The main purpose of this research is to determine whether appropriate technology can contribute towards revitalization of the Myaamia language. Language revitalization refers to the development of programs and other learning opportunities that result in re-establishing a language, which has ceased being the language of communication, and bringing it back into use in everyday life. Although it seems possible that various technologies can play an important role in these efforts, a survey of language revitalization programs has shown little assessment of the role of technology in language revitalization. In this project, a case study was done to determine, to what extent, if any, appropriately designed technology (in this case a Smartpen) can be useful in Myaamia language revitalization efforts. The result collected, after participants had used the research material, showed that technology, if configured appropriately and made interesting and purposeful, can play an important role in language revitalization efforts.
SMARTPEN TECHNOLOGY AND REVITALIZATION OF THE

MYAAMIA LANGUAGE

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1. Introduction

Language revitalization refers to the development of programs and other learning opportunities that result in re-establishing a language, which has ceased being the language of communication, and bringing it back into use in everyday life [12]. A language that is not a language of government, education, commerce, or used widely in other community domains is a language whose very existence is threatened in the modern world [12]. At Miami University, the Myaamia Project is engaged in revitalizing the Myaamia Language amongst members of the Miami Tribe of Oklahoma. The Myaamia language is one of many languages in the United States that is experiencing revitalization by community members.

Computer technology alone cannot save a language. However, any technology if designed appropriately can play an important role in supporting language revitalization programs. At the time of this research, formal assessments on the role of technology in indigenous language revitalization programs were scanty at best. A recent technological survey indicating the absence of data on this issue was one of the major motivating factors for conducting this research [10].

This thesis is a study of the potential for technology, specifically Smartpen computing technology, to support the Miami Tribe of Oklahoma’s work in revitalization of the Myaamia language.

2. Background and Related work

2.1. Myaamia Language Research Materials

The impact of technology on language revitalization is not an area of research that has been thoroughly explored. The fact that the Myaamia language was formally a sleeping language, and only in the last 15 years has been experiencing a revitalization effort, means that most publications about the revitalization effort for this language are recent and few. The major source of research materials came from the Myaamia Project Office, which has been engaged in the revitalization effort on Miami University’s campus since
2001. Other additional sources of research materials come from looking at similar tribes (i.e. small language communities who had few or no speakers remaining). One particular language group that had the most research available is the Hawaiian language. Although it may be a stretch to compare these communities for a number of reasons, it was quickly pointed out by the Myaamia Project staff that caution should be exercised about using the successes of one group to define the successes of another. For this reason, care was taken when using materials involving the Hawaiians and the application of their findings to the Myaamia Tribe effort.

Not surprisingly, it was difficult to locate any journals, articles or papers that specifically address benefits of specific technology to the Myaamia Tribe, or any small tribe for that matter. Some of the software that was looked at, like the Hawaiian *leoki*, only offers advantages to the individual user and to the best of the knowledge of the researchers involved in this project, there has been no research that specifically quantifies benefits to the larger language revitalization effort. In other words, this study contributes to a new and developing area of research where there are few relevant resources. The hope is that this research will encourage others to begin looking more closely at the role of technology in native language revitalization.

### 2.2. Language Revitalization and Technology

Many Native American communities in the United State are engaged in language and cultural revitalization in both formal and informal ways. The Myaamia Project at Miami University of Ohio has already been mentioned as an example. One of the most advanced and talked about effort is the Hawaiian revitalization project currently undertaken at the University of Hawaii. Other encouraging work is being conducted through the American Indian Language Development Institute at the University of Arizona, and its focus is on the effects of technology in language and cultural development [10]. The following is a review of work that has been carried out on language revitalization.
Hinton [12] reviews different approaches used in various language revitalization efforts like school-programs, adult language programs, and home-learning. However, this work does not discuss the role of technology in these language revitalization efforts. The absence of any discussion about the role of technology indicates a lack of information or data on the subject. Warschauer [27] discusses research conducted on the role of technology on Hawaiian culture. His paper includes a discussion on one of the first online bulletin board in the world, which was done entirely in the native language (Hawaiian). Issues discussed include; the positive and negative roles of the Internet on the Hawaiian culture, the role of multimedia in non-western communication, and the role of the Internet in exploring and discussing cultural identities. However, the paper does not provide a methodology used to measure the impact of technology on the Hawaiian culture, and no specific results are attained from the analysis of collected data. In an attempt to discuss the survival of indigenous language in recent years, Walsh explores efforts in language revitalization and documentation and the engagement with indigenous people [25]. The author concludes that it is unclear why some language revitalization methods fail while others succeed. What is clear, according to this paper, is that the process of revitalization is profoundly political. However, this is not the direction this research is intended to go. This research is more concerned with the study of the impact of technology on revitalization.

Diepes investigated the use of technology in Native American language revitalization [29]. His work reviewed the literature on language revitalization and technology and identified the following recurring themes [29]:

1. Funding: The comparably low cost of technology is one of the generally recognized benefits.
2. Bridging distance: Technology and the Internet in particular can help connecting scattered communities.
3. Technology can only be part of greater efforts.
4. Indigenous communities are diverse so diverse ways of dealing with revitalization of languages are required.
5. The degree of openness a community shows toward outside experts is significant for the likeliness of successful revitalization efforts.

Through the use of case studies of three Native American tribes, the Confederated Tribes of Grand Ronde, the Confederated Tribes of Siletz Indians (both in Oregon), and the Miami Tribe of Oklahoma, Diepes made the following conclusions:

1. Technology plays a central role in the revitalization efforts of all three communities investigated.
2. Technology is used in all cases to raise awareness about ongoing revitalization efforts. Technology is chiefly used to bridge the distance between scattered communities.
3. Technology offers an economical way to distribute language materials and connect scattered communities. Up to date technology can make language and culture more relevant in present day life.
4. Technology can only be part of the larger efforts. Older forms of technology or data storage become obsolete. Some types of technology, such as online dictionaries, are very work intensive.
5. Any form of technology can help to raise the prestige of culture and language and simultaneously increase community involvement. The Internet has enabled wide access to language materials. Computer games, websites, blogs and social networking sites can provide new language domains.
6. Bridging the generational gap: language transmission to children. Although technology can play a supporting role, immersion schools and family are the most important domains for language transmission to children.

Galla [10] explains how technology has been employed in efforts towards the revitalization of the Hawaiian language. However, the author notes that no major efforts have been made towards measuring the impact of technology in language revitalization, which is the purpose of this research. Her work focuses on both traditional and contemporary cultures and finding new ways to practice and preserve culture, where a computer system comes in handy. The research is based on the Hawaiian tribe, of which
the author is a member. However, most aspects of the discussion in her paper apply to other indigenous tribes. The Internet is a useful tool when it comes to these efforts because it allows indigenous people to search for material, download readily available files (music and other learning material), and communicate to each other via email. The author also looks at technological examples by other indigenous language communities, which have unlimited access to digital audio recording, e-mail, live chat, video recordings, interactive audio video conferencing, or surfing the Internet to playing computer games. The author classifies these technologies into three categories: [10]

i) Low-tech initiatives: these emphasize one sensory mode, allowing the learner to receive the indigenous language through sight or hearing e.g. a movie in Hawaiian with no subtitles or subtitles in another language other than Hawaiian. Another example is having a movie in English with subtitles in Hawaiian.

ii) Mid-tech: Here, one is able to hear and see the indigenous language e.g. a movie in Hawaiian with Hawaiian subtitles.

iii) High-tech: These enable synchronized or asynchronized communication or multimodal interactivity between the user and the technology. By using technologies that are current, the youths, who tend to want to be at the forefront of new technology, can easily be engaged. Some examples here are blogs and audio conferencing.

As will be seen later in the discussion, the application that was developed in this research falls in classification iii, because it allows user interaction. Since the research is based on revitalizing the Myaamia Tribe’s language and culture, a brief discussion on the Myaamia Project follows next.

2.3. The Myaamia Project

The Miami Tribe of Oklahoma, which is the original source by which Miami University of Ohio takes its name, is composed of a population exceeding 3,500 citizens scattered around the U.S. Three populations are concentrated within the states of Indiana, Oklahoma and Kansas. These population centers reflect the forced removal route that
began in 1846. After years of treaties and land loss, many Myaamia people were loaded on canal boats in north central Indiana and forced to a reservation in eastern Kansas, with a portion remaining in the ancestral homelands. By the 1850s the Miami reservation in Kansas was allotted and by 1870, tribal members living in Kansas were forced to endure a second removal to Indian Territory, which became the state of Oklahoma. Today, the seat of Miami tribal government resides in Miami, Oklahoma. By the early 1900s the land base had been reduced to individual allotments and the tribal entity held no communal land. It took the economic ventures of the 1990s to create a financial resource for the tribe to purchase its current 1,500 acres of land holdings in today’s North Eastern Oklahoma. In the early 1960’s the last native Myaamia speakers passed but due to extensive documentation on the language, it is currently undergoing a successful language reclamation effort [3].

One of the central outcomes of the Myaamia Tribe’s effort to revive their language was the development of the Myaamia Project at Miami University in July 2001. The aim of the Project is to advance the language and cultural research needs of the Miami Tribe [3]. Some earlier efforts of the Myaamia Project include the following [4].

**Children’s multimedia:**

This project aims at developing interactive media programs to aid children in learning the Myaamia language. Dr. Bob Vogel, Dr. Doug Troy, and Dr. Glenn Platt of Miami University, Ohio, led a class in the spring of 2009 that developed an interactive multimedia computer game to reinforce children’s leaning of the language [4].

**Myaamia language research:**

This ongoing research continues to uncover vast amounts of linguistic information from the many thousands of extant pages of language materials dating back to the late 1600s. It is estimated that of the available materials, tribal linguists are approximately 30-40% through the documentation after over 20 years of work.
Ethno-Botany:

This project involves the study of plant use in the Myaamia Culture. Elder knowledge, in conjunction with nearly 250 plant references form the written records, were utilized to conduct the first major ethno-botanical study of the Myaamia Tribe. Important ecological knowledge and ethno-botanical uses were uncovered and are currently being utilized in land management practices and educational programs with tribal youth.

Historical landscape of Myaamia:

This research is aimed at reconstructing the historical cultural landscape of the Myaamia people. Reasserting place names and understanding the historical ecology of the homelands yields important information about the interaction of people and place [4].

Lunar calendar:

The purpose of this research is to reconstruct the Myaamia Lunar Calendar and to utilize this information to strengthen ecological ties, observe seasonal occurrences and to revitalize the traditional time keeping system all in the context of Myaamia language and culture [4].

Myaamia cookbook:

This project emerged out of the previous ethno-botanical work and has uncovered a vast amount of information regarding the traditional diet of the Myaamia people as it relates to plants. The goal of the project is to educate tribal members about the benefits of a traditional diet in response to the many current health issues in the community, diabetes being one of the most prominent. The product will be an easy to use cookbook designed to help tribal members identify, store, and prepare traditional foods for every day eating. In addition, it also provides an aid to healthy eating through making the correct choices as regards to nutritional choices.

Jesuit document translator:

This ongoing research is aimed at transcribing and translating the early 18th century language documents of the Jesuit missionaries who lived among the Miami-Illinois people. These older documents have a unique cultural and historical purpose in the overall work of Myaamia language revitalization [4].
The Myaamia Project also provides, among other things, a link to the Miami Tribe of Oklahoma’s website, an online Miami dictionary and a link to the past conferences (Myaamiaki Conference) – which contains video and pictures of events during the conferences [4].

Other links provided on the Myaamia Project website are, a list of publications including: The Lunar Calendar, Myaamiaki Eemamwiciki: The Miami Awakening, kaloolitiitaawi: A myaamia phrase book, animal, birds and insect flush cards and a Miami Children's Book of Language [4].

Many of the Myaamia project activities are aimed at supporting a home-learning environment conducive to learning the Myaamia language and culture. The Myaamia Project has identified a group of Myaamia families who are willing to use and evaluate the language-learning materials [3]. These families played a key role in the case study used by this project, as will be discussed later.

**2.4. Challenges to Language Revitalization and Related use of Technology**

The following are some challenges facing Native American tribes and ways in which technologies might assist language revitalization [27].

1) **Preservation of native languages and culture**

For centuries, the U.S. government policy has supported forceful assimilation of native people into the larger society. These concerted efforts have been destructive towards native language and cultural practices. Of the 175 native languages currently spoken, nearly 90% are moribund, meaning they are no longer being passed fluently to the next generation. Linguists and Anthropologists have long recognized that the loss of these languages means the loss of entire human knowledge systems, which is a loss to all of human society. Tribes also feel these shifts and are concerned over their ability to preserve their cultures and thus their unique cultural identity. What was once maintained through oral
tradition is quickly becoming dormant and socially more difficult to perpetuate. Although for some tribes there is extensive documentation, many are lacking documentation and some cultures are resistant to any attempt to document traditional knowledge. However, some tribal programs, various scholars and archivists have made some efforts to document and make heritage resources available to those interested in learning. A good example is the Hawaiian Leoki (powerful voice), which is the first bulletin board done entirely in a native tribe.

2) **Dissemination of new materials**
   The Internet is viewed as a tool to develop and disseminate earlier materials. It is particularly important because there are a few native speakers who are dispersed and textbooks are much more expensive and therefore it provides a powerful outreach tool.

3) **Forging connections**
   According to Fishman, the key to language revitalization is to achieve an ‘intergenerational and demographically concentrated home-family neighborhood’ which is the genesis for mother tongue transmission [8]. As noted earlier, the problem in many Native American communities is the dispersion of tribal members in different locations. However, through the Internet, small dispersed communities, without tribally controlled schools of their own, have been able to take classes online through immersion programs.

4) **Achieving relevance, significance and purpose:**
   One important aspect of a language is for it to be seen as important for the future and not just learning the past. Hornberger states that, “Language revitalization is not about bringing the language back, but bringing it forward” [13]. Native people have suffered from centuries of English only policies and view language and cultural revitalization as an important aspect in developing a socially sustainable future for their communities. The use of computers to learn a language is proving important because it is popular with the younger generation. For a language to be
relevant, it must be one that can be used in the present as well as the future. Technology makes achieving language relevance possible since it can be employed in many aspects of life, some of which will be addressed by this research.

2.5. Computing and Language Revitalization

As mentioned earlier, Galla explores the role technology plays in language revitalization [10]. Although technology can be viewed as having negative and positive influences in culture preservation, the focus of this research is mainly on the identification of positive aspects. A few major areas in which technology might play a key role in revitalization efforts have previously been discussed. Some examples of technology use include digital audio recording, e-mail, chat, video recordings, interactive audio video conferencing, and uses that range from surfing the Internet to playing computer games. Teachers are challenged to find which technology their students interact with on a day-to-day basis and try to incorporate them in their teaching or everyday interaction. Technology can provide opportunities to communicate and interact using the language. An important note is that technology should be the media that aids learning by keeping language learning as the goal and outcome of the media experience. However, students are bound to reap double advantages i.e. learning the language and becoming familiar with technology at the same time.

2.5.1. The culture of computing

As mentioned above, technology can be viewed as harmful or beneficial to language revitalization. How neutral or non-neutral is technology to the culture? To examine this issue further, Galla’s conclusion has been provided as an example perspective.

“There is a huge gap pertaining to technology and indigenous language revitalization that needs attention. In order to indicate whether technology has an impact (positive or negative) on language learning, a research study, as well as a language assessment, must be conducted. The overall sense from the published articles on indigenous languages suggests that there is a general
“contentment” and satisfaction to what technology has provided. Yet there is no data that shows that the technology used in the classroom has affected language learning in any way. The literature does not reveal whether students are evaluated in content areas and skills or if the use of technology was assessed. A self-assessment would be a possible tool to evaluate growth and development of the language learner. Using self-assessment, students can track their own progress and become responsible for their learning and their potential. Overall, the critical assessment and in-depth study on the integration of technology and the indigenous language should include at bare minimum the program used, the purpose of the tool, how the tool is actually being used, how the students are being assessed, what is being assessed, and overall effectiveness. In addition, it is important to note how the tool has made its way into the classroom; was the technology integration initiated by the teacher, school board, student, IT director or was it a requirement from a higher administrator?” [10]

This research aimed at investigating the issues raised by Galla; determining a way to assess the impact of technology in language revitalization with a focus on potential benefits. Examples of technology such as the Internet were mentioned earlier. In this research, the focus is on a promising new technology: The Smartpen.

Currently, digital pens fall into two categories; those that let users write anywhere using wireless positioning technology and those that employ specialized paper to track a pen’s movement. The various pens, falling in any of the two groups, which were considered for implementing the application in this research and why the Livescribe Smartpen (discussed in section 2.6) was chosen over them, are discussed next.

2.5.2 The Digital Pens:

a) Nokia Pen:

The Nokia Digital Pen allows one to create colorful and personal multimedia messages (MMS). One can draw a picture or write something, and send it to the compatible phone
that supports Bluetooth wireless technology. The image can then be displayed on the phone or forwarded as a multimedia message to another compatible phone or to an e-mail address. The Nokia Digital Pen also allows one to write meeting minutes or personal notes, and save them in a PC. The Pen can save up to 100 A5 pages. All these pages can be sent to a PC by placing the pen in a connectivity stand, which is connected to the PC through the USB port [23]. See figure 1.0 for the Nokia Pen.

![Nokia Pen](image)

**Figure 1.0 Nokia Pen [35]**

**Advantages**

- Just like will be seen with the Livescribe Smartpen, this pen is compact making it look more like an ordinary pen rather than a computer
- The fact that it can use both Bluetooth and USB connectivity makes it convenient to many situations e.g. when one does not want to tether the pen, they will use the Bluetooth
- The animated desktop playback allows for the creation of many graphics

**Disadvantages**

- The USB download requires a brief Internet disconnection which may be inconvenient if one is running other applications that relay on the internet
It does not have capability to allow users to develop custom applications that can interact with paper projects. This means that it does not also have capability to enable the design of paper projects like will be seen with the Livescribe Smartpen. It is the last disadvantage that made the choice of Livescribe Smartpen easy. As will be explained in the software design section, the aim was to develop a paper application that could interact with the software application (penlet) that was developed. As can be seen from the discussion of the Nokia Pen, this capability is not possible with the Nokia Pen. However, efforts have been made by a group to develop a paper tool kit to work with the Nokia Pen [29]. The Stanford HCI group started a paper application which has however since stalled and are offering the project to a willing party. The team involved in this research was at one point thinking about taking up this project so that it could employ the Nokia Pen. That, however, was prior to the pre-release of the Livescribe SDK 1.0 for the Livescribe pen. With the release of the Livescribe SDK 1.0, it was bound to be less time consuming than pursuing the incomplete Stanford project for the Nokia pen.

b) The Leapfrog Tag and Fly Fusion Pen

Leapfrog markets two digital pen products, the Leapfrog Tag and Fly Fusion Pen. The popular Leapfrog Tag product combines children’s books with a digital pen so that a child can point the pen to the words and illustrations of a book and the pen will “read” the text or describe a picture. See figure 2.0. This product is very similar to the product ultimately developed for this research and would have made an excellent platform for the products developed for this research. However, the system is proprietary and Leapfrog does not provide an environment for developing custom books and software for the Tag pen.

The Fly Fusion pen uses the dot paper technology, called FLY Paper, which is discussed in section 2.6.1. It is very similar to both the Nokia Pen and the Livescribe Smartpen in the manner in which the notes written on a special paper are captured, digitized and transferred to a computer using a USB cable. Just like the Nokia Pen, the software can be bought or downloaded online after connecting the pen to the computer through the USB cable. See figure 2.0 for the pen image.
This pen however does not have the capabilities to allow users to design their own custom applications and as such, just like the Nokia Pen, it could not meet the requirement of this project.

c) **IOGEAR’s Mobile Digital Scribe**

This is the first device ever to capture natural handwriting from any surface, and store it in the receiver for future use. It uses ordinary ink to write on any paper. The Mobile Digital Scribe stores handwritten notes, memos or drawings for easy upload to any computer at the user’s convenience. Unlike other pens that have been discussed, no special digital notepad is required [30]. Also, when the Mobile Digital Scribe is connected to a computer, handwritten text and drawings are displayed directly on the computer screen just like the other pens. As with the above described pens, it was not chosen because of lack of capability to allow developing custom applications as the research demanded. See figure 3.0 for the image of the pen.

![Image of IOGEAR’s Mobile Digital Scribe](image-url)

**Figure 3.0 IOGEAR’s Mobile Digital Scribe [30]**
d) Dane-Elec’s ZPen

Dane-Elec’s ZPen allows one to write with the pen on any kind of paper and upload the handwritten notes on a PC and view them on screen just like the other discussed pens. It also enables finding keywords back on the handwritten notes. The handwritten notes can be converted to digital text, to be used in the standard word processing [31]. This pen was not used for similar reason that was mentioned for the other pens. See figure 4.0 for the image of the ZPen.

![Figure 4.0 Dane-Elec’s ZPen [31]](image)

Other pens considered from Logitech and Sony Ericsson, like the other discussed pens, do not support developing custom applications.

2.6. Livescribe Smartpen Technology

Though many details in this section also apply to the pens that have already been discussed, the focus of this research is on the Livescribe Smartpen. The Smartpen technology, produced by the Anoto Group, is a combination of pen, computer, and special paper that allows written words, drawings, and audio to be captured by the pen, processed, and transmitted to other devices. Figure 5.0 illustrates the basic design of a Smartpen.

![Figure 5.0 Smartpen internal features [1]](image)
There are various versions of the pen, based upon technology produced by the Anoto Company. Besides a processor and memory, some versions include a microphone and speaker for audio capture and playing, an infrared camera for capture of handwriting and drawings using special paper, a small LED display, a USB connector, and a wireless transceiver.

Some commercial applications of the Smartpen are: Use by college students for taking notes and recording lectures, data entry in warehouses, data entry in the healthcare field, and a number of pen-based software applications that include language translation, in which a user can write a word in English and the pen will speak the translation in another language, and games.

As was stated, this thesis is an investigation of the potential for Smartpen technology to support the language revitalization of the Myaamia Tribe. The following section describes the Smartpen technology in more detail.

2.6.1. How the Smartpen works

The Paper
Anoto Smartpens work with paper that is printed with a unique pattern, a dot pattern. See Figure 7.0. The dot pattern allows the Smartpen’s software (through the camera) to uniquely identify each page, and the position of the pen on the page. This allows the pen to execute software based on the position of the pen on the paper. For example, a calculator with numbers and math operations can be printed on the dot pattern paper and the pen can be programmed to execute a calculator program when the pen is touched to the printed calculator [1].

The Pattern
The Anoto dot pattern, which is almost invisible to the naked eye, is composed of many small black dots that can be read by a digital pen. The pattern marks the exact positions of the digital pen on the paper. Another striking thing is that the pattern on each paper has a unique identity enabling each page to be distinguished from each other.
The Smartpen can use two types of papers:

- Open paper (OP)

This refers to the sections of the dot paper that various pulse Smartpen applications can be associated with at runtime. When an application runs and a user writes on this section, the application can claim the dots in the regions. See figure 6.0 for the open paper region.

- Fixed Print (FP)

These are the regions defined during an application development. No application is allowed to claim them at runtime. These areas are identified by printed graphics, mostly as paper controls [18]. See figure 6.0 for the fixed print region.

![Figure 6.0 Pen, open paper and fixed print [18]](image)

Also see figure 7.0 for the dots on paper.
The Pen

The Smartpen resembles and feels like using an ordinary pen, as shown in Figure 6.0. The difference though is that it contains an integrated digital camera, an advanced image microprocessor and a mobile communications device for wireless connection as shown in figure 5.0. When used with the Anoto paper, a Smartpen can capture, store and then securely send the handwriting to a computer. The discussion below shows how a Smartpen converts and transfers ink to digital data [1].

When writing

When writing, the digital snapshots of the pattern on the paper are automatically taken by the Smartpen’s camera at more than 50 pictures per second. Every snapshot contains enough data to determine the exact position of the pen and what it writes or draws, including the time each pen stroke was made as well as which particular paper page was written on. The pen data contains all information about the pen strokes written on the page which includes:

- The location (coordinates for each pen camera picture taken by the pen)
- The exact time when they were written
- Who wrote them
- The identity of the paper form and of the specific pages
This data is then retained in the pen’s memory inform of a series of coordinates. The pen can store up to 50 full A4/Letter size pages of handwritten data [1]. See figure 5.0 for the pen and its important components. Also see figure 8.0 for the Smartpen and paper.

![Figure 8.0 Smartpen and paper (book) [1]](image)

**Transferring data from pen to a computer**

Data capture by the pen can be transferred to a PC using a USB port. This capability is used by Note-taking applications (marketed to college students) and in data entry applications. The Smartpen applications in this research did not make use of this capability.

One of this research’s objectives was to develop an application for the Smartpen (called penlets) that was to be employed in language revitalization using the Livescribe Smartpen. Penlets and the associated penlet Software Development Kit (SDK) 1.0 are described in the next section [20].

**2.6.3. The Penlet SDK 1.0**

The development environment for Livescribe penlets is the Eclipse Integrated Development Environment (IDE) and the Livescribe penlet SDK. It consists of the open-
source Eclipse IDE with custom plug-in written by Livescribe. The plug-in is packaged as Eclipse feature, which supports both Windows and Mac [20]. Note that the documents provided with the SDK provide detail information on what is needed to develop a successful pen and paper application. These documents also provide a step by step instruction on how to install the requirements and where to find everything and consequently, they are the best source of information for any Livescribe developer.

The Penlet SDK provides a Java Application Programming Interface (API) that enables developers to program penlets and load them to the Smartpen. An Eclipse plug-in is provided for programming. To facilitate application development, the API provides classes and methods and sample applications that contains features that can help developers. Through the API in general and these sample applications, one can do open and fixed paper application development, character recognition, stroke capture, pen event handling, nav plus menuing to switch applications, persistent application storage, and pulse Smartpen display operations [18].

The SDK 1.0 supports the following platforms:

- Windows XP SP2/SP3 and Windows Vista
- Mac OS X 10.5.x on Intel (Leopard)

In addition to the platform, developers must have the following to be able to develop pen and paper applications:

- JDK 6 and above. Note that the JDK is required since the JRE alone will not suffice. This can be downloaded at the Java Sun website.
- Eclipse 3.4, called Ganymede, is the preferred version of Eclipse. However, Eclipse 3.3, Europa, and Eclipse 2.2 are also supported. These various versions of Eclipse can be found at the Eclipse website. If one chooses to use the Eclipse version provided with the SDK, in the EclipseFullInstall folder, there would be no need to configure Livescribe plug-in in Eclipse because this action has already been performed. Consequently, the use of the provided Eclipse is recommended.
- Another option, instead of Eclipse, is NetBeans 6.1 or above which can be downloaded at http://www.netbeans.org.
• Gostscript and Ghostview – These are applications for viewing Postscript printer files which are freely available online.
• Livescribe Desktop – This will be discussed in the next section.
• Audio editing software such as Audacity, which is freely available.
• Image editing software such as Adobe Illustrator or Gimp.
• A Postscript-enabled printer like the Xerox color printer.

To download the SDK, developers must first register as a developer in the Livescribe Developer Group [17]. Instructions on how to do this are given on the Livescribe website and once one has registered, downloading should be straight forward.

2.6.4. Other Resources

The Smartpen has the capability to play audio files and display images only if the resource files are formatted suitably. Images must be in Livescribe-specific ARW (raw image file) format, while audio must be any of WAV (Windows Wave), WavPack or AAC-LC (Advanced Audio Coding-Lossy Compression) files. The SDK provides a tool for doing the conversion to achieve the Livescribe specific format, given a resource.

The Livescribe desktop

This is the computer component of the Livescribe Platform that allows one to transfer, store, search and replay notes from the Smartpen. In addition, it allows one to upload Smartpen content to the web and also manage the pen’s content in some desired fashion on the Livescribe desktop. Through the Livescribe desktop, one can print the dot papers instead of buying a writing book. For instruction on how to print the dot papers, go to: http://www.livescribe.com/smartpen/dotpaper.html.

One must make sure that their Livescribe desktop software is updated to the most recent version (1.6 at the time of this writing) and the Smartpen firmware to the most recent version (also version 1.6 at the time of writing). Updating the Smartpen firmware should be done automatically when the Smartpen is connected to the Livescribe desktop.
3. Software Applications

To investigate the research question of whether appropriate technology might contribute to Myaamia language revitalization, two Smartpen-based products were developed and assessed: a Myaamia animals picture book and a Myaamia Phrase book both printed on open dot-paper. For each book, the Smartpen was programmed to play the names of the animals and the phrases when the pen tip touches the appropriate image or phrases in the books. A CD titled “Animal & Phrases”, which contains the website of the animal picture book and the phrase book, was also developed. The purpose of this CD is to supplement the books and also provide a base of assessment of how the Smartpen use fairs in comparison to other methods, in this case a website on CD.

3.1. The developed Myaamia Language Penlet Applications

The following sections describe the design of the two books, using the Livescribe paper design capability.

3.1.1. Animals Picture Book

The animals picture book was primarily designed with the young child in mind. One of the features of this book is that images are important to animal identification and no English is used. The Smartpen was programmed so that a user can tap the Smartpen tip on the picture of an animal and hear the Myaamia name of the animal. The user could also tap the Smartpen tip on the mouth region of the animal picture to hear the typical sound the animal makes. An alternative is to tap on the pink or yellow regions provided below the animal image. This book was designed using the method discussed in section 3.2. See figure 9.0 for a page of the completed animal picture book.
3.1.2. The Phrase Book

The Phrase Book was originally created for a more adult learner and English translations are provided. The Smartpen was programmed so that a user could tap the Smartpen tip to a rectangular yellow box to the left of a written phrase (in Myaamia and English) and hear the pronunciation of the phrase in the Myaamia language. It was also designed using the approach in section 3.2. See figure 10.0 for a page of the completed phrase book.
3.1.3. The “Animal & Phrases” website on CD

The “Animals & Phrases” CD contains a website with the sound recordings of both books. The purpose of the CD is to provide an alternative to the Smartpen / picture book, i.e. another way for families to hear the audio. To use this CD, one must have the following installed on their computer:

a) QuickTime player.

b) Any browser, Internet explorer, Firefox, Netscape or Opera

The choice of QuickTime came after much deliberation. The aim was to make the use of the CD as simple as possible. Consequently, the researchers wanted to provide an environment where a user does not have to move from one window to another. This explains the choice of the use of buttons that the user could click on to hear the sound. The use of the embedded tag with QuickTime as the choice of player was the best option because it enabled control of the player button, to an appropriate size, to appear on the browser. Also, downloading QuickTime, which is provided online for free to those who don’t have it, was much easier in addition to the fact that QuickTime comes installed in Apple Macintosh computers. See figure 1.0 for how the page appears with the buttons to play the sound using QuickTime.

Figure 1.0 QuickTime buttons
3.1.4. Books and software design

The Smartpen applications are designed and programmed to work with the books. Initially, the design was based on SDK 0.9.1, which involved a more manual design of the book pages. Using the SDK 0.9.1, blank dot pages were to be printed and the Smartpen programmed such that it would recognize a written word on the page. An image or a word would later be printed on top of the area where the word was written, since it was known that the Smartpen had claimed that region. This would entail the researchers to get all the Smartpens that were going to be used in the research before programming the paper. All the Smartpens that were to recognize an area had to be used to write on that area before printing a picture or a word on top of that area. This was a very tedious and time consuming exercise. The reason this manual approach was taken was because the SDK 0.9.1 had no capability for paper design. All this changed with the pre-release of the SDK 1.0.

SDK 1.0 has paper design capability, meaning developers are able to create their own paper application as opposed to going through the manual approach method that was considered before its release. The fact that the pre-release SDK 1.0 is a beta version (at the time of this writing) means that it still has some bugs that will be mentioned later in the discussion.

The next section describes the design of the penlet software that allows the Smartpen to play the Myaamia words to accompany the two books.

3.2. Penlet Programming

For this research, both the books and the associated penlet application must be developed. The penlet application is the software in the pen that plays the animal name (or sound it makes) or phrase in the books when the pen tip is touched to specific areas of the book pages called “active regions.” To develop these products, the following steps were followed [21]:

- Design and create page images and sound files
- Create a penlet project for the penlet software that will play the Myaamia language sound files
• Create a paper product project for the books
• Design the books by adding images, linking paper products to the penlet, creating active regions, and generating event code for the active regions
• Code the penlet software to play the appropriate Myaamia language sound files for each active region in the books

3.2.1. Designing and creating page images and sound files

First, a list of animals that were to appear in the picture book was identified and collected. These are the common animals that Myaamia members are most likely to see occasionally. They included animals like raccoon, beaver, squirrel, lizard, fish and birds like Blue Jay. The images of these animals had to be in the .eps format and as such, the various .jpeg and .gif images were converted to .eps using Adobe Illustrator suite. For other available software that can be used for this conversion, see the documentation that comes with SDK 1.0.

Next, the Myaamia language sound files that contain the animal names in Myaamia had to be downloaded from the Miami online dictionary. These sound files were then converted to .wav files because this is one of the formats that the Smartpen works with. To do this conversion, Audacity software, which has a free download online, was used. It also allowed for the editing of the sound files and setting the correct size, 16,000 bits as required by the specification of penlet design with the Smartpen. The researchers then went online and downloaded sound files that contain the sound made by some of the animals that were chosen to appear in the book. This was just to enhance the learning of the animals’ names and also make the book interesting especially to children, who were the initial key target group for this book. These sound files were also converted to .wav files using Audacity.

3.2.2. Creating a penlet project

The penlet project is the Java code that will detect the event of the pen touching an image or phrase and play the correct sound file. Livescribe suggests the creation of the penlet
project before the paper product project, because the paper product will need to be linked to the penlet. The penlet project is created in Eclipse using the Livescribe Pelnet Project Creation Wizard. It is at this point where Smartpen events that the pelnet was to respond to were selected. The wizard auto-generated the code to respond to those events. The major event used in this research is the penDown event.

3.2.3. Creating a paper product project

The paper project is where the books are designed on the dot paper. The project was created in Eclipse using the Livescribe Paper Project Creation Wizard. The wizard created an electronic version of the paper known as an AFD file which contains paper attributes, dot space, images, and penlet linkages. AFD files were used for printing the paper product and for deploying to the Smartpen.

3.2.4. Designing the paper product

After creating the paper project with the wizard, the images and text were added to the region using Eclipse. Linking the images (or phrases) to the penlet (in order to play the sounds) was done by assigning active regions to the images or other places on the paper. The Eclipse plugin has commands for inserting images (in EPS format) onto the paper design. Various properties can be assigned to images such as a name, ID, and the Z-Order. Each paper region was then linked to a penlet class through the application ID of the penlet project.

The next step was to create active regions using the paper designer that will trigger penlet events to play the Myaamia language sound files when the pen is touched to those regions. The Eclipse plugin has an Active Regions tool for creating the active regions. It is noted here that all the active areas follow the same procedure in the design of the picture book and the phrase book. See figure 12.0 for the image of the book design.
Figure 12.0 Animal picture book design

The aim here is to play the sound of the name of animal when a person touches the picture of the animal with the tip of the Smartpen and also play the sound the animal makes when any region in the mouth area of the animal is touched by the tip of the Smartpen. Consequently, another active area was placed around the mouth section of the animal. In so doing, the box occlusive was checked and the Z-order was set to an ID that is lower than that of the active region that contains the animal picture. This simply allows the active area that contains the animal picture to be overwritten with the active section that plays the sound the animal makes. For more information on the occlusive property and the Z-Order, see the documentation provided by the pre-release SDK 1.0. The design of the phrase book followed the same procedure. See figure 13.0 for the phrase book design.
Sometimes playing the relevant sound file whenever some animals pictures were touched by the tip of the pen proved challenging. This is because some picture pigments were too dark which consequently tended to block the dot location on the paper. A good example is the picture of the alligator, which failed almost all the time to play the sound file when the picture was tapped on. A solution to this would have been to find another picture that was lighter in color. However, this seemed challenging because it was not know which picture would work or fail, meaning a situation could have a arose where a lot of time was being spent trying all the pictures. Consequently, it was decided that the inclusion of two extra active regions for each animal was necessary. One was for the sound file of the name of the animal in Myaamia while the other was for the sound the animal makes. These two rectangular regions were placed below the animal image and two colors, that were experimented with and found to always allow for the sound file to be played, were chosen. A pink image was placed on the animal name region and a yellow color image on the animal sound section. See Figure 12.0 for this design. This guaranteed that the sound files were always played because the blocking of the dots was eliminated using the pink
and yellow pigments. As can be seen from figure 13.0, the yellow color was chosen for the active regions in the phrase book.

### 3.2.5. Coding the penlet

The Eclipse plugin will auto-generate code for the active regions. The programmer must select the events to be caught. For this project, the penDownEvent was used. This is because most of the action involves touching the pen to the active region on the paper in the book. Within Eclipse, next to the event names, the user can click “Go to Function” to open the penlet for further editing. See figure 14.0, for the image of the penlet design environment with a snapshot of the code. For more information about the penlet and paper design, please see the documentation that accompanies SDK 1.0.

![Figure 14.0 Penlet code location](image)

See Code extract 1.0 for illustration of the code used in the research.
protected boolean penDownEventDelegator(long time, Region region, PageInstance page)
{
    boolean eventHandled = true;
    switch (region.getAreaId())
    {
    Case 301:
        eventHandled = onButterflyPenDown(time, region, page,
"kaakatakilenkwia");
        break;
    case 603:
        eventHandled = onGoatPenDown(time, region, page, "Goat");
        break;
    default:
        eventHandled = false;
    }
    return eventHandled;
}

protected boolean onButterflyPenDown(long time, Region region, PageInstance page,
String MyaamiaName)
{ 
    this.player.play("/audio/Butterfly.wav");
    this.DisplayTextOnPulse(MyaamiaName);
    return true;
}

protected boolean onGoatPenDown(long time, Region region, PageInstance page, String EngName) {
    this.player.play("/audio/Goat.wav");
    this.DisplayImageOnPulse(EngName);
    return true;
}

//displaying the text
public void DisplayTextOnPulse(String MiamiName)
{
    if(this.display.getCurrent()! = this.labelUI){
        this.display.setCurrent(this.labelUI);
    }
    this.labelUI.draw(MiamiName,true);
}
//displaying the image

public void DisplayImageOnPulse(String EnglishName)
{
    if(this.display.getCurrent()!=this.labelUI)
    {
        this.display.setCurrent(this.labelUI);
    }

    //process image and display
    Class cls = this.getClass();
    InputStream stream = null;
    Image MiamiName = null;
    stream = cls.getResourceAsStream("/images/"+EnglishName+".arw");
    try{
        MiamiName = Image.createImage(stream);
    }catch(IOException e){
        e.printStackTrace();
    }
    finally{
        if(stream !=null){
            try{
                stream.close();
            }catch(IOException e){
                stream = null;
            }
        }
    }
    this.labelUI.draw("",MiamiName, true);
}

**Code Extract 1.0**

The code extract illustrates how events are caught, how each image or phrase is identified, and how the sound files are played. The statement switch(region.getAreaID()) returns the active area ID. The ID is used to play the appropriate sound file, and display the Myaamia word on the LED display, using the appropriate Livescribe API function.

To further illustrate how the design works, the active region named Butterfly is first clicked on the paper. Note that the event handler calls the function called onButterflyPenDown, which plays the sound using media player and then calls the function DisplayTextOnPulse. This function displays the Myaamia name of butterfly, “kaakatakilenkwia” on the pulse of the Smartpen by using the method labelUI.draw.
Some Unicode characters, like Š, could not be supported by Eclipse and the Smartpen software, therefore displaying the names of animals whose names contained this letter proved very challenging. To solve this, any name with this letter, e.g. “paapiichśia” meaning goat, was to be displayed as an image on the Smartpen. To do this, the same procedure as when displaying “kaakatakilenkwia”, is used. However, instead of using the function DisplayTextOnPulse, DisplayImageOnPulse is used. This method converts the image to .arw, which the Smartpen uses, and then uses method labelUI.draw, to display the image on the Smartpen’s display.

Table 1.0 summarizes the main API functions used in the penlet.

<table>
<thead>
<tr>
<th>API function</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int getAreaId()</td>
<td>This function returns an integer assigned to uniquely identify an active region.</td>
</tr>
<tr>
<td>player.play()</td>
<td>This method uses media player to play a sound file in any of the following formats; .wav, .wv and .aac</td>
</tr>
<tr>
<td>displayTextOnPulse(String)</td>
<td>This is a custom function that displays a string on the pen’s display</td>
</tr>
<tr>
<td>Stream getResourceAsStream(String)</td>
<td>This method is used to create a stream given a path to a picture file. It is this stream that is used by the method createImage(stream) to create an image from a file</td>
</tr>
<tr>
<td>InputStream createImage(stream)</td>
<td>This method generates an image to be displayed on the pen pulse given a stream</td>
</tr>
<tr>
<td>DisplayImageOnPulse(string)</td>
<td>This a custom function that displays an image on the pen’s display</td>
</tr>
</tbody>
</table>

**Table 1.0** Major Livescribe API functions used in the penlet application

For further API functions and explanation of usage, see the documentation that comes with SDK 1.0.
4. Research Methodology

4.1. Thesis Question

The thesis question is to investigate how Smartpen technology can help to achieve relevance, significance, and purpose within current Myaamia Language revitalization efforts, especially within the home environment. Although important, this research is not geared towards gauging language fluency or any changes in fluency.

The effectiveness of both books and the website, discussed in section 3, was self-assessed by Myaamia Tribe families, the approach suggested by Galla. The families were selected in 2008 by the Myaamia Project with the help of the Miami Tribe’s Office of Cultural Resources. Ten families in all were selected and have been involved in assessing other products in addition to what was provided in this research. These selected tribal families all have young children in the home, have parents who are motivated to help their children learn, and understand that their role is to test a variety of products produced through the Myaamia Project. Each of the participating families was given all the research materials and no control group was factored into the research design. The purpose behind this approach was to simulate the usual experience in that it is typical for Myaamia tribal families to automatically receive educational materials from the Myaamia Cultural Resources Office in the mail without asking for them.

4.2. Assessment Methodology

Galla [10] suggests the use of self-assessment as a method to evaluate growth and development of the language learner. Using self-assessment, students can track their own progress and become responsible for their learning and their potential. Overall, the critical assessment and in-depth study on the integration of technology and the Myaamia language should include at bare minimum the program used, the purpose of the tool, how the tool is actually being used, how the students are being assessed, what is being assessed, and overall effectiveness.
Overall approach

To assess the potential and limitations of the Smartpen technology on language learning, a pre- and post-assessment methodology was used. The aim in this assessment was to determine how the Smartpen technology affects language learning and how the technology influences attitudes about the language.

Throughout the assessment process, the researchers worked closely with the Myaamia Project staff to identify participating families, define assessment instruments, and to interpret the results. The Myaamia Project staff has years of experience in other language-related projects and their assessment, such as summer programs for the youth.

The materials used in the assessment included:

- Animal picture books
- Myaamia phrase books
- A webpage with audio provided on a CD to accompany the two books
- Smartpens, loaded with the penlet, to be used with the picture and phrase books
- A brief instructional guide, for families, on how to use the books, CDs and the pens.

All the participating families were given all materials listed above. A pre- and post-assessment survey, which formed the basis for data extraction, was used to collect information. Consequently, to ensure that all the families filled these documents, no further research material (the Smartpen, CD and booklets) was released until the completed pre-survey was returned. The families were given two weeks to use the research material, upon which the post assessment was conducted by sending them the post-survey. The following are the phases of the assessment process that were followed:

I. Identifying families to participate in the research

Below are the initial criteria that were used in selecting families to participate in the assessment:

- Families who had little or no prior knowledge of the language.
Mostly families with children. This, however, was not a rigid requirement.

Identify roughly 10 participating families to make sure that there was sufficient data to help in drawing conclusions.

II. Pre-survey of family attitudes about language-learning and the usefulness of technology

The purpose of the pre-survey was to determine a base-line of current experience with language-learning, general attitudes about using technology, and general feelings about using technology to learn the language. Appendix 1 shows the complete pre-survey questionnaire. Information was collected about:

- The current comfort level in using computer technology.
- The current attitude or interest in learning the language and culture.
- The current attitude or interest in using technology to learn the language and culture.
- The past experience in using technology to learn the language or culture.

See section 3.4 for more information about the pre-survey.

III. Family experience with the materials

This step involved distribution of materials to families who were expected to use them for a period of two weeks. During this period, the parents were expected to help their children with the material in case they experienced any difficulty.

IV. Post-survey of family knowledge and attitudes

This phase was designed to measure the changes in family member knowledge and attitudes about the language, language-learning, and the usefulness of the Smartpen. Appendix 2 shows the complete post-survey questionnaire, and section 3.4 provides an overview of the pre- and post-surveys.
V. Analysis of results

This step involved the analysis of the data that had been gathered from the questionnaires and follow-ups. The aim here was to try and establish the impact of the Smartpen in learning the language, and the use of technology in general. It was also an objective to find out information concerning the ease of use of the Smartpen as compared to the CD.

VI. Drawing conclusions

This was the final step of the assessment methodology. Here, based on information from steps 4 and 5, a conclusion on what the research found about the use of the Smartpen in learning a language was drawn. At this stage, it was possible to answer questions like: Did the Smartpen make it easier to learn the language? Was it easy to use? What was the attitude towards the pen and the CD? Does technology generally have a positive influence on language revitalization?

4.3. Pre-survey and Post-survey Structure

As has been mentioned, the goal of the surveys was to assess the potential of using technology for language and culture learning. With this in mind, questions were designed to measure:

- The impact of the Smartpen on interest in learning the language and culture
- The impact of the Smartpen on using technology to learn the language and culture
- The impact of the Smartpen technology on:
  - Preservation of language and culture
  - Dissemination of language and cultural materials
  - Forging connections with other tribal members
  - Influencing perceived relevance, significance or purpose of a language
- Helpfulness of the Smartpen within the family

Table 2.0 summarizes the questions in the surveys in the above categories.
### Pre-survey

**Did the Smartpen influence interest in learning the language and culture?**

- My child has expressed interest in learning more about the Myaamia language and culture:
  - strongly Disagree/ disagree/ neutral/ agree/ strongly agree

**Did the Smartpen influence interest in using technology?**

- I am comfortable using:
  - computers/websites/other
- My child is comfortable using:
  - computers/websites/other
- My child uses technology about:
  - never/monthly/weekly

**About how much time per week do you anticipate using the technology sent to you over the next two weeks?**

- Over the past 2 weeks, our family used the website on the CD:
  - never/more/less
- Over the past 2 weeks, our family used the Smartpen:
  - never/more/less

**How often does your family participate in Myaamia language/culture learning activities?**

- Over the past 2 weeks, how often did your family participate in Myaamia:
  - language/culture learning activities

**How often do you currently use the Myaamia language with your child?**

- Over the past 2 weeks, how often did you use the Myaamia language with your child?

**About how much time per week do you anticipate using the technology sent to you over the next two weeks?**


### Questions specific to our research questions

**Technology like computers and websites can help preserve Myaamia language and culture:**

- strongly Disagree/ disagree/ neutral/ agree/ strongly agree

**Technology like computers and websites can help disseminate Myaamia language and cultural materials:**

- strongly Disagree/ disagree/ neutral/ agree/ strongly agree

**Technology like computers and websites can help forge connections with other tribal members:**

- strongly Disagree/ disagree/ neutral/ agree/ strongly disagree

**Technology like computers and websites can help the language seem more relevant, significant, or to have a modern purpose:**

- strongly Disagree/ disagree/ neutral/ agree/ strongly agree

**In what ways, if any, is your family currently learning the Myaamia language/culture?**

- Did our materials influence the way that you learned the Myaamia language/culture? If so, how?

**What technology such as computers, websites, etc., (if any) has been helpful in learning the language or culture in your family?**

- Please compare the website and the Smartpen:
  - Which was most helpful and why?
  - Which was least helpful and why?
  - Which was easiest to use and why?
Have you tried to use any technology to learn the language or culture that was not helpful? If so, what?

We would like your suggestions on how websites or Smartpens might be used in other ways to assist your family with the Myaamia language or culture. Please share any ideas and suggestions that you have.

Please share any other experiences or opinions (good or bad) that you have about using computers, websites, or similar technologies to help to revitalize the Myaamia language or culture.

Table 2.0 Pre- and Post-Surveys

In the design of both surveys, brevity and specificity were very important in order to gain the information that was required. The intent was not to make families overburdened by extensive surveys, which likely would have led to less detailed information. Emphasis was to be placed on using the research materials rather than spending a lot of time responding to questions from the survey.

It was also important for specific questions in the two surveys to be similar to one another. This was done to track attitude changes towards technology and the Myaamia language. For instance, a question about a child’s interest in learning the Myaamia language was included in both surveys to observe changes in attitudes in response to the materials. This question, together with others in the survey, would then help to ascertain the impact of technology in language revitalization. It has long been known that when language ideology shifts so does language use and therefore, it was important to be able to observe minor shifts as a result of product use.

A question regarding the level of comfort in using technology was asked in order to determine the effectiveness of the instruction manual. This was to ensure that the materials provided were constructed in a way to be as user friendly as possible. The researchers could also anticipate the difficulties that the users might run into and prepare to respond to their questions in case they asked for help. Although not a major goal, it could also be tracked if the research materials had contributed towards a scenario where a
user became more conversant with using the technology since they were asked the same question in both surveys.

Users were not asked to use the materials for a certain number of hours a day, yet the researchers wanted to examine the impact of the technology on the actual time they used the materials. This was the purpose behind the question asking users to approximate the amount of time they were willing to spend using the material on a day-to-day basis. In the post-survey, they were asked how much time they actually spent using the material on any given day. Researchers could then compare the hours predetermined by the users in the pre-survey to the hours recorded in the post-survey. An increase in hours in the post-survey might indicate increased enthusiasm over the material likely due to the technology. However, it should be cautioned that the difficulty in using the materials due to technology challenges or the users’ age can affect how much time is spent using the materials. In order to eliminate the ambiguity that might have arose due to the issues discussed herein, another question in the post-survey asked users to explain why they spent more or less time than originally anticipated. This allowed a more accurate interpretation of the result. Motivation is hard to gauge, but it was believed at the onset of this research that technology could motivate, at least for a time, and it was important to try and capture that in the survey data.

In both surveys, the main goal was to determine the potential impact that technology had on the use of Myaamia language and cultural materials in the hope that increased positive interactions between users and the language materials produced, due to the technology, would motivate language learning. Through these survey questions, researchers could assess whether the technology impacted users attitude towards learning their language and culture in a positive way. Users could respond from on a scale of ‘agree’ in the pre-survey to ‘strongly agree’ in the post-survey. Alternatively, they could also respond in the opposite direction from ‘agree’ to ‘disagree’. In order to shed light on possible causes in changes of attitudes, they were further asked to explain why they had changed their mind if they did.
In the post-survey, questions were also asked about users’ preferences towards either the Smartpen and the books or the CD containing the website with the animal and phrases sound file. The aim of these questions was to find out whether the Smartpen made learning easier. The researchers also had follow up questions to find out why the users preferred the CDs or the Smartpen. By determining this information, it could be known which form of technology the potential users would prefer in future or how to make the use of any one of them a lot easier. Lastly, it was important to get the suggestions from the various users. In the post-survey, the families were asked to give any suggestions about the materials, especially on how they could be improved or even used for other purposes. The aim here was to make their responses a corner stone for future works.

5. Research Findings

5.1. Background

As was mentioned in the research methodology, the families that were participating in the research were asked to use the materials provided for a period of two weeks. Initially, a group of ten families was identified to participate in the research, based on the criterion that was mentioned in the methodology section. Before these materials were sent to them, they were expected to have completed and sent back a pre-survey. However, two families did not respond to the pre-survey, so this research was conducted with the participation of eight families, which was an acceptable number to give sufficient feedback to sample results. Of these eight families, one did not have children while the other group was made up of the tribe’s business committee members, which consists of five elected leaders. This meant that some of the questions in the pre- and post-survey would be irrelevant to them and only adult related information could be extracted.

Of the eight families that participated two lived in Oklahoma, three lived in Missouri, two lived in Indiana, and one lived in Washington, D.C. This caused mailing times to be varied and so families didn’t receive their materials at exactly the same time. It was therefore important to ensure that all families had received the entire research material package before starting to count the fourteen days of use. To reduce any chance for bias in the results, it was important to make sure that all the families had the same number of
days to use the material. To enable this, the researchers waited for all the pre-surveys to be completed and returned before mailing the research material package to all the families at once. The families were then asked to keep track of their fourteen day use upon receiving the package. They were also asked to communicate with the researchers that they had received the package and started using the materials. This communication from the participating families prompted the sending of the post-survey to them.

The idea of first sending the pre-survey followed by the main package of the research material and lastly the post-survey was strategically planned. Sending the entire package in a single mailing could have saved time and money. However, the choice of splitting it up into three separate mailings enabled the researchers to have greater influence over how the families participated in the assessment process. First, as has been explained, sending the pre-survey and receiving the completed version back before sending the research material, was a way to determine which families would be most committed and able to participate in this research. The pre-survey also identified vital information like computer literacy levels and whether the participating families had children or not. Understanding the computer literacy levels of the families guided researchers in preparing an appropriately worded instruction manual. This increased the chances of proper use and reduced the potential for damaging expensive tools like the Smartpen. The pre-surveys were also expected back first so that when the research material was sent to the families they would concentrate their efforts on using the material rather than worrying about filling the forms. After all the pre-surveys were received, families were sent the next packet of materials. This second mailing contained; a Smartpen, two CDs (one for installing QuickTime and the other that contained the website for sound files of phrases and animal names), a USB cable, two booklets (an animal picture book and a phrase book), headphones and an instruction manual on how to use the provided materials, was sent.

While the families were using the materials, they were contacted through email and phone calls to check on how things were going. Most of them seemed to be doing fine and enjoying the use of the materials, especially the Smartpen. They were provided with a number to call and/or an email address in case they had questions or were experiencing
difficulties. All communications with the families were handled through the Myaamia Project office and the Tribe’s Cultural Resources Office, since these two entities are both set up to work directly with the tribal community and the families are all familiar and comfortable with the staff. The Myaamia Project staff would then contact the researchers to inform them how things were going. After the two week test period, the families were sent a post-survey that completed the assessment process. The post-survey was very similar in nature to the pre-survey because the researchers wanted to compare and contrast changes in attitude, with regards to various aspects of technology and the Myaamia language in general. It is also noted here that by sending the post-survey later, chances of compromising the opinions of families were reduced. For instance, the researchers did not want a situation in which the use of the Smartpen excited some family members, causing them to pre-maturely complete the post-survey before using the materials for the entire two week period.

### 5.2. Responses to Questions in Surveys

Table 3.0 summarizes the finding that the Smartpen was indeed an effective technology for increasing the use of language and cultural materials.

<table>
<thead>
<tr>
<th>Smartpen usage</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did the Smartpen influence interest in using technology?</td>
<td>Most respondents agreed</td>
</tr>
<tr>
<td>Did the Smartpen influence interest in learning the language and culture?</td>
<td>Most respondents agreed</td>
</tr>
<tr>
<td>Was the Smartpen effective in helping to preserve the language and culture?</td>
<td>Most respondents agreed</td>
</tr>
<tr>
<td>Was the Smartpen effective in helping to disseminate the language and culture?</td>
<td>Most respondents agreed</td>
</tr>
<tr>
<td>Was the Smartpen effective in helping to forge connections with other tribal members?</td>
<td>Most respondents agreed</td>
</tr>
<tr>
<td>Was the Smartpen effective in helping the language and culture seem more relevant, significant, or have a modern purpose?</td>
<td>Most respondents agreed</td>
</tr>
<tr>
<td>Was the Smartpen helpful in your family?</td>
<td>Most respondents agreed</td>
</tr>
</tbody>
</table>

**Table 3.0** Summary of findings.

The individual responses that led to the conclusions in table 3.0 are discussed next.
5.2.1. **Comfort of using technology**

When families were questioned in the pre-survey about their comfort level using technology (computers and website) most of the eight participating families gave a positive response. One participant said he was not comfortable with computers in the pre-survey. A similar question was asked in the post-survey with an addition of the Smartpen. The post-survey responses were similar to the pre-survey responses. The feedback from this question did not yield much information because there was little to no change between the responses. However, as indicated earlier, the pre-survey response to this question enabled the preparation of the instruction manual as clear as possible so that the use of the materials that were to be dispatched later would be easy to use. It was also concluded that the families involved were fairly computer literate.

5.2.2. **The impact of the Smartpen on interest in learning the language and culture**

See the results on tables 4.0 and 5.0 when a question was asked whether the children in the families participating in the research had expressed an interest in learning more Myaamia language and culture.

<table>
<thead>
<tr>
<th>Number of participants</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>No Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

**Table 4.0** Children expressing an interest in learning Myaamia language and culture (Pre-survey)

<table>
<thead>
<tr>
<th>Number of participant</th>
<th>Is about the same interest as before</th>
<th>More interested than before</th>
<th>Less interested than before</th>
<th>No children</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 5.0** Children expressing an interest in learning Myaamia language and culture (Post-survey)

From the post-survey, there is a greater interest in learning Myaamia language and culture by the participants after using the research material. Six of the eight families, 75%, reported that they are “more interested than before” in learning the Myaamia
language and culture. Since there was no other variable, apart from the research materials that the families had time to use, it can be said that the technology influenced this change. Adults and children may have been encouraged to learn the Myaamia language through high tech tools like the Smartpen. This shows that if the technology is really made interesting and easy to use, like the case of the Smartpen, there is a chance that language users, like children, can be encouraged to participate more in language learning and consequently revitalization efforts.

When the families were asked, in both the pre- and post-surveys, how often they participated in Myaamia language/cultural learning activities, the following were the responses (tables 6.0 and 7.0).

<table>
<thead>
<tr>
<th>Number of participants</th>
<th>Not at all</th>
<th>A few times a year</th>
<th>A few times a month</th>
<th>A few times a week</th>
<th>Daily or almost daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

**Table 6.0** How often families participated in Myaamia language/Cultural activities (Pre-survey)

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A few times altogether</th>
<th>A few times a week</th>
<th>Daily or almost daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**Table 7.0** How often families participated in Myaamia language/Cultural activities (Post-survey)

And when they were asked, how often they used the Myaamia language with their children i.e. before they received the research material, the following are the response distribution (tables 8.0 and 9.0).

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A few times a year</th>
<th>A few times a month</th>
<th>A few times a week</th>
<th>Daily or almost daily</th>
<th>No child</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 8.0** Times spent by families and their children using Myaamia language (Pre-survey)
These questions could not unearth much about the research material because the results from both the pre- and post-survey are mostly identical. This may be as a result of the fact that the families who participated in this research, together with their children, have been participating in various language revitalization programs and this one was just one of them. However, the Smartpen technology did seem to have a positive impact on learning, which is addressed next.

5.2.3. The impact of the Smartpen on using technology to learn the language and culture

The question: “Did our materials influence the way that you learned the Myaamia language/culture? If so, how?” brought very interesting responses. One response was: “Yes. My children showed younger Miami children (nephews) the pens and animal noises. It was great to see them being the teachers.” This shows an example of a positive impact the materials, especially the Smartpen in this case, had on the users. If a learning material can cause excitement among the users, then it is bound to be used more often and consequently increase the speed in which the language can be learned. The fact that the children from this family were willing to act as teachers of their nephews show they had somehow taken to learning the language and influencing those around them to do the same. This seems like a good way to create awareness about the Myaamia language and therefore encouraging the family members to try and speak.

Another family responded to the same question as follows: “Our strongest learning tool to date has been flash cards and repetition at opportune moments. For most of the periods of testing, the kids showed an interest in the items sent, but it wasn’t clear that they were learning new materials from them. I would say this was particularly true of the phrases. Towards the end of the test, we went to a park and saw several things for which I knew Myaamia words existed, but did not know those words
I challenged them to learn these words using ONLY the smartpen and had them listen to it over and over and over. I would say that it made learning much quicker when focused on specific item with some relevance to them. I also saw that their pronunciation had considerably improved when mimicking the word files with the smartpen.”

The above response is another example of how some users were applying the research material in their everyday lives. It also shows that the materials influenced how they were learning the Myaamia language. This means that if most of the learning activities incorporate some of the research material, especially the Smartpen, interest in learning Myaamia language may be increased which aids the revitalization efforts.

One of the major aims of this research was to get users’ responses, using both pre-survey and post-survey, on the next four issues (5.2.4 – 5.2.7). The number of the entire participants, in any given choice on the survey, has been totaled and tabulated as shown on tables 10.0 through 13.0.

5.2.4. The impact of the Smartpen technology on preservation of the language and culture

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-survey</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Post-Survey</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 10.0 Technology in helping in preservation of Myaamia language and culture

From the data in table 10.0, it can be seen that there is a general agreement among the research participants that technology can help in preservation of Myaamia language and culture. The results show that even before the research materials like the Smartpen and the CD were sent, there was a positive view of technology in language preservation as shown in the pre-survey result. However, for one participant there is an increase in belief that technology can have a greater impact on language and cultural preservation. It is therefore arguable that technology can be greatly employed in this aspect based on the opinion most of the users.
5.2.5. The impact of the Smartpen technology on dissemination of the language and culture

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-survey</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Post-Survey</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 11.0 Technology in helping in dissemination of Myaamia language and cultural materials

Just as in language and cultural preservation, there is a general agreement that technology is important in disseminating Myaamia language and cultural materials as shown by both surveys in table 11.0. It is noted here that the agreement on this point is stronger than in the preservation. In fact, one shift from agreeing to strongly agreeing can be seen. It may be the case that the users here see the power of computers, Smartpens and CDs in the dissemination process. For instance, there is the power of emails in communicating and CDs in sharing materials, which seem quite obvious. Then there is the Smartpens which were used together with the books to disseminate the learning materials, in this case Myaamia phrases and names of animals.

5.2.6. The impact of the Smartpen technology on forging connections with other tribal members

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-survey</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Post-Survey</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 12.0 Technology in helping to forge connections among tribal members

From table 12.0 there is some general consensus that technology can be important in forging connections among tribal members. From the data, it can be observed that one respondent moved from strongly disagreeing to at least being neutral on this issue. This can be attributed to the technology because it is the only variable between the two surveys. In general, it is probable that the result of the pre-survey is from the fact that people have used computers and other technology devices in communicating or keeping in touch with one another, which emphasizes a strengthening of community and family
kinship ties. For example, keeping in touch using emails or even chatting in Myaamia online reinforces community kinship and also helps in maintaining a shared identity. From the use of research materials that were sent, families are beginning to share learning experiences and knowledge with other families. This indicates an increased connection among tribal members strengthened through language and cultural learning experiences.

5.2.7. The impact of the Smartpen technology on perceived relevance, significance and purpose of the language

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-survey</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Post-Survey</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 13.0 Technology in helping Myaamia language seem more relevant and significant

Just as all the other factors that have been so far addressed, there is a general agreement that technology can make language seem more relevant and significant for today’s lifestyles. There are two notable shifts (25%) among the participants: one respondent moved from “strongly disagree” into agreement and a second moved from “neutral” into agreement. (See table 13.0). It might not be hard to see why there is much consensus here. The Smartpen is arguably the most popular digital pen on the market and making it useful for the Myaamia language helps users see their language as part of technological growth and removes the stigma that native languages are archaic and not useful in the modern world. This is especially an important point to the youth who are always at the forefront of new technology. The youths are consequently encouraged to view their language (Myaamia) as a useful language within the technology, which may cause them to devote more time to learning it. This in turn contributes to the revitalization efforts.

5.2.8. Helpfulness of the Smartpen within the family

This research was also valuable in helping determine future educational and communicative applications of Smartpen technology for the Myaamia Tribe. As such, questions that would enable users to give their input on this matter were formulated. For
instance, users were asked: “We would like your suggestions on how websites or smartpens might be used in other ways to assist your family with Myaamia language or culture”. Responses to this question were varied. One family suggested that the Smartpen should be incorporated in more day-to-day activities for instance, having more games that children could play while learning Myaamia language. Others suggested using the Smartpen with Myaamia weather charts and programming it to help learn common household phrases like brushing ones teeth, eating and some basic school vocabulary. These are all good ideas and currently the process of looking at ways of incorporating games to be used with the Smartpen, is being explored. One game being considered is an online number guessing game in Myaamia. Plans are currently underway to make a Smartpen version of this game.

A second response to this question was: “If families could read winter stories to their children and have the Myaamia version stored in the smartpen, the longer passages could really help with in-context word recognition and retention”. This is another good idea that is implemented with the Leapfrog Tag pens. With the SDK 1.0 and the Smartpen, it should be possible to program the pens to play stories in the Myaamia language. The only limitation is the storage capability of the Smartpen in relation to materials created. The largest Smartpen currently has only a disk capacity of 4 GB. Having to store several lengthy stories will inhibit the number of other applications that the Smartpen can hold. However, four or five stories with reasonable length would not be a problem to store in the Smartpen.

5.3. Smartpen vs. CD

It was explained earlier that the CD was created and supplied to the families to compliment the Smartpen and to act as a comparison with the Smartpen. Some questions that were used to contrast this comparison are as follows:

When we asked the question: “Over the past 2 weeks, our family used the website on the CD?” the following are the responses received.
<table>
<thead>
<tr>
<th></th>
<th>Did not use</th>
<th>More time than anticipated at the start</th>
<th>Less time than anticipated at the start</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Smartpen</td>
<td>0</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

**Table 14.0 CD use versus the Smartpen**

From the results in table 14.0, it can be seen that four families responded that they did not use the CD, while every family seemed to have used the Smartpen. In fact, five families said that they had used the Smartpen more than they had anticipated compared to only 1 for the CD out of the eight families. To find out the possible reasons why this might have been the case, the following follow up question was asked:

*Which (pen or CD) was the most useful and why?*

The biggest reason given for the use of the Smartpen was its portability compared to the CD. With the CD, one needs a computer, which is not always portable. In addition, some software must be installed before using the CD, which requires a degree of computer literacy and patience when the computer does not respond to the CD. This would lead to more time in identifying and fixing installation problems. One respondent said: “*They (family members) generally agreed that the smartpen was the more useful because it is accessible and immediate. It didn’t require us to boot up the computer, load the file, sit upstairs, etc. Perhaps that experience would be different if the computers were integrated into our daily lives, but it isn’t.*” Yet another said: “*The smartpen was most helpful due to the ability to use it in numerous locations in or out of the home*”. And another responded: “*The pen was more helpful because you don’t have to be able to read. My 2 years old grandson enjoyed using the pen by himself. No need to insert disks or navigate to a website.*” Yet another person saw it a little different by answering: “*I think the smartpen provided a better learning experience, however the website would be most economical since most people own computers or have access already.*” The question of economics of the Smartpen will be addressed later in the discussion.

When a follow up question was asked about which of the two tools (Smartpen or CD) was the least helpful and why, the following are some of the responses that were received. “*The website was less helpful because it was not as accessible*”. This response
emphasizes the analysis of portability that was already mentioned. Yet another response to this question was: “websites –kids have had these kinds of programs before, they were more excited about the smartpen”. From this response, it can be seen that the Smartpen was also used more than the CD because it was a new technology that people had not used before. This may have prompted them to use the Smartpen more, consequently increasing interest and hopefully improving their Myaamia language skills. Some post-survey returns pointed to difficulties some families were experiencing with the CD. One family said: “The downside of the smartpen is the cost of the pen. I found that the website was a little more awkward to use and my web browser (safari) crashed some of the time I used it.” It is true that the sound file button configuration could appear a little different with different Internet browsers. The website CD had been tested with two browsers, Mozilla Firefox and Internet explorer, and it was thought that it would work alright with these browsers. However, it is true that the website on the CD performs differently with other browsers and some computers. This highlights one of the merits of using the Smartpens and the books because there were no software complications to worry about just as some users have mentioned in their responses.

One final question regarding the use of the Smartpen and the CD was, to find out which of the two was the easiest to use and why. Some of the responses are as follows:

“I think the smartpen was the most user-friendly and easy to use.” Yet another said: “The book and pen was easier to use because there was no need for computer or power. It was more portable”. Another response was: “The smartpen seemed easiest for my child due to her interest”. All these responses emphasize the portability and user friendliness of the Smartpen as compared to the CD.

Now the attention is turned on the issue of cost of the Smartpen. One respondent commented: “It would be easy to say the smartpen, but I think that depends in part on cost and availability. For many in our community, the choice between a free CD or a $175 smartpen is no choice at all. For us, I would certainly consider buying the smartpen or a couple to have in different parts of the house”. It is true that the Smartpen would be very expensive for most families to consider buying. However, every new and sophisticated technology seems to be costly, yet people still acquire them for what they
can do. Considering the capability of the Smartpen as compared to the CD, the researchers believe it can be a good addition to a Myaamia household if made affordable. Moreover, it can be programmed to achieve other Myaamia learning objectives as will be discussed later.

**Verdict on Smartpen vs. CD**

Up to this point the discussion has shown that the Smartpen received very positive reviews. This indicates that if technology can be made user friendly and more exiting to the user it can be a very important tool for language revitalization. There can only be positive response in language revitalization if people are excited about learning the language in question. From the responses, the Smartpen seems to be that exciting tool that made participants interested about using it and consequently leaning the language. What needs to be further explored is to what extent the ‘newness’ and the ‘excitement factor’ play into actual language learning, which this research does not address.

6. Limitations and Challenges

**6.1. Livescribe Pre-release SDK**

Most difficulties that were faced in this research were mainly as a result of the new SDK from Livescribe. In the beginning, there was only pre-release SDK 0.9.1, which had no paper design capabilities. Some options that had been explored to go around this problem, mainly the Stanford paper application and the method discussed in section 3.1.4, had their own shortcomings that have already been mentioned.

The pre release of the Livescribe SDK 1.0, in June of 2009, proved timely. The ability to design personal dot paper made the implementation a little bit easier. However, being a beta version of the SDK 1.0 meant that there were some bugs in the software and sometimes various paper designs did not behave as expected. For instance, some pictures would turn red, upon compiling the penlet, under some strange circumstance. When this happened, it was necessary to upload the pictures in question again in their respective active regions, before recompiling the software. This worked, but would fail again
occasionally for other regions and it can only be speculated that there is a bug in the software.

To produce working software with the pre-release SDK 1.0, and especially where the result is the printed dot paper application, Postscript tools, which include Ghostscript, are needed. The research ran into a number of errors involving the installation of the wrong Postscript software or just some limitation of the Postscript software itself. Sometimes, the whole application would refuse to compile because of a single character in the document that Postscript could not handle. A good case is the Myaamia letter š, which posted a number of problems. Before finding out that this was what was causing problem, the researchers had to delete everything from each page, one at a time, while compiling after every single deletion to find if that was the location of the error. This took a lot of time because the application being implemented was large and each time it was compiled, it took a lot of time to complete.

Another problem was printing errors that, after spending considerable time trying to investigate, were due to copying from MS Word, Notepad or any non-Eclipse location and pasting on any region on the dot paper being designed. This necessitated typing all of the phrases in the Eclipse paper design section, which took a lot of time and increased the chances of many typing errors. A lot of time had to be spent proofreading the books for any spelling mistakes and as expected, there were many which were corrected. The method that was used in the books and Smartpen design does not therefore guarantee a high accuracy in the end product (mainly the books) because it cannot be said for sure that there are no errors. This is made worse by the fact that most of the words in Myaamia are long and spelling errors, while writing them, is likely. If the Eclipse compiler, provided with the pre-release SDK 1.0, could allow the tracing of the location of an error on any page on the paper being designed, the development of the application could be made a lot easier. The hope is that the final version of the SDK 1.0 is much improved, so that less time is spent trying to fix these errors during the design process. It is noted that most of the errors and difficulties that are being discussed herein have been reported to Livescribe so that they can be fixed to enable a release of an improved Livescribe SDK 1.0.
Another issue is that the pre-release SDK 1.0 does not work very well with Windows Vista machines, especially when it is the 64 bit operating system machine. Although one can compile and deploy penlet application from the 64 bit Vista machine, this research’s experiment showed that it was difficult to print from some computers. The researchers ran into problems with the Postscript software, although they had followed all the instructions on the user manual and used the most appropriate Postscript version for the type of Vista machine that they were using. The problem limited the software development activities to mostly Windows XP machines. This is another problem for Livescribe to address since it has already been posted on the developer’s forum and emailed to the Livescribe chief developers. It is again hoped that the final SDK 1.0 will address the problem so that penlet design becomes truly operating system independent.

Currently, a limited number of printers have the necessary drivers to print dot paper applications. This meant that some of the printers that the researchers were planning to use could not print the papers especially with the earlier SDK 0.9.1. Refer to the manual provided with the SDK 1.0 for the printers that can be used to develop a paper application for a Livescribe Smartpen. This was not a major problem with the Pre-release SDK 1.0, though still some printers that were tested and had been recommended did not work with the applications that were developed by the researchers. Eventually, the Miami University Computer Science Department’s Xerox color printer, which failed very few times in printing dot paper request, was settled on. It is not known whether this is a problem with the pre-release SDK 1.0 or the drivers on some of the printers. As was always done, the Livescribe development team was alerted of this printing difficulty.

Other very strange errors with the pre-release SDK 1.0, especially when the Smartpen was connected to some computers, were encountered. There are some few occasions when the Livescribe desktop detects the Smartpen when it has been connected, but Eclipse fails to detect it. This means that the Smartpen content cannot be viewed in Eclipse and a penlet cannot be deployed to a Smartpen because it is not being recognized. In the beginning, to solve this problem, the researchers migrated to another machine which worked fine. However, they had to go through the whole tedious process of installing all the software needed to prepare the development environment, which took a
considerable amount of time. The researchers also tried to rectify the problem with the troublesome machine by downloading the Pre-release SDK again. Fortunately, this worked. This shows that sometimes the pre-release SDK 1.0 gets corrupted and there may be a bug in it. It is hoped that the final version of the SDK 1.0 will take care of this problem.

6.2. Designed Penlet Limitation

In the initial plan, the researchers wanted the Myaamia name of an animal to be played whenever a user tapped the tip of the Smartpen on the picture of the animal in the animal picture book. However, this approach did not work with some pictures, especially those with darker colors. A good example is the picture of the alligator, which is very dark. It was realized that the darker colors were blocking the dot locations on the paper and consequently, the camera on the Smartpen was finding it difficult to locate them. A possible solution to this problem was to keep looking for pictures that could respond as expected. However, this was not very possible because most pictures kept failing while a few like the picture of the catfish worked as was required. Consequently, the research decided to go for another approach; putting pink and yellow rectangular boxes below the pictures on active areas. The pink boxes were for the sound file for the Myaamia name of the animal while the yellow ones were for the sound the animals makes. This seemed to always work as desired, when the user tapped on any of the boxes. Although it removed one of the sophisticated desirable features, it produced a guaranteed to work result.

It was desirable to add more color to the books that were produced, especially a different font and color to what existed for the text. However, after much exploring, it became clear that Eclipse did not have this capability for paper design. If Eclipse had this capability, the books’ cover page could have been made much more attractive, especially that of the phrase book. The control of font size also seemed difficult and consequently, it was challenging to have the same font on all the pages, more so on the phrase book. The possible solution was to keep stretching or shrinking the various text boxes in the paper design until something reasonable was achieved. It is again hoped that the final release of
the SDK 1.0 would have this capability to enable designing of much more appealing paper applications.

6.3. Other Challenges

As was mentioned, to carry out this research, roughly ten or more Myaamia families were needed to participate. This would have enabled a reasonably broad source of research data. In this regard, ten families that had promised to participate in the research were sent the pre-surveys. Unfortunately, only eight of these families completed and returned the pre-surveys. The research’s rule was that only those families that had returned these initial surveys would receive the main package of the research material. This means that the data collection source had been reduced from ten to eight families. Maybe conducting this research at a different time rather than the summer could have yielded a greater participation, because the non-response may be attributed to families travelling during this period. Nevertheless, eight families was still a good number to produce some reasonable results.

7. Conclusion

Based on the results of this case study, appropriate technology like the Smartpen can contribute positively towards language revitalization. This finding is a confirmation of Diepes findings [29]. Although the sample size is small and based upon self-assessment, the results indicate that appropriate technology contributes to language and cultural preservation, dissemination of language materials, forging connection among tribal members and helps raise the social status of a language. In addition, the surveys showed that most participating families enjoyed using the Smartpen. In this case, the Smartpen is an improvement on the website CD in terms of flexibility and ease of use. Most families indicated that one of the major benefits of the Smartpen, as compared with using computers, is convenience. The Smartpen and supporting books offered a more flexible environment for language learning. A good example to illustrate this is a parent who pointed out that their son could continue studying and learning the language using the books and the Smartpen while in a car.
Although the Smartpen was generally viewed positively, one of the obstacles that could inhibit the extent to which the Smartpen may be used within the community was its cost. Some participants indicated cost as the main limiting factor to its acquisition and use. This issue has therefore raised a legitimate concern between how useful technology, like the Smartpen, can be compared to its cost.

Finally, the flexibility of the Smartpen’s software capabilities was mentioned as being a positive attribute for programming the Smartpen to do different things. For instance, a Smartpen dictionary or even a number guessing game could easily be future functions of the pen. With the Smartpen being arguably the most flexible digital pen on the market, based on its capability to be used with custom paper applications, it is felt that its usefulness may outweigh its cost under some circumstances. Therefore, it is the conclusion of this research that it would be useful to make this kind of technology available to help in language learning activities. Based on the results, it can be said with some certainty that employing good technological tools like the Smartpen, can contribute positively to revitalizing languages, like the Myaamia language, that struggle to find a purposeful place in the modern world.

8. Future work and recommendations

8.1. Paper Design

To develop completely separate applications, Livescribe allows developers to license a set of unique dot papers. In the beginning, the researchers aimed to have the phrase book and the animal picture book designed separately to simplify the programming and to speed up deploying of both the paper application and the penlet to the Smartpen. However, this was not possible because a test print license rather than a real license from Livescribe was being used. Having a real license would enable laying claim to certain pages in the Livescribe database. This would avoid the case of overwriting the already deployed application anytime a new application, that has been designed, is deployed to the same Smartpen. Acquiring a real license will be a major priority for any further projects involving Livescribe tools.
8.2. Exploring SDK 1.0

The final version of SDK 1.0 was released around September 10 of 2009, long after this research had implemented its software with the pre-release version. What this means is that the capability of the final release versus the pre-release have not been exhaustively explored. However, the surface level analysis shows that there is not much difference between the two. It is therefore an aim to explore this new SDK in detail to see if it solves any of the difficulties that were experienced with the beta version. For instance, it will be important to find out whether it fails to recognize a USB connected Smartpen, from some computers, like the pre-release version did at times. How does it respond to printing paper products? Can it be smoothly used with a 64-bit Window Vista or Windows 7 machine? Generally, doing a new paper application with this new SDK 1.0 will answer most of these questions.

8.3. New Applications

In section 5.2.8, it was observed that a number of families participating in the research made various practical suggestions about how the Smartpen could be used. For instance, someone suggested that the Smartpen should be programmed to be used with a Myaamia lunar calendar, while another wanted a Smartpen driven Myaamia dictionary. One participant even suggested programming the Smartpen to store and play winter stories to their children if triggered. These are some of the projects that are currently being planned to be implemented in the future. It has already been seen that applications like these will encourage various Myaamia families to participate fully in revitalizing their language. Since children are the future of any tribe, plans are underway to implement game based applications with the Smartpen. An application that comes to mind at this point is a Myaamia number guessing game. This application already exists as a computer game and now it has to be seen how children will react to it if it is a portable Smartpen-based game.
References


Appendices
Appendix 1

TECHNOLOGY PRE-SURVEY

Aya! The Miami Tribe of Oklahoma Cultural Resource Office and the Myaamia Project would like to thank you for your willingness to participate in projects that help us to understand how technological tools can help revitalize our heritage language and culture within the family. Please complete this pre-survey and return it in the self-addressed envelope. Should you have any question, please contact the Cultural Resources Office at 918-542-1445.

Your Family Name: ______________________

1) I am comfortable using the following technologies. Circle any/all or none that apply.
   - Computers
   - Websites
   - Other (please specify): ____________________

2) My child is comfortable using the following technologies. Circle any/all or none that apply.
   - Computers
   - Websites
   - Other (please specify): ____________________

3) My child has expressed interest in learning more about the Myaamia language and culture (circle one).
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

   Please circle the response you find most accurate:

4) My child uses technology about ….
   - Not at all
   - A few times per month
   - A few times per week
   - Daily or almost daily
   - What kinds of technology, if any, does your child use?

5) How often does your family participate in Myaamia language/culture learning activities?
   - Not at all
   - A few times a year
   - A few times a month
   - A few times a week
   - Daily or almost daily

6) How often do you currently use the Myaamia language with your child?
Not at all  A few times a year  A few times a month  A few times a week  Daily or almost daily

7) Technology like computers and websites can help preserve Myaamia language and culture.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

8) Technology like computers and websites can help disseminate Myaamia language and cultural materials.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

9) Technology like computers and websites can help forge connections with other tribal members.
   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

10) Technology like computers and websites can help the language seem more relevant, significant, or to have a modern purpose.
    Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

Please respond to the following questions:
11) In what ways, if any, is your family currently learning the Myaamia language/culture?

12) About how much time per week do you anticipate using the technology sent to you over the next two weeks?

13) What technology such as computers, websites, etc., (if any) has been helpful in learning the language or culture in your family?

14) Have you tried to use any technology to learn the language or culture that was not helpful? If so, what?

15) Please share any other experiences or opinions (good or bad) that you have about using computers, websites, or similar technologies to help to revitalize the Myaamia language or culture.
16) What type of school does your child attend? (*Circle one*)

   Public       Private       Home school

17) Has your child attended the Tribe’s children’s summer camp (Eewansaapita)? If so, how many times?

   NEEWE!
Appendix 2

TECHNOLOGY POST-SURVEY

Aya! The Miami Tribe of Oklahoma Cultural Resource Office and the Myaamia Project thanks you for testing our technology tools! Please complete this post-survey about your experience and return it in the self-addressed envelope. Should you have any question, please contact the Cultural Resources Office at 918-542-1445.

Your Family Name: _______________________________________________________

1) I am comfortable using the following technologies. Circle any/all or none that apply.
   Computers   Websites   Smartpen   Other technology (please specify):
   ______________________

2) My child is comfortable using the following technologies. Circle any/all or none that apply.
   Computers   Websites   Smartpen   Other technology (please specify):
   ______________________

   Circle the answer that applies best:
   3) After using the materials, my child’s interest in learning more about the Myaamia language or culture is.
      About the same interest as before   More interested than before   Less interested than before
      If you circled more or less, can you explain why the time was different than anticipated?

4) Over the past 2 weeks, our family used the website on the CD ….
   Did not use   More time than anticipated at the start   Less time than anticipated at the start

5) Over the past 2 weeks, our family used the Smartpen ….
   Did not use   More time than anticipated at the start   Less time than anticipated at the start
6) Over the past 2 weeks, how often did your family participate in Myaamia language/culture learning activities?
Not at all  A few times altogether  A few times a week  Daily or almost daily

7) Over the past 2 weeks, how often did you use the Myaamia language with your child?
Not at all  A few times altogether  A few times a week  Daily or almost daily

8) Technology like the website or Smartpen can help preserve Myaamia language and culture.
Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

9) Technology like the website or Smartpen can help disseminate Myaamia language and cultural materials.
Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

10) Technology like the website or Smartpen can help to forge connections with other tribal members.
Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

11) Technology like the website or Smartpen can help the language seem more relevant, significant, or to have a modern purpose.
Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

Please respond to the following questions:
12) Did our materials influence the way that you learned the Myaamia language/culture?
   If so, how?

13) Please compare the website and the Smartpen:
   Which was most helpful and why?
Which was least helpful and why?

Which was the easiest to use and why?

12) We would like your suggestions on how websites or Smartpens might be used in other ways to assist your family with the Myaamia language or culture. Please share any ideas and suggestions that you have:

NEEWE!
INSTRUCTION MANUAL

(Please read this document before using any of the materials provided)
Instruction Manual

The Miami Tribe of Oklahoma Cultural Resources Office and the Myaamia Project would like to thank you for your willingness to participate in this project. The goal of the project is to find ways to use technology tools to assist with learning the Myaamia language.

**What to do:** For this study, we want you to use the enclosed picture book and phrase book to learn more Myaamia language. We have provided sound files that go along with the two books. You have two ways to play the sound files:

1) Using a website, provided to you on the enclosed Animal & Phrases CD
2) Using a **Smartpen** along with the two books

We simply want you to try both and tell us what you think of these technology tools!

Please **read** this instruction manual carefully before using the materials provided. It is meant to make the use of the books and CDs a lot easier. Also make sure you have filled a **Pre-Survey** provided earlier, before using these materials, and sent it to us in the return envelope. A **Post-Survey** will be provided after **two weeks** for you to give us your comments about the technology tools.

First, make sure that you have the following materials in the package provided:

- i) An animal picture book titled, aweehsaki
- ii) A phrase book titled kaloolitiitaawi, meaning “let’s speak”
- iii) A Livescribe Smartpen accompanied with a Charging cradle and Headset (**The use of the headset is optional**)
- iv) A CD, labeled **Animals & Phrases**, with a webpage of sound files for the animal names and phrases contained in the books.
- v) A CD, labeled **QuickTime**, with the QuickTime software for playing sounds files from the webpage.
- vi) A list containing the names of the animals in the picture book, both in English and Myaamia

**Instructions on how to use the materials**

We expect these materials to be used for a period of **two weeks** from the time they are provided. Please make sure that the materials are handled with care because we will be taking them back, especially the pens, for further development. Although the phrase book is meant for the adults, while the animal picture book is meant for children, any member of the family should use any of the materials provided. Adults can work with their children in using the materials. We will now give a step by step instruction on how to use each of the provided material.
Using the Livescribe Smartpen to hear Myaamia spoken:

The pen is contained in a **leather-like case**. Gently, pull out the pen from its case. The picture below shows the components of the pen: [36]

1) Power button  
2) Stereo headset jack (connect headset or headphones here)  
3) Built-in microphone  
4) Display  
5) Built-in speaker  
6) USB connector  
7) Infrared camera  
8) Removable ink cartridge  
9) Rechargeable battery (non-removable)

**a) Switching the pen on/off and recharging the pen:**  
Gently press the power button (labeled 1), and the pen will be on after a few seconds. After use, the pen should always be switched off and returned to the leather-like case or put in the charging cradle.

The pens that we have provided are fully charged and they can be used continuously for 2 to 3 hours before needing recharging, but you will eventually need to charge the pen. The pen is accompanied by a charging cradle attached to a USB cable. It is charged by plugging the USB cable into a USB port of a computer and placing the
pen on the USB cradle (see the picture in the next page on how this should look like). After doing this, sometimes a new window titled “**Found New Hardware wizard**” might pop up. When this happens, just click on the cancel button on the window and ignore any subsequent messages. About 45 minutes to an hour of charging should be sufficient for every two to three hours of use.

![The Smartpen placed on the cradle](http://blogs.canoe.ca/canoetech/product-review/pulse-smartpen-ultimate-back-to-school-gadget/)
b) Using the Smartpen with the books:

i) The animal picture book – awehsaki

This book contains pictures of 48 animals, two on each page. The first page gives a brief instruction on how to use the book so you can always refer to this section. Below the picture of all the animals in the book, there is a pink box. Some animals also have a yellow box below the pink one.

The pink box – on the left of this box, the name of the animal on the picture is given in Myaamia. By touching the tip of the pen gently on the pink box, you can hear how this name is pronounced in Myaamia. You can hear the name of the animal a number of times by continuously touching on the pink box.

The yellow box- For those animals that have the yellow box below the pink box, you can touch the tip of the pen on the yellow box to hear the sound the animal makes.

For those pictures that are not so dark, you can sometimes touch the pen on the picture to hear the name of the animal. Sometimes touching on the mouth
area of the animal gives the sound the animal makes. However, the most reliable method is to touch on the pink and the yellow boxes.

ii) The phrase book: - Kaloolitiitaawi

This book contains mostly the greetings and introduction phrases. Just like the picture book, a brief instruction on how to use the book is given on page one. The book contains a phrase in English with an equivalent Myaamia translation below it. To the right of the phrase, the response both in English and the Myaamia is given. In some cases, there are multiple responses given.

To the left of each Myaamia phrase and response, a yellow box is provided. To hear the pronunciation in Myaamia, use the tip of the pen to gently touch on the yellow box. Keep touching any time you want to hear the phrase again.

Volume control

Sometimes the volume on the pen might be too high or too low to hear properly. On page one of each book, there is a volume control at the bottom right corner of the page which looks like the picture on the next page.

To increase the volume, touch the tip of the pen on the volume control symbol that resembles the sign: “^”. To decrease the volume touch on a similar symbol that points downwards. The last symbol on the volume control is for muting the volume. You can keep touching any of these symbols until you achieve the volume that you want.

Using the website on the CD to hear Myaamia language spoken

The “Animals & Phrases” CD contains a website with the sound recordings of both books, giving you another option to hear the phrases or the animals’ names in Myaamia. To use this CD, you must have the following installed on your computer:

i. QuickTime player. If you don’t have QuickTime, see the section below, QuickTime installation. If you have QuickTime, ignore this section.

ii. Any browser, Internet explorer, Firefox, Netscape or Opera
QuickTime Installation for Windows:

Before using the Animals & Phrases CD, make sure you have QuickTime player. Macintosh computers should have QuickTime. Windows computers may not. Use the steps below to check whether you have QuickTime.

Checking whether you have QuickTime

I. Double click on “My Computer” icon on your desktop
II. Look for the C drive icon on your desktop. It is labeled with a C enclosed within parentheses - (C :)
III. Double click on this icon i.e. C drive that you saw in step 2
IV. Now look for a folder called Program Files and double click on it
V. Next look for a folder called QuickTime. If you find it, then you have QuickTime and there is no need to install it again from the CD provided, labeled QuickTime
VI. You can now close the folder window.

If your Personal Computer is missing the QuickTime player, follow the steps below to install it:
   i) Insert the CD labeled “QuickTime” onto your computer’s disc drive
   ii) Open the CD by double clicking on it
   iii) Double click on the icon labeled QuickTimeInstaller.exe
   iv) Click on next until QuickTime is installed
   v) When the installation is finished, remove the “QuickTime” CD from the disc drive
   vi) You are now ready to use the animal and phrases CD

How to use the Animals & Phrases CD:

Insert the CD labeled “Animals & Phrases” into your computer and let it start. (If it does not start automatically, open the CD through the “my Computer” icon on the desktop and double click on index.html file.) A page with two links, Animal name sound recordings and Phrases sound recordings, comes up. By clicking on the relevant link, you will be brought to a page of sound recordings for that book. Sometimes the page may take a few minutes to load, so wait until all the pictures or phrases have been displayed. When using Internet explorer, a yellow bar may appear at the top of the page telling you that your security is being protected. If this happens, just right click on the yellow bar and choose the option, “Allow Blocked Content” and choose “Yes” option when the next window comes up. This will allow all the sound files to load. In general, when the computer prompts you, allow any action that will enable you to play the CD. The picture book page contains a picture of all the animals given in the book. The order of these animals mirrors the order in the book.
By clicking on the button under the picture, you can hear the Myaamia name. The phrase book page follows a similar trend.

Conclusion

We hope your use of these materials will be straightforward and enjoyable. Should you have any question, please contact Cultural Resources Office at: (918) 542-1445