Co-designing Digital Tools to Enhance Speech and Language Therapy Training in Ghana

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ABSTRACT

Ghana has a population of over 27 million people, of which 1 in 15 may have a communication disability. The number of speech and language therapists (SLTs) available to support these people remains remarkably small, presenting a major workforce challenge. As an emerging profession, there remain significant challenges around educating the first generation of SLTs. Ghana, however, has a healthy digital infrastructure which can be taken advantage of. We describe a comprehensive study which aimed to co-design a set of locally appropriate digital tools to enhance SLT training in Ghana. We contribute insights into how digital tools could support social learning and the transition from student to independent practitioner and future clinical supervisor. We offer a set of design recommendations for creating an online Community of Practice to enhance continuing professional development.

Author Keywords

Speech and Language Therapy; Ghana; Co-design; Mobile Learning

CSS Concepts

• **Human-centered computing~Interaction Design;** *Interaction design process and methods*; Participatory Design.

INTRODUCTION

Communication disability is poorly recognized in Low-Middle Income Countries (LMICs), with scarce availability of rehabilitation services [54]. The number of people with a communication disability in Sub-Saharan Africa (SSA) is not accurately known, but estimates suggest it may affect up to half of all people with disabilities, around 1 in 15 people [16]. Services for people with a communication disability can be provided in a range of formal and informal ways, with a key component in the global North/ High Income Countries (HICs), being rehabilitation services provided by Speech and Language Therapists (SLTs). The number of SLTs in SSA, however, is extremely limited. Fagan and Jacobs reported on SLT service availability across 18 SSA countries and their data indicated an average of 1 SLT per 12 million people [54].

The SLT workforce in Ghana reflects the workforce challenge across SSA; in 2017 there were estimated to be 5 practicing SLTs providing services in a country with a population of over 27 million [17, 52]. To address the need for SLT services, the University of Ghana launched a Masters level (MSc) qualifying program in Speech and Language Therapy in August 2016. However, several challenges remain in delivering a vocational course of this kind, in a context where SLT is a newly emerging profession. For example, there are currently limited staff resources to enable adequate clinical supervision of students during practical placements, as well as supporting the newly qualified SLTs to continue their professional development specific to the culture and context they work within [40]. In an attempt to address this, University of Ghana currently receive external support from SLTs in the UK, Australia and USA, but relying on this support is not scalable in the long-term. There is a need to develop a Community of Practice [49] which is self-supporting.

Through this project we aimed to co-design technical solutions which would address the specific needs of trainee SLTs in Ghana and help to support the growing community of SLTs, who will have a wide geographical spread as the profession develops. Given the mobile phone market in Ghana is one of the most developed in Africa, and there has been a continuous improvement in the country's mobile broadband penetration rate [18], we saw a particular opportunity for mobile technologies to enhance SLT training and build capacity for the long-term professional development of Ghanaian SLTs.

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This paper describes an iterative co-design process which engaged 20 participants who represented the majority of the SLT profession in Ghana. Participants took on the role of co-designers, 'experts of their experience', playing a role in knowledge development and idea generation, whilst the researchers took on a facilitator role providing tools for ideation and expression [41]. Through a series of semi-structured interviews, workshops and a week-long design probe study, we explored their experiences of studying SLT and the challenges of delivering SLT clinical education in Ghana. Based on these insights, we generated four design concepts for digital tools to enhance SLT training and ran 2 further co-design workshops to explore and refine these. Our intention is not to present finalized technology designs, rather, we highlight how our co-design approach elicited empirical insights, and how some of these could be addressed through digital tools. We contribute insights into how these tools could be used to help scaffold and enhance social learning that supports the transition from SLT student through to independent SLT practitioners, who will become future clinical supervisors. Finally, our work can be more broadly applied to understanding around how to support other newly emerging professions in LMICs.

BACKGROUND AND RELATED WORK

Speech and Language Therapy

Speech and Language Therapy is an allied health profession which focuses on the prevention, diagnosis and treatment of a range of communication disabilities. The role of an SLT (also known as Speech-Language Pathologists) is to improve their clients' communication skills and interaction with their environments, thereby mitigating the effect of a communication disability on their lives [38]. People with communication disabilities (PWCD) can experience a range of disorders which can be broadly categorized as: 1) Speech disorders, affecting a person's ability to produce speech sounds and/or their voice. This can include problems making the correct sounds, or producing them in a fluent manner (e.g. stuttering or lisps); 2) Language disorders, affecting a person's understanding and use of language, whether written or spoken (e.g. aphasia); 3) Social communication disorders, affecting the use of language in different social settings. These include problems with adapting language to different purposes, audiences and settings (e.g. Autistic Spectrum Disorder); 4) Cognitive-communication disorders, affecting the way an individual processes thoughts. These can affect memory, attention, analytical skills and critical thinking (e.g. dementia) [2]. SLTs are also responsible for diagnosing and treating swallowing disorders, which affect the consumption and swallowing of food (i.e. dysphagia) [37].

The scope of practice of SLTs can be broadly divided into two areas: clinical service delivery and community-based rehabilitation (CBR). Clinical service delivery may be conducted in collaboration with the patient, their family and other medical professionals involved in their care [38]. CBR deals with the effect of communication disability on populations as a whole rather than focusing on the individual [54]. This includes services such as outreach to educate members of a community on communication disabilities and how to make communication environments more inclusive, to facilitate the participation of PWCD in society [52].

An SLT's fundamental knowledge, including speech and language pathology, psychology, phonetics and linguistics, is taught within a university course, but their professional development must be ongoing. Qualified SLTs need to constantly update and refresh their knowledge in the light of new research [21]. The clinical workplace for SLTs is a complex, dynamic and rapidly changing environment, necessitating the ability of students and practitioners to learn new skills quickly. To work effectively as an SLT, core skills must be learned, including interpersonal, information gathering, therapy, problem-solving, decision making, and organizational-management [21]. Reflective practice is another important component of SLT clinical practice and education as it has 'the potential to foster the generation of knowledge from practice, balance and contextualize science with patient care, facilitate the integration of theory and practice, link evidence-based practice and clinical expertise and contribute to the cultivation of ethical practice' [7, p.81]. Many of these skills are developed independently through a process of constantly reflecting on one's practice and seeking new opportunities for learning.

Speech and Language Therapy in Ghana

Ghana is a West African LMIC that is regarded as a leader in areas such as economic growth, free speech and education within SSA [50]. Ghana has also been making strides in the healthcare industry, with a relatively successful national medical insurance system and high-quality medical practice in urban areas [11]. However, as is also the case in many other LMICs, people with communication disabilities in Ghana are considered a medically under-served population, meaning they face issues with regards to service availability and service accessibility [52]. SLT services that currently do exist are in many cases not being taken advantage of due to a variety of economic, social and cultural factors (e.g. SLT is currently a 'paid for' service in Ghana; there is a considerable cultural stigma towards disability; the role of traditional and religious practices) [51, 52].

Examining the current state of SLT in Ghana highlights the challenges faced in the delivery of services, which are limited, with very few SLTs available [17, 52]. SLTs in Ghana tend to be concentrated around major cities like Accra (the capital), thus making access more difficult for people in remote, rural areas, as well as minority linguistic and ethnic groups [51]. There are around 75 ethnocultural/native groups in Ghana each speaking at least one distinct language, although some languages (e.g. Twi) may be commonly spoken by other cultural groups [35]. This contrasts with HICs where SLT services are more widely distributed across the population (although HICs face their own challenges with the accessibility of SLT services, particularly those without universal healthcare) [51]. To remedy the lack of

SLTs in Ghana, the government have provided funding to establish the MSc in SLT program at the University of Ghana.

Due to a scarcity of indigenous SLTs, Ghana previously relied on 'outsider' SLTs; Western expatriates, immigrants and volunteers [27]. Over time the role of these 'outsiders' has shifted from one where they have dominated the implementation of SLT practices in Ghana, to a more collaborative effort with 'insiders', native SLTs and institutions in the country. While there are no doubt advantages to the role played by 'outsiders' (e.g. knowledge transfer, expertise on service development and the provision of resources), it is worth noting that expertise provided by 'outsiders' is based on their own experience in HICs, and many foreign workers arrive to Ghana with limited cultural and linguistic understanding of Ghanaian people [27]. This is problematic as it often results in a 'Eurocentric' approach to the treatment of PWCD, with an emphasis on the values and cultural practices from European or 'Western' societies, often at the expense of including worldviews from other societies [27, 33, 51]. Cultural appropriateness must be considered during the implementation of SLT resources in Ghana. Imported clinical treatment must be conceptualized within the existing multisectoral framework of CBR practices in order to create services relevant to Ghanaian people and cultures [52].

Digital solutions to support clinical training

Shaping the learning health system has been identified as one of the grand challenges for HCI researchers and one which will require a bottom up approach to engaging patients and clinicians [44]. Previous HCI studies exploring SLT have largely focused on designing technology applications for specific use cases within SLT treatment [13, 26, 29], however, we are not aware of any studies with a focus on designing digital tools that support the enhancement of SLT education and training. That said, there has been work exploring the role of digital technology in enhancing clinical skills training within other medical fields. For example, Khan et al. [22] describe the use of an accelerometer-based skills assessment technique to support surgical students in learning suturing skills and several authors have explored the role of simulation for clinical skills training [39, 46].

Further, scholars in HCI and learning sciences are increasingly converging around research on participatory design for learning [1, 14, 55], with theory from education playing a vital role in creating usable and effective learning tools. In particular, designing for reflection is becoming increasingly important in HCI research exploring the value of technology in supporting interpersonal skills training within clinical settings such as counselling [45].

Within our study we embed reflective learning theories into our study design - as discussed by DiSalvo [10], who explored how learning theories are enacted through participatory design and how greater awareness of these can inform practice. Reflective practice is a process of learning through, and from, experience, towards gaining new insights of the self and one's practice [4, 19, 30]. It is an important component of SLT clinical education and practice [7]. Within our design process we explored the students' experiences of reflective practice but also embedded reflective practice as a method of generating learning within the participatory design process.

THE STUDY

The aim of our study was to co-design a set of locally appropriate digital tools to enhance SLT training in Ghana. We approached the research with a view to understanding the educators' experiences of teaching and supervising clinical education in Ghana, and the learning experiences of trainee SLTs and their future aspirations. In doing so we aimed to explore the potential for technology to support SLT training, through an iterative process of co-designing ideas based on identified challenges and issues. The research took place in three phases; (1) Scoping phase: involved a consultation exercise, interviews, a workshop and development of a design probe toolkit; (2) Probing phase: used the toolkit as a form of exploratory research; and (3) Co-design workshops: where design concepts, based on the insights from the earlier phases, were ideated around, evolved and refined.

Research context

The study was led by researchers from the University of Bristol working with the University of Ghana SLT Team, Manchester Metropolitan University, Knowle West Media Centre (KWMC), a not-for-profit organization with experience of co-design with diverse communities, and The British Ghanaian Therapy Partnership (BRiGHt). The University of Ghana SLT team (3 staff) are based at Korle Bu Teaching Hospital in Accra, which is the only public tertiary hospital in the southern part of Ghana. They run the SLT clinic four days a week and teach the MSc in SLT. They are supported by a group of 6 student interns in their pre-qualification stage who are undertaking a one-year internship after completing the MSc. A further 6 student interns work in other community organizations in Ghana, for example in centers or schools working with children with special needs. The majority of these are based within Accra.

Participants

There were 20 participants in our study; 3 educators, 12 students, 4 student interns and 1 UK based SLT who is part of BRiGHt, a UK based network which helps to support remote mentoring of the interns. They represent the majority of the current SLT workforce in Ghana. The educators are Ghanaian and completed their SLT training in the UK. Two had their training funded by the Ghanaian government, so that they could return to set up the MSc in SLT. The third is an experienced SLT who worked in the UK for 24 years before returning to Ghana, where she has been working as an SLT since 2007 and has also established an NGO. The students and interns are all Ghanaian. The students were the second cohort studying the MSc, who had commenced their studies in August 2018. The interns were part of the first cohort of students who completed the MSc in July 2018.

Figure 1: (left to right) toolkit activities: 1) My journey to becoming an SLT; 2) My support network; 3) My practice as an SLT; 4) My creative self; 5) Future me

Our research study was conducted between January and July 2019, during which we conducted a 2-week research visit at Korle Bu Teaching Hospital, where we conducted interviews, a design probe study and co-design workshops. Our work also draws upon the findings of a consultation exercise undertaken in Ghana between the 14 - 18th August 2017. We obtained research ethics approval from the University of Bristol and the University of Ghana. Participation in the study was voluntary and the participants could opt to withdraw their data from the study. The following sections describe how data were collected and analyzed in the three phases, the findings of each phase and how this informed the development of the next phase.

PHASE 1: SCOPING

Consultation exercise

Two members of the research team (authors McNaney and Marshall) travelled to Ghana for a primary visit to scope opportunities for collaboration and prioritize the needs of the SLT group. During their time they ran 3 workshops (one with students and 2 with the clinical educators) and 3 observation sessions (held in different sites where students complete their clinical placements) to understand the needs of both the students and educators. The whole team then generated a set of priorities for collaborative working, with top priorities identified as a need for; (i) ways to structure critical reflection for the students so it becomes embedded in everyday practice, and (ii) support to enhance the capacity of clinical supervision of the students. Data were collected in the form of field notes and photographs of workshop materials but were not audio recorded.

Design probes toolkit development

Design probes are used within the Pre-design and Discover phases of the design development process, called the 'fuzzy front end' of design, where knowledge gained serves as the foundation for prototyping ideas [42]. Probes were first developed as cultural probes, created as a research method to counter the challenges of designing new technologies for unfamiliar groups [15], but their use has since become widespread in both scope and divergence [48].

We were aware that when designing for groups that are not well known to the designer, it can be difficult to gain a true understanding of the group's culture and attitudes, and to uncover preferences, concerns and desires [15]. Therefore, we decided to use probing as an exploratory research method to understand these areas in more detail with the students, as a process of collaborative discovery and learning. Our aim was to create a design probes toolkit to be used by the students, to explore their experiences of reflective practice (identified as the top priority during the early consultation). We used the toolkit to help build a dialogue between the researchers and students in order to gain a better insight into of their SLT learning experiences, the challenges they face and their aspirations. The probes invited them to reflect upon and verbalize their experiences, feelings and attitudes of clinical education.

We developed initial design ideas for the toolkit through a co-design session facilitated by KWMC: The Factory (a community makerspace) which was attended by the University of Bristol researchers and the BRiGHt mentor, who provided vital insights into how suitable the activities

might be for the Ghanaian students. We decided the students would receive the toolkit at the start of the research visit and use it over a one-week period, we would then conduct a follow-up interview in week 2 of the research visit. The toolkit contained 5 probes (activities), 1 to complete each day, allowing some flexibility to fit around their busy study timetable. Our intention was for the toolkit to be playful yet professional. In the design we took into consideration the context in which activities would be completed (e.g. likely to be at home where internet access may be limited and students would have limited time due to study pressures), cultural considerations (e.g. some research has highlighted a marked unfamiliarity with ideas about reflective practice in SSA, and a difference between Western and African perceptions of self [3]), the suitability of materials for the context and the fact the toolkit needed to be robust enough to be transported from the UK to Ghana.

The toolkit contained five activities, described below and shown in figure 1:

(1) 'My journey to becoming an SLT': explored the students' learning journey. A map showed various learning stages and they were asked to pick stickers (words and emojis) to represent how they felt or hoped they would feel at those times.
(2) 'My support network': explored who the students get academic, emotional and practical support from, and how, using stickers and a Venn diagram.
(3) 'My practice as an SLT': asked students to reflect upon on a clinical session that went well and one that went badly by completing two comic strips.
(4) 'My creative self': asked students to pick an activity they enjoy outside of work and prepare an item that signifies this to bring to the interview. This encouraged reflection on soft skills that might contribute indirectly to their professional practice.
(5) 'Future me:' asked students to imagine where they will be working, with whom and how they might use technology in 20 years' time, through prompt cards.

Figure 2: Toolkit for SLT students containing probes

Each activity was put into an envelope, with an instruction card. The boxed toolkit also contained stickers, pens and pencils, sweets and a gift (see figure 2). The use of the toolkits is described in phase 2.

Interviews and workshop

Our first research activity during our visit was to explore the SLT educators' and students' experiences of clinical education using semi-structured interviews which would allow new concepts and ideas to arise. These were conducted at the start of the research visit in Ghana. We interviewed the educators (n=3) individually which took between 30 and 60 minutes per interview. The questions included their role in the MSc delivery, how they were involved in clinical education, their experiences of clinical supervision in practice and its challenges, and their use of technology within clinical education. The students (n=12) were then interviewed in pairs (6 interviews in total), which took 30-45 minutes per interview. The questions included what they were enjoying about the MSc and what they found difficult, their experiences of clinical education and placements, if they share learning and who with, and their use of technology. We also ran a workshop with the interns (n=3) based at Korle Bu Teaching Hospital which lasted 90 minutes. The aim was to gain a better understanding of the types of clients and conditions the see in the SLT clinic, how they prepare for and reflect on clinical sessions, to understand their typical week, and how they use technology, or might use it in the future. As one intern was unable to attend the workshop, we interviewed them after, exploring in more detail the types of clients they see in clinic, where they travel from and the types of resources they have access to. The interview lasted 21 minutes.

Interviews and the workshop were audio recorded and transcribed verbatim. The University of Bristol researchers conducted inductive thematic analysis on the data [5]. A line by line analysis was undertaken in which concepts were identified and labelled within the data. The codes were subsequently categorized into emerging themes, provisional codes were updated based on discussion with the other authors until agreement was reached. No codes existed prior to the analysis, they were created through constant comparison of the data which led to the construction of themes that captured the core topics and concerns coming from the data. The information generated was used to inform phases 2 and 3 of the research study. When discussing the findings, the educators, students and interns have been allocated a code number (E1-E3, S1-S12, I1-I4).

Phase 1 Findings

Low capacity to deliver clinical education

The lack of trained SLTs to support clinical supervision was a challenge experienced by educators, students and interns alike. This led to significant extra work for the three clinical educators who had to be with each student during their placements: *"we don't have any speech and language therapists in the community…when we're doing the clinicals we physically have to be there with them, go into the*

community" (E1). This led to concerns around the fact that, as the MSc takes on more students there would be an increased need for more trained SLTs to support their clinical supervision. In addition to this, the educators identified challenges in finding appropriate placement venues for the students, and the fact that, due to a demand for their skills, vetting different centers could in itself be an onerous task: *"SLTs are like gold dust….there are more people wanting us at their centers. And so we have to go and check out their standards….so it has been challenging finding the right places"* (E1).

The educators were hopeful that, in time, the current interns would take on the clinical supervision role, which would in turn increase the capacity for future student cohorts: *"we are hoping that these interns will practice for a while and then they will start the supervision"* (E2). However, given how new the SLT training program is, they were mindful of the different levels of competency that trainees might have *"interns have varying degrees of strengths"* (E1), leading to an uncertainty over how effective this scaling up of clinical supervision might be. Further adding to this uncertainty was a lack of understanding around the possible career pathways for the students, with a concern that the allure of private practice might add to the already existing health inequalities within Ghana: *"I was really conscious that they didn't all…especially the first two or three sets of trainees… end up setting up privates practices…but would be able to work in institutions, public sector and large places and be able to see more people, rather than just a selective few"* (E1).

Lack of access to specialist skills

A key issue that arose, particularly around the fact that SLT is a newly emerging profession in Ghana, was a lack of specific specialist skills required to build the knowledge base of the students. E1 described *"we definitely can't teach everything…there are certain areas that are quite specialist…in the UK we would get guest lecturers to come. Whereas here, where there are only a limited amount of therapists, there are no specialists"*. A workaround for this was to invite overseas SLT specialists to provide Skype or recorded lectures. However, the students often struggled with this format, due to a lack of interaction during lessons: *"it's a bit challenging because there's a difference between having the person right in front of you...when the person is not really present, it makes it difficult to get the understanding"* (S5). Issues with insufficient audio-visual equipment was also seen to raise challenges: *"the voice notes kind of lecture don't really support our learning. We find it very difficult to hear sometimes when the voice is being played"* (S6). Where in HIC institutions for example, most lectures would be accessible to students through online archives, there was no current system to make this type of resource available to the Ghanaian trainees.

Issues around specialism were not seen to be something that was easily achievable for the Ghanaian therapists in the short term, due to the fact that the profession is still in its infancy: *"they need a few years in their areas of work before they can even be considered as having a command in their areas…we've been trying to advise everybody to be a generalist-specialist"* (E1). Where in HIC settings specialism tends to develop during early stages of training, in Ghana therapists are required to cultivate broad experience bases, in order to increase the capacity of SLT services.

Travel within Ghana

Participants described how, as their profession builds, so too does the demand for their services. However, there remained challenges around the lack of understanding around the role of SLTs, which could cause issues with client expectations. Clients often wanted a 'quick fix': "*when they come and you tell them these are some of the things we can practically suggest, things for them to go and practice, they don't like that. They want a quick fix…"* (E3). Many travelled long distances to attend, some even staying in the capital city with their families or a hotel for the duration of a therapy block: *"The patients we see here come from all over the country. Some people come from up north… they come with a flight… they lodge in a hotel"* (I4). These not only caused pressure on the students: *"I think we will have to work on our confidence level, as we are going in as SLTs …they are very happy expecting much from us"* (S3), but also acted as a barrier for many less affluent clients to attend therapy: *"travel time to the hospital, money…makes it very difficult, sometimes, for people to…attend sessions"* (E2).

Travel was not only an issue for clients; most of the students, interns and educators had a significant commute each day, with I2 saying *"I travel 3 hours to work, I live in [city outside Accra] so it's far"* and S7 mentioned that during the week she stayed with extended family leaving her children in the care of others *"there is a lot of traffic on the road so I usually have to get back to Accra on Sunday, so Monday I can make the class"*. Several of the students would leave early in the morning to avoid traffic, e.g. *"I have to be here very early, get here like 6.30"* (S7), and arriving home late at night: *"I live very far, so getting home very late at night'* (S10).

In light of these challenges and the increasing demand for SLT services, Educators discussed the importance of training key people within the community to increase knowledge and understanding of SLT, and to build capacity for improving the reach of SLT: *"when we go into communities, community placement, we expect them [SLTs] to train staff…. that's why the training is very important we focus more on working with their facilitators…So if you get a facilitator who is very strong and really understands these things, then you are more or less hopeful that they are going to continue"* (E2). This highlights the focus and importance of CRB approaches within the Ghana context.

Cultural Diversity of Ghana

Given the cultural diversity of Ghana, there was much importance placed on the need to build cultural competence throughout training: *"understanding of the different cultures we have in Ghana, different languages…the different value*

systems…the different understandings and different religions" (E1). Students were encouraged to reflect on behaviors that arose during clinical sessions with their clients which represented difference from their own cultural norms. It was not only the clients who were culturally diverse, the students themselves came from a range of different backgrounds, with many speaking different native languages. As such, the student cohort itself was seen as a useful resource for peer support around certain cultural differences: *"being different can be difficult, it can be odd…if we have a whole class, you know 12 students being odd, then there's kind of comfort in numbers"* (E1).

Current use of technology

Technology used within the SLT training was limited to laptops used for both teaching and writing assignments, and mobile phones for accessing information and communication. The interns described how client information is limited and provided through paper case notes at the start of clinic, so they use their mobile phones to access information on conditions: *"the pediatric doctor writes a note. Just a note that the child is not talking, so that's the only information that we have…usually we go onto our phones and read up before the session…5 minutes…just to give you an understanding of the condition"* (I1).

WhatsApp was by far the most popular platform discussed by participants, who had a number of different groups, including one for students and educators and one for interns. The Educators discussed using it to share information: *"I do a lot of WhatsApp to give them information about…upcoming placements, about the expectations, sending them documents for evaluation"* (E2). WhatsApp is perhaps a natural choice for communicating due to its commonality in Ghana: *"WhatsApp is more popular in Ghana as compared to other platforms"* (S3) and *"because of the use of smartphones, almost everyone has the use of WhatsApp"* (S9) and cheap: *"it's economical too"* (S4).

However, there was much discussion around data usage and access. Students often bought data bundles each month and thus had a limited data allowance. Without access to WiFi, they were thus often using their personal data allowance frequently for work/ study related things: *"those on campus have privilege, they have WiFi…I have to spend on my own bundle…The network is very poor, we had a lecture this semester…he's expecting us to…search for articles…google will not open for you to type what you are looking for"* (S8). Videos were a popular way to share information amongst each other on the WhatsApp platform, but students were mindful of how much data they used: *"I buy in a bundle for the month, I don't watch a lot of videos, I use it mostly for downloading WhatsApp, assignments. When it's getting close to the end of the month and I know I have a lot of data, then I use the rest for videos" (*S10).

PHASE 2: PROBING

Phase 2 was conducted following the scoping stage. We first held a 30-minute briefing with the 12 students, where the researchers gave an overview of the study aims, handed out the toolkits, explained each activity individually and provided an opportunity to ask questions. The students completed the 5 toolkit activities in their own time over the following week. They then attended an individual follow-up interview, with discussions facilitated through their completed toolkits. We talked through each of the 5 activities individually and we photographed each artifact, so the students could keep the toolkits. This gave us an insight into the individual students, an opportunity to interpret the material and to start to identify design opportunities with the students. Each interview took around 30 minutes and they were audio recorded and transcribed verbatim. Thematic analysis was conducted by applying the same method described in phase 1 and we included analysis of the design probe artifacts. The findings provided inspiration for the development of design concepts in phase 3.

Phase 2 Findings

Large amount of clinical knowledge to learn

A common challenge the students expressed was the amount and variety of clinical knowledge they needed to learn. This was seen to cause significant anxieties around their feelings of progress within the course: *"the first semester was very technical so I didn't really understand and I was wondering if I would make it to the finish…when I finished the first semester exams and then we started in placement, then I was happy because I realized…I can now connect the teaching"* (S4). A number talked about a 'decision point' when they decided whether or not to carry on: *"I got to the point where I was really asking myself if I really wanted to do this course…I had to spend a week or so just asking myself questions…and I realized… I have to learn"* (S2).

Culturally specific training

Discussions continued to highlight the importance of the SLT training being culturally specific. For example, language was mentioned: *"the mother understood one of our local dialects… and fortunately for me I could also speak Ga very well so I was able to explain things"* (S7), issues around gender: *"in this part of the world… the women is taking care of the child"* and people's perceptions of disability: *"in Africa there is this stigma of working with people with disability"* (S10). The lack of Ghana specific learning materials was also highlighted *"we don't have lots of articles or lots of research on speech and language, communication disorders in our part of the world"* (S12).

Importance of peer support

The importance of peer support was a topic which arose frequently, students supported each other with subjects they were less familiar with: *"my colleagues in terms of when I do not understand anything, I fall on them, specially the linguistics part of it"* (S6) and they provided emotional support to each other: *"with emotional support I think my friends in my class. So they are the ones that encourage me"* (S5). They talked about peer learning: "*I have three or four friends I learn with…we are able to relate to the cases, a case they saw during their placement in clinic. And then we share*

ideas on that" (S9). In the 'My creative self' activity students mentioned the importance of empathy, listening, interaction and teamwork to them.

Future work aspirations and increasing use of technology

In the future, the students envisaged they would be working in a variety SLT roles, including in hospitals: *"working in the Military Hospital…they don't have any speech and language therapists there"* (S4), in the community: *"working with a foundation…for children with special needs…I am going to be the Founder"* (S11) and as academics: *"I would be working in an academic institution… after practicing as a SLT for a number of years…I would like to give back my experience"* (S12). They also mentioned different geographical locations, including rural areas: *"I will be working in my own clinic that's community based so other people can come and access me…out in the community, in the rural areas"* (S6).

With regards to future technology use, there was interest in how it could be used to support learning; "*envisage a school environment that employs appropriate technology to facilitate learning of students, cutting edge equipment and monitoring tools"*(S2); to manage patient records: *"it's paper based here...sometimes you come and your folder is missing…if it's more electronic it is easy information"* (S4); and for patient facing information: *"I will do research…create communication visuals for clients"* (S11).

PHASE 3: CO-DESIGN WORKSHOPS

Building upon the phase 1 and 2 findings and based on approaches drawn from [56, 28], the researchers developed design concepts for digital tools to support the SLT training that were responsive to the participants' needs and desires, and representative of the highly specific Ghanaian context. We focused on how the tools could support the learning journey from 'student' to 'intern' through to 'independent SLT practitioner'. The design concepts were evoked in 2 co-design workshops, lasting around 90 minutes, with 6 students in each workshop (see figure 3). Generative tools (personas and card sorting activities) were used to support participants to respond to the design concepts; to collect user insights, encourage critique and inspire creative responses in the form of new design ideas.

Four design concepts were presented on individual cards, they each had a SLT trainee persona describing a specific challenge (e.g. 'Sarah is reading the clinical notes for her next client. The session starts in 5 minutes so she feels under pressure. It sounds like pediatric dysphagia, but she wants to quickly remind herself of the signs and symptoms'). The challenges arose from the earlier phases of the co-design process i.e. assessing specialist information during clinic, identifying if information is culturally appropriate, structuring information to make it more searchable and creating specialist education resources that are easily accessible. Underneath each challenge was a digital tool which might help to address it:

1) *SLTShare* is an application which allows you to share information with your fellow students and other SLTs. When posting information, you put a hashtag in front of the keywords (e.g. #dysphagia #ADHD), like you do on social media platforms i.e. Twitter or Instagram. The hashtag makes it easy to search for messages with a similar theme or content hashtag. So, searching #dysphagia allows you to find all the posts that have been tagged with that hashtag. The SLTShare app curates information on the different themes making it quick and easy to search and access information.

2) *SLTInfoRater* is a web-based resource which allows you to evaluate the usefulness of different sources of SLT information and share this with others. After you have read, listened or watched the information you rate how useful you found it, giving it a thumbs up if you liked it or thumbs down if you disliked it. You can also add a comment explaining why. Then use the star rating to rate how culturally appropriate the information is and again add a comment to say why you gave it this rating. SLTInfoRater makes it quick and easy to access and share trusted and culturally appropriate sources of SLT information.

3) *SLTFinder* is a chatbot mobile-based application that allows you to structure searches for specific SLT information and commission SLT information which is not already there from experts. A chatbot is a computer program which uses text or auditory methods to search for information. SLT experts register their specialist areas with the system and add relevant information and they can also be contacted via the system to add further information.

4) SLTEduShare is a mobile based application where microlearning content can be created by SLT educators, students and practicing SLTs in Ghana and other countries (SLT Peers). Small lessons are created quickly, with minimal assistance, through the use of system templates (with guidance) for adding content (a micro lesson) - which could be a short article (500 words), a 3-5 min video or audio file, or a picture activity etc. The micro lesson is shared with their SLT peers, who are encouraged to comment on the content and other messages, encouraging social learning. When uploading a micro lesson the author adds relevant tags so the content can be searched and accessed quickly. The application also has a function to allow learners to register and vote for what their interests are so educators can assess what content it would be most helpful to create.

Students discussed the concepts in groups, the features they liked/disliked and their feasibility, capturing ideas on sticky notes and voting for their favorite. Using a card sorting activity, we examined their favorite ways of accessing information in different time contexts (e.g. 5 minutes, 1 hour or >1 hour). The workshops were audio recorded, transcribed and thematic analysis was conducted as in the earlier phases. Data generated in the workshops was analyzed to understand the responses to, and engagement with, the design concepts and to derive considerations for the discussion of our work.

Figure 3: Co-design workshop with students

Phase 3 Findings

Curating and structuring information

Participants liked the tools which curated and structured information, allowing them to *"get information quick"* (S8). S11 commented: *"I remember some time ago back in clinic, I was looking at a client's folder…we weren't allowed to be looking on our phones as much…but if I had that app I'd just go in"*. Having the ability to search for particular topics was seen to have value: "*you're able to put all information that is related to a particular topic together to make it easier to access specific information"* (S3) so that they did not have to sift through masses of online information in order to find what they need in the short space of time they have to plan a session: *"I like the fact that it's structure based…Google gives so much information…once you go on finder it gives you exactly what you want"* (S2).

Rating for usefulness and Ghana appropriateness

Features which allow people to rate information (e.g. thumbs up or down and star rating) were popular as they were familiar: *"very familiar. Everyone everywhere knows what it means, the green, the red, the star…it's quick to read"* (S1), and help build a picture of information being accessed: *"apart from people going there to search and giving their thumbs up and thumbs down, it will give us an idea of the kind of conditions that are existing"* (S8). A feature to rate cultural appropriateness was popular to quickly identify if the information shared was relevant to them: *"I like it because of the relevance of cultural associations when it comes to the practice of SLT, because as with any language, the practice outside is different to what it is here…when I want to download an app, I look at the rating…the various comments that people have given to give me some sort of information as to what the information coming is about and how relevant it has"* (S4) and if it might be useful to apply in their context: *"I think it's something that would really help, because if I'm looking at the cultural context of it… something which is evidence-based and in Ghana"* (S11).

Important information comes from experts

A recurring theme was the importance they placed on information being provided by a competent or 'expert' SLT. Establishing trust in the information being provided via an online platform was seen to be important: *"it's work that's already been done by other people…who you don't know their competence level"* (S3). Seniority was seen to be particularly useful for enhancing trust: *"the info is coming from a specialist, someone who's trained in that field, then you know the information we are getting is more accurate and the person has practiced in that field for a long time so it cannot be Wikipedia information"* (S9). Although, some also saw the value in their peers sharing information: *"I think it's good getting information from your peers. Because sometimes your peers are able to explain certain concepts to you better than your teacher"* (S2). They felt it was important that once they graduated, they should be sharing learning content: *"I think it should be a compulsory activity for every Ghanaian SLT, because there's very little in terms of content from Ghana. So we all have responsibilities to act"* (S2).

Learning content for different timescales

The students had several different needs in relation to timescales. How quickly information could be accessed was important: *"I'm not getting any information and I'm waiting and then this patient is there. How long do I wait?"* (S4) and: *"it has to be shared by someone… how immediate do you get a response"* (S9). When they need to access information in 5 minutes, video was the preferred format: *"I think that in five minutes, you could watch a video and then have information about what you want to see"* (S1) and *"the visual element is really helpful for learning"* (S11) followed by infographics: *"we can get quick facts that we can easily read and lay our hands on when you want to prepare for a case or make an intervention"* (S6). Videos accompanied by a transcript were particularly helpful if the presenter had an accent. When participants had an hour or more, using a website rose in popularity as they can access different types of learning content: *"I prefer the internet, because… I can get the information. I can get videos from websites…I can read text from the website"* and: *"I prefer now to read more and… what people have written. More variety and then you can make lots of relations and associations"* (S2). However, there were issues with accessing web-based content in short timescales: *"connectivity is not reliable, if you've only got five minutes, you don't want to waste it trying to get onto a website, you'd much rather have a video you can automatically access"* (S3).

DISCUSSION

Through a set of engagements with participants who represented the majority of the SLT profession in Ghana, we have explored how a set of locally appropriate digital tools could enhance SLT training. Here we contribute insights into how digital tools could support social learning and the transition from student SLT through to independent practitioner and future clinical supervisor. We offer design recommendations for creating digital tools to enhance continuing professional development and to create an online Community of Practice.

Leveraging peer supported learning

Peer supported learning was identified as an important component of SLT training in Ghana; the students support each other practically and emotionally in a variety of ways, drawing upon their multi-disciplinary backgrounds to help one another navigate course content. They already share information and resources, largely via WhatsApp, but we identified a need to better structure this information. Future digital tools which improve the curation and access to this information would support the learning needs of the students and interns as they grow into independent professionals.

Peer supported learning is broadly studied in HCI in international contexts. Celine et al. describe self-organized learning environments (SOLEs) for social activism amongst young people across the globe [8]; similarly Mitra describes 'School in the Cloud', a creative online space where children from across the world gather to share knowledge and learn [31]. However, the extension of this work into SSA is limited [43]. The 'just-in-time' information requirements of the SLTs in Ghana, who will be using the digital resource in practice, also renders a need for content to be mobile. We can learn lessons from others who have looked at peer supported learning [20, 47] and Communities of Practice (CoP) in healthcare [6]. Studies have explored how mobile technologies can facilitate the acquisition of clinical skills including 'just-in-time' learning [9], support clinical placements in isolated placement settings [32] and be an effective education tool in rural South Africa supporting reflective practice, emotional support and belongingness [36].

Utilizing existing platform structures and practices

The participants' familiarity with apps was extremely limited and therefore we want to leverage what they already use. Reconceptualizing existing communication platforms helps to overcome many of the hurdles associated with attempts to migrate users onto new and unfamiliar platforms [24]. WhatsApp was popular for both communication and information sharing between all the participants. They liked to be able to share information simultaneously, with notifications straight to the phone, so that every person had access to shared content. We observed this was also reflective of their way of working offline, where educators were keen that students should all have the same experience.

HCI researchers have started to explore the use of WhatsApp for engagement and learning within a global context. One study looked at its use in a university programming course in Namibia and found undergraduate students used it to share learning resources and support each other with problem solving [34]. WhatsApp was also used in the 'What Futures' project to engage large numbers of geographically distributed participants across 5 countries in meaningful action, they found it was a low cost and effective engagement mechanism, where structured groups were created who produced information rich in multimedia artifacts [24]. The participants in our study indicated they would want to share a variety of multi-media content and access different content depending on time availability. An HCI study on engagement with health information found young people had preferred media formats, such as video, audio books and games [28]. Diversity in user preferences for different types of learning content is also found in Massive Open Online Courses (MOOCs) [25].

Quick and low-cost access to Ghana specific content

Any content would need to be easily accessible and inexpensive, as the participants do not have ready access to data. For future platforms to be accessible, they would also need to be relatively offline. An option to preview content and comment, so users can make decisions on whether to watch or not, would be helpful and could also help them feel more part of the community. Studies have shown that commenting mechanisms can be powerful elements for making sense of others' opinions on dynamic media [57] and an interactive commenting system on videos can help to increase the sense of community [12]. The participants had limited time to access content in clinic, so structuring it in a way that is simple to access specific content will also be vital. The use of metadata tagging is a reasonable way to do this (e.g. hashtags or keywords). Ghana appropriate tagging/ metadata was also seen by participants to be useful for increasing accessibility of context.

Scarce access to data/connectivity is a design constraint that will inform how the digital tools develop. The next stage of the research will identify which features can be taken forward into future designs and implemented in offline ways (or not) and identify the trade-offs in terms of functionality versus data accessibility. A challenge also remains around the SLT's dependency on personal data allowance for internet access when working outside the clinic.

CONCLUSION

Through this study we have offered an understanding of the challenges of educating the first generation of SLTs in Ghana. Using an iterative co-design process, we explored how digital tools could enhance SLT training and developed four design concepts. These were not intended to be finalized solutions, rather they served as a tool to facilitate discussion and identify the important features of digital tools to support SLT education and practice. There is great potential for creating an online CoP - a learning environment which scaffolds information and supports sharing and learning amongst trainee and experienced SLTs in Ghana and involves 'outsider' SLTs and specialists providing additional support. Future research is required to further scope the design space for this CoP, so that it responds to the identified needs of the SLT community in Ghana, the challenge of scarce access to data/connectivity and is developed in a way that it becomes scalable and self-supporting.

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