Mobile applications for Indigenous language learning: Literature review and app survey

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This paper investigates mobile applications (apps) intended to support Indigenous language revitalization efforts in Canada and the mainland United States. It examines the role that apps may play in language revitalization movements beginning with a literature review which focuses on the benefits and drawbacks of apps as a medium for Indigenous language learning. This paper continues with a review of 32 apps, discussing examples of different pedagogical strategies and trends seen across Indigenous language apps. The community-driven app development process is examined, including funding sources, the role of development companies, and the level of input and recognition of community members. This paper concludes with a discussion synthesizing the findings of the app review in the context of the best practices and challenges identified during the literature review process. The original research conducted during the app review, and the analysis of these findings in light of the literature review, aims to make a contribution to the currently small body of literature focussed specifically on apps for Indigenous language learning.
Keywords: Indigenous; mobile applications; language revitalization

1 Introduction

Mobile applications (apps) are an increasingly mainstream tool for language learning. As smartphones become the go-to internet-capable device, new apps are emerging to support a wide range of daily activities, including educational and cultural learning. Despite the recent proliferation of apps for Indigenous language learning, literature on the topic is scarce. Literature on adjacent topics, such as mobile devices as sites for language learning, and the implications of making Indigenous cultural content available online, offer some background when examining the specific topic of apps for Indigenous language learning. Both the literature review and the app review found that pedagogical effects of apps are difficult to assess, but the enthusiasm and linguistic pride generated around these apps have highly positive implications for language revitalization movements. Delivering Indigenous language learning content through the app format presents technological and social challenges; however, based on user reviews and comments, apps bring many benefits. Apps are emerging as a promising tool for language revitalization and maintenance movements that are encouraging Indigenous language use in daily life.

2 Methodology

This paper is a synthesis of a literature review and original research regarding the nature, use and creation of mobile applications for Indigenous languages in Canada and the mainland United States.

2.1 Concurrent literature review and app review

The literature review surveyed existing studies on mobile apps for language learning and mobile apps in Indigenous contexts. The app review involved a primary source investigation of available apps, intended to contribute to the currently small body of literature focused specifically on mobile apps for learning Indigenous languages. The goal was to illustrate the landscape of mobile apps, recognize trends, and identify the strengths and shortcomings of these resources in terms of app content and approaches to app development.

Apps were investigated first hand for content and design. In order to analyse the user experience, various features of the apps, such as games and quizzes, were used as intended for learners. Customer reviews of the apps on the Apple and Google Play stores were also examined. Research was conducted regarding prominent Indigenous language app developers, profiled in section 4. The process of discovering and selecting apps for inclusion in the app review was multifaceted. Apps mentioned in the literature were included, as were apps associated with each of the Indigenous app developers. Apps were also discovered through news stories and in the Apple and Google Play stores' "more by this developer" and "you may also like" feeds. It is worth noting that all apps examined in this study are referenced with their current version number since apps are often updated and may change in the future.

These two phases, the literature review and the app review, were conducted concurrently and informed each other. The advantages and challenges of using mobile apps for Indigenous language learning identified during the literature review were considered when examining the apps, and the trends noticed during the app review prompted further investigations into the literature. The findings from these two phases are synthesized in the discussion section.

2.2 Inclusion/exclusion criteria for app review

The app review considered apps that include Indigenous language content, either written or spoken, and that were created by or in partnership with Indigenous communities in North America. The app review was limited to apps available from the Apple App store for iPhone or Google Play store for Android devices. Apps solely available for tablets, web-browsers or TVs were excluded from this review. As such, educational apps for tablets, often intended for use in schools, are outside the scope of this paper. Web-apps are also outside the scope as they present advantages and challenges which are distinct from those offered by mobile apps. For example, web apps require a constant high-speed internet connection, unlike mobile apps which can be downloaded once and then used offline.

The app review specifically targeted apps that include some level of user engagement. For example, *Ojibway TV*, an app created by Ogoki Learning

Systems, consists of original content in the Ojibway language and is marketed as 'Netflix for Ojibway' (Pauls, 2017). As this app is not available for mobile devices and does not have an interactive element, it was outside the scope of this study.

This app review was limited to publicly available apps and therefore did not consider apps which have been made private to a community. Additionally, the app review considered only apps that are available for download for free. Some Indigenous language learning apps charge a small fee for download and such apps were excluded from the review.

3 Literature Review

There is a lack of literature focused specifically on mobile applications for Indigenous language learning; most of the literature concerns the use of mobile devices for language learning of majority languages. Some of the factors affecting majority language learning are relevant to Indigenous language learning while others, such as learner's motivations and issues of cultural context, may not be. Accordingly, literature related to majority language learning will be discussed here for its relevant points but will not be assumed to be entirely applicable to the Indigenous language learning context.

Additionally, much of the literature is focused on the learner's perceptions of mobile-based learning, rather than on measurable learning outcomes. For example, a study on the use of mobile augmented reality tools for Indigenous language learning in Mexico relied on surveys asking participants about the tools' perceived usefulness and ease of use, and their intention to use similar tools in the future (Bojórquez, Villegas, Sáchez, García-Alcaraz, & Vara, 2016). This method of assessment does not provide clear data regarding the pedagogical effectiveness of the app in terms of improving linguistic proficiency, unlike assessment using standard language tests. However, results of a qualitative nature are relevant to Indigenous language revitalization initiatives because a large component of revitalization involves generating enthusiasm and prestige around language use rather than achieving purely pedagogical outcomes (Lo Bianco, 2018).

3.1 General findings

The literature describes many unique advantages that mobile apps offer for language learning in general, and for Indigenous language learning in particular. Mobile apps for language learning are portable, economically accessible, suited to independent study, customizable, and fun for the learner. According to the literature, these characteristics provide unique learning benefits that may be particularly well suited to Indigenous language learning contexts. Section 3.2 describes these unique benefits.

The literature regarding using mobile apps and other technological tools for Indigenous language learning in particular identifies some specific concerns and challenges surrounding the use of mobile apps within Indigenous language revitalization contexts. Some challenges, such as rapid technological obsolescence, is an issue for mobile apps in general but may be particularly difficult for Indigenous communities due to funding reliant on one-time grants.

Other concerns identified in the literature, such as issues regarding maintaining cultural ownership when linguistic and cultural content is incorporated into a commercially produced software product, specifically affect mobile apps within the Indigenous language revitalization context. These challenges and concerns are described in sections 3.3 and 3.4.

In general, the literature identifies a unique role that mobile apps can play in Indigenous language revitalization movements: they allow self-directed learning in the absence of a teacher or proficient speaker and they can be used however and whenever the learner chooses, which allows them to be easily integrated into a busy leaner's life.

3.2 Advantages of mobile apps for language learning

Mobile devices are uniquely positioned as a language learning tool. They offer portability, context sensitivity in that mobile tools can adapt to the user's current location and time, and individuality in that devices are customizable to a user's needs (Miangah & Nezarat, 2012). These attributes allow mobile apps to help "fill in the gaps" left by traditional teaching methods such as language classes and textbooks. The unique traits of mobile apps can offer economic accessibility, a reduction of language anxiety, self-determination and language prestige for Indigenous languages.

3.2.1 Portability

One of the most prominent benefits of mobile apps is portability, which facilitates the exploitation of the users' free time (Miangah & Nezarat, 2012). Mobile devices "[increase] learners' capability to physically move their own learning environment with them" (Ogata & Yano, 2003, p. 2). Mobile devices afford ubiquitous learning (Park, 2011). Learning on a mobile app is not confined to a classroom; it may take place on transit, in waiting rooms, and during other gaps in the learner's day. The main challenge for adult language learners is the lack of time for dedicated language learning (McIvor, 2012). Since Indigenous languages are generally being learned for personal reasons, as opposed to academic or professional reasons, learners of Indigenous languages may have more difficulty than other language learners in finding time to devote to their learning (McIvor, 2012). Miangah and Nezarat (2012) consider mobile-assisted language learning to be an "ideal solution to language learning barriers in terms of time and place" (p. 315).

In many parts of the world, members of Indigenous communities whose traditional way of life has been disturbed by the dominant culture are forced to emigrate from their traditional territories in search of economic opportunities (Ovide, 2013). This trend is reflected in Canada where Indigenous peoples are increasingly moving off reserve and into urban centres (McIvor, 2012). Urban shift poses challenges for language revitalization efforts, due to a lack of access to other speakers and therefore decreased opportunities for creating domains of use (McIvor 2012). Mobile device-based language learning offers advantages for these Indigenous language communities with diasporas (Koole, 2018). Unlike many traditional language learning strategies, the use of mobile apps is

not restricted to those who live in close proximity to other members of their Indigenous language speech community.

3.2.2 Reduction of Language Anxiety

Grimshaw and Cardoso (2018) found that using mobile apps collaboratively can reduce language-related anxiety regarding pronunciation or fear of being "wrong". Their study looked at the pedagogical benefits of a mobile game which prompted computer-mediated oral exchanges between players in the target language. One learner reported "It's more easy to speak to other people when I see the screen" (p. 167).

Many language learning apps offer a quiz component (see Yamózho Kúé Society, 2015, Binasii Inc., 2018, and Gabriel Dumont Institute, 2015, for examples). Feedback tools of this nature allow learners to make mistakes in private, rather than being corrected by a teacher or an Elder. This feedback can increase a learner's comfort level and allow them to eventually speak in conversation with greater confidence (Begay, 2013).

Mobile apps can also foster linguistic connections within the home and family. Begay (2013) describes how *Navajo Toddler*, an app designed to teach Navajo to young children, allows the whole family to get involved in language learning. Using the app, parents who themselves do not speak Navajo are able to introduce their children to the language and learn it together (Begay, 2013). Learning together builds linguistic confidence by giving learners the space to make mistakes together, and relieving learners of the pressure to produce "correct" speech.

3.2.3 Economic Accessibility

Unlike language classes or traditional study materials, mobile apps offer the advantage of economic accessibility in that learners often already own the learning tool (Stockwell, 2010). Mobile devices are increasingly becoming users' primary or sole technological device: in 2018, 77% of American adults owned a smartphone while 73% owned a laptop or desktop computer (Pew Research Center, 2018). Since most learners already own a smartphone, there is usually no cost to the learner in acquiring and using a language app with the exception of some apps that require a small purchase fee.

Mobile apps are also well-suited to Indigenous language learning by virtue of their offline usability (Koole, 2018). Many Indigenous communities in Canada are geographically remote, and homes in these areas may not have high speed internet connections or may experience slow service or frequent service interruptions. Internet connectivity fees in Canada are among the world's most expensive (Koole, 2018). Mobile apps circumvent this economic barrier by allowing learners to update their applications and data when they have sufficient internet access and continue learning offline without an internet connection (Koole, 2018).

3.2.4 Self Determination

Creation of a mobile app allows a community to independently develop a language curriculum, without the governmental constraints which would be

imposed on curricula taught in schools. The contents of an app, the methodology of the app's development, and the participation in the app, such as who contributes to its creation and who can use it after its creation, can all be autonomously decided by the community (Ovide & García-Peñalvo, 2016). Learning resources that work for one Indigenous group may not necessarily be effective for another group (Koole, 2018). Mobile apps are a way for a community to develop pedagogical tools appropriate to their own cultural context (Koole, 2018).

Mobile apps also empower individuals to take charge of their learning by making the shift from teacher-led to student-led learning (Miangah & Nezarat, 2012). Language apps are often the only tool available to an individual who wants to learn a language but does not have access to traditional learning resources, such as language classes or textbooks (Begay, 2013).

3.2.5 Fun and Language Prestige

Another advantage of mobile apps is the novelty and "fun" associated with them. The development of new Indigenous language learning apps is often publicized in the media (see Karstens-Smith, 2018, Maratos, 2018, and Patton, 2018) which increases awareness about language revitalization efforts. Attitudes towards mobile-based learning is generally highly positive: 82% of participants in Viberg and Grönlund's 2013 study agreed or strongly agreed that they "will, or already do, benefit from the use of mobiles in their [language] learning" (p. 175). Grimshaw and Cardoso (2018) found that students who used a mobile game to practice English, the target language, reported that the game was "more fun than English class" (p. 170). Regardless of whether the "fun" component actually translates into increased learning outcomes, the visibility and enthusiasm generated by a mobile app can increase the prestige of learning the language.

3.3 Disadvantages of mobile apps for language learning

Mobile apps are not the solution to reversing language shift; rather, they can serve as one tool among many in a language revitalization effort. According to Mark Turin, former chair of the First Nations and Endangered Languages Program at the University of British Columbia (University of British Columbia, n.d.), "tools and technology don't save language — speakers do" (Turin, as cited by Karstens-Smith, 2018). Like any tool, mobile apps have their drawbacks, specifically rapid obsolescence, intra-community conflict, and pedagogical limitations.

3.3.1 Rapid Obsolescence

The rapid pace of technological change is a major challenge for any technology-based community initiative. This challenge was apparent during the literature review process; since the nature of mobile apps has evolved so rapidly, literature from as little as ten years ago may now be out of date.

Apps, like other software products, are published in periodically updated versions. For this reason, the app version numbers and publication dates for the apps examined in this paper are included in the references. In order

to use an app, users must have a device whose version is compatible with the current version of the app. This compatibility issue puts pressure on individuals, who may face economic challenges in maintaining an up-to-date device (Koole, 2018), and puts pressure on communities to continually update their app so that it is compatible with new devices.

Developers of Indigenous language apps use this continual update process to fix bugs, respond to user criticism and requests, expand existing features, and add new features (e.g. see the version history for *Ojibway* (Ogoki Learning Systems Inc., 2017a)). This process can allow the app developer to respond to the needs of the community and tailor the learning tool to the requirements of the users. However, continual updating can prove unfeasible for apps funded by one-time grants or other non-renewable funding sources.

If the required maintenance is not done, apps may eventually be removed from the Apple and Google Play stores. Apple reviews apps on an ongoing basis and removes outdated apps (Apple, 2019). The removal of an app from the app store signifies a major loss, as the development of a language app requires considerable effort, labour, and funding from a community. Challenges of maintenance are compounded by the need to support apps on two platforms: both Android and iPhone. Resource and code maintenance can become expensive and time-consuming when two divergent projects must be managed simultaneously (Rivera, Tesoriero, & Gallud, 2018).

3.3.2 Intra-community Conflict

Begay (2013) analysed the public comments left on Indigenous language learning apps in the Apple app store and found that reception of the apps by members of the community was mixed. One comment on the *Speak Navajo* app questioned its value, stating "real Navajos teach their kids Navajo, not some stupid app" (Begay, 2013, p. 73). Creation of an app also necessitates decisions regarding spelling, orthography, pronunciation, and the nature of the app's content. Begay found that many users were critical of the pronunciation and spelling used by the apps. Thornton Media, the largest Indigenous language app developer, tries to mitigate these issues through a thorough proofreading process with community members (Thornton Media, n.d.a), however many of these spelling and pronunciation conflicts may arise not from "mistakes" but from dialectal differences. Begay also stresses the importance of thorough community review of app content during the development process, as several users of the *Speak Navajo* app commented their disapproval that the app included content that was inappropriate for children, such as translations for "alcohol" and "cigarette" (Begay, 2013, p. 71).

3.3.3 Pedagogical Limitations

Mobile apps can be seamlessly integrated into the learner's life, using a device they already own. This offers the benefit of convenience, though the disadvantage of possible lack of focus. Stockwell (2008) found that learners may be more easily distracted from their language learning tasks when using a mobile device. The learners reported that they "couldn't get into study mode" while using a mobile device (Stockwell, 2008, p. 260). Notifications and other interruptions on a smartphone could disrupt a language learning activity. This

"noise" characteristic of mobile learning — its entanglement with personal activities — makes evaluation of its pedagogical outcomes difficult (Park, 2011).

Ahmed (2016) found that Duolingo, a popular mobile language learning app, is more effective for beginners than for advanced learners and this finding may generalize to Indigenous language learning apps. Grimshaw and Cardoso (2018) also found that while mobile gameplay helped learners to speak the target language together by reducing their linguistic anxiety, it was not clear whether this benefit extended to the classroom environment after use of the mobile game was completed.

3.4 Cultural considerations

Mobile apps facilitate access to learning materials on an as-needed basis (Koole, 2009). For example, in an Indigenous context, learners can use an app to look up relevant words during cultural activities. Koole (2009) suggests that learning in response to authentic cultural and environmental cues in this way may enhance encoding and recall of the material.

Mobile apps have the advantage of context sensitivity in that their use can be determined by the current location and time (Miangah, 2012). This offers the potential for communities to develop apps that are geographically rooted to reflect the connection between Indigenous languages and the land. For example, mobile augmented reality systems can use GPS features to deliver content based on the user's location (Bojorquez et al., 2016). Ogato and Yano (2003) describe a computer-supported ubiquitous learning system for English and Japanese language learning which delivers vocabulary relevant to the users' current GPS location.

Bojorquez et al. (2016) found that cultural relevance was of high importance when developing a mobile tool for Indigenous language learning. Effective Indigenous language learning apps combine cultural themes with language acquisition (Begay, 2013). However, inclusion of cultural material in mobile apps must be done in a conscientious way. Koole (2018) suggests that a committee of Elders should determine processes for recording, storage, and distribution of cultural information. Elders and other community members must be involved in the mobile app development process to ensure that the nature of the material shared is culturally appropriate (Koole, 2018).

App development initiatives must also take care to ensure that the community does not inadvertently cede ownership of cultural property. As defined by the United Nation's Principles and Guidelines for the Protection and Heritage of the Rights of Indigenous Peoples, cultural property includes stories, prayers, and audio recordings of linguistic material such as speech and songs (Daes, 1995), all of which are often included in language apps. Thornton Media (n.d.b) warns that when a software company produces an app containing such material, the company may argue that the recordings are "part of the software" and therefore are owned by the company. Ownership of cultural property must be safeguarded during the app development process; Belarde-Lewis (2011) stresses that loss of ownership of cultural property is a violation of tribal sovereignty.

3.5 The role of a successful indigenous language learning mobile app

Mobile apps are not the solution to language shift and will not on their own create proficient speakers (Ahmed, 2016). However, mobile app projects developed through thorough community consultation can form one part of a successful language revitalization effort.

The unique technological attributes of mobile devices provide certain pedagogical affordances (Park, 2011); the learning that takes place on mobile apps is spontaneous, informal, personalized, and ubiquitous (Miagah & Nazarat, 2012). These characteristics make mobile apps well-suited to the family home as a site of learning, which may be particularly appropriate to the Indigenous language revitalization context. A user of *Navajo Toddler* reported "My kids use it just about every day. It warms my heart to hear my daughter describe something like an apple in her native tongue" (Begay, 2013, p. 76). Mobile apps allow spontaneous, independently motivated learning without access to a language teacher or native speaker, which can bring the language into a home even when the parents are not speakers. Mobile apps also generate enthusiasm and interest in the language. Learners consider apps more "fun" than traditional language homework (Ahmed, 2016; Grimshaw & Cardoso, 2018).

The general consensus from the literature is that the purpose of mobile apps is not to replace traditional language teaching. Rather, they serve as a convenient supplement for independent and motivated learners. Mobile apps provide a learning opportunity free from geographic, temporal, and economic constraints. They offer a judgement-free experience to increase learner confidence. A learner in Grimshaw and Cardoso's (2018) study found that the language learning mobile game helped to "open their mouths" to the language.

4 App review

The main goal of the app review is to summarize the current landscape of apps and app development in Indigenous Language movements. The goal is not to create criteria for assessing Indigenous language apps, but to survey available apps. This review examines a wide range of language apps from a number of different communities and developers to identify trends in terms of app type, app content, and approaches to app development.

4.1 General findings

Many different styles of apps are available, reflecting a variety of goals and approaches. Some apps focus on one specific goal or learning strategy, while others offer a wide range of different activities, including stories and games. Most Indigenous language apps offer a combination of dictionary functionality, common phrases, vocabulary practice, games, quizzes, and cultural content. Table 1 shows the distribution of different components across the 32 apps reviewed in this study.

Table 1: Components in reviewed apps

Component	Count of total reviewed	Total reviewed
Total Apps Reviewed	32	100
Credits	28	88
Audio	26	81
Vocabulary Categories	19	59
Phrases	18	56
Dictionary	13	41
Vocabulary Search	13	41
Games	11	34
Quiz	11	34
Pronunciation	9	28
Story	8	25
Voice Playback	5	16
Bookmark Function	4	13
Prayer	2	6

Story apps often feature one or more traditional Indigenous stories accompanied by illustrations. These apps may show an English translation alongside Indigenous text (e.g. *First Nations Storybook - Bush Cree* (Aglaia Software Inc., 2018)), and may include a read-along feature with an accompanying Indigenous language audio track (e.g. *Puktewit* (Mi'kmaw Kina'matnewey, 2015)). Story apps seem to be developed with the twofold goal of teaching traditional stories and strengthening language skills. Since these apps do not teach vocabulary or grammar, they appear to be intended for an audience with an existing level of linguistic proficiency.

While many apps include a game as a subcomponent, there are some apps that solely consist of a game. Some game apps interactively introduce vocabulary while delivering cultural content (e.g. *Nitap* (Ni'gweg Collective, 2018)), while others gamify more traditional language learning strategies such as flashcards (e.g. *Opaskwayak Cree Match Game* (Binasii Inc., 2017a)).

Most apps offer a wider range of language learning resources. Often, they include a vocabulary section organized by category, such as animals or body parts (e.g. *Tłı̨chǫ Intro* (Yamózho Kúé Society, 2015)). There is variety in how the meaning of the Indigenous words are explained: some apps have accompanying illustrations only (e.g. *Long Plain Word Quest* (Binasii Inc., 2018a)), while most include the English translation as text, often in addition to an illustration. Many apps also offer a vocabulary quiz feature or a dictionary component. The former quizzes the users on vocabulary items taught by the app, while the latter is characterized by a search feature to facilitate dictionary lookup. These dictionaries may be fully bilingual in that they can be searched in both English and the Indigenous language (e.g. *SENCOTEN* (First People's Heritage Language and Culture Council, 2017)), while others are one-directional, allowing search in English only (e.g. *L'nui'suti* (Mi'kmaw Kina'matnewey, 2017a)).

Many language apps also include varying degrees of cultural content. Some apps incorporate cultural content into the language learning activities by including prayer (e.g. *Long Plain Word Quest* (Binasii Inc., 2018a)), songs (e.g. *Navajo Toddler* (Shortman, 2015)) and traditional stories (e.g. *Wowkwis aq Ka'qaquj* (Mi'kmaw Kina'matnewey, 2018)). Other apps feature a distinct section with English text describing the culture and history of the peoples who speak that language (e.g. *L'nui'suti* (Mi'kmaw Kina'matnewey, 2017a)).

A common feature of many apps is a credits section acknowledging the Elders and other contributors to the app, including those whose voices appear in the recordings. These credits vary in detail: some apps list every contributing individual including Elders and members of the technical development team (e.g. *Opaskwayak Cree Language Dictionary* (Binasii Inc., 2017a)); some include a culturally relevant dedication (e.g. *Tlicho Intro* (Yamózho Kúé Society, 2015)); some include information about the Indigenous organizations involved (e.g. *Long Plain Ojibway Dictionary* (Binasii Inc., 2017b); some include biographical details about the speakers whose voices appear on the app (e.g. *Ojibway* (Ogoki Learning Systems Inc., 2017a)); and others contain no credits at all (e.g. *Secwepemc* (First People's Cultural Council, 2018)).

While developing language apps, app developers and community partners strive to maintain cultural sensitivity (Exchange District Biz, 2017). The wide variety of Indigenous language learning apps available reflect the variety of goals within language revitalization and language maintenance movements, from building linguistic proficiency to strengthening cultural connection. Each group that creates their own app includes components, such as a reference dictionary, story, quiz or prayer, as they feel is relevant or important to their community.

4.2 Software development

A variety of different groups, including small cultural organizations (e.g. Wikwemikong Heritage Organization, 2017), larger Indigenous organizations (e.g. Mi'kmaw Kina'matnewey, 2015), educational institutes (e.g. Gabriel Dumont Institute, 2015), and Indigenous nations (e.g. Galton, 2016) have created Indigenous language learning apps. Many apps include a credits section acknowledging individuals who were involved. This sometimes includes recognition of granting organizations, however not all apps make their funding information available so there is not a clear picture of all funding sources. Those that make funding information available tend to have been funded by a combination of government grants.

Much of the funding comes from government agencies which include the federal government (Mi'kmaw Kina'matnewey, 2015; Gabriel Dumont Institute, 2015), the provincial government (e.g. Government of the Northwest Territories contributed to *Tłı̨chǫ Intro* (Yamózho Kúé Society, 2015)) and Indigenous bands (e.g. Timiskaming First Nation contributed to *Anishinabe Translator V2* (Galton, 2016)). Other sources include post-secondary institutions (e.g. University of Saskatchewan contributed to *Michif Lessons* (Gabriel Dumont Institute, 2015)), and the Canada Council for the Arts (e.g. *Nitap* (Ni'gweg Collective, 2018)).

Indigenous language apps incorporate a variety of tools that are useful for a learner and maintain cultural sensitivities (Exchange District Biz, 2017).

Communities may make their own app or utilize a company which specializes in such processes. There are three prominent companies that specialize in Indigenous language apps: Thornton Media, Ogoki Learning Systems, and Binasii. Combined, these companies have published a majority of the popular Indigenous Language apps available in the Android and Apple app stores. Each of them has developed or expanded the way that Indigenous language apps are being used, developed, and recognized by communities, language learners and academics.

As shown in Table 2, the majority of the 32 apps reviewed in this study were made in partnership with one of these three specialized companies.

Table 2: Developers of reviewed apps

Developer Category	Count of total reviewed	Total reviewed
Binasii	9	28
Ogoki Learning Systems	6	19
Thornton Media	6	19
Community member(s)	3	9
Other	7	22

4.2.1 Thornton Media

Thornton Media's president, Don Thornton, is Cherokee (Thornton Media Inc., n.d.b). Thornton states in a *Native Gaming* article "... Thornton Media, [is] the only language tool company in the world devoted to indigenous people" (Thornton, 2009, p. 29). This suggests that they paved the way for the Indigenous Language app format to be increasingly utilized as a learning tool.

Most Thornton Media language apps follow a defined template. Their apps seem to focus on improving linguistic proficiency, consisting of both reference and vocabulary learning components. The visual layout and design are similar across apps using their code. Some examples are *Tłı̨chǫ Intro* (Yamózho Kúé Society, 2015), *Denesųłı̨né* (Thornton Media Inc., 2018d) and *Speak Cayuga* (Thornton Media Inc., 2018e). The company ensures that communities retain ownership of their language and cultural property. They also allow communities to use their own Apple developers accounts if they wish, and allow limited distribution if requested (Thornton Media Inc., n.d.b).

4.2.2 Ogoki Learning Systems

Ogoki Learning Systems (Ogoki) is a Canadian Indigenous-run company (Ogoki Learning Systems, n.d.). Since 2011, they have developed language learning apps for various Indigenous communities and their respective languages (Dadigan, 2013). The company was founded by Ojibwe father, Darrick Baxter, who designed an app, *Ojibway* (Ogoki Learning Systems Inc., 2017a), to support his 12-year old daughter in learning her language (Baxter, 2014).

Baxter says, "I wanted every parent to experience that magical moment when their child is speaking their native language" (Baxter, as cited in Halstead, 2015, para. 7). To this end, Baxter made the impactful decision to release

Ojibway's modifiable source code for public download (Milburn & Baxter, 2012).

Community groups creating their own apps have thus had the benefit of the source code being an accessible resource to use as a template. Open source sharing of this app's code is of benefit in many ways. Baxter hopes to remove financial barriers to app development and inspire members of Indigenous communities to learn how to code (Vega & Walter, 2016). Ogoki estimates that they have created 150 apps in the App Store (Ogoki Learning, 2018). However, as of January 2019, significantly fewer apps by Ogoki Learning Systems and Ogoki Learning Inc. are publicly available for download in the Apple App Store and Google Play Store. These are not limited to language apps but extend to wider community initiatives (see *Mille Lacs Tribal Police* (Ogoki learning Inc., 2016)). Many of the 150 apps the Ogoki website refers to may have been published under another developer's license, may no longer be available, or may be private to community members.

Publicly available language learning apps created by and posted under Ogoki include but are not limited to *Garden Hill* (Ogoki Learning Systems Inc., 2017c), *Hupa Language App* (Ogoki Learning Systems Inc., 2018b) and *Sandy Bay Ojibway* (Ogoki Learning Systems Inc., 2017b).

4.2.3 Binasii

Binasii is a Canadian Indigenous owned and run company (Binasii Inc., n.d.a). Beginning as an organization focused on training community members to use computer software, they branched out and began app development in 2017 (Daniels, 2017). Now, Binasii conducts media work ranging from branding to web design to virtual reality (Daniels, 2017).

Binasii, like Ogoki, built themselves into a recognized company specializing in Indigenous language app development based on a single request for a language reference tool (Exchange District Biz, 2017). After being asked for a Cree-English dictionary app, Binasii produced *Opaskwayak Cree Dictionary* and an accompanying language game app, *Opaskwayak Cree Match Game* (Daniels, 2017). Binasii often produces two or more apps for single languages, such has Saysi Dene (Binasii Inc., 2017d; Binasii, 2018b), Long Plain Ojibway (Binasii Inc., 2017b; Binasii Inc., 2017c) and Dakota (Binasii Inc., 2018c; Binasii Inc., 2018d). This format allows for increased usability, as it delivers manageable amounts of information to the learner at a time. This also enables the apps to span a wide range of linguistic and cultural contexts.

4.3 *Three exemplary apps*

In this section, three apps will be described in detail. These are just three of many high-quality Indigenous language apps and are by no means the only apps worthy of special attention. However, they each have unique qualities that make them strong examples in terms of their contributions to language revitalization and language maintenance. *Long Plain Ojibway Dictionary* is an example of a strong reference app due to its advanced search features and structure. *Speak Oneida - Part 1* is distinguished by its comprehensive learning modules organized according to grammatical function. *L'nui'suti* is notable for its

inclusion of thorough and relevant information about cultural and linguistic history.

4.3.1 Long Plain Ojibway Dictionary

While some language apps include focused lessons, *Long Plain Ojibway Dictionary* (Binasii Inc., 2017b) is primarily a reference tool. The app contains a bilingual Ojibway-English dictionary, wherein users can search for translations by typing either the English or the Ojibway text. It also offers vocabulary in a category format, allowing users to discover words pertaining to a certain context. Each word entry is viewable in its own 'page' with the Ojibway text, English gloss, and Ojibway audio. Some of the categories place words within various contexts, such as questions, greetings, statements and commands. As a reference app, it supports users in utilizing Oneida vocabulary to varying degrees, either providing them with words or full sentences.

One user commented "Perfect app to teach not only myself the language but my child will benefit" (Myran, 2018). *Long Plain Ojibway Dictionary* is beneficial both as a reference material for speakers and as a self-study tool for language learners.

4.3.2 Speak Oneida - Part 1

Speak Oneida - Part 1 (Thornton Media Inc., 2018b), published by Thornton Media, is the first in a two-part series of quality pedagogical language apps. It is a multifaceted app with a reference component, cultural stories, vocabulary, and grammar modules. *Part 2* is an extension of *Part 1* and offers a more advanced level of linguistic content for learners. *Part 1* is available through both the Apple and Google play stores, making it more accessible than *Part 2,* which is only available through the Apple App store. This profile describes *Part 1* only.

The cultural section includes images, video and audio with the latter accompanied by Oneida language subtitles. The *Images* section displays photos of crafts, historical events, and newly built schools. The video featured in the *Cultural Notes* section is 'A Brief History' narrated by Loretta Metoxen, an Oneida Tribal historian. Cultural audio features songs such as *;lahʌtéshu* ('leader dance'). These are each accompanied by Oneida lyrics and the English translation.

The *Reference* section includes a searchable dictionary of words. Each word is matched with their grammatical components, Oneida text and English gloss, along with their respective audio.

The language learning resources in this app are grammatically focused. The first module in the *Categories* section is titled *Vowels & Consonants*. This module teaches users how to make the sounds represented in the Oneida orthography by using references to similar English words. This is followed by a module about the use of diacritics and unfamiliar consonant clusters which include /tsy/, /tsi/ and /tshy/, /sy/. The second set of modules focuses on identifiers such as pronouns, greetings and clan references. Once the learner has been taught how to make sounds in the language and some basic morphology, they are introduced to basic nouns and verbs. Modules build on each other adding various person and plural markers.

There are three sections within the modules. One section is for learning the new vocabulary, the second is a game to reinforce learning, and the third is a quiz. The *Learning* section consists of a set list of words linked to their entries in the reference section. The tools available include audio recording for the users, audio playback, an audio replay button, and the option to hide the English glosses. The *Games* section offers a 4-square game, where the user listens to an audio clip of a word or phonetic description and chooses the best photo to match. The *Quizzes* section includes listening, reading, view a picture, and self-assessing your own recorded speech. Each quiz has easy, medium and hard levels.

Speak Oneida's modules dedicated to phonetics and grammar give users a strong foundation for learning their language. The inclusion of morphological structure and the focus on verbs and inflected nouns make this app a valuable pedagogical tool well suited to the structure of the language it teaches.

4.3.3 L'nui'suti

L'nui'suti (Mi'kmaw Kina'matnewey, 2017a) is a Mik'maw language app intended as an introduction for beginners (Mi'kmaw Kina'matnewey, 2017c). It was made by Mi'kmaw Kina'matnewey, an organization which advocates for educational and language rights and for Mi'kmaw people (Mi'kmaw Kina'matnewey, n.d.). It includes vocabulary items organized by category and a search function for these words, which is searchable only by their English gloss. It also includes a pronunciation guide for the Mi'kmaw alphabet. As noted in its description on the app store, the words and phrases included in *L'nui'suti* appear only in the first-person conjugation.

L'nui'suti is notable for its *People* section which includes English-language information about the history and language of the Mi'kmaw people. It explains the history of language loss and the effects of residential schools and describes current revitalization efforts. The *People* section also includes a section, *Written*, explaining the process of developing an orthography for Mi'kmaw. Including such information provides useful context to the learner. For example, understanding how the orthography was developed may be useful for a new learner comparing the unfamiliar orthography with English. Additionally, information regarding current revitalization efforts for the language can connect the learner with other helpful resources.

5 Discussion of findings

The authors have experience with pedagogical language learning, field documentation, and language technologies. Our backgrounds allow us to take on the unique perspective of both app users and researchers in this emerging field. We are Euro-Canadian peoples engaging with these resources for academic purposes. We are not Indigenous peoples and we acknowledge that we are not in a position to speak to the values or views of Indigenous communities. Our goal in the following discussion is to offer one picture of possible options for Indigenous app development and the furthering of this research. The absence of the perspective and input of Indigenous communities

in this research is discussed in this section as a factor to include in future research.

5.1 Assessment

Empirical assessment of apps based on outcomes related to linguistic proficiency poses challenges. App user reviews can offer some insight into the impact of apps for Indigenous language learners.

5.1.1 Empirical Assessment

Success is an ambiguous term and there is currently no standard for what constitutes a successful app for Indigenous language learning. An app could be considered successful if it is popular or widely used. Alternatively, it may be successful only if it achieves clearly defined pedagogical goals regarding increasing linguistic proficiency. Success may also be based on the emotional impact the app has on the user, such as increasing cultural or linguistic pride. In order to assess an app, the app creator's goals must be known and clearly defined. If the criteria used for assessment are not aligned with the app's goals, the assessed level of success will be misleading. The goals that motivate app design choices are not publicly available, and interviews of companies or communities regarding their intentions for each app have not been conducted as part of this research. Without this information, empirical assessment of app success could not be performed in a meaningful way.

5.1.2 Consideration of User Reviews

Without an evaluative framework based on pedagogical outcomes, apps may be evaluated in terms of their reception by the community. One method of gauging this reception is through public user reviews on the Apple App Store and Google Play store. Public user reviews are not a reliable tool for measuring the pedagogical quality of an app, since reviews rarely contain detailed information about a user's learning experience. However, reviews do offer some insight into the role and reception of these apps. Many apps have reviews claiming that the app had been very helpful for language learning, as well as reviews suggesting additions or changes to the app. One review of *Ojibway* states "Love it... Very great app. My 7 year old daughter enjoys it as much as i do. Wish for there to be an updated version.however.. More words &Phrases" (Google User, 2015). Reviews containing requests for expansion for app content can be seen as evidence of an app's pedagogical effectiveness since the user seems to have learned all the existing content and is ready for more.

While reviews may not be a clear indicator of quality, our investigation of user comments on the Apple and Google Play stores support the suggestion from the literature that mobile apps cultivate enthusiasm around Indigenous languages. Overwhelmingly, user comments on the Apple and Google Play stores were highly positive and emotionally charged, reflecting strong linguistic and cultural pride. One user of *Tal-Tluen?*, a Mi'kmaw phrase building app, commented "Deadliest app ever / This app has changed my life! ...you need to tell all your friends about this app and call your band office tomorrow and get them to put this in your [*sic*] communities newsletter cause it's that deadly"

(TrevG23, 2016). Equally superlative reviews were found for many other language apps, reflecting the contribution apps can make to increasing the prestige of Indigenous languages. As one user of *Ojibway* commented, "Ojibway language is where it's at" (Jarvis, 2015).

Additionally, online comments support the suggestion by Koole (2018) that mobile apps are significant for a community's diaspora. Public reviews on *Anishinaabemowin, Ojibway* give evidence for the power of apps to connect diaspora to their homeland and heritage. One user commented "I love this app. I am a 23 year old Ojibwe who was raised outside the tribe, the language and culture are inseparable. I want to embrace my Native heritage and this app allows me to do just that" (King, 2017).

5.2 The app creation process

Our app review revealed a wide and varied landscape of Indigenous language mobile apps, and many possible avenues for app development.

5.2.1 Options for App Content and Design

Many different app styles exist, and each app reflects the unique values and goals of its development team. Although vocabulary games might be what first come to mind when one envisions a language learning app, beautifully designed apps exist which focus on prayer, song, and other cultural content. Apps can tell traditional stories in engaging and culturally appropriate ways, or they can deliver relevant cultural and historical information. With endless options for how to use the app format, the most impactful apps we have experienced as users seem to have been created with a clear goal.

Many quality all-inclusive apps exist which provide learners with a full view of the language and a number of tools for their learning. Alternatively, Binasii's practice of developing a pair or suite of apps appears very beneficial for learners. Each component, such as reference materials, games, and stories, is separated into its own individually downloadable app. This strategy allows a separation of concerns, which may be less intimidating for a learner.

Apps with grammatical modules and an explanation of the language's morphology may be especially useful to language learners. Currently, most language apps focus on noun and verb vocabulary and offer relatively little grammatical material, with the notable exceptions of *Speak Oneida - Part 1* and *Anishinabe V2*.

5.2.2 Technological and Cultural Considerations in App Development

App development involves a wide range of contributors which may include Elders, language and culture experts, school and band officials, and software developers. Software development may be done by a self-assembled team or by an outside developer such as Thornton Media, Binasii, or Ogoki. These companies are familiar with the context of Indigenous language revitalization and have ready-made templates which can streamline the app development process. They also guarantee that ownership of audio recordings and other cultural property will be protected.

An alternative and exciting avenue for app development is the use of open source software templates, such as the one released by Ogoki intended specifically for the development of apps for Indigenous language learning. Access to an open source template makes it easier to develop an app in-house by involving community members with an interest in programming.

Most apps include credits to recognize the time and emotional labour of Elders and other community contributors. In addition to showing respect, crediting contributors prevents future researchers from attempting to have speakers unnecessarily repeat completed work.

Another important consideration for an app development team is whether to release their app publicly or make it private to community members. Publicly available apps are easily accessible to members of the diaspora, for whom the apps may be significantly beneficial. However, cultural practices may dictate that certain content be restricted to community members. In such cases, those involved in the app's development may decide to restrict their app accordingly.

A challenge encountered throughout the app review process, which is indicative of a challenge faced by Indigenous app developers and users, is the issue of compatibility between iPhone and Android. One author had an iPhone and the other had an Android phone, and this affected which apps each author could review. For example, *Speak Oneida - Part 1* is currently available for both iPhone and Android, but *Speak Oneida - Part 2* is available on iPhone only. Supporting two distinct operating systems increases the time and cost of app development and maintenance. As a result, communities sometimes decide to release their app on a single platform only and in the process, the app becomes inaccessible to a large portion of potential language learners.

Publishers of mobile apps must release updates relatively frequently in order to keep up with new device requirements. When a community does not have the resources for such maintenance, apps quickly become inaccessible to many users. For example, users of *Saulteaux* have left emotional reviews requesting an updated version and expressing disappointment that the app is no longer compatible with their devices. One user commented "Please please update the app so I can use again I was so happy when I found it!" (SaulteauxMama, 2017).

5.3 Future work

This study is only scratching the surface of what information can be considered in researching the field of Indigenous Language Apps. No previous comprehensive review of apps for Indigenous language learning exists and literature on the topic of mobile apps for Indigenous language learning is generally scarce. To find sufficient information to build on, short of directly communicating with communities and developers, we cautiously referenced research conducted up to 16 years ago (Ogata & Yano, 2003). Using possibly out of date research requires a strong disclaimer to the reader and future researchers. Considering this, a suggested next step is to do a first-hand study. This study could be of a sociolinguistic nature, looking into the variation of language use and values communities have of their respective languages. This study could be applied to the pedagogical benefits of individual app components, or varying combinations of these components. This paper would

then be revisited, considering the findings of these new and relevant studies.

A barrier to analysing the development, success and effectiveness of apps is obsolescence. As mobile device operating systems are updated and new device models are released, functional obsolescence (when a device is no longer capable of running specific tasks) largely prevents researcher and user access to old apps. Therefore, we and future researchers cannot view old apps for analysis of design trends or developments. Papers such as this are a valuable resource as it documents a number of apps at the current moment in time, many of which could become obsolete in the future.

6 Conclusion

Indigenous communities and community groups are looking for the best ways to distribute language learning materials. As language revitalization, maintenance, and preservation efforts build, an increasing number of people are using technological tools to support the integration of language learning into their daily lives. This report surveyed the published literature on Indigenous language apps and discussed their possible role in a learner's journey.

The literature review discussed intentions and benefits of apps such as cultural knowledge, portability and accessibility of information for a learner. Rapid obsolescence, dialectal differences, and the practical limitations of mobile devices were explored as potential challenges for apps as a learning tool. With reference to the literature review, we as users carried out the app review through direct interaction with apps.

The app review surveyed 32 different apps built for a wide range of different Indigenous languages. Three prominent companies were profiled to illustrate the creation of language apps as an increasingly popular tool for language revitalization movements. As users, we engaged with each app for either pedagogical, cultural or referential purposes. Three apps, one for each respective category, were profiled to highlight the qualities we appreciated as users.

Language apps are a productive and flexible tool that can make a valuable contribution to language revitalization movements. In our discussion, we explore considerations for app development projects and future work in the field. Much more research can be done in the area of Indigenous language app development and use as this exciting field continues to grow.

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