Mediating Access: How Visually-Impaired Users Leverage Collaborative Learning to Keep Up With Mobile Phone Innovations

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Abstract: We illustrate learning strategies used by visually impaired mobile phone users to support device information gathering and troubleshooting. Observing experiences of adult mobile users in Bangalore, India, we find that functional access and device familiarity is acquired through a range of digital and interpersonal consultations. We find that generic smartphones are increasingly becoming primary digital assistive devices due to their in-built accessibility features, yet the available information and user guides on these devices is biased towards sighted users. Consequently, device users rely on collaboratively learning from peers for general device familiarity and troubleshooting. We propose that collaborative learning will likely be a central to technology adoption and maintenance as artifacts and interfaces evolve constantly, forcing people for whose needs the devices may not have originally been designed, to learn and adapt constantly.

Keywords: accessibility, smartphones, India, collaboration, tech support, Android, iOS

Introduction

Much CSCL research has focused primarily on educational and learning issues of importance to advanced industrialized societies, often necessarily so because advanced technology has been available primarily in these contexts. Salient issues addressed by researchers have focused on higher-level skills in science and mathematics and on formal learning environments. This overall research agenda has been determined by institutional constraints, funding imperatives, and areas of national needs within the context of developed countries.

The "typical" context of consumer technology use, particularly mobile phones, is a moving target as smartphones fall in cost and come to be the expected norm for basic communications. A result of this has been widespread uptake of smartphones by populations for whom these devices were not originally designed – including people using the devices in atypical ways, such as through non-visual interfaces in the case of people with visual impairments. In recent years, smartphones have also seen rapid adoption in parts of the Global South — a term that recasts formerly used terms such as Third World and Developing Nations to refer to people living in poor nations as well as the poorer parts of wealthy, industrialized nations (Pagel, Ranke, Hempel & Köhler, 2014). Smartphone use in the Global South has however been different in a few ways from the typical "western" setting – first the devices tend to be lower-end, thus less processing power and memory, second, they run on narrower network bandwidth, impacting what is seen as the typical operating environment for these devices.

The differences in device environments have consequences for mobile users with visual impairments living in the Global South. Within the context of assistive technologies (AT), mobile phones have come to play a critical role even though these devices were not necessarily designed for this user population. Mobiles have allowed individuals to better control their communication environments, find and maintain networks, apply for jobs, and access news and entertainment. With ever evolving mobile phone ecologies, though, AT users have to constantly adapt to newer devices and interfaces. This can be problematic because people with visual impairments lack access to training and tech support for AT through much of the Global South for two reasons. First, the institutions through which people in the West get access to technological training, such as accessible public libraries or educational institutions, are not equipped to offer access to and training for AT. Second, the overall lack of awareness of AT among the general public through much of the Global South means that sighted friends, family and colleagues of people with disabilities have limited knowledge of AT and do not know how to help others learn. Consequently, people with visual impairments have to collaborate with each other to learn to use and manage their technology either through direct interactions and online resources.

Mainstream market-oriented consumer technology production has meant that accessibility has usually been an after-thought in the design process. Consequently, people with disabilities have traditionally relied on collaborating with each other to select, learn to use, and adapt new technologies, and circulate this knowledge within their own community. Smartphone use by people with visual impairments presents scenarios in which interface, hardware, and network elements present challenges outside the realm of sighted smartphone use on device use and management, necessitating consultative learning within the accessibility community.

Prior work and research objective

While seemingly novel within the context of current research efforts, analysis of non-industrialized settings has a significant lineage within research on learning. Starting with studies by Cole and Scribner (1981), Lave (1987), Saxe (1990), empirical findings from non-industrialized settings have significantly shaped learning sciences research. Ideas such as situated learning, legitimate peripheral participation, cognitive apprenticeship, and the integration of learning and everyday practices, as discussed for instance by Lave and Wenger (1991), have emerged primarily from ethnographic studies of non-industrialized communities (Lave, 1987). Yet, if we examine the impact of learning research or even attempts to design learning in non-industrialized settings, the outcome has been minimal (for exceptions see Evans et al., 2008; Kral & Heath, 2013). There seems to be either the implicit assumption that what is good for a the 'mainstream' early adopter is transferable to other settings, or that learning is so contextually bounded that it is not productive to even try to transfer lessons to settings different from those commonly found. This is further complicated when the learner population is at an intersection of marginalities, where informal settings may not only be the primary accessible mechanism for acquiring applicable skills but may also present a more potent mechanism, as illustrated by findings from the family math project (Martin, Goldman, & Jimenez, 2009).

People with disabilities often lack formal mechanisms of support, especially in our field site — India, which in turn means they need to rely on their individual and community resources. The motivation to learn how to use new technologies is high as personal technologies, such as mobile phones, offer the theoretical possibility of bypassing structural inequities faced by AT users and provide social and economic access. The challenges in adapting these technologies for non-sighted use has been well documented (Kane et al, 2011), and that despite people turning to their community for tech support, there is a dearth of learning support tools (Rodrigues et al, 2015). While there is much research on mobile accessibility, most work focuses on innovation and usability (Olivera 2011) little has focused on how visually-impaired users learn and continue to support their accessibility needs.

To this end, we present an exploratory empirical case study that pinpoints some of the specific areas of recurrent device use challenges on product information, hardware management, and interface usability for which people use various in-person and virtual consultative learning techniques. Most mainstream sources that have reference or learning material about mobile devices such as sellers or discussion sites have training guides, reviews, and specifications that primarily speak to the typical use cases. Moreover the flood of information through crowdsourced contributions make such sites difficult to scan quickly for performance information beyond basic accessibility features.

The range of devices available in the market, and their short shelf life on online sales platforms, and the constantly updating versions of mobile OS (especially Android) make evaluation of models and their performance hard to gauge. Whereas the old model of mobile AT, in which people with visual impairments used devices with separately installed software exclusively for sight-free interaction meant that the knowledge of the fairly stable software, rather than the hardware environment was key to managing devices, and the community had unique awareness and closed groups with expert users to help troubleshoot. The smartphone paradigm shifts the focus of accessibility management to the overall device and the app environment, increasing the need for ensuring appropriate knowledge filtering mechanisms to serve device learning and maintenance needs. In poorer parts of the world, the lack of public accessibility centers or educational institutions, coupled with the tendency of consumers to purchase inexpensive devices, further exacerbates technical challenges related to accessibility.

Field setting and methodology

The work presented here is a subset of a larger scale study (Pal, Viswanathan & Song 2016, Pal et al 2017) research conducted with 81 participants with visual impairments in Bangalore, India that included a survey administered in 2015. The survey, described in Table 1, was followed by in-depth semi-structured interviews with a subset of 26 respondents; interviews took place over two rounds till April 2016. A requirement for participation was that respondents had to own and use daily a mobile device with assistive technology, typically either a functioning screen-reader or magnification software.

We required that all respondents be working-age adults. Our sampled respondents ranged in age from 21 years to 61 years. We recruited survey respondents through snowballing, with original contact through disabled people's organizations (DPOs), and online accessibility groups. As we see in the sample description in Table 1, 55 individuals in the sample were male and 26 were female. This is partly due to the difficulty in accessing who own their AT, which can be expensive, and women with disabilities have lower access to employment or control over household finances. Our sample also over-represents college graduates compared to what is typical for persons with visual impairments in India

Roughly a third of respondents had some functional vision, but only 8 of the 81 sampled persons used magnification as their primary interface; the vast majority used some form of speech output. We collected data on whether respondents had lost sight early or late in life, since late vision loss typically means an individual did not go to educational institutions equipped to train individuals in the use of assistive technologies, and also is a factor in one's social contacts with other visually-impaired people. Past sighted experience using technology like computers can also indicate comfort with interfaces and a conceptual understanding of technical metaphor.

Table 1: Sample description of survey participants

Measures	Male (55)	Female (26)	Total (81)
Median Age	29 years	32 years	31 years
Low Vision (Moderate – Severe Vision Loss)	34.5%	30.8%	33.3%
Profound Vision Loss / No Sight Perception	65.5%	69.2%	66.7%
Late Vision Loss (after age 12)	25.5%	30.8%	27.2%
College Graduates	78.2%	88.5%	81.5%
Median Cost of Mobile Device	US$ 192	US$ 223	US$ 203
Median Years Using a Mobile Device	9.0	8.5	9.0
Median Years using a Smartphone	1.0	0.5	0.6
Smartphone Users	67.3%	80.8%	71.6%
Mobile Browser Users	63.6%	46.2%	58.0%
Mobile Social Media Users	69.1%	53.8%	64.2%

71.6% of respondents in our sample were smartphone users. The remainder used feature phones, which are not basic mobiles with simple call and text but rather have limited processing and browsing capability. These phones typically run on the Symbian platform. The median years of using a smartphone is less than 1 year for the sample — thus our data were collected at a point when many people were newly transitioning away from feature phones and starting up on the app space and a range of internet-based services.

Outcomes of the survey data relate to a series of issues around the use of various functionalities of mobile devices by people with visual impairments – which we have discussed extensively, particularly around issues with managing interactions on touchscreen devices (Pal, Viswanathan & Song 2016). Following the surveys, our qualitative research focused on themes that emerged out of the survey analysis. Interviews probed issues around technical barriers and support, technology adoption and transition, technology-related adjustments at workplaces, and the role of social networks in technology use.

All interviews were conducted in English, Tamil or Kannada and were transcribed verbatim. Following the transcriptions, we coded and analyzed the interviews for themes, and in this research we focus primarily on technical barriers and support. The purpose of this paper is not to use qualitative methods to highlight the frequency or types of technical barriers or support but rather to delve into a single pre-identified theme – technical challenges -- how these challenges manifest and how mobile users go about managing them.

Findings

Respondents reported different challenges depending on the devices they used. For feature phones, we found that problems tended to be related to management and stability of third-party software and TTS (text-to-speech) packages such as system crashes, and a smaller number of interface related challenges around keeping track of key commands, shortcuts and compatibility with online material. Challenges around the use of smartphones were relatively more device-centric including issues with system settings, hardware configurations, and cache management, but also interface concerns such as input, and app usability. We primarily focus here on the smartphone use challenges and strategies used to manage them.

Concern areas for smartphones

Product reviews

Respondents talked about needing reviews from within the VI community because the majority of product reviews online (when available in an accessible format) were written focusing on the sighted user experience, except in the cases of apps that were specifically designed for accessibility. Respondents posted questions, often through mailing lists or social media, about specific apps to learn from someone else within the community with first-hand experience before making a decision to purchase. Even within the VI community, the range of skill levels and device environments of users meant that product reviews needed nuanced explanation on initial set up, performance etc. We found that the notion of product reviews itself is relatively new since the past feature phone

environment that people upgraded from had fewer products to choose from, and the "review" was a consultation with an expert, usually a trainer at a non-profit working with people with disabilities, who provided input on device and software choices. The breadth of the smartphone device market meant that even experts knew little about individual device models and their performance

Hardware specifications

Related to product reviews, respondents noted challenges with assessing the appropriateness of hardware specifications for devices they planned to purchase. This was reported to be particularly true for Android-based smartphones, of which there is a wide range with distinct capabilities, as opposed to iOS devices, which have less variation between devices. In absence of the appropriate hardware requirements for certain functions, especially voice-based processing and output, a device may be accessible only in theory. The cyclical popularity of certain brands makes them attractive from a cost point-of-view, especially as specific telephony carriers offer deals on them. We found in our sample both globally significant brands such as the Samsung Galaxy and Moto G series phones, as well as less-expensive brands including Xiaomi, Micromax, and Asus phones. Respondents noted that the risk of picking up one of these brands was that they were newer, and it was harder to learn consultatively from people who had owned one for a long time. This was important to estimate performance on Bluetooth pairing, battery life over time using assistive technologies (which may take more power than typical sighted navigation), and built-in software such as file and music management, which also differ across devices.

Input management

Input management was a significant concern for smartphone users, especially those who were relatively new converts. There are multiple options — using external hardware, voice input with speech recognition, or virtual keyboard settings like drag-and-release input (in which a finger must roll over a virtual keyboard that reads out alphabet until the user comes to the right key, upon which the specific letter is recorded), double-tap (in which the finger taps twice on a virtual keypad when at the right letter). Unlike with sighted smartphone users, where switching from one mode of input to another is unlikely or unnecessary, non-sighted use involves trying out and sometimes switching even after one is a fairly adept user of a specific type of input. Other add-ons that work well for sighted users such as auto-complete typically get in the way during speech-based navigation.

Output management

Users reported issues with adding separate TTS packages (both for feature phones and smartphones) because these packages can be acquired separately from the in-built TTS to work with the existing screen-reading software. TTS management came up frequently in our interviews in part due to language issues particular to India. Users reported having Hindi, Kannada, or Tamil TTS (of which there were multiple options) which ran into problems with compatibility and quality of output, for which some technical consultation was necessary.

Bundled services

Devices with custom builds from a telephony service provider required users to acquaint themselves with the specific functional environment of devices that may differ from the standard flavor of Android. Such bundled software are typically part of productivity suites or push ads, these can lead to accessibility-related annoyances where users need to customize their AT or TTS speed, as the bundled settings came into effect with each reboot.

Strategies

Other than figuring out a device on one's own, there are two most used strategies that respondents report having used. The first is referring to non-profits that work with people with disabilities, and the second is talking to others in the community for technical help either directly or online. We found that respondents do not turn to the typical sources sighted people reach out to. Only 5 out of 81 respondents mentioned going to the showroom or to the device company's representative for assistance. Sighted users were sometimes contacted for smartphone problems, though this posed privacy problems as the device owner could not tell what the sighted intermediary was doing. Only one feature phone user (of 21) sought help from a sighted person for a major failure. In general, some form of discursive troubleshooting was the norm for both minor and major breakdowns and help scenarios.

In-person collaborative learning

For most respondents, the smartphone environment was seen as a game-changer in terms of the ability to do things, even if they faced challenges with adoption and use. Some respondents switched to smartphones willingly on counsel of friends and others did so as there was no longer a choice with feature phones being phased out of the market. Interviews frequently highlighted respondents' excitement about using technology.

> *In the beginning I did ignore my family for at least a couple of weeks when my attention was completely absorbed by the phone. I have always been excited by new technology, now that I am confident of using touch – I keep experimenting with new apps. And I am waiting for the upgrade to Android Marshmallow....it has made it possible for me to have continuous conversations with my friends.* (Female, 39 years)

Accessible mobile devices enable collaboration by making the participation in social networks easier. Social networks can be critical in learning about devices and making decisions on platforms and apps, but also in just casual browsing or conversations that are not specific to purchase moments, but add to one's familiarity with technology. Social networks can be critical for people who acquire a visual impairment late in life as there is generally little awareness of accessible technology in the mainstream media. Respondents discussed challenges getting good information on accessible technology through sighted friends, especially in the pre-smartphone era.

> *I don't have many friends in the VI community as I am a late blind person. My friends are mostly sighted... At the time I got this mobile, my major concern was accessibility. I'd heard from people that Android phones had a lot of constraints when it came to accessibility.* (Male, 39 years)

People who acquire visual impairments in later life may have familiarity with visual interfaces and better access to sighted intermediaries is helpful in mediated learning, but their lack of contact with other blind people reduces access to detailed first-person commentary or the option of deciding collaboratively on appropriate purchases. In the above case, purchasing the wrong Android, meant getting stuck with an unusable smartphone.

Even on platforms like iOS and Android where the accessibility features are easily available on anyone's smartphone, troubleshooting with sighted intermediaries is not always helpful, since people do not typically look up their own accessibility features when they don't use it themselves. The average workplace in India does not have a lot of people with vision impairments, further distancing the sighted mainstream from accessibility concerns. With this lack of public awareness and exclusion of accessibility from public institutions, the non-profit sector has played a central role in Bangalore's accessibility sphere. Respondents spoke of turning for accessibility consultation to non-profits that offered training for screen reader use on desktop devices. These organizations served as repositories of information and expertise on AT, both through institutional knowledge of training, and through pools of graduates who used AT. Non-profits were an important means of acquiring AT in the past since they had agreements with distributors to bundle AT software into a certain feature phone models and sell those at bulk prices (a result of which has been the popularity of the Nokia N series phones among respondents, which were offered in such bundles). However, the onset of smartphones has also meant that the AT acquisition has moved from institutional purchases to something negotiated directly by consumers.

Users now often turn to friends who they meet informally and tap into advice when encountering technical barriers. We found that social connections influenced decisions on devices as well as carrier networks, since in India there are no calling fees for in-network calling, so people keep multiple SIM cards which they top-up, but switch networks on data use as and when deals come by, since AT use can be data heavy.

> *Usability was a primary concern while transitioning. I still continued to use the regular keypad phone as my primary phone for some time even after I got the touch phone. I got another SIM card for my new phone and I was using this touch phone to browse the internet and practice navigation, while I learnt to use the touch phone ... I checked with my other friends to see how they were able to use their phones. ... I thought to myself, if they can do it so can I.* (Male, 31 years)

Smartphones can also play a role in making the assistive device more of an exchangeable, relatable device in respondents' domestic settings among sighted family members, because these were often platforms that others in the household knew (Android, iOS), as opposed to the older feature phones that worked with screen readers.

> *I learnt to use the (keypad) phone mostly all by myself. It was not so difficult to learn after understanding the basic key strokes. If at all there was any difficulty, I used to ask my friends who were also using Talks and got solutions to the problem [With the smart phone] I also had help from my mother…to understand different icons. Once I showed her all the different smiley emoticons and got her to describe them to me so I knew what they all looked like.* (Female, 29 years)

In this instance of collaborative learning, the mother helped with visual items and in the process got familiar with her daughter's phone. The initial experience of exploring the interface trained both newbies to smartphones use. Consequently, the daughter felt a sense of security that a trusted person was familiar with her technology environment, and knew what kinds of help her mother could offer, versus when she needed to consult a friend.

Online collaborative learning

The mobile purchase is invariably prefaced by some consultation. With feature phones these consultations were with friends or DPOs. Online question-asking and research was common for smartphone purchases, especially when these were made through Indian e-commerce sites, which make it harder to "try out" and return. This put the onus on buyers to research thoroughly before purchasing. But as we find with the quote below, price was still a major driving factor. Buying phones with poor processing power meant needing to make do with a cheap mobiles as a secondary device to a desktop device rather than a viable replacement for workplace activities.

> *I was looking for a phone in the Rs. 7000 (US$110) category only. At that time, this was one of the better options available... I did not get to check out the phone before buying it because it bought it from Flipkart... there is a lot of pressure about taking calls and assisting customers. I use two different ear phones, one for taking customer calls and the other for listening to JAWS on the computer. This is very challenging.* (Female, 35 years)

The two primary means of online and collaborative learning that emerged in discussions were threaded emails and social media. Threaded email lists emerged out of the DPOs which initially set these up for their members or extended community. Over time, these grew to be major "go to" places for consultation where people both posted specific questions, but also followed threads to listen in on what mobiles were recommended by others.

> *[When I have a problem] I would try my hand. I would use all my tools, when nothing happens only then will I go to Enable India. If Enable India is not able to help me or something then I will try asking Access India. It is a mailing list. Sometimes people out here, the visually challenged people over here in IBM, they themselves could be of help.* (Male, 30 years)

As we found with the respondent above, posting to mailing lists was done after exhausting first-person contacts. In part, this is driven by the social norms of an open online forum: Respondents were cagey about asking questions deemed too basic because a number of the mailing lists have a number of advanced users of mobile technology, and many conversations can be fairly technical.

The advent of Facebook and WhatsApp groups came up repeatedly in interviews as having impacted people's ability to get quick tech support. Mailing lists were inherited from the desktop era, and isolating a single email ID and sending questions to individual respondents rather than the entire group required some work. On social media, the easy addition of contacts (and their integration into platforms like iOS and Android) made asking questions to both the entire group and to individual members easier. Social media groups offered the option of collaborative learning where new technologies were reviewed and posted with replies or comments that allowed for natural threads of conversations and clarifications, which tended to be cumbersome on email.

> *Finding out about the gestures and learning to use them took some time. I also did not know the terminologies that were being used for using the touch phone. Learning the location of the icons and remembering their positions was a challenge ... I struggled very badly for the first 2 weeks at least. I used to keep checking online for tips to use Android phone. I came across a Facebook group for visually impaired Android users. Over there I saw a post for joining a WhatsApp group for visually impaired Android users. I applied to join the group and was added. This WhatsApp group changed my Android experience. There are some very advanced users who give tips on how to use Android phone with TalkBack.* (Male, 31)

The growth of WhatsApp in India within the mainstream population pushed the demand for Android devices among people who wanted to be included wile circumventing paying for SMS services, which are typically charged per message. WhatsApp was reported as accessible, including advanced features like creating or exiting groups. It also allowed users to easily put together their own sub-groups at their own levels of expertise for help.

We also found that collaborative learning was not necessarily shifting from email to social media, rather people used both simultaneously. Respondents participated in smaller groups with more intimate questions and posted general device queries on larger, open mailing lists such as the "eyes-free" group on Google (a resource for Android users) and the Daisy Forum, a group that started with discussions on document formats but moved to general technology assistance. These groups have evolved to a role of answering high-level generic questions of relevance to the entire VI community such as commentary on new OS developments or device in the market, policy issues, and reviews of major products or apps.

Discussion

No learning strategy operates exclusively online or face-to-face; the two have morphed in form over time and operate in tandem. Gaining technological fluency in particular has now become a continuous process in which both online and offline networks and information access play a crucial role (Barron & Kafai, 2006). Our study, first and foremost, foregrounds the complexity of learning about new devices and applications for users of AT and illustrates how these users are able to leverage their "learning ecology" to gain fluency (Barron, 2004). Their ecology consists of other users who face similar challenge, non-profits that work with users of AT, and a larger online community to which they have access, and depending on prior fluency as well as the change in technology, different resources are leveraged for learning.

For initial interface learning with both feature phones and smartphones, we find a consistent pattern of consultation with others in the community, but with the key difference that non-profits have traditionally been more involved in training with feature phones. The feature phone environment bears an important similarity to the desktop screen reader learning environment in which understanding the basic operational framework requires structured learning of the basics, thus many respondents reported taking orientation classes. Beyond basic operations, shortcuts and workarounds are critical to effective use, which makes consultations with human contacts an important source of tips and tricks. The "closed" nature of feature phones with AT, that only people with visual impairments use them, makes the community the sole source of almost all learning resources.

Unlike with feature phones, which for at least a few users were the first interaction with screen reading, all respondents who had moved to smartphones had some prior experience using feature phones with screen-reading software. While there were a few training classes for Android run by the same non-profits that offered screen-reader training, most respondents reported no formal training, despite significant misgivings about the basic interface. Here, the one-on-one consultations with friends and colleagues were reported as helpful because the challenge with touchscreen-based smartphone interfaces is getting over the initial shock of having no tactile feedback. We find a mix of excitement alongside apprehension for people deciding to make the switch. Such an environment is arguably well suited for collaborative learning because users are intrinsically motivated and their concerns are best managed through the homophily effect of helping their colleagues learn to use the devices. We find thus a combination of collaborative information-gathering online during the information gathering phase (i.e. experiences of other visually impaired users posting publicly about their transitions to smartphone use) and collaborative informal learning with friends and colleagues after one acquires the device (i.e. first hand tutorial sessions or consultations with other smartphone users).

We also find that learning issues vary by stage. Early learning issues differ from some of the longer-term challenges. On hardware management in particular, we found that users received significant amounts of conflicting information about challenges with certain devices because of battery and storage issues that often did not emerge until several months after starting to use the devices. Mailing lists are a source of high-level information on devices, but mainly cover the major, widely used devices. Lists can be inadequate for the more relevant specifications information that is needed at the time of purchasing a device. Thus knowing one should buy a Moto smartphone is potentially harmful information because a low-configuration (E series, for instance) would appear to work well initially but soon run out of memory and battery with the relatively power-hungry accessibility apps. Information on such devices would also be directly misleading when looking at reviews on online shopping sites such as Amazon or Flipkart, because these would be high ratings assuming sighted use.

Respondents reported developing preferences on input techniques such as drag-and-release in conversations with friends rather than through online interactions. An online interaction was to post a high-level query on a mailing list or WhatsApp about a device or interface followed by a request for anyone willing to answer questions to contact off-list. We found more willingness among people to ask direct questions about phone models, and smartphone apps, bundled services, or questions about TTS packages on lists, but less willingness to discuss troubleshooting issues like input or output management. The reasons for these distinctions in question-posing behavior are likely related to community norms – mailing lists are widely used for skill-agnostic questions such as reviews or generic questions around interface use that have significance for the user experience of the community at large, rather than very specific individual troubleshooting issues.

Conclusions and implications

Accessibility work will likely constantly have to play catch-up with the emerging landscape of interactive experiences. Some of the problems faced by the participants in this research are unique to Global South settings due to income and institutional barriers. However, issues around hardware specifications for new devices and product reviews in the app space are problems that are true for people who need to use accessibility features on a regular basis across geographies. This study also has implications for our understanding of collaborative learning, much of which has focused on children or on workplace learning, where drivers of learning typically include concurrent groups that work toward a goal, at least a loosely understood one. The changing nature of assistive

technologies from an older model where generic devices were given additional adaptive capabilities to make them accessible, to a new environment where mainstream smartphones have inbuilt accessibility capabilities brings people with visual impairments closer to the sighted mainstream on one hand, but also creates new challenges for their learning environments. In this study we have shown how access is mediated through human and digital resources for access, and that for the users of accessible technology, the real challenges lie in building learning strategies to confront an ever-evolving technology environment. Collaboration and communication, it appears thus far, will be a central need for success.

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