org/10.1016/S0142-694X(98)00011-8
Winograd, T. (1997). The Design of Interaction. In *Beyond Calculation* (pp. 149–161). New York, NY: Springer. https://doi.org/10.1007/978-1-4612-0685-9_12
Winschiers-Theophilus, H., & Bidwell, N. J. (2013). Toward an Afro-Centric Indigenous HCI Paradigm. *International Journal of Human-Computer Interaction*, *29*(4), 243–255. https://doi.org/10.1080/10447318.2013.765763
Winschiers-Theophilus, H., Zyl, I. van, Goagoses, N., Jat, D. S., Belay, E. G., Orji, R., & Peters, A. (Eds.). (2018). *Proceedings of the Second African Conference for Human Computer Interaction: Thriving Communities.* ACM, New York, NY, USA.
Witkin, H. A. (1964). Origins of cognitive style. In C. Sheerer (Ed.), *Cognition: Theory, research, promise*. Harper & Row.
Witkin, H., Oltman, P., Raskin, E., & Karp, S. (1971). *A Manual for the Embedded figures tests*. Palo Alto Calif.: Consulting Psychologists Press.
Wolf, T. V., Rode, J. A., Sussman, J., & Kellogg, W. A. (2006). Dispelling “design” as the black art of CHI. In *Proceedings of the SIGCHI conference on Human Factors in computing systems - CHI ’06* (p. 521). New York, NY, USA: ACM Press. https://doi.org/10.1145/1124772.1124853