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Abstract

Minority language communities lack access to educational technology that facilitates literacy skill building. The approach currently taken by most educational game app developers privileges widely spoken languages and often requires intensive resource investment. In response, a new game app was designed to provide easily localized, pedagogically appropriate games for literacy skill building. Scalability to multiple minority languages was possible through a programming design based on language packs that could be compiled by local implementation teams without specialized technical skills and without significant resource investment. We describe the scalability issues encountered when localizing the app for the initial ten minority language pilot groups and how a language-neutral app design that relies on language packs to specify language-specific content and parameters can adequately address these issues. When it comes to meeting the demands of growing education technology markets in underserved Indigenous and minority communities, localizing an app initially designed for maximum scalability is more feasible than investing significant resources converting apps custom designed for one language into new languages.

Introduction

Educational Apps around the World

The sight of a child with eyes glued to a chiming cell phone, tapping and swiping the screen is part of the everyday tableau of the 21st century. Although concerns about negative effects of prolonged screen time persist, parents often bend limits for games with educational value. That educational value has been validated by multiple studies (Griffiths et al.; 2020; Xie et al., 2018). Educators also recognize potential benefits of “gamification” and want to leverage the motivating effects of games in educational contexts (An, 2020). The global reach of educational game apps is expanding every year (mEducation Alliance, 2020).

Educators and development workers have focused on creating apps for English and other dominant world languages. A multi-country study on the use of apps for literacy intervention in at-risk populations in Ethiopia, Uganda, India, South Africa and rural United States was able to offer participants a package of 70 educational apps in English (Breazeal et al., 2016). However, resources developed in English or other widely spoken world

languages cannot serve the entire world. *Localizability* (how feasible it is to customize a resource for a new local context and language) and *scalability* (how easily a system can adapt to handle growth) are foundational to the educational technology discussions in development work circles.

Educators are capitalizing on the growing availability of mobile devices, even in remote regions. Schools and families can often obtain smartphones or tablets for about one-tenth the cost computers, and mobile devices can be more suitable than computers in environments with unreliable electricity, high heat, humidity, or dusty conditions. In many of these emerging markets, people speak one of the world's approximately 7,000 minority languages. There is a growing need for quality educational apps that serve minority language speakers and support home language literacy initiatives, efforts which are often foundational in meeting development goals in multilingual contexts (Trudell et al., 2016). Children and schools are not the only potential users of literacy apps. In UNESCO's strategy recommendations to foster quality and inclusive lifelong learning for all, they stress the need for literacy promotion to serve diverse, multilingual populations and to foster literacy skill-building for youth and adults (especially women) outside formal school environments (UNESCO, 2014).

In this article, we survey the current languages served by award-winning educational app providers, and the paucity of interactive educational apps for Indigenous languages in Latin America. Then, we outline the features that would make game apps for minority language literacy most effective for three typical learner profiles. We describe a viable prototype of a maximally scalable literacy game app, Alpha Tiles. We describe the problems encountered and solutions proposed while localizing the app in ten pilot projects for minority language communities in Mexico, Thailand, Myanmar, Vanuatu, and Romania. Based on the demonstrated flexibility of Alpha Tiles in localization, we recommend others pursue a similar language-neutral app design, aiming for scalability through customized language packs that make localizations highly feasible.

Developing a Maximally Scalable App

The programmer documented the current focus of educational app developers on widely spoken languages. He consulted with literacy specialists to understand the typical learner profiles and needs of minority language users. He surveyed the available apps for Indigenous languages of Latin America and evaluated their shortcomings for literacy skill-building. Then he created and informally field tested a scalable app designed to address the accessibility and pedagogical issues that were noted.

Educational Apps around the World

In the realm of educational app production, developers often invest significant resources creating a customized literacy app for one language at a time. Since 74% of the people on earth speak one of the world's 100 most-spoken languages, it is logical to allocate significant resources to serving communities with millions of potential users. Table 1 shows the progress that award-winning digital education sponsors have made localizing their products in multiple languages. The languages are ranked in tiers based on the global number of speakers. Table 1 makes it clear that most developers are focusing their efforts on the top 100 languages.

Table 1. Survey of Languages Served by Award-Winning Educational Apps

| Digital product (Sponsor/Developer) | Tier 1 (1-10) | Tier 2 (11-50) | Tier 3 (51-100) | Tier 4 (101-200) | Tier 5 (201-500) |
|--|--|---|---|---|---------------------------|
| Chimple (Chimple Learning) | English | | Swahili | | |
| Akili Series (Ubongo) | English Portuguese | French | Swahili | | |
| Antura & the Letters (Video Games without Borders) | Arabic English Portuguese* Spanish* | French Pashto* | Dari* | | |
| onecourse (onebillion) | English | French* | Swahili | Chichewa | |
| Grapho Games (Learning Intelligence Group and University of Jyväskylä) | English Mandarin Portuguese Spanish | French Indonesian | Dutch Swahili | Afrikaans Chichewa Norwegian Finnish | |
| Kit Kit School (Enuma) | English Spanish* | | Swahili | | Rohingya |
| Feed the Monster (Curious Learning) | Arabic Bengali English Hindi Portuguese Spanish | French Hausa Igbo Iranian Persian Javanese Marathi Pashto Turkish Ukrainian Vietnamese Yoruba Indonesian | Kinyarwanda Nepali Northern Kurdish Oromo Somali South Azerbaijani Swahili Tagalog Thai Zulu | Afrikaans Chichewa Ganda Georgian Haitian Creole Northern Sotho Setswana Shona Southern Sotho Tajik Tsonga Xhosa | Ndebele Swati Venda |

*denotes a project in development at the time of the survey.

There is tension between providing a quality product and providing a realistically localizable, scalable product because of the high resource demands associated with quality in developed countries. For example, onebillion

was a joint winner with Enuma of the 2019 Global Learning X Prize, \$15,000 USD grant to develop a modular app program to teach literacy and numeracy. The onebillion website indicates an intent to be scalable to any language. However, each localization requires an expert description of the language and culture, 160 translated stories, a bank of 185,000 words, culturally appropriate professional illustrations, trained local staff to create and test learning units, and trained native speaker recording artists to professionally produce 32,000 audio files. The relatively small number of speakers the app would potentially serve in minority language communities understandably does not make the investment worthwhile for an organization that is trying to reach one billion children.

Learner Profiles and Needs in Minority Communities

The 100 most widely spoken languages represent only 1.4% of the languages on earth. For the 2 billion people who speak one of approximately 7,000 minority languages, learning to read in their home language provides new opportunities within their own community and can be a gateway to higher levels of bilingualism, education, and economic advancement. Research consistently shows that home language literacy initiatives in early grades scaffold the learning of a national language of instruction and significantly impact educational success for minority language speakers (Lim et al., 2018). To effectively address “learning poverty,” the World Bank unequivocally acknowledges that countries with many linguistic minorities need learning and teaching materials for each language (World Bank, 2019). Yet there is not a single literacy app currently available in thousands of these minority languages.

Without outside assistance, it falls to local educators to make customized minority language apps for the community. Some developers assume that simply making educational software open source is the key component that will equalize access to digital educational resources. However, we are unaware of any examples of minority language communities adapting an open source project to make an educational app in Latin America. Researchers working with English-speaking college students noted that even when students have specialized programming skills, there are significant barriers to getting involved in open source projects (Morgan & Jensen, 2014). Since the local workers involved in minority language app production are not usually trained in programming or literacy acquisition, they often rely on online app builders. These app builders may be ill-equipped to handle their language’s use of special symbols, tone marking, or stacking diacritics. App builders designed for Roman scripts may not function well with the non-Roman scripts of Asia, which introduce different challenges to literacy education and publishing (Kosonen et al., 2007). Furthermore, app builders generally offer limited options for creating interactive content or games.

An effective minority language literacy app ideally addresses the needs of the following learner profiles: young children who speak a minority language at home but are formally schooled in a majority language; older children, adolescents, and adults who are bilingual and literate in the majority language of education but not their home language; and adults who are monolingual in the minority language and not literate in any language. Often minority language speaking children struggle with initial literacy skill acquisition because instruction and reading materials are in a language they do not comprehend well. Initial literacy instruction in their home

language enhances their emerging reading and language acquisition in the majority language of formal instruction. Individuals who are already literate in the language of education often need explicit instruction and practice to transfer their literacy skills to reading their home language, which may have a more complex orthography, additional graphemes, or different sound-symbol relationships compared to the majority language. In the fall of 2020, the programmer surveyed the 159 non-religious apps available on the Google Play Store for minority languages of the Spanish-speaking countries of Latin America. The inventory revealed the paucity of quality resources available, and many apps fell into several categories that do not serve minority language learner profiles well. Some apps are designed for “heritage learners” who want to learn vocabulary in a minority language spoken by their parents or grandparents. The user interface presumes fluency in a majority language and they focus on language acquisition, not literacy acquisition. Some apps intend to teach minority language speakers to read but fail to offer appropriately scaffolded learning progression for learners who lack basic literacy skills. For example, an app may start with a passive recognition activity that shows a picture and the spelling of the word that labels the picture. With no interactive practice learning to read or spell, the next activity shows the picture and asks the user to spell the word from memory or asks the user to complete a reading-based quiz. Ideally, literacy apps provide significant amounts of guided step-by-step practice between initial exposure to sounds and symbols and active reading or production of correctly written words. Effective literacy games help learners build on what they already know as they develop skills incrementally, and they enlist learners as active participants at each stage of skill-building (Lin et al., 2018, p. 14). Some apps are clearly designed for young children and are less appealing to older children or adults. Also, some apps like Feed the Monster are designed so that a user cannot skip levels and must begin with very basic sound-symbol relationships and letter discrimination activities. Although these are pedagogically appropriate for the beginning stages of literacy development in preschool age children, they are not appropriate for a youth or adult who is literate in a majority language and seeking to become literate in their home language.

As shown in Table 2, for the 553 living minority languages of Latin America, only 159 non-religious apps serving 70 languages were found in the Google Play Store in September 2020. Of those apps, 113 offered only a passive experience, typically a digitized dictionary or picture vocabulary, where user interaction is limited to tapping on a word or image to listen to an audio file. Forty-six apps offered a game or interactive user experience. Within those 46 apps there were 58 different activities. These activities included true/false and multiple-choice quizzes, drag and drop activities, hangman, memory, and bingo. Six apps included some type of spelling activity, but not a single app had a scaffolded series of activities that developed the progression of skills needed to move incrementally from letter discrimination to sound-symbol relationships to word recognition and decoding to spelling production.

Table 2. Non-Religious Apps in Latin American Minority Languages

| Total apps available for 553 minority languages of Latin America | Total languages served | Apps that offer interactive elements | Apps with spelling activities | Apps with scaffolded literacy skill-building activities |
|--|------------------------|--------------------------------------|-------------------------------|---|
| 159 | 70 | 46 | 6 | 0 |

App to Meet Minority Language Literacy Needs

These observations raised the question of whether it would be possible to design a basic game app architecture that would be easily scalable to multiple minority languages and still meet the need for interactive games that progress in a pedagogically sound way from basic letter recognition activities to more complex decoding and spelling tasks. It would have to be easily populated with a particular language's word list, image files, and audio files and be able to handle the challenges of a wide range of orthographies. There was also the question of whether local implementation teams could be equipped (with minimal support) to independently provide the necessary customized language packs, even in contexts that could not invest significant amounts of time or money in the production of local media files.

The first step was to design a set of games, Alpha Tiles. In a systematic review of literature on the effectiveness of educational apps and young children, researchers noted that children learn best from engaging, interactive activities that are appropriately scaffolded and provide repeated and varied practice of foundational skills. Interactive apps can provide these beneficial learning experiences when they are well-designed (Griffiths et al., 2020). The skill progression activities in Alpha Tiles were developed in consultation with literacy specialists with experience working in unrelated minority languages in different regions of the world. The collection of nine basic games, comprising 21 levels of challenge, attempts to meet the initial literacy skill-building needs of the three learner profiles described above by providing tasks that test letter recognition, sound-symbol relationships, basic decoding, and beginning spelling.

Although certainly less ambitious and comprehensive than many of the award-winning literacy apps surveyed above, multiple features of Alpha Tiles make it much better suited for the learner profiles found in minority language communities than what is currently available based on the survey of Latin American minority language apps.

- Games progress in a pedagogically sound way from symbol recognition to word recognition to spelling production, and can be used to develop either initial literacy or transfer literacy skills. Of the six component skills required for fluent reading, the games address at least three; phonological awareness, decoding, and word recognition. Depending on the scope of the word list provided by the implementation team, it may also enhance vocabulary knowledge (Lin et al., 2018).
- A user can start playing anywhere in the game series. It is not necessary to master a beginning level to unlock more advanced levels. This allows users to gauge their own learning needs and do what they find challenging and interesting. Users with basic literacy in a majority language may skip the initial games designed to introduce letters and sounds and proceed to the games that will improve their reading and spelling.
- The user interface is completely icon-based and does not use any text. Avoiding a majority language interface allows illiterate or monolingual users to interact on the same footing as literate and/or bilingual users. Avoiding minority language interface spares the implementation teams the burden of translating interface text in order to customize the app and makes it more easily scalable.

- Games are designed with “discoverable interaction mechanics” (Curious Learning, 2020). Users receive clear feedback when they have succeeded or failed through audio cues and color changes, which promotes intuitive learning of how the game works through curious play. Since no explicit instructions are required, implementation teams do not have to translate game instructions.
- Since a family or classroom learning group might share the same phone or tablet, users select avatars to track individual mastery of games and overall scores. Once a game has been successfully played twelve times, a star is awarded. Users also collect a total score of “gems” by playing games correctly. Up to twelve unique avatars are available on a single device and progress under each avatar is tracked by the app and remembered for subsequent playing sessions.
- Games are designed to appeal to both children and adults. Play is based on simple taps, not precise or complicated finger maneuvers. This eliminates frustration that might arise in young children with less developed psychomotor skills or in older users who lack experience with digital devices and video games and may have lost manual dexterity with age (Lin et al., 2018).

Language-Neutral App Design and Language Packs

The app’s programming infrastructure is language neutral and pulls localized language content from language packs provided by a local implementation team. The programming infrastructure is based on symbol tiles (letters, digraphs, syllables, etc.) defined by each local implementation team in their language pack. Language packs contain a word bank of 100-200 words and data files that specify a language-specific tile inventory, distractor tiles, keyboard, and other setting decisions made by the team. The language pack also contains a set of image files and audio files that correspond with the word list. The Alpha Tiles word parser uses the list of tiles to segment the provided words into tiles for game play. The team determines what constitutes pedagogically important units for literacy in their language when specifying the tile inventory. This allows for maximum localizability in minority languages with complex orthographies (e.g., tone markers, stacking diacritics, or symbols not found on majority language keyboards) and non-Roman scripts.

To streamline the process of checking the language packs to make sure the files provided are formatted correctly and meet the necessary criteria for the app to function correctly, the programmer created a validator. The validator reviews and confirms folder and file hierarchy, folder and file names, internal file consistency and file-to-file mapping. It also provides warnings about excessively long words (poorly suited for early literacy games), and flags potential problems like tiles that are not found in word-initial position in any word on the word list.

Case Study: Using Filters and Language Packs for Localization

Ten local implementation teams provided feedback during the development of Alpha Tiles. The languages included in this pilot project were Amoltepec Mixtec of Mexico, Central Pame of Mexico, Eastern Lawa of Thailand, Kayan of Myanmar, Kayaw of Myanmar, Maskelynes of Vanuatu, Mitla Zapotec of Mexico, San Pedro Quiatoni Zapotec of Mexico, Teocuitlapa Me’phaa of Mexico, and Vlach Romani of Romania. Four of the languages require tone or accent marking, two have stacking diacritics, and Eastern Lawa uses a non-Roman

(Thai) script. Working through problems that arose demonstrated that a significant amount of flexibility can be built into the program. Given the great diversity of scripts, orthographies, and ideal learning progressions, there are certainly limits to how scalable a single program design can be for every minority language that exists. However, the following examples represent certain language-specific issues that the app design was able to accommodate.

Sequence Ambiguity

In Kayan, some letter sequences were ambiguous to the word parser. For example, the sequence <a>, <n> should be taught as a single tile <an> in the word *hwaban* but as two separate tiles <a> and <n> in the word *pană*. This is analogous to the <p>, <h> sequence in the English words *phone* and *haphazard*, where in the first case <ph> represents a digraph for /f/, and in the second case <p> and <h> are separate consonants. Solution: To derive the tile output <p><a><n><ă> - and not the tile output <p><an><ă>, the word *pană* is entered in the word list as {pa.nă}. The period now instructs the word parser to insert a syllable break and parse the ambiguous sequences into the correct tiles, and it strips the period out before displaying the word.

Multi-Function Symbols

In Teocuitlapa Me'phaa, some symbols have multiple functions in the orthography. The symbol <n> represents a consonant, but it also indicates the preceding vowel is nasal. When assembling the game tiles list, the implementation team was initially asked to label each tile on the list as 'consonant,' 'vowel,' or 'other.' Labeling the <n> as 'consonant' caused the word parser to misinterpret all instances when the <n> appeared as a nasal marker. Labeling the <n> as 'other' excluded the consonant <n> from all the games that select for consonants. Solution: In the game tiles list, the letter is entered normally for the more common function and labeled a consonant. For the less common function (nasal marker) it is entered surrounded by parentheses and labeled other. Parentheses are also added around <n> used as a nasal marker in the word list. The word parser now uses the parentheses to correctly identify the function of the letter and strips the parentheses before displaying the word. Teams can now choose different distractor tiles for each function and the two <n> tiles are taught as different sounds with appropriate example words in the introductory games.

Few Tiles that Occur in Initial Position

In Kayan, Eastern Lawa, San Pedro Quiatoni Zapotec, Mitla Zapotec, Maskelynes, and Central Pame, most of the tiles do not occur in the word-initial position. As a result, the first game did not function well, because it introduced only those tiles that occurred in word-initial position. Over 60% of the tiles were not introduced in some languages. Solution: A new file in the language pack, the settings file, was added that allows implementation teams to define language-specific default parameters for games. For game 1, setting 1 will only introduce tiles that occur in word-initial position, setting 2 introduces all tiles in the inventory and selects words with the featured tile in any position if it does not find a word in which the tile occurs initially, and setting 3 introduces all tiles and selects from all words with the featured tile, regardless of its position.

Short Words and Long Words

In Kayaw, there are a small number of nouns composed of only one tile, and many nouns composed of two or three tiles. Games such as word search require a minimum of two tiles to allow a first and second unique tap, and some games are based on filling in a missing tile to make a word, which works better with words of a longer tile length than one or two. In Vlax Romani, nouns composed of ten or more tiles are common. Longer words may have to wrap to be displayed on a cell phone screen, which is not ideal for beginning readers. Longer words would also never be selected by certain games because of built-in limits (e.g. maximum 7 tiles for the word search game). Solution: The programmer added filters specific to each game to ensure that only words of a specified minimum tile length are selected from the word list for that game. Filters were also added that allow the maximum word length to be adjusted from its default setting. The validator now generates a report about the word lengths of the submitted list and creates a recommendation to encourage an ample inventory of shorter or longer words if they are lacking.

Game Ordering

Implementation teams did not agree with the preset order of games. Vowel discrimination games are challenging for languages like Kayan and Kayaw, because they have many vowel tiles. Whole word discrimination games are challenging for languages like Amoltepec Mixtec with its longer words and for San Pedro Quiatoni Zapotec, which has a very low diversity of tiles occurring in the initial tile position. Solution: A new file is now part of the language pack that includes a default games sequence which can be edited to adjust the order or delete games or challenge levels that are not wanted for a specific language.

Additional Issues Raised by Teams

It was not possible to address all the difficulties and suggestions by using a simple programming adjustment or filter, but the following improvements are planned and under development in response to the initial feedback. First, the existing validator is useful for programmers but lacks a user-friendly interface for teams to use independently. The programmer is developing Alpha Tiles Assistant, a small, easy-to-install program that will guide the implementation team through language pack preparation. It will allow teams to run validation checks locally and work through a checklist of tasks or edits without the programmer's direct involvement. Second, some literacy consultants thought that implementation teams should select an order of instruction for predefined groups of tiles, so students could master tiles in sets instead of being introduced to the entire tile inventory all at once in the earliest games. This would allow implementation teams to begin instruction with the highest frequency letters or the most straightforward sound-symbol relationships, and then progress to lower frequency or more difficult letters. We are planning a feature that allows implementation teams to designate the tiles to different instructional blocks, and filters will be added to control which blocks are activated for that game or challenge level. More challenge levels of some games will be added to incrementally introduce blocks of tiles until the entire tile inventory is activated. Additionally, a more basic introductory game that introduces letters and their associated sound is being developed. A game to help learners of tonal languages practice perceiving

and marking tone differences is planned. Third, teams have requested built-in reporting capabilities so that teachers or parents can generate progress reports or track time spent practicing on a specific avatar. This would also facilitate future studies on the efficacy of the games in improving literacy skills, which may help communities procure funding for home language literacy initiatives. Fourth, several pilot teams indicated that children and families preferred to play the games together in a cooperative group instead of as individuals. Literacy apps are typically designed for individual play, something that may not be a good fit in cultures where learning is most often done in groups. Designing exclusively for individual play also fails to capitalize on the ways collaborative play enhances children's engagement in touchscreen learning (Wohlwend, 2015). Non-expert peers can provide beneficial scaffolding to support each other's emerging literacy skills when they play literacy game apps in groups (Kulju & Mäkinen, 2019). One feature of Alpha Tiles that already supports collaborative play is that advancement after a correct response is displayed is not automatic, it requires an additional screen tap. This allows more time for onlookers to ponder the answer entered by the person operating the device, and it allows time for peers to explain to one another why an answer was correct (Kulju & Makinen, 2019, p. 20). The programmer is considering additional ways that games could be optimized for potential group use, and the possibility of incorporating some multiplayer functions that would allow players to take turns cooperating on the same device towards a shared goal.

Discussion

For a product to be scalable to minority language communities, developers need to find a middle road between an approach to localization like the one taken by onebillion (where the developers spend significant amounts of time and money working with local teams to produce customized content) and an approach that publishes open source code and expects communities to do their own localization. As seen in Table 1, Curious Learning leads the way in successfully scaling Feed the Monster to multiple language communities, including some minority language communities. Granted, the scope of what children can learn from Feed the Monster (letters and sounds) is much narrower than the ambitious aims of onecourse (fluent reading), but that is also instructive. Full-fledged literacy programs require copious amounts of leveled, age-appropriate reading material, and in many minority languages this literature inventory does not (yet) exist. For example, the Global Book Alliance reported in 2016 that in Malawi, the Tumbuka and Yao language communities each had over 2 million speakers, but fewer than 20 book titles were available in either language (World Bank, 2019). However, given that children who learn basic decoding skills in their home language are much better positioned to acquire fluency and literacy in a national language of education, there are good reasons to develop apps that introduce beginning literacy skills in minority languages, even if the minority community lacks a full-fledged literacy program or the body of literature needed to support one. When children develop positive attitudes toward reading because they sufficiently understand the language they are learning to read, those positive attitudes and behaviors can transfer to the school setting where their comprehension of a national language may be more limited and frustration levels may be higher (Klaas, 2016). Learning apps that promote the practice of home language decoding and spelling skills have been shown to improve overall student literacy scores when compared to control groups that only received classroom instruction (Jere-Folotiya et al., 2014).

If app developers make heavy demands on the local implementation teams to produce or collect vast quantities of high-quality content themselves (e.g., expertly translated texts, large inventories of words, professional grade recordings, custom images, etc.), the demands will be prohibitive in many minority language communities. If app developers spend considerable time designing custom single-language apps for one community at a time, they will be limited in how many communities they can serve. Taking cues from Curious Learning's successful approach, the scalability of Alpha Tiles is maximized by a program design that relies on customized language packs provided by a local implementation team. Preparing a word bank of 100-200 words and the accompanying image and audio files for the language packs does not require significant resource investment from the community, yet they can be produced locally with minimal involvement of the app developer. Local teams did need to be equipped to prepare the language packs in a standardized way. Alpha Tiles implementation teams were provided with access to online guides and Google slide presentations about how to prepare the necessary files. Training videos in English and Spanish were offered to demonstrate techniques like trimming and normalizing audio files and resizing and cropping image files to create the appropriately standardized file sets. Technical support was offered via email or video conference in English or Spanish. We found that with such support, local teams with basic computer skills could be trained to do the file preparation and media editing required. No programming skills or prior media production experience was necessary to compile the language packs.

This language pack approach to localization has several benefits. Since the word lists are created by the implementation team and not translated, literacy workers are able to address language-specific literacy issues. For example, they can choose words that are not too long for beginners, words that follow typical spelling rules, and words that have initial sounds that are as representative as possible of the tile inventory. Image files are also provided by the implementation team, allowing for culturally appropriate and locally relevant images. If images are pre-selected for an app, it can be problematic. Culturally universal images are often not possible (e.g., a "house" or a "mother" look different depending on where someone lives). Delegating the selection of images to the local teams also allows them to make decisions about the pros and cons of photos versus clip-art images. While local photography (jpg files) may often be the most culturally appropriate, it may be difficult to collect local images or to obtain the appropriate permissions and copyrights. Photo files also make the app size much larger, which can be an issue in areas of the world where many of the devices used are several versions behind what is currently available in majority world markets in terms of RAM and storage. Clip art icons (png files) may be a better choice, since they are easier to obtain, it is easier to manage permissions, they keep the app size smaller, and they may be more appealing to children. Allowing local teams to make these decisions ensures more sensitivity to the local context and results in a better literacy product than simply translating material with preset images.

Conclusion

As digital technology extends its reach and minority communities in remote areas gain access to mobile devices and the internet, literacy and development workers need access to the opportunities educational apps offer for school-based and home language literacy initiatives. Alpha Tiles attempts to meet the needs of the typical

learner profile of this demographic. It provides a prototype for a literacy skill-building game app that can address some of the unique issues posed by minority language orthographies. Producing the language packs needed for a localized version does not place unrealistic demands on the local implementation teams or the app developer, which promotes scalability. As localization issues are addressed by making the programming more flexible and adding options to define language-specific parameters in the language packs, the game app becomes even more scalable. With more collaboration on designing scalable apps, minority communities will not be left behind as app developers and educators strive to make screen time as valuable as possible for children and adults in educationally underserved areas of the world.

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