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Digital Domains for Native American Languages

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In the decades since the *Handbook of North American Indians* was conceived in the 1960s, digital forms of communication have become ubiquitous for non-Indigenous languages in North America, often serving as the primary domain of communication. The role of computers and the Internet as tools for accessing Native American language materials is discussed briefly in Volume 2 (Hinton 2008:351) using the data available by 2005–2006. This chapter reviews the emerging role of digital technologies that support Native North American languages as a communicative medium in the 21st century. The digital domain remains underdeveloped for Native American languages, though the examples discussed below provide evidence that this is beginning to change. While digital technologies including email, text messaging, websites, and social media have become integral to communication in English, Spanish, French, and other languages of wider communication, few of these technologies are fully supported in Native North American languages.

In the second decade of the 21st century, no Native North American language had yet fully entered the domain of digitally mediated communication, though a few languages were partially supported at the level of computer or mobile device operating systems. As new domains of language use facilitate new ways of communicating in Native languages, many more languages are beginning to take advantage of digital technologies. Where intergenerational transmission has ceased or been greatly reduced, these digital language communities provide venues for new speakers to practice and expand their language skills.

Two types of digital language communities can be distinguished. In a PRIMARY digital language community, Native language serves to mediate interaction with the digital tools, whereas in a SECONDARY digital language community interaction is mediated in a dominant language, typically English, French, or Spanish in North America. An analogy can be drawn with monolingual and bilingual dictionaries. A primary community is like a monolingual dictionary, in which the Native language is used to navigate and search through the dictionary. In contrast, a secondary community can be compared to a bilingual dictionary, in which a dominant language is used to access Native language content. Just as there are few monolingual dictionaries of Native North American languages, there are few primary digital language communities.

This distinction between primary and secondary communities has both practical and theoretical implications. While few Native North American languages have yet to make progress toward creating primary digital language communities, secondary communities have emerged for almost all languages. And for some languages these secondary communities have become the major focus of language use. This is particularly true for languages that have been recently

re-awakened (i.e., revived from documentary sources in the absence of surviving speakers). For such communities, where all members are in a sense learners, the digital domain provides a new space for language use. Secondary digital communities also serve to bring together in virtual space diaspora communities that are widely distributed in physical space owing to migration.

This chapter surveys the digital domains for primary and secondary communities, drawing on examples from several Native North American languages as of 2016. Given the diversity of language situations in the region, this survey cannot claim to be comprehensive (see "Native American Languages in the New Millennium," this vol., for further discussion of language diversity in North America). Languages with official governmental status, such as Kalaallisut (Greenlandic Inuit) in Greenland, typically have more access to digital resources than do small languages without official status. Nevertheless, new technologies such as social networks have helped to level the playing field by enabling the creation of digital domains even in under-resourced communities; hence, the examples discussed in this chapter can be considered largely representative of the emerging digital domains for North American languages at the beginning of the 21st century. The more theoretical question of whether primary digital language communities are necessary to support language revitalization efforts will be discussed at the end of the chapter.

Primary Digital Language Communities

The digital realm can offer more or less support to languages as a tool of interaction, and some languages are currently better supported than others. Few languages can be considered to be fully supported in the digital realm. In an exhaustive survey Kornai (2013:6) found only 16 of the world's languages to be "thriving" in the digital realm—English, Japanese, French, German, Spanish, Italian, Portuguese, Dutch, Swedish, Norwegian (Bokmål), Danish, Finnish, Russian, Polish, Chinese, and Korean–with full text input and operating-level support. Most interaction between human and device (computer, mobile phone, etc.) is thus mediated by one of these 16 languages. In North America the language of mediation is generally English, French, or Spanish, so that even when accessing digital Native American language content one must use English or French or Spanish to access that content. At the beginning of the 21st century no Native North American language was fully supported as a primary digital language community, in the sense of having operating systems, spell checkers, speech recognition, web-based content, and other technologies necessary to mediate digital interaction using the language. However, some Native American languages had at least partial support. For example, both Navajo and Kalallisut (Greenlandic) have significant Wikipedia content in the Indigenous language.

Many of the tools and technologies addressed below are commonly overlooked in discussions of support for Native American and other minority languages. These tools are essential to supporting a primary digital language community, but they exist behind the scenes. The very invisibility of these tools is a corollary to their essential nature. These tools are necessary to maintain digital communication in a language, and the tools themselves must exist in the background and not interfere with the actual communication.

Operating System Support

In the early 21st century, interaction between humans and digital devices (computers, tablets, phones, etc.) is mediated by an operating system. The operating system handles input through keyboard, voice, or other means and provides a way for the user to navigate through different applications and settings. This interaction is inherently language-based, and most operating systems provide support for interacting with the device in a choice of several different languages. For the most part these operating system languages are languages of wider communication with many tens of millions of speakers, but endangered languages, including Native North American languages, are increasingly supported by modern operating systems.

Microsoft Windows offered its first support for Native American languages with the Cherokee language pack for Windows 8, introduced in 2012. Windows 10, released in 2015, now offers language packs for 111 languages with a broad geographic range, but Cherokee remains the only Native North American language, while Quechua and K'iche' are the only 2 Latin American Indigenous languages currently supported by Windows.

The Macintosh operating system (Mac OS) has consistently provided the best support for non-English languages, including Native North American languages. The latest version, Mac OS 10.11 El Capitan, released September 2015, provides full support for 30 languages plus an additional 3 language varieties, and an additional 262 languages have limited operating system support. Twelve of these are Native North American languages: Unangam Tunuu (Aleut, ale); Hinóno'etíít (Arapaho, arp); ᏣᎳᎩ ᎦᏬᏂᎯᏍᏗ (Cherokee, chr); Tsėhésenėstsetȯ (Cheyenne, chy); Mvskoke (Creek, mus); ᐃᓄᒃᑎᑐᑦ (Inuktitut, ike); Kalaallisut (Greenlandic, kal); Lakȟól'iyapi (Lakota, lkt); Míkmawísimk (Micmac, mic); Kanien'kéha (Mohawk, moh); Diné Bizaad (Navajo, nav); and Shiwi'ma (Zuni, zun). However, this lists greatly exaggerates the level of support provided for these languages.

For the most part only a limited number of features have been implemented in the target language, while the remainder of the interface makes use of a secondary language. For example, with the primary operating system language set to Inuktitut, only the month names and days of the week have been translated; the remainder of the interface is in English, including the button marked "Today," the word "Search," and the time-frame selection box "Day | Week | Month | Year" (Figure 1). So in this case partial operating system support for Inuktitut consists of translation (and in this case transliteration) of 19 words.

And the situation for Inuktitut is much better than that for the remaining eleven languages. Changing the primary language to Diné Bizaad has no effect on the Calendar app and no apparent effect on the interface more generally. For example, even with the primary language set to Díne Bizaad, the Language & Region setting dialogue remains entirely in English (Figure 2). This contrasts sharply with the situation for the 33 languages with full support. For those languages all interface text, not merely the names of months and days, is given in the target language.

The situation is somewhat better for iOS, Apple's mobile operating system for phones and tablets. iOS version 9 provides built-in support for 46 languages plus an additional 7 language varieties, though none of these are Native American languages. However, iOS allows developers to provide support for any language through the use of an ISO 639 language code. Thus, even though the operating system may not support Native American languages, it is in theory possible for a developer to build an app that does provide this support. However, to date no developers have taken advantage of this opportunity. For example, the Diné Bizaad app uses an English

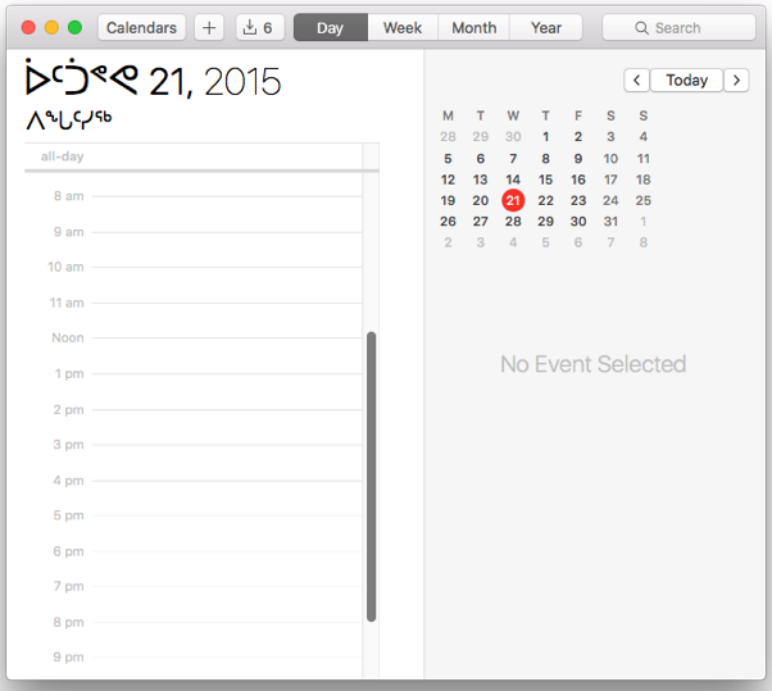

Figure 1: Calendar app in Mac OS 10.11 with primary language set to Inuktitut (Author's data, 2014)

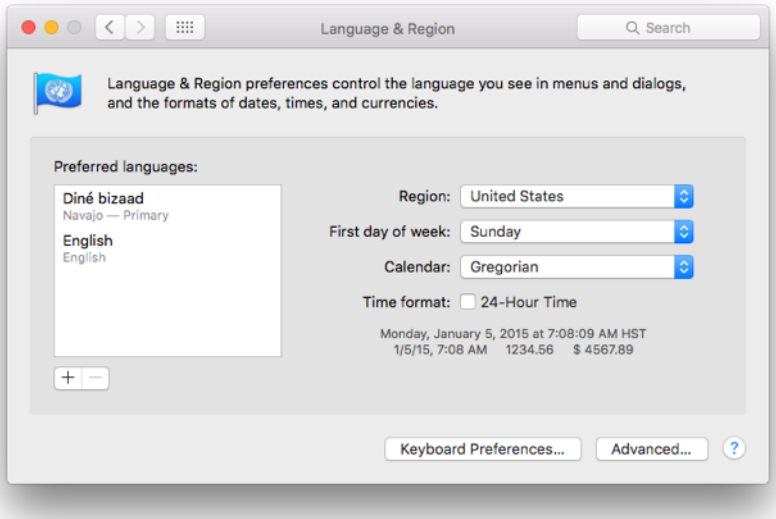

Figure 2: Mac OS 10.11 settings page showing primary language set to Diné Bizaad (Author's data, 2014)

interface that presents the user with a number of options, including: Dictionary, Clanship, Categories, and Word of the Day. In theory it would be possible for the developer to localize the app in Díne Bizaad language; however, the implicit assumption is that the user will interact with the app using English, not Diné Bizaad.

Software Localization

Software localization refers to the process of translating menu items, buttons, dialog boxes, and even help files into a particular language. Localization can provide support for Native North American languages by encouraging the use of the language in the digital domain. For example, while it is certainly possible to compose an email in Native language using an interface written in a language of wider communication, the use of a Native interface may help to promote such an activity. As of 2016 the Gmail email software had been localized into 55 languages, including one Native North American language, ᏣᎳᎩ ᎦᏬᏂᎯᏍᏗ (Cherokee). When Cherokee is chosen as the interface language for Gmail, all commands and options are presented in the Native language. To send an email message, the user taps the ᎾᎦᏅᏗ button. A Google virtual keyboard extension can be employed to facilitate entry of non-Latin characters. The Google Internet search engine has also been localized into Cherokee, allowing users to search for Cherokee terms and find resulting web pages with Cherokee language content (see https://www.google.com/webhp?hl=chr). Here the Google search catchphrase "I'm feeling lucky" has been translated into Cherokee as ᎡᎵᏊ ᎢᎬᏱᏊ ᎠᏆᏁᎵᏔᏅ ᏱᏂᎦᏛᎦ. As of 2016 search had been localized into 159 languages, though Cherokee was the only Native North American language among these.

Google is just one of many software developers that offer instructions, and in some cases assistance, on the localization process. In general, the process requires translation of a list of words and phrases. Complete localization of advanced programs such as the OpenOffice suite may require translation of more than 20,000 text strings; however, it is not necessary to translate every bit of text. Localization projects can begin with commonly used text such as menu items and proceed into less commonly accessed areas of the program. In this way a localization project itself may inspire a community of learners, as participants collaborate to provide the necessary translations.

Spell-Checkers

Interaction with digital devices relies crucially on spell-checking—namely, the ability for the device to recognize incorrectly spelled words and suggest corrections. In 20th-century computing the primary purpose of a spell-checker was to assist with proper spelling during composition of a document. Thus, "a good Navajo spell-checker would give a boost to the emergence of Navajo literature" (Slate 2001:401). In the new millennium spell-checkers are not just useful for writers; spell-checkers are integral to interaction with digital devices. This is true not because users have imperfect knowledge of spelling conventions (though this may also be the case) but rather because of the nature of text input on digital devices. When using a keyboard for text entry, most users have a high rate of input errors. These errors are tolerable owing to the existence of spell-checking software, which recognizes errors and attempts to correct them. Spell-checkers are particularly important to text input on mobile devices, where small keyboards result in frequent

input errors. These devices often make use of predictive spelling, in which software attempts to determine the intended word before the user has finished entering it.

As of 2015 no Native North American language had a spell-checker at the operating system level that works with all installed software. However, a Kalaallisut (Greenlandic) spell-checker is available for several word-processing programs, including Microsoft Office, LibreOffice, and OpenOffice (oqaasileriffik.gl/langtech/spell-checker/). The Kalaallisut spell checker, known as *kukkuniiaat*, is the product of more than a decade of development with the official support of Oqaaserpassualeriffik, a division of the Greenland Language Secretariat devoted to language technology (Langgård 2005).

Automated Speech Recognition

Like spell-checkers, the ability for digital devices to recognize speech is critical to human interaction with those devices. As devices become smaller and more mobile traditional text-based input becomes less useful, the ability to speak to a device becomes more important. This ability requires speech recognition software tuned to the particular language of interaction. For major world languages, well-developed acoustic models are available to facilitate speech recognition (though support for regional varieties may be lacking). As of 2015 no such models had been widely implemented for Native North American languages. However, the development of speech recognition for small languages is an area of active research.

The Sphinx project at Carnegie Mellon University now provides an open-source speech recognition toolkit. Testing with North American languages Inupiaq and Ojibwe suggests that highly accurate speech recognition rates can be achieved with those languages by extracting an acoustic model from as little as 30 minutes of narrowly transcribed speech recordings (Sitaram et al. 2013). Support for automated speech recognition for North American languages is likely to increase in the coming years.

Web-Based Content: Wikipedia

A final aspect of primary language communities to be considered in this section is the existence of web-based content. The Internet forms an integral part of 21st-century life and hence is also crucial to the digital future of Native languages. Almost all aspects of modern life in North America require or expect some kind of interaction with web-based content. To create a primary language community for a Native American language thus requires creation of web-based content in that language. Here it is important to distinguish between content *about* a language and content *in* a language.

A good illustration of this distinction is provided by the collaborative Internet encyclopedia Wikipedia.org. Since its founding in 2001, Wikipedia has grown to become the default reference source for almost any question. Wikipedia is arguably an essential component of digital existence. However, most of this content is in just a few languages of wider communication. There is a significant amount of content *about* Native American languages, but this content is for the most part written in English and forms part of the English Wikipedia. In 2014 there were Wikipedia versions in 289 different languages, plus another 340 at the "incubator" stage, a development platform with less stringent article standards than the full Wikipedia. Incubator pages can be requested for languages that lack a community of at least five active editors

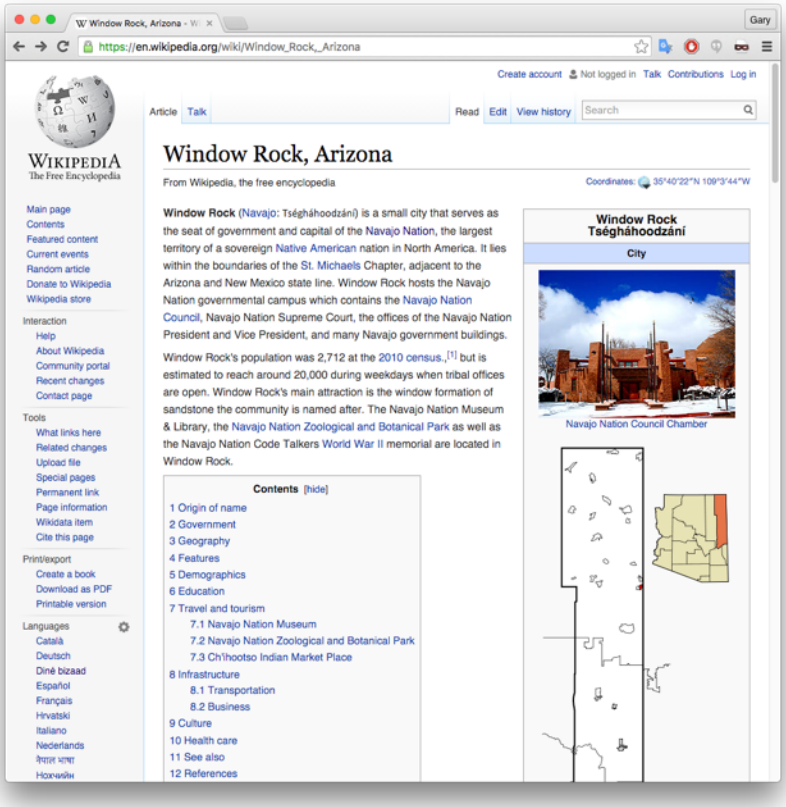

Figure 3: English Wikipedia entry for Window Rock, Arizona (en.wikipedia.org/wiki/Window$_{R}ock,_{A}\,rizona$, accessed August 1, 2016)

(incubator.wikimedia.org/wiki/Incubator:Wikis#Wikipedia). The incubator category represents an experimental development stage; content on incubator pages may not be entirely in the target languages, and pages may have very little content.

It is crucial to understand the significance of the distinction between a Wikipedia page which is about a Native language and one which is in a Native language. Compare the English Wikipedia entry for Window Rock, Arizona (Figure 3) with the equivalent Navajo Wikipedia entry for Tséghahoodzání (Figure 4). The English version does contain some Native language, particularly the Navajo name for Window Rock, but the text and the menus are entirely in English. In contrast, all aspects of the Navajo page are in Navajo. The page URL begins with the Navajo language Wikipedia code "nv." Menu items such as yínishta' (read), łahgo áshłéél (edit), and hanishtá (search) are all in Navajo. Even the name of the site, Wikiibíídiiya, has been transliterated into Navajo. Note further that the Navajo page Tséghahoodzáání is equivalent to the English Window Rock page, but it is not simply a translation. The content is different. This is in keeping with Wikipedia practice. Wikipedias for different languages are not translations of each other, and an article in a given language need not contain an equivalent article in other languages.

Wikipedia provides a space for language use in the digital realm, and it is often among the very first digital language communities to become active (Kornai 2013). Thus, where significant Wikipedia content in an Indigenous language does exist, it is often a harbinger of the language's

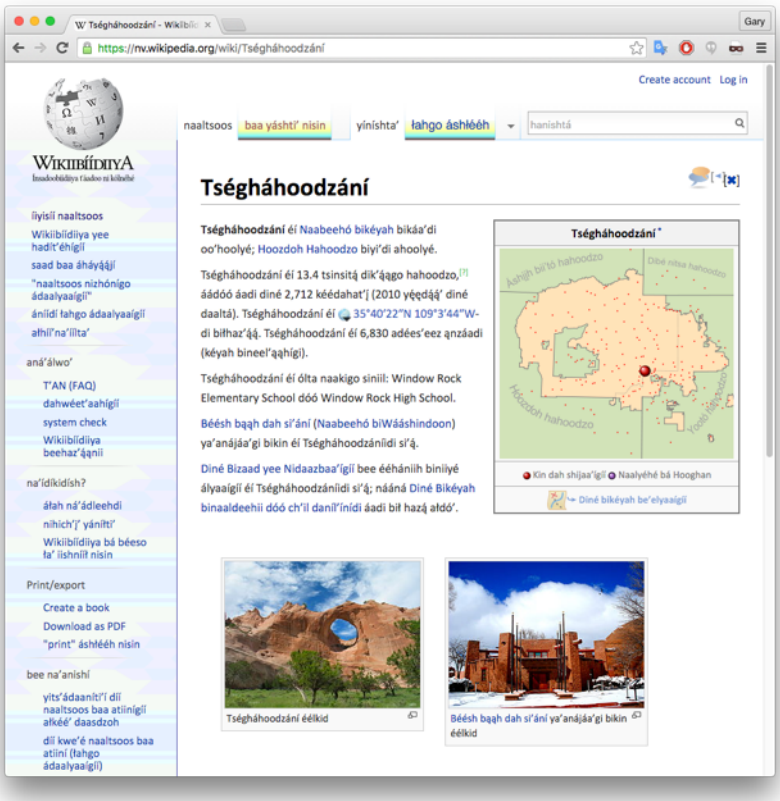

Figure 4: Navajo Wikipedia entry for Tségáhoodzání (nv.wikipedia.org/wiki/Tséghá-hoodzán%C3%AD, accessed August 1, 2016)

Figure 5: Alabama Wikipedia Incubator entry for Adams, Massachusetts (incubator.wikimedia.org/wiki/Wp/akz/Adams,$_{M}assachusetts$)

entrance into the digital realm. As of December 2014 there were at least 30 Wikipedias for Native North American languages, most at the incubator stage. Only two Native North American languages have any significant Wikipedia presence, with more than one thousand substantive articles. These are Navajo (ISO 639-3 nav) and Kalaallisut (ISO 639-3 kal). Navajo had by far the largest Wikipedia presence, with many substantial articles, but most Native American Wikipedia sites lack significant content. For example, the Alabama (ISO 639-3 akz) Wikipedia consists entirely of pages devoted to towns in New England and Germany, each containing approximately 30 words of text. The content of each page is essentially identical with the exception of the place names. These pages were ostensibly machine-generated and do not reflect an active Wikipedia community.

For other Native North American languages Wikipedia coverage can be inconsistent. For example, although the Nahuatl language Wikipedia boasts more than 10,000 articles, only 91 of these are substantial (containing more than 450 characters). Yet among these 91 articles some extremely rich and useful content can be found; the entry for *Mexihco* is more than 50,000 characters in length.

The number of Wikipedia articles for Native North American languages is small enough to be easily counted. The Wikimedia Foundation maintains an up-to-date listing of the size of Wikipedia by language; however, these numbers are inflated by vacuous articles such as the entry for Adams, Massachusetts, mentioned above (meta.wikimedia.org/wiki/List$_{o}f_{W}ikipedias$). To remove these effects we can use the counts generated by Kornai (2013), which use a threshold of 450 characters (essentially one paragraph) to count a page as a real, substantive Wikipedia article. This threshold effectively excludes articles generated algorithmically by robots. (The Adams, Massachusetts, article above has a mere 36 words.) The results for Native North American

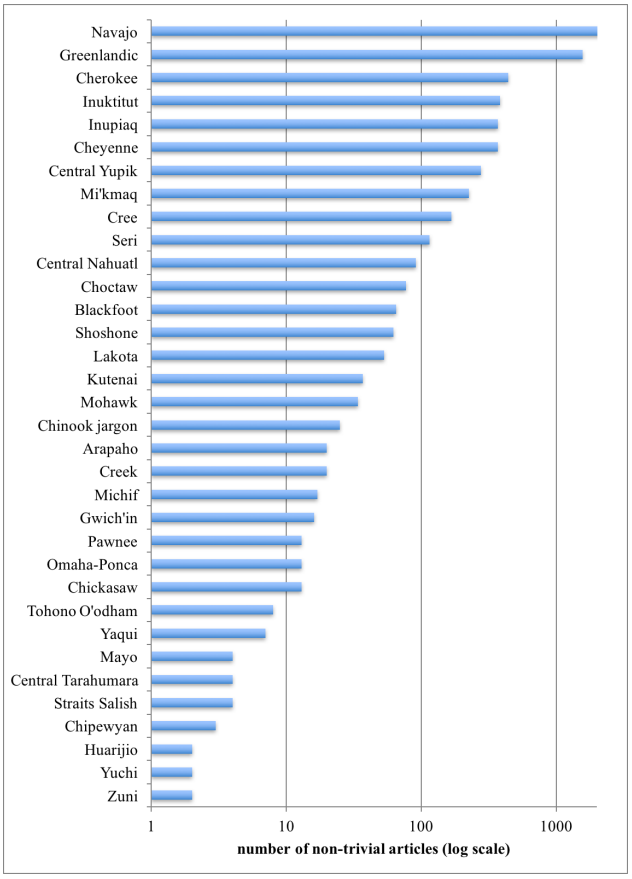

Figure 6: Number of (non-trivial) Wikipedia articles (official and incubator) in Native North American languages (logarithmic scale)

languages are summarized in Figure 6. As this table shows, only 34 Native North American language Wikipedias have substantive content. By far the largest of these are Navajo, with nearly 2,500 articles, and Kalaallisut, with more than 1,500 articles. Seven more languages have more than 100 articles each: Cherokee, Inuktitut, Inupiaq, Cheyenne, Central Yup'ik, Mi'kmaq, and Cree. The Alabama language discussed above does not even show up in this list; that is, no Alabama Wikipedia article counted met the 450-character threshold.

Of course there is plenty of information about Native languages on the regular (English) Wikipedia. Entering "yugtun" as a search term in the English Wikipedia brings up an article on the Central Alaskan Yup'ik language. But this is an article *about* Yup'ik written *in* English. Although it contains a number of Yup'ik words, it is clearly not the same as a Wikipedia article written in Yup'ik. That is, the English Wikipedia entry on Yup'ik is not an example of a primary digital community for Yup'ik. Rather, it is a reference source whose target community consists of people whose primary language is English. While the English Wikipedia entry for Yup'ik may be digital, it has more in common with non-digital reference sources on Yup'ik, such as with the Yup'ik Eskimo Dictionary (Jacobson 1984). Both the English Wikipedia entry for Yup'ik and the print dictionary contain many Yup'ik words, but the primary medium for both is English. All explanatory information is written in English. In the case of the Wikipedia entry, this includes all navigational information and meta-information such as help files. Native

language reference sources written in English, French, or Spanish—whether digital or not—are clearly useful in language maintenance contexts, but they do not constitute examples of primary language communities. The English Wikipedia currently contains entries for almost every Native American language, and while some of these entries may attract an active community of Wikipedia editors, they are not examples of primary digital language communities

Secondary Digital Language Communities

The first decade of the 21st century was a time of radical shift in approaches to Native American language revitalization and maintenance (see "Native American Languages in the New Millennium," this vol.). Where previous approaches focused on the continuation of existing forms of language in diglossic situations, a new generation of learners has embraced new media tools to create digital domains for language use. These domains are essentially secondary language communities (cf. Golla 2001) that exist in parallel with primary Indigenous and non-Indigenous communities, often operating under entirely different social conventions. Rather than continuing language in its original form, secondary language communities provide a space for language learners to explore new modes of communication in a safe and encouraging space. In particular, these new domains are largely free of the usual evaluative filters and linguistic purism that have impeded the success of traditional language programs, thus allowing for the emergence of new forms of language.

Language use among participants in these domains differs greatly from the full fluency imagined in earlier approaches to language revitalization, but it offers a renewed sense of linguistic ownership, as participants actively shape new language varieties. The examples reviewed in this chapter are drawn from across North America and reflect the diversity of approaches made possible by new technologies. What they share is the promise of secondary language communities that foster language use and offer a novel and promising future for Native American languages. The following subsections cover several types of secondary digital language communities, including websites, mobile apps, games, and social media.

Websites

As of 2015 almost every Native North American language had some form of web presence, and most had more than one site devoted to the language. A fairly comprehensive listing of web resources is maintained by the organization Native Languages of the Americas (www.native-languages.org/languages.htm). Three broad types of Native language websites can be distinguished, though the distinctions between these types are often fuzzy, as many sites serve more than one function. Static sites function to establish an online presence for the language; portal sites provide access to digital content such as archival recordings; and interactive sites invite users to engage dynamically with the site and thus function as a virtual center for language use.

Static websites typically provide contact information for a language program, though they may also include additional information about the language. The Gwich'in Social and Cultural Institute site is trilingual and may be viewed in Gwich'in (Kutchin; Slobodin 1981) in addition to English and French. The site provides dictionary samples, maps of communities, basic phrases,

and information on the status of the language (www.gwichin.ca). A key feature of these websites is that they are directly controlled by a tribal entity that thereby asserts a form of ownership over the language, drawing on language as a marker of identity. In addition, most languages also have sites that are not under direct control of the language community—for example, Wikipedia pages (in English) or academic research project sites. However, static websites maintained by tribal entities provide an Indigenous space for the language on the web, distinct from non-Indigenous sites. Nearly every Native North American language now has at least a static website maintained by a tribal entity, and many languages also have portal and/or interactive sites.

Portal sites consolidate access to language resources in a single virtual location. The organization First Voices has worked with Indigenous communities across Canada to develop community language portals that consolidate words, phrases, song, stories, and recordings (www.firstvoices.com). Information can be password protected to limit access to those within the community. The ability to implement fine-grained access restrictions is often a key feature of portal sites. The Mukurtu Content Management System supports the development of portals that allow authenticated users to upload content and apply carefully designed cultural protocols (www.mukurtu.org; Christen 2008). The prototype implementation of the Mukurtu system is the Plateau Peoples' Web Portal, which provides access to several different archival collections (see "Emerging Digital Networks," this vol.). Though the Plateau Peoples' Web Portal contains language material, its content is not limited to language. This is a characteristic of many portal sites, whose scope is often much broader than language.

Many portal sites are directly related to archival repositories. The Dena'ina Qenaga web portal (qenaga.org) was created to provide access to existing archival documentation housed at the Alaska Native Language Archive (Holton et al. 2007). A searchable digital archive serves as the core of the site, but the site also functions as a general point of access for information about Dena'ina. This additional content was created mostly as part of distinct, separate language projects and brought together under one virtual roof through the mechanism of a portal. But portals can also be created from scratch with bespoke content.

For example, the Haida language website Xaat Kíl serves as a portal to a variety of information about the Haida language, much of which was created specifically for the site (www.haidalanguage.org). The site contains links to a pronunciation guide, an audio phrasebook, and a Haida story, and several grammar lessons. The story is provided in Haida with interlinear English translation, and each Haida word is hyperlinked to a glossary entry. The grammar lessons include interactive quizzes that test learners' knowledge of Haida grammar. The various pieces of this site were created at different times, and they do not all have the same interface design, yet the website brings all of these features under a single umbrella so that users have comprehensive access to Haida language resources.

The third broad type of language website includes interactive features that have become an essential component of the Internet landscape in the new millennium. The emergence of interactive websites represents an evolution from stand-alone multimedia products such as CD-ROMs, which were popular during the last decade of the 20th century (see "Emerging Digital Networks," this vol.). Like multimedia CD-ROMs, interactive websites bring together text, images, audio, and video to provide a rich user experience. The use of recorded media is particularly helpful for language learners who may be unfamiliar with orthographic conventions and desire to know how the language is pronounced. Recorded media also allow users to hear particular speakers, thus providing an important cultural connection. Unlike stand-alone CD-ROMs,

interactive websites offer the promise of both greater interactivity and increased sustainability.

Where stand-alone multimedia products were designed for offline use, interactive websites allow for communication through the Internet. Website users can communicate through embedded chat applications, and progress through the site can be monitored and rewarded through an associated database. Websites may also be more sustainable than stand-alone products since they can be updated continually. Most CD-ROM products are no longer accessible—and without regular maintenance and support, this fate will almost certainly apply to many of the current websites.

Another difference between stand-alone and web-based multimedia in practice is that web-based products tend to be less comprehensive in nature. Stand-alone products are usually viewed as one-off creations, often undertaken at great expense in order to "preserve" language. Thus, developers often choose to include as many aspects of language and culture as feasible, so that a CD-ROM may include time-aligned texts, an alphabet guide, a talking dictionary, place name maps, and the like. In contrast, the extensible nature of the Internet favors the development of more focused products, which can then be virtually linked to other complementary online language resources.

Such a distributed approach is seen in web-based multimedia applications developed for the Dena'ina language by a number of different authors. These include a phrasebook (Balluta and Evanoff 2005), an alphabet guide (Williams 2005), a collection of texts with aligned audio (Kari and Berez 2005), field recordings (Kari and Holton 2005), and a more comprehensive site focused on the Kenai dialect of Dena'ina (Boraas and Christian 2005). Each of these projects was developed independently by a different team, and each focuses on a different aspect of the Dena'ina language, yet when combined virtually, they become a much more powerful distributed resource. Moreover, this combined resource is flexible and extensible: it can grow in response to community needs. Each individual project site can be modified and adapted as necessary, and additional projects can be developed and linked in. Uniformity is sacrificed in favor of extensibility. The individual sites do not all have the same look and feel, and information may be repeated across more than one site. In this case, a Dena'ina alphabet guide can be found on both Boraas's and Williams's sites.

A distributed approach is not necessarily obligatory for a web-based project. Web-based multimedia may be every bit as media-rich and polished as stand-alone multimedia. A good example of this is the Dane Wajich project website hosted by the Virtual Museum of Canada (Doig River First Nation 2007). This site was conceived around the event of the rediscovery of a drum which had been lost for some years. It includes links to place names, stories, songs, and biographies of Dreamers who make songs. The polished form of the site makes it almost indistinguishable from a well-made stand-alone product. As with many multimedia products, the core of the content focuses on time-aligned recordings, in this case video recordings displayed with time-aligned Dane-Zaa transcriptions and English or French translations (depending on choice of interface language).

Even a polished, comprehensive product such as the Dane Wajich site takes advantage of the extensibility of the web to include virtually embedded language information. This includes an alphabet pronunciation guide embedded within the site, with the same look and feel. But it also includes a link to an interactive conversational phrasebook based on an earlier printed phrasebook (Holdstock and Holdstock 1992). The phrasebook site has a completely different look and feel from the Dane Wajich site, having been developed originally as a stand-alone CD-ROM

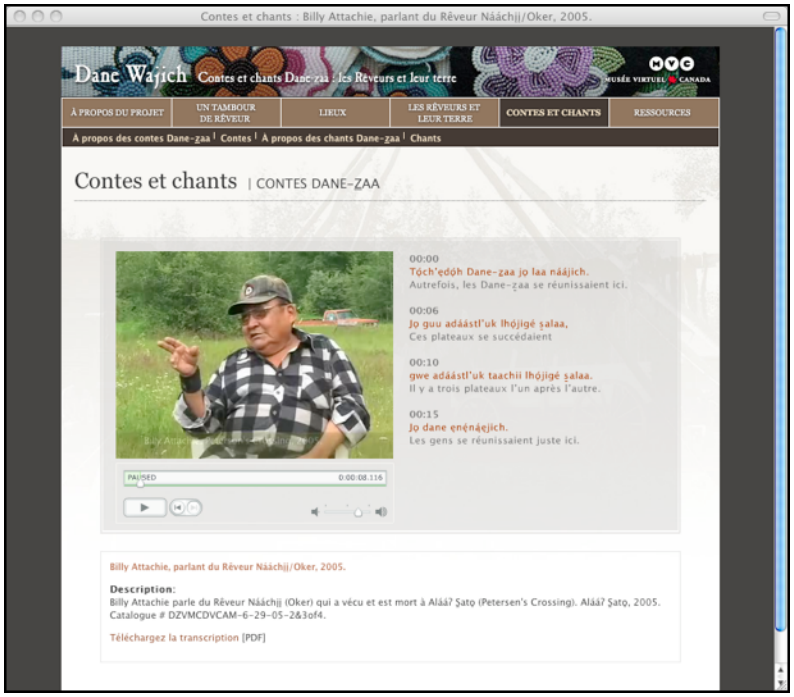

Figure 7: Story excerpt from Dane Wajich website (Doig River First Nation 2007) (www.virtualmuseum.ca/sgc-cms/expositions-exhibitions/danewajich/francais/stories/video.php?action=fla/billypetersons, , accessed August 1, 2016)

under the auspices of different institutions with a different project team. There is some overlap between the sites; for example, both sites include a pronunciation guide. But in the end, users benefit from multiple points of view, and developers benefit from being able to split large tasks into manageable chunks. This virtual integration of essentially separate sites demonstrates the power of the web for multimedia language development.

An increasingly prominent feature of Native language websites is the incorporation of principles of computer-assisted language learning (CALL), using computer technologies to emulate the interactivity of a traditional language classroom (Ward and van Genabith 2003). Learners progress through CALL courseware by listening to prompts and dialogues and responding appropriately. The software evaluates users' responses and assesses comprehension, guiding a learner's pace through the course (Hubbard 1996). While 20st-century approaches to CALL made use of stand-alone, purpose-built technologies, new web technologies make it possible to create language courseware that can be accessed using an ordinary web browser. There are many examples of CALL websites for Native languages. One such site is the dAXunhyuuga' eLearning Place developed by the Eyak Language Project (Figure 8).

CALL websites offer the promise of increased usability and sustainability compared with stand-alone commercial products such as RosettaStone Iñupiaq (NANA 2007). Websites can be developed at a substantially lower cost and thus are within the reach of many Native American language programs, facilitating incorporation of culturally appropriate content. For example, the dAXunhyuuga' site (eyakpeople.com) uses of a rewards system through which users accumulate points ("berries") as they progress through the course. This incentive system serves to draw users

Figure 8: dAXunhyuuga' eLearning Place (www.eyakpeople.com)

together in virtual space, thereby creating a community of learners. Online learning experiences extend into the physical world as well, as learners frequently discuss the accumulation of berries when they meet in person, as at Eyak language workshops in 2014 and 2015. The Eyak site also incorporates images of language learners and community members, enhancing the sense of personal connection to the learning process. For Native languages, and endangered languages more generally, CALL can serve to raise the social profile of the language both within and outside the community (Ward and van Genabith 2003).

Mobile Devices and Mobile Apps

In the second decade of the 21st century, access to the digital domain is shifting from the personal computer, which facilitated the Internet boom of the late 20th century, to mobile computing platforms, including smart phones and tablet computers. The release of the Apple iPhone in 2007 put computing power in the palm of the hand and facilitated the development of dedicated mobile applications. This new platform has become increasingly important for Native languages, in part because it allows developers more control over technical issues such as orthography and media. One of the major barriers to language learning in the context of endangered languages is the limited opportunity to hear the language being used. In many Native North American communities Native languages are no longer used as languages of daily communication, so learners have few opportunities to be exposed to the language.

Apps for Native languages offer the ability to hear the language spoken at any time using a device that can be carried in a pocket and is thus constantly accessible. The Ojibway app serves as an electronic phrasebook with categorized lists of English words and phrases. Tapping one of these phrases plays a recording of an equivalent Ojibway phrase. For example, tapping "Hello" causes the app to play a recording of the Ojibway word *aaniin* (the written Ojibway word is not displayed). A slightly different approach is taken by the Dinak'i Upper Kuskokwim dictionary app, which provides a searchable list of Dinak'i language dictionary entries, including more than 2,700 sound files demonstrating pronunciations of words and sample sentences. Both phrasebook and dictionary apps are available for dozens of Native North American languages, with more appearing regularly. Many projects are currently seeking to create apps based on print dictionaries, either by making new recordings or by taking advantage of archival recordings.

In the early decades of the 21st century, mobile apps fill a role similar to that of CD ROMs in the latter part of the previous century. Namely, mobile apps allow developers to package multimedia content in a way that gives them more complete control over rendering of text and audiovisual playback. Websites rely on the user's browser, which may or may not provide complete support for the content supplied by the developer. However, the emergence of new web standards that directly support multimedia, including HTML5, may eventually render this distinction moot, making it possible for complex applications to be developed as ordinary websites, obviating the need for dedicated mobile apps. At the same time this shift to HTML5 will help to solve two of the greatest challenges for developers of mobile apps for Native languages. The first challenge is the need to develop applications for several different operating systems and devices; the second is the need to continually provide updates to apps as operating systems and devices evolve.

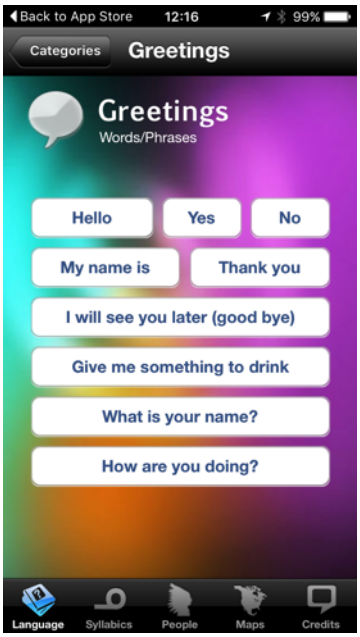

Figure 9: Screen capture of Ojibway app showing Greetings (itunes.apple.com/us/app/ojibway/id477459816?mt=8)

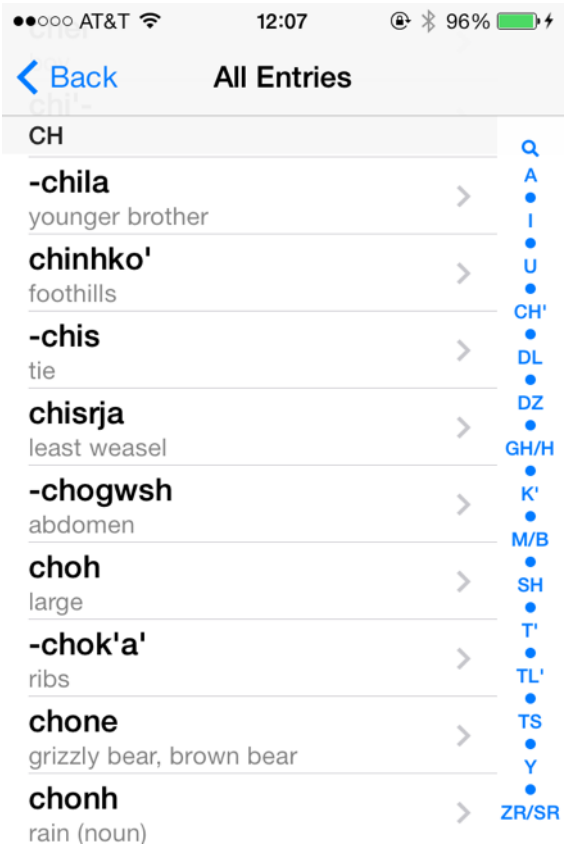

Figure 10: Screen capture of Dinak'i app showing dictionary list (itunes.apple.com/us/app/dinaki-upper-kuskokwim-dictionary/id733068863?mt=8)

Games

Gaming—whether using a personal computer, a mobile device, or a dedicated gaming device—is now an established part of digital culture. A study by the Entertainment Software Association, an industry group, suggests that 42 percent of Americans spend at least three hours a week playing video games (Entertainment Software Association 2015). The interactive nature of video games offers great potential for their use in language learning, though the effectiveness of so-called educational games remains the subject of much debate (Vogel et al. 2006). In the context of language learning, educational games can mimic communicative strategies, providing virtual opportunities for iteration of words and phrases in different contexts and facilitating collaboration and social interaction between learners (Butler 2015). Although some aspects of gaming have been incorporated in interactive websites and apps, as discussed above, fully developed educational games for Native languages have yet to emerge.

One notable development is the release of the game Never Alone (*Kisima Inŋitchuŋa*), a role-playing game with significant Inupiaq language content (neveralonegame.com). Though not a language-learning game per se, *Kisima Inŋitchuŋa* is notable for its rich cultural and linguistic content, including narrative in the Inupiaq language and video recordings of Inupiaq elders. The game play itself incorporates traditional Inupiaq values, for example emphasizing collaboration rather than competition between players. One significant effect of the *Kisima Inŋitchuŋa* game is to bring the Inupiaq language and culture into the 21st century by providing a current venue for language use which is attractive to Native youth. In this way the developers hope to bridge the divide between elders and youth and in so doing create "games that celebrate and share under-represented and indigenous people and cultures in positive, authentic and respectful terms" (Upper One Games 2014).

There remains much debate regarding the effectiveness of gaming as a language-learning tool, though most studies acknowledge the potential of gaming in supporting indigenous languages (Vogel et al. 2006). Some research suggests that gaming may be an especially appropriate learning tool for children and young adults who have grown up with digital devices, since games are amenable to cognitive styles that are non-linear, instantaneous, and autonomous (Butler 2015). However, there is tension between the desire to develop artistically rich and aesthetically attractive games such as *Kisima Inŋitchuŋa* and the need to incorporate established principles of second language acquisition (Peterson 2013). The *Kisima Inŋitchuŋa* game cost millions of dollars to produce yet still received critical reviews from computer gamers. The need to devote resources to creating realistic and satisfying game play makes it even more challenging for game developers to incorporate appropriate pedagogical standards. In time these development costs will likely decrease and gaming will come to play a much more important in the conservation of Native North American languages.

Social Network Sites

Social network sites are web-based services that allow individuals to connect a digital user profile with other users within a more or less bounded system (Boyd and Ellison 2008). At the beginning of the 21st century social network sites were increasingly used by Native American language activists to create secondary language communities online. The most popular of these sites was Facebook (see "Social Media" this vol.), which allows the creation of both unmoderated, open

communities that any Facebook user can join and closed communities that require moderator approval in order to join. Communication within these sites tends to be meta-linguistic in nature. Many postings are inquiries about pronunciation of an Indigenous word or a request for translation into an Indigenous language. These are largely discussions about Indigenous language rather than communication in Indigenous language. Nevertheless, social network sites offer several advantages for the promotion and maintenance of Indigenous languages.

Like other secondary language communities described by Golla (2001), social network sites offer freedom from the purism and evaluative filters that often plague language revitalization programs (cf. Dauenhauer and Dauenhauer 1998; Holton 2009). Most communication is mediated through written rather than spoken languages, so users need not fear criticism of their pronunciation. While written orthographic standards or conventions do exist for most Native North American languages, these standards are generally not enforced in the online social media environment. As with non-Indigenous languages, the rules for online communication, whether through a social network, text messaging, or some other electronic means, tend to be much more relaxed than in the domain of print publication. Communication within this online domain is viewed as ephemeral, and content is considered more important than form. Users of social network sites often feel freer to explore and experiment with Native language than they would in a face-to-face language situation.

Social network sites are also by design asynchronous, though in practice interaction takes place in a near-synchronous manner. That is, social network sites occupy a space between synchronous face-to-face conversation and asynchronous written communication. Conversations may play out over time, giving non-fluent users plenty of time to decode a posting and compose a reply. The amount of delay is up to the user and may vary with each interaction. Although users may wait days or even weeks before making a new post, more typically the delay is a matter of hours or less. This delay gives users time to consider a message and compose their reply. Such a delay would be a barrier to communication in a synchronous face-to-face interaction, but in the social network world the delay is expected and so goes unremarked. Other forms of interaction that would not be readily tolerated in face-to-face communication are also facilitated by social network sites. Participants may choose various levels of dialogic interaction, even lurking as "listeners" who read but do not reply to posts, or performing as "speakers" who post but do not respond. Lurking listeners may benefit enormously from exposure to Native language use, eventually joining the conversations in a more active role.

At the time of writing Facebook was by far the dominant social network site for Native North American languages. To better gauge the role of Facebook in Native North American language maintenance, the author conducted an informal survey in October 2014. Participants were recruited through Facebook using the author's own professional networks, and respondents self-selected. More than 100 responses to the survey were collected over a period of three weeks, and the majority of the respondents were Native American. More than half of respondents reported posting Native language content to Facebook at once a week, and more than 40 percent reported reading Native language content on Facebook on a daily basis (Figure 11). Nearly every Native language in North America currently has a Facebook group devoted to it, and in many cases there is more than one group for a given language. These groups serve as a virtual gathering space, disseminating information about language and language-related events while also providing a forum for discussing language and issues related to language revitalization.

According to survey respondents the most common postings in Facebook Native language

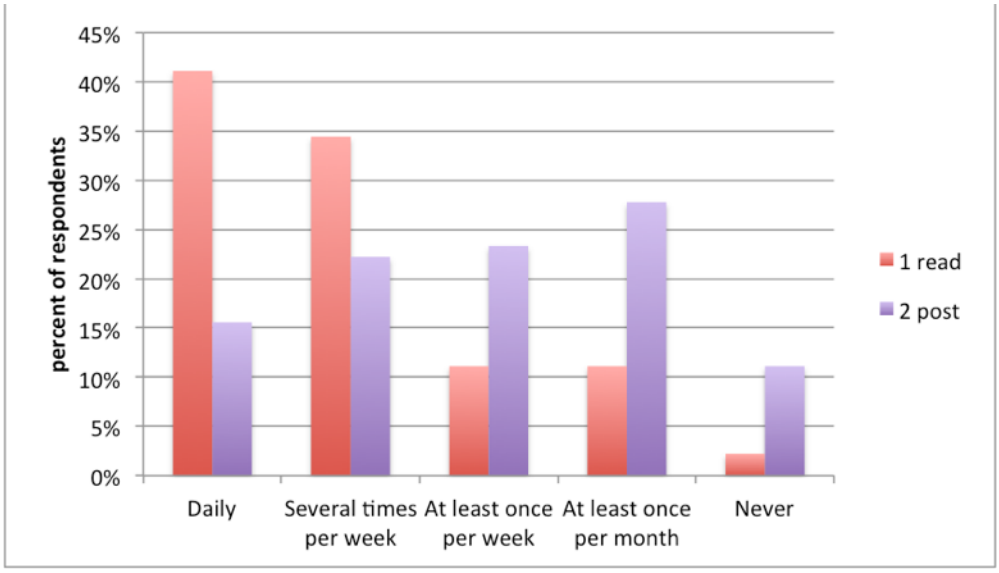

Figure 11: User reported frequency of reading and posting on Facebook Native language groups (Author's data, 2014)

groups involve asking how to say something in a language or the meanings of words, though plenty of other topics are discussed as well, as shown in Figure 12.

Inquiries can be as simple as "how do you say X," as in the exchange in Figure 13, which appeared on the Gwich'in language Facebook group. More complicated inquiries may involve multiple suggestions for translations and require members to check with elder fluent speakers to confirm word meanings. For example, a post in the Gwich'in language group asking for a translation of "never give up" first proposed *ekhè' guudòonuh sr*ò' but then generated replies with three alternative suggestions: *ehkleh uudu'uhnuuhshro'oh*, *aakha'goiinaya*, and *aakha'goiinya' shro'*. The thread finally settled on the first term, which was "verified by my elder mentor." In this way the network effects of social media provide greater access to the knowledge of elder fluent speakers.

Facebook groups also serve as venues for meta-discussion about the evolution of language and the development of grass-roots language policies. In the following exchange in the Gwich'in language group, a member expresses concern about the word *jidii atł'oo* to distinguish the color "green" from "blue." Five members participate in this exchange, using a combination of Gwich'in and English—sometimes in the same post—but the impact of the discussion is far greater since all members are able to read and follow the discussion.

Perhaps most importantly, social media provides a venue for language use. When speakers and learners are spread across several communities and distant diaspora populations, social media can provide a critical mass of language enthusiasts who can converse online. Social media platforms like Facebook provide a domain in which the default language is Native language. According to survey respondents nearly 70 percent of postings on Facebook Native language groups have at least some Native language content (Figure 14).

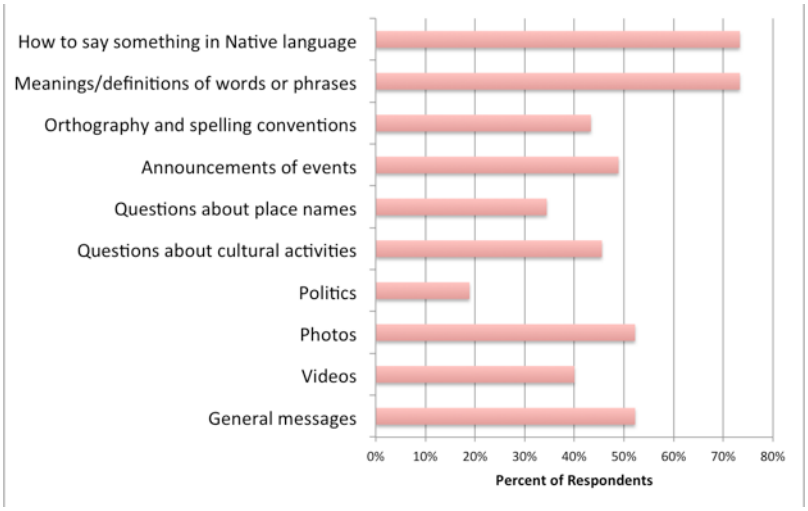

Figure 12: Topics reported as being discussed regularly or fairly often (Author's data, 2014)

Figure 13: Inquiry about word meaning on Facebook Gwich'in language group (www.facebook.com/groups/46303709235/)

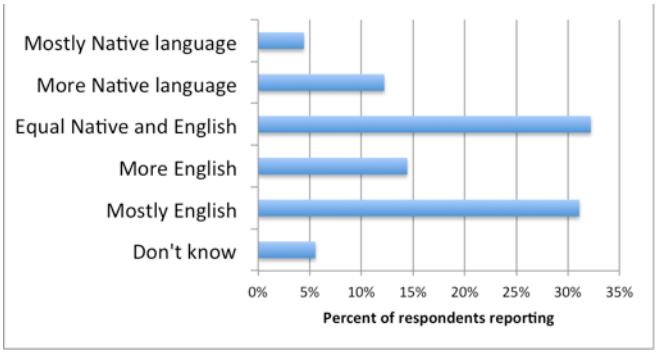

Figure 14: User perceptions of the mix of Native language and English in Facebook posts (Author's data, 2014)

Digital Media

The production and sharing of digital media—that is, digital video, audio, and photographic content—by community members serve as an important secondary domain for Native language use. Readily available tools, such as digital video recorders embedded in mobile phones, facilitate creation of digital media with Native language content. These media can then be distributed through Internet file-sharing services to a wide audience. From a pedagogical perspective the use of digital media has a significant advantage over social network sites in that it reduces the focus on literacy (Holton 2011); however, this distinction will continue to blur as social network sites such as Facebook incorporate more digital media content.

At the beginning of the 21st century, file-sharing services such Google's YouTube (youtube.com) and Apple's iTunes (itunes.com) hosted significant content in Native North American languages, much of it focused on language instruction or language performance. The Naqenaga ("our language") YouTube channel provides short video lessons demonstrating conjugations of Dena'ina (Athapaskan) verbs. The participants in the videos are often language learners themselves, so the production process itself is an important domain for language use.

Another use of digital media is the translation or dubbing of existing media into Native languages. By removing the need to create and produce video content, the creators of dubbed media can focus on the language content. The American Indian Language Development Institute at the University of Arizona has advocated this approach, resulting in the creation of dubbed scenes from several popular films. One example is a roughly eight-minute-long scene from the film *Star Wars: The Empire Strikes Back*, dubbed into Tuscarora (Iroquoian) (Chew 2015). A more elaborate project undertaken by the Navajo Nation resulted in the dubbing of the entire original Star Wars film into Navajo, using a team of translators and actors. Dubbing projects require the creation of new vocabulary and thus help to demonstrate that Native languages have a place in the contemporary world, countering assumptions that Native languages are limited to traditional domains.

Finally, digital media can also provide a space for linguistic performance, particularly music. YouTube hosts many examples of musical performance in Native languages, including traditional music, new music, and translations of popular music. The Alaskan Yup'ik music group Pamyua has produced new music in the Yup'ik language, incorporating traditional elements and modern themes (Pamyua 2016). Translation of popular non-Native music provides another route for bringing Native language into the contemporary world, as exemplified by Kelly Fraser and Martha Kyak's translation into Canadian Inuktitut of the popular song "Diamonds" (Kyak 2013).

Creating a Virtual Space for Language Use

The various digital technologies work together to create secondary language communities and thus provide a space for Native language use. A common feature of all of these technologies is that they make use of English (or French, or Spanish) as the interface language. That is, these tools are *about* Native language, not *in* Native language. Still, these digital tools have great promise to support continued maintenance of Native languages. One of the greatest challenges facing the continued maintenance of Native languages in North America is finding a domain for use of the language. Non-Indigenous languages have taken over most domains of daily communication, including work, education, politics, and mass media, leaving little room for potential speakers to

use the language. Emerging secondary digital domains now provide an explicit virtual space for language use.

Conclusion

Since the *Handbook of North American Indians* series was conceived in the 1960s and implemented in the 1970s to the 1990s, new digital domains have emerged for Native North American languages, leading to the establishment of both primary and secondary language communities. As we enter the new millennium none of these languages has a fully thriving primary community, though almost all Native American languages have developed secondary communities, particularly through the use of social media. Secondary communities now exist even for languages that were silent for many years. It is important to bear in mind that the technologies associated with secondary digital language communities are ephemeral. Websites, mobile apps, and social network sites will disappear over time. Holton (2011) notes the large number of websites that are themselves either endangered or inaccessible owing to shifting web technologies. For example, a Shoshone video game developed in 2013 is no longer accessible (web.archive.org/web/20130904020758/http://theeneegame.com/). Digital technologies require constant maintenance and upkeep. Commercial products may cease to be available to language communities, as with the now-defunct Orkut social media site. While digital technologies can facilitate communication in Native American languages, thereby contributing to language maintenance, the inherent fragility of these technologies renders them less useful for preservation of those languages.

The shifting and evolutionary nature of digital technologies reinforces the critical importance of one digital domain not discussed in this chapter: the digital archive. The sine qua non of digital archiving is attention to long-term preservation of digital data in perpetuity. Digital archives of Native languages will thus ensure that the underlying digital data on which all of the technologies discussed here draw will continue to be accessible into the future (Barwick 2004).

Digital archives serving Native North American languages include the California Language Archive, the Alaska Native Language Archive, the American Philosophical Society, and the National Anthropological Archive. These and other digital archives will play a crucial role in the future of Native languages in the digital domain. Digital archives can also play a more direct role as a catalyst in language revitalization efforts (Berez and Holton 2006; Dobrin and Holton 2013), especially as archives are increasingly developed and maintained by tribal entities rather than non-Indigenous academic institutions (Shepard 2014). Archival materials can supply resources for the development of future digital domains using technologies that have yet to appear. That said, digital archives and secondary digital communities created from them cannot replace the communicative function of language. Kornai (2013:2) compares archival language resources to museum objects and argues that online audio files of an elder tribesman reciting folk poetry "will not facilitate digital ascent." This statement should not be interpreted as an argument against digital archiving, but it provides an important caution regarding the role of archiving in language maintenance. Language archiving is necessary and desirable, but archiving alone is not sufficient to maintain language as a communicative form.

The question remains as to whether Native languages will be relegated to secondary communities or whether it will be possible to develop primary digital communities for these

languages as well. As discussed in this chapter, the current prospects are not promising. Only one language, Kalaallisut, currently has an active primary digital language community, with support for text input and spell checking. As language use moves into the digital realm, Native American languages risk being left behind in a digital-only world. Even those languages that are still being acquired by children may be doomed if they fail to effect a digital transition by providing support for digitally mediated communication (Kornai 2013). The extent to which Native American languages can be maintained without digital support remains an open question, but languages that lack digital support will clearly face significant barriers in an increasingly digital world. Native American youth born in the 21st century are being raised in a world of digital communication, and if they are faced with a choice between non-digitally mediated communication in an Indigenous language and digitally mediated communication in a non-Indigenous language, it will be difficult, if not impossible for them to continue use of Native language.

It is worth noting that the challenges presented by the digital realm are not unique Native North American languages; many major world languages currently lack adequate digital support. In a recent comprehensive survey of 30 European languages, only English was found to have "good" support for the four primary language technology areas of machine translation, speech processing, text analysis, and speech and text resources (Rehm and Uszkoreit 2012). As with Indigenous and minority languages across the globe, the future of Native North American languages is now intimately tied to the digital domain. Language use across the world has moved into the digital realm, and this shift is unlikely to be reversed in the foreseeable future. Two decades ago it was possible to argue that the digital realm was less crucial to language maintenance. In evaluating the prospects for language revitalization Joshua Fishman (b.1926, d. 2015) who pioneered the work on bilingual education, language revival, and planning, argued,

> Although cyber-space can be put to use for [reversing language shift] purposes, neither computer programs, e-mail, search engines, the web as a whole, chat boxes or anything directly related to any or all of them can substitute for face-to-face interaction with *real family embedded in real community* (2001:458, emphasis in original).

Fishman could not have foreseen the 21st-century digital revolution and the concomitant rise of digital domains that are now no less *real* than face-to-face communities. Whether or not Native American languages can be sustained solely through digital communities remains an open question. There is certainly no "technical fix" that can by itself lead to continued language survival (Dauenhauer and Dauenhauer 1998). However, without digital technologies Native American languages cannot continue to play a role as communicative systems.

This is ironic, given the devastating effect that 20th-century media had on Native languages. Michael Krauss noted the correlation between the timing of the introduction of television in rural Alaskan villages and onset of language shift to English, referring to television (an emerging technology at the time) as a "cultural nerve gas" that quietly and insidiously destroys culture and language (Lewan 1999). To this day the community of Arctic Village, where television did not appear until 1980, remains one of the most viable Dene language communities in Alaska. It is thus tempting to assume that new digital technologies will have equally devastating impacts, effectively finishing the job. But as discussed in this chapter, there are reasons to question that

assumption. Where 20th-century media were passive, new digital media are interactive. Native peoples in North America are taking control of these digital domains in ways that actually support and enhance Native languages.

As the 21st century began, a seminal article asked, "Can the web save my language?" (Buszard-Welcher 2001). The short answer to this question is of course negative: neither the web nor any other digital technology alone can save a language. Living languages require communities of speakers, and technology cannot substitute for that. However, digital technologies can foster these communities, as is now happening across Native North America. Many of these efforts are helping to bring Native languages into the modern world and dispel notions that Native languages are associated with the past (cf. Ward and van Genabith 2003). Moreover, though not discussed in this chapter, it has often been argued that documentation should be the highest priority for severely endangered languages with only a few remaining speakers (Hinton 2001:413), and digital language technologies can also support language documentation (Thieberger 2012; see "Native American Languages in the New Millennium," this vol.).

Digital documentation and archiving will at the very least allow Native American languages to be carried along with the rising digital tide, but maintaining these languages as vehicles of communication in a new digital world will require increased support at the level of operating systems, input methods, and other digital resources. To rephrase Buszard-Welcher's original question: Can we save languages without the web? The answer is clearly "no." Digital technologies are not merely providing new domains for Native languages; they are facilitating the transformation of Native languages into a world in which digital communication is the norm.

Sources

The *digital technologies* discussed in this chapter are likely to become obsolete over time; however, several online discussion lists keep abreast of ongoing developments in language technology. Phil Cash Cash maintains the Indigenous Languages and Technology listserv (www.u.arizona.edu/ cashcash/ILAT.html), and Living Languages maintains a listserv and a website (livinglanguages.org.au//). Richard Littauer maintains a repository for open source code serving endangered languages (Littauer and Paterson 2016). The journal *Language Learning & Technology* (llt.msu.edu/), published three times a year, provides a peer-refereed forum for discussion of current issues in educational technology for languages, including but not limited to Native North American languages.

Digital archives serving Native North American languages include the Alaska Native Language Archive (www.uaf.edu/anla); the Archive of the Indigenous Languages of Latin America (www.ailla.utexas.org/); the California Language Archive (cla.berkeley.edu/); the Sam Noble Museum of Natural History (www.snomnh.ou.edu/); and the American Philosophical Society (amphilsoc.org/cnair). All of these archives are members of the Digital Endangered Languages and Musics Archives Network, an international umbrella body promoting standards for archiving endangered languages and cultures worldwide.

A list of Indigenous *language apps* can be found at the Resource Network for Linguistic Discovery (https://web.archive.org/web/20200217120239/www.rnld.org/languageapps), although this site is no longer maintained. Ogoki Learning Systems, creator of the Ojibway app

discussed in this chapter, provides a list of Native American apps that can be downloaded for free (www.ogokilearning.com/native-american-language-apps/). FirstVoices produces apps for several Canadian languages (www.firstvoices.com/en/apps). Several Native American apps are reviewed by Petersen (2013).

FirstVoices (www.firstvoices.com) has also produced language learning games for several Native American languages. Petersen (2013) reviews the literature on computer gaming and language learning more broadly.

A list of different language editions of *Wikipedia* can be found at en.wikipedia.org/wiki/List_of_Wikipedias. A description of the Wikimedia Incubator, with instructions on starting a new Wikipedia in a language, can be found at incubator.wikimedia.org.

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