For Indigenous learners worldwide, access to authentic learning is paramount. This dissertation provides some insight into how modern technologies may be used to provide authentic and relevant learning for Indigenous learners. A framework was developed and used within case studies to solicit feedback on its efficacy. An iterative process was used which allowed for a final version, the I-DIGEST version that elicited positive results and many suggestions for possible future areas of application.
FRAMEWORK FOR AUTHENTIC AND RELEVANT LEARNING SYSTEMS FOR INDIGENOUS LEARNERS
John G. Loewen

FRAMEWORK FOR AUTHENTIC AND RELEVANT LEARNING SYSTEMS FOR INDIGENOUS LEARNERS

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ABSTRACT

There are a lack of authentic and relevant learning opportunities for Indigenous learners worldwide. The research in this thesis addresses this issue from a transformative and constructivist worldview, as in order to provide answers to problem issues of empowerment, the topics of inequality, oppression, and alienation (Creswell, 2014) must be addressed and discussed. Arising from this discussion, the purpose of the project is to find ways of providing authentic and relevant learning opportunities for Indigenous learners, with the hope of removing some of the constraints imposed on these learners, such as the inequities of race, ethnicity, and culture. This project was initiated in earnest in 2012, with the majority of the research taking place in 2015 and in 2016, during intensive redesign of the framework and subsequent case study and prototype development, culminating in expert interviews with the purpose of providing analysis of and feedback on the framework and prototype tools.

The findings indicate that the current educational model for many Indigenous learners is not working and that an appropriate theoretical and practical framework is required to understand the process of Indigenous knowledge transfer for Indigenous communities. To provide an alternative path towards culturally relevant and authentic learning for Indigenous learners, an iterative framework was designed and implemented in three phases: firstly, as an unnamed framework, secondly, as the I-SLATE framework and finally, as the I-DIGEST framework. Formal and informal feedback from the first unnamed framework led to the second iteration, the I-SLATE framework. Evaluation of the I-SLATE framework presented some issues, the most important being the need to provide an alternative ICT methodology from the one proposed for providing authentic learning. This led to the final iteration of the framework, the I-DIGEST framework, which produced very favourable results and many suggestions for possible areas of application for the framework. The components of the framework are intended to be reusable and may be adapted for different hardware/software and platform requirements.
The final section of this dissertation discusses possible future directions for this type of research in the field of Indigenous knowledge, Indigenous learning and ICT. Overall this dissertation demonstrates that this area of research is very new and, as such, has a bright future of almost endless possibilities.

**Universal Decimal Classification:** 371.69, 371.333, 37.043

**ERIC Thesaurus:** Indigenous knowledge; Indigenous populations; Inclusion; Culturally relevant education; Story telling; Nonformal education; Technology uses in education

**Yleinen suomalainen asiasanasto:** perimätieto; alkuperäiskansat; inklusio; kulttuurinen kestävyys - koulutus; suullinen perinne, kertomusperinne; informaali oppiminen, kokemusoppiminen; tietokoneavustetinen opetus, tietokoneavustetinen oppiminen
ACKNOWLEDGEMENTS

This research journey has been long, spanning over seven years of my life, living and working in various parts of the globe, following my family’s dreams and aspirations, with a small backpack containing a laptop full of PhD research, topics ranging from Indigenous epistemology, Indigenous knowledge, holism, ICT approaches, fuzzy logic, digital storytelling, participatory engagement and community protocol, just for starters. The origins of the research truly began in my childhood, as I was raised in a remote, rural location, a set of islands now called by their correct name, Haida Gwaii (land of the people), off the north west coast of Canada. Living so close to the land and off of the land, holism as a way of thinking was part of my upbringing, yet as a white settler, the formal educational learning that my classmates (both Indigenous and non-Indigenous) and I were exposed to was solely of a Western Eurocentric nature. This did not at all parallel the informal learning that I was exposed to outside of the classroom in day-to-day subsistence living. Failure rates in the secondary education system of my upbringing were very high, with my high school routinely rated by the Fraser Institute (a non-partisan research and educational organization) as one of the lowest achieving schools in the province of British Columbia, Canada (for example, this school was rated 288th out of a total of 289 in 2014). When I graduated from high school and moved away for university and on to work and to further education, I had difficulty coming to terms with this, and as the years went by, the questions changed to, “Why is this STILL the case?” and, “What are the reasons?” These are the burning intrinsic informal questions that have driven this research from the beginning as my real-life experiences within this educational system made me realize that, although the system had worked for me, there were many people around me for whom it was clearly not working.

From my own reality then, and from a formal perspective, this research began in an old colonial mansion in Jakarta, Indonesia, a leftover relic from the days of colonial oppression, rotting and falling apart, since demolished in the pursuit of “modernization”.

It was an interesting place for this journey to begin as, to me, this building was a metaphor for change within educational institutions, with “modernization” standing not for the traditional Western ideal of social evolution and urbanization, but in fact for the ideal of Indigenous knowledge inclusion, an ideal still considered backward and outdated by many, a relic of days gone by, days of “previous glory”.

With my research proposal, a continuation of my Master’s thesis, in hand, my former supervisor, Dr. Kinshuk, suggested a school in Finland, and specifically the IMPDET program, as one that might be interested in what I was proposing. I had never been to Finland and had never heard of the town of Joensuu, but I contacted the IMPDET director, Dr. Jarkko Suhonen, who was indeed interested in what I was
proposing. So after all of the formal procedures, my PhD journey began in early 2011. Since then, it has taken me from Jakarta to Beijing, China, with a year spent reviewing literature and revising frameworks, culminating in the unexpected early arrival of my first child, back to Canada for lecturing work at three different universities, to Joensuu for a semester of coursework, and more recently, to three years in Myanmar and now in Thailand, spending any time I can researching and writing, with the end result being the writing of this thesis. The reason for highlighting the transient nature of my life during this time is because it has pulled me away from a sense of community; whenever I go back to where I am from, to visit, I am able to observe how strong the bonds are within the communities. This has provided insight into how indelible the connections are to community, and how important trust building within communities is to the people who have always lived there. As I am the sole funder of my PhD research, I am at the will of the economic realities of maintaining a livelihood, and thus, my research has been performed as best as possible within this reality, not being as tightly tied to community as I would wish.

Thankfully, over these transient years I have maintained a semblance of professional and personal community and I am very thankful for this. Firstly, from the bottom of my heart, I would like to thank Dr. Kinshuk, with whom I have been associated now for over 10 years. Through all the changes and challenges in my life, he has been there as a supervisor, advisor, mentor, cheerleader, and friend. I would also like to thank Dr. Jarkko Suhonen for his excellent guidance and advice on writing, resources and all other things PhD, and to Professor Markku Tukiainen for his expert advice on research methodologies and practicalities.

Special thanks to Dr. Nian Shing Chen for his advice and recommendations during the journal submission process.

And lastly, of course, to my family, both immediate and extended, who provided endless support, direction, and feedback throughout this long and winding journey.

Joensuu, September, 2018
John Loewen
**LIST OF ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer Automated Design</td>
</tr>
<tr>
<td>CEAA</td>
<td>Canadian Environmental Assessment Agency</td>
</tr>
<tr>
<td>GPS</td>
<td>Geographical Positioning System</td>
</tr>
<tr>
<td>I-SLATE</td>
<td>Indigenous Slate of Learning Authenticity Tools for Education</td>
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<tr>
<td>I-DIGEST</td>
<td>Indigenous Digital Storytelling Framework</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
</tr>
<tr>
<td>IEEE LOM</td>
<td>IEEE Learning Object Metadata</td>
</tr>
<tr>
<td>IK</td>
<td>Indigenous Knowledge</td>
</tr>
<tr>
<td>IMS</td>
<td>Instructional Management System</td>
</tr>
<tr>
<td>IMS-LTI</td>
<td>IMS Learning Tools Interoperability</td>
</tr>
<tr>
<td>JIF</td>
<td>Journal Impact Factor</td>
</tr>
<tr>
<td>JRP</td>
<td>Joint Review Panel</td>
</tr>
<tr>
<td>LBMLG</td>
<td>Location-Based Mobile Learning Game</td>
</tr>
<tr>
<td>LMS</td>
<td>Learning Management System</td>
</tr>
<tr>
<td>M-learning</td>
<td>Mobile Learning</td>
</tr>
<tr>
<td>NEB</td>
<td>National Energy Board</td>
</tr>
<tr>
<td>PD</td>
<td>Participatory Design</td>
</tr>
<tr>
<td>RQ</td>
<td>Research Question</td>
</tr>
<tr>
<td>SCORM</td>
<td>Shareable Content Object Reference Model</td>
</tr>
<tr>
<td>SWOT</td>
<td>Strengths, Weaknesses, Opportunities and Threats</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Program</td>
</tr>
</tbody>
</table>
LIST OF ORIGINAL PUBLICATIONS

This thesis is based on data presented in the following articles, referred to by the Roman Numerals I-VI.


AUTHOR'S CONTRIBUTION

I) The author formulated the research questions, conducted the literature review and, from the literature review, determined the components of the multidisciplinary approach and designed the framework presented. Prof. Kinshuk advised on the paper writing and presented the paper on behalf of the author at the 2012 IEEE T4E conference in India.

II) The author formulated the research questions and designed the original framework presented. Prof. Kinshuk gave direction on the writing and organization of the paper and provided final editing and review.

III) The author formulated the idea of providing fuzzy logic as an ICT solution. David Loewen advised on the formulation of, and provided valuable local context for, the case study implementation. Prof. Kinshuk and Dr. Suhonen advised on the paper writing.

IV) The author provided further design of the framework and formulation of the AI approach using fuzzy logic techniques. Formulation of the case study example, including local context, was provided by David Loewen. Prof. Kinshuk and Dr. Suhonen advised on the paper writing.

V) The author provided further formulation of the framework, including the creation of two case studies and design of the prototype tools to provide validation of the case studies. The author also conducted all of the interviews and analyzed all of the interview data. Prof. Kinshuk, Dr. Suhonen and Prof. Nian Shing Chen advised on the writing of the paper, providing their valuable expertise in structure and content to ensure publication in an appropriate journal.

VI) The author provided the redesign of the framework and prototype tools and conducted all of the interviews and analyzed all of the interview data. Prof. Kinshuk and Dr. Suhonen advised on the writing of the paper, providing their valuable expertise in structure and content to ensure publication in an appropriate journal.
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1 INTRODUCTION

This dissertation highlights the exploration of novel and useful ways of using Information and Communication Technology (ICT) approaches to promote and to incorporate Indigenous thought in education. It contains materials from journal papers, book chapters and conference proceedings written by the author and summarizes their findings. In some ways, it may be considered to be ground breaking research, but this is dependent on whom you are talking to. From most Indigenous people’s perspectives, holistic thought is the way, and has always been the way, to make sense of the world. From the dominant Eurocentric perspective, as the literature shows, there is a lack of understanding of holism and a distinct lack of inclusion in formal education (Johnson, Sievert, Durglo, Finley, Adams & Hofmann, 2014). It is here that further research is necessary, and it is here that the research that is the formal part of this thesis begins.

Indigenous communities throughout the world have had deep relationships with their environment since time immemorial. In the past 20 to 25 years there has been a movement towards recognition of these relationships (Takeda, 2015; Turner, Ignace & Ignace, 2000). The knowledge gleaned by Indigenous peoples has been recognized as an indispensable component of the handling and care of local resources. Overwhelmingly, this knowledge is deemed important. Indigenous knowledge is not the domain of Indigenous peoples alone – all communities have developed their own body of knowledge over generations (Gorjestani, 2000). Unfortunately, the inclusion of this knowledge into community-based knowledge and learning systems has been sluggish. Presently, the bulk of educational materials used by Indigenous peoples are standardized and colonial in methodology and structure. Community members who have not been exposed to this cultural methodology find no relevance in the learning materials and, consequently, success rates are low. Those that do survive in this academic environment find themselves “caught between two worlds” (Abrams, Taylor and Guo, 2013). Additionally, many members of Indigenous communities feel a very strong connection to their traditional lands and as a result do not want to move away from their communities, to the “big city” to further their knowledge and education. They have a desire to remain within their communities, to learn, to interact, and to give back. These community members define their being from the connections and relations to their home environment (Turner et al., 2000; Aikenhead & Elliot, 2010). In many cases this remoteness limits educational opportunities for learners in that there is a dearth of opportunity to access learning content.

There is a desire for many remote, rural, Indigenous learners to remain within their communities and to learn using methodologies that are appropriate to their differing worldview and epistemology (Battiste, 2002). The context of the learning
environment, in this case a worldview opposed to the current epistemological model, requires a delicate and realistic understanding of the environment of the community or communities concerned. A number of researchers have identified the need for learners to participate actively in the pursuit of their educational goals (Lave & Wenger, 1991; Lee, Eustace, Hay & Fellows, 2005; McGloughlin & Lee, 2010). To allow for learner participation, constructivist theory has been identified as an effective paradigm in a cultural context, particularly where the learners can create their own personal knowledge to provide context and authenticity of learning (Zualkernan, 2006; Brown, Collins & Duguid, 1989; Herrington & Oliver, 2000). Constructivist theory allows for the generation of authentic tasks and learning situations. As an example, following this model, Indigenous learners will be able to incorporate their own experiences, in many cases as a form of local or Indigenous knowledge, into the design of learning materials. To facilitate this process, Sen (2005) and Raseroka (2008) have identified ICT as a significant tool for the capture of Indigenous knowledge, to facilitate both its preservation and access beyond person-to-person communication. Due to the desire of community members to remain in their home communities, ICT tools can support Indigenous students’ lifelong education through distance education programs (Donovan, 2007). In delivering culturally relevant learning materials to remote communities lacking in infrastructure, mobile devices show promise (Shih & Tseng, 2009; Liu and Hwang, 2010).

As highlighted previously, many research initiatives have identified the need for an alternative path for Indigenous learners (McAuley, 2009; Duveskog, Kemppainen, Bednarik & Sutinen, 2009). What is missing from the research is the concretization of a standardized methodology (particularly in the area of geographical and cultural context) for the storage and retrieval of cultural knowledge that may be used for culturally and contextually relevant teaching (Hartnell-Young & Vetere, 2008). Thomas (1997) identifies two deficiencies in the research: how learners approach learning tasks is not well documented, so specific approaches to learning content need to be considered as essential components of a pedagogy that addresses cultural needs, and teachers need to be trained to implement such pedagogy effectively. Pulkkinen (2003) reminds us that ICT education projects are often missing the human, social component. Pedagogical methods need to be concretized, and best practices have to be identified for applying them (Stone, Briggs & Smith., 2002; Hartnell-Young & Vetere, 2008).

The research presented in this dissertation provides potential approaches (in the form of a framework or frameworks) to solve the issues identified, and then asks for feedback from educational and knowledge experts who come from both Indigenous and non-Indigenous backgrounds, who are either tightly or loosely bound to community on the framework and approach. The intention of this methodology is to discover if there is a framework or approaches to learning that are mutually inclusive, rather than exclusive, thereby bridging knowledge systems by highlighting commonalities rather than differences.
1.1 PROBLEM STATEMENT

There is a lack of a suitable formal standardization for compiling culturally contextual learning materials, creating learning objects from this material, and delivering them to Indigenous learners. Indigenous learners in this context may refer to any community that emphasizes ecological and rural associations. Gruenewald (2003) refers to this as following a place-based pedagogy, which is needed so that the education of citizens may have an effect on the well-being of the social and ecological places that these people actually inhabit.

In order to find an approach to deal with this problem, the following research questions have been devised. The first question aims to study the literature to discover the status of the educational models for Indigenous learners. The second question attempts to find a formal way in which to define an effective framework to formalize an understanding of Indigenous knowledge transfer in education. The third question aims to define ICT approaches towards providing relevant and authentic education for Indigenous learners.

1.2 RESEARCH QUESTIONS

The research questions are the underlying foundation of this research and have guided the focus from the start. As stated in the introduction, the initial impetus for the research arose from curiosity and concern around the lack of success for Indigenous learners from within the communities where I grew up and attended school. This curiosity led to the first research question, RQ1.

**RQ1:** What is the current educational model for Indigenous learners? Is this model working? Why or why not?

The methods used to answer this question included a literature review and background studies, and interviews. The main answer to this question was realized predominantly in the literature review as many scholars, both Indigenous and non-Indigenous, have posed this question in their research.

Once the research had identified issues for Indigenous learners within the current educational model, the next step was to provide possible ways in which to formalize a way forward towards incorporating Indigenous knowledge in education, leading to the second research question, RQ2.

**RQ2:** What kind of theoretical and practical framework is appropriate for understanding the process of Indigenous knowledge transfer in the context of an Indigenous community?
This question was initially addressed in the literature review and background studies, and the answers were refined through qualitative interviews and informal queries.

Once a better understanding of possible ways of incorporating Indigenous knowledge into learning was acquired, the goal was to provide Indigenous learners with improved opportunities for learning within current educational systems, leading to the third research question, RQ3.

**RQ3: Is there an alternative learning path that Indigenous learners may follow that provides cultural relevance and authenticity, leading to higher levels of interest and engagement?**

This question was answered primarily through the implementation of the framework via case-study simulation and prototype tool creation. Following this, qualitative interviews were used to validate whether the framework and implementation approaches effectively answered this question.

A summary for the research methods used to answer each of the research questions is provided in Table 1.1. Additionally, the table provides the publication number and the chapter within this thesis where each research question is addressed.

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Method</th>
<th>Chapters in Thesis</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ1</td>
<td>Literature Review</td>
<td>2, 4, 5, 6</td>
<td>(Paper I – Paper VI)</td>
</tr>
<tr>
<td>RQ2</td>
<td>Literature Review, qualitative analysis</td>
<td>2, 4, 5, 6</td>
<td>(Paper I – Paper VI)</td>
</tr>
<tr>
<td>RQ3</td>
<td>Literature review, case studies, interviews, qualitative analysis</td>
<td>2, 4, 5, 6</td>
<td>(Paper IV, Paper V, Paper VI)</td>
</tr>
</tbody>
</table>

Each paper included in this thesis has endeavoured to answer one or more of the research questions RQ1, RQ2 and RQ3.

Paper I, titled “Indigenous Knowledge and ICT: An Interdisciplinary Approach to Culturally Inclusive Education”, through its literature review further answers RQ1 by identifying gaps, specifically that of the need for innovative ICT for the transfer of Indigenous knowledge into culturally inclusive education. Paper I also defines all of the components necessary in an interdisciplinary approach to providing authentic and relevant learning to Indigenous learners.

Paper II, titled “The Need for Technological Innovations for Indigenous Knowledge Transfer in Culturally Inclusive Education” lays out the original conceptual framework design that is the foundation for the progression of the rest of the thesis and answers research question RQ1. This is based on the analysis of the previous litera-
ture, which identified the importance of the role of Indigenous knowledge in culturally inclusive education, and how ICT may aid in providing a bridge to allow for the inclusion of Indigenous knowledge in the educational curriculum for Indigenous learners worldwide.

Paper III, titled “Towards an ICT Framework for Providing Inclusive Learning Objects for Indigenous Learners” provides “the glue”, so to speak, in the form of a framework that models holistic thinking and incorporates it into the educational system for Indigenous learners. The glue is provided by fuzzy logic concepts, which are used to show proof of concept by simulating qualitative thinking within a simple expert system case study example.

Paper IV, titled “A Proposed Model for Creating Authentic Learning Objects for Indigenous Learners” further develops the framework designed in Paper III and provides a specific fuzzy logic case study example in a Canadian First Nations context that incorporates holistic thinking into the creation of fuzzy logic rulesets that are used to simulate qualitative thinking. It also provides for the retrieval of authentic learning objects based on the results of the expert system output. The focus of this paper is to answer RQ3 by presenting a framework that allows authentic learning for Indigenous learners to take place.

Paper V, titled “I-SLATE: A Framework for Creating Authentic and Relevant Learning Opportunities for Indigenous Learners” endeavours to further answer RQ3 by providing validation of the I-SLATE framework, which was revised and improved upon from Paper IV. Indigenous and non-Indigenous educational and educational technology experts are interviewed for feedback on the framework, to provide feedback on how the I-SLATE framework addresses and provides answers to RQ3.

Paper VI, titled “I-DIGEST: An ICT Approach Using Digital Storytelling to Provide Authentic Learning Opportunities for Indigenous Learners”, through an additional iteration of the framework developed and presented in Paper V, further answers RQ3 by providing validation of a revised version of the I-SLATE framework. Indigenous and non-Indigenous educational and educational technology experts are interviewed to provide feedback on how the I-DIGEST framework addresses and provides answers to RQ3.

In order to show the interconnectedness and interdependencies of the publications included in this entire body of research, a diagram is provided in Figure 1.1.
This correlation diagram illustrates where each research question is addressed and how each publication attempts to answer the question, and provides a brief explanation of the reasoning behind the progression from one publication to the next. The circular shape of the diagram shows interconnectedness from an Indigenous perspective, and also illustrates that this process is iterative due to the ever-changing nature of Indigenous knowledge.

### 1.2.1 Structure of the Dissertation

This thesis contains five chapters and six publications, and is organized as follows. Chapter 1 introduces the motivation behind the research, including the problem statement and research questions. Chapter 2 reviews the literature on Indigenous knowledge and thought, the current state of culturally focused education, ways in which Indigenous knowledge and Western knowledge may be bridged, ICT approaches to Indigenous education, and lastly, mobile and distance technologies for Indigenous education. Chapter 3 provides the research design, starting with the overall research approach, including the philosophical worldview approach employed, the design context, research design and research methods used, and finishing with a section outlining the relevance of the papers as they relate to the research questions and the overall thesis. Chapter 4 provides a summary of the overall findings of the research found in each of the research papers (Paper I – Paper VI) that make up this thesis. Finally, Chapter 5 provides a discussion of the findings by highlighting the important findings of the research and how they relate to a transformative worldview, for example, how this research may benefit...
communities of Indigenous learners. Additionally, this chapter identifies and describes some of the limitations of the research within this thesis, provides some concluding remarks, and provides some possible directions for future research in the interdisciplinary domains included in this thesis.
2 LITERATURE REVIEW

The starting point of this research is to provide improved learning conditions, in the form of relevant learning opportunities for Indigenous learners. Based on this, a literature review was conducted that explores the key factors that must be considered for providing these opportunities. This section begins by outlining the framework followed to perform the initial literature review. From the literature review, the key factors determined include identifying different knowledge systems, exploring culturally focused education, bridging knowledge systems, and identifying approaches that may support bridging.

The focus, then, is to find a way, or ways, with which to incorporate Indigenous knowledge into formalized education. The main tools to effect this change involve ICT approaches and therefore these must be explored as well.

2.1 LITERATURE REVIEW FRAMEWORK

As was shown by the research in Paper I, gaps were discovered, specifically the lack of innovative ICT for the transfer of Indigenous knowledge into culturally inclusive education. The inter-disciplinary nature of the different knowledge categories required to address the research questions highlighted an important first step that needed to be addressed before beginning the literature review process, specifically, what domains of knowledge to include in the research, and how these domains are related to each other. As with any research, a comprehensive understanding of the field or fields of research is required. Paper I identified the need for the integration of Indigenous knowledge into education for Indigenous learners and also a way in which to store this valuable and, in many cases, disappearing commodity. The components of this interdisciplinary approach are shown in Figure 2.1.
From this diagram, and using the research questions as a guideline, the concepts of educational technology, Indigenous knowledge, ICT, and learning pedagogy were determined as the domains in which to position the research. As a next step, the goal was to identify the levels of interdisciplinary cohesion (the “glue”) between these disciplines. A Venn diagram approach, to show how the four disciplines are related, is shown in Figure 2.2.

The positioning of the research begins at the joining of the three main areas, specifically Indigenous Knowledge & Thought, Indigenous Education and Educational Technology. ICT is important in that it provides a way in which to acquire, store, and retrieve all of the other disciplines in a standardized reusable manner.
As the main research focused around educational technology, the Google Scholar 2017 h5-index for “educational technology” for 2017 was used to select the journals. After weighing the merits of both the h5-index and the ISI Journal Impact Factor (JIF), the h5-index was chosen due to its free and accessible nature. Using the h5-index the following top ten h5-index journals were selected:

- International Journal of Educational Technology & Society (IJET&S)
- Computers & Education (C&E)
- Distance Education (DE)
- Australasian Journal of Distance Education (AJET)
- British Journal of Educational Technology (BJET)

To cast a fairly wide net to start, the date ranges for every search performed were set from 2000-2017 inclusive. The next phase of the review process was to devise relevant keyword search terms from the research questions (RQ1, RQ2, and RQ3) for the article search. To incorporate the areas of Indigenous knowledge/thought, educational pedagogy and mobile devices in our search results, the following keywords were devised:

- Indigenous learning
- mLearning, m-learning (independent searches for each spelling were performed separately on each journal and added together)
- Cultural context
- Environmental context
- Indigenous knowledge
- Contextual learning
- Experiential learning

Each key phrase was input into the Google Scholar advanced search option set to search the entire body of each article for an “exact match”. The initial search results returned 1667 articles from the five journals. The results, which have been broken down by search criteria and journal name (shown in the first row by their acronym, listed earlier), are shown in Table 2.1.

Table 2.1. Search criteria and number of results by journal

<table>
<thead>
<tr>
<th>Search Criteria</th>
<th>IJE&amp;S</th>
<th>C&amp;E</th>
<th>DE</th>
<th>AJET</th>
<th>BJET</th>
<th>TOTAL</th>
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<td>Indigenous learning</td>
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<td>0</td>
<td>4</td>
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<td>mLearning, m-learning</td>
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<td>150</td>
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<td>Cultural context</td>
<td>35</td>
<td>87</td>
<td>133</td>
<td>32</td>
<td>54</td>
<td>341</td>
</tr>
<tr>
<td>Environmental context</td>
<td>3</td>
<td>14</td>
<td>10</td>
<td>2</td>
<td>6</td>
<td>35</td>
</tr>
<tr>
<td>Indigenous knowledge</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Contextual learning</td>
<td>16</td>
<td>26</td>
<td>30</td>
<td>12</td>
<td>13</td>
<td>97</td>
</tr>
<tr>
<td>Experiential learning</td>
<td>56</td>
<td>170</td>
<td>219</td>
<td>87</td>
<td>171</td>
<td>703</td>
</tr>
<tr>
<td>TOTAL articles found</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1667</td>
</tr>
</tbody>
</table>
The seven relevant keyword searches are shown in the left-most column with the number of articles returned using that exact phrase as part of the Google Scholar search. Analysis of Table 2.1 highlights the lack of research in the areas of Indigenous learning (a total of only four articles found) and Indigenous knowledge (a total of only nine articles found), providing further impetus and focus for this research.

To note, in order to keep the sample to a manageable size, these papers were selected from the most prominent journals in the field using the search criteria outlined. Additional papers may have been omitted due to their not meeting the specified criteria.

The selection process revealed a limited number of relevant published articles that met the stringent criteria set out from the onset of the search. From the results found, a manual search of the abstracts for each article was performed to determine relevance. As a structured scientific approach did not find an adequate number of interdisciplinary peer citations and general references, a more ad hoc approach was taken. This parallels the concept of Indigenous thinking as it requires making decisions based on experiences, prior knowledge and available data.

Using the research questions as a guideline, the following relevant domains/areas were created to organize the themes for the literature review:

- Indigenous knowledge and thought
- Culturally focused education
- Bridging knowledge systems (providing some interdisciplinary “glue”)
- ICT approaches for Indigenous education
- Mobile and distance technologies for Indigenous education

Each of these themes is expanded on in the next section (Section 2.2).

### 2.2 INDIGENOUS KNOWLEDGE AND THOUGHT

A useful starting point is to identify what constitutes colonial, standardized thinking and learning and then to describe how is it different from Indigenous knowledge and thinking. In this discourse, it is a very important question to provide answers to before moving forward. As Smith (1999) observes, it is difficult to discuss research methodology and Indigenous peoples in the same breath without providing an analysis of imperialism and without understanding the complex ways in which the pursuit of knowledge is deeply embedded in the multiple layers of imperial and colonial practices. More often than not, the discussions on Indigenous knowledge and thought are about what it is not rather than what it is. For example, according to Battiste (2002), Western perspective has sought to reduce it to taxonomic categories that are static over time, to reduce it to quantifiable observable empirical elements, to state that Indigenous knowledge has no validity except in
the spiritual realm, and additionally, that “traditional knowledge” denotes a relatively old body of data; taxonomic studies categorize and make this knowledge static. Moving to what it is, Indigenous knowledge and thought is experientially grounded (Kawagley & Barnhardt, 1998; Battiste, 2002). Indigenous knowledge comprises the complex set of technologies developed and sustained by Indigenous civilizations. Often oral and symbolic, it is transmitted through the structure of Indigenous languages and passed on to the next generation through modelling, practice, and animation, rather than through the written word (Battiste, 2002). Additionally, the diverse elements of an Indigenous people’s heritage can only be fully learned or understood by means of the pedagogy traditionally employed by these peoples themselves, including apprenticeship, ceremonies, and practice (Daes, 1995). According to Kawagley and Barnhardt (1998) Western education tends to emphasize compartmentalized knowledge, which is often decontextualized and taught in the detached setting of a classroom or laboratory. The notion of competency in Western thought is defined based on predetermined ideas of what a person should know, which is then measured indirectly through various forms of “objective” tests. From a Western Eurocentric perspective, writing or literacy has been used to determine the breaks between the past and the present, the beginning of history and the development of theory, as the mark of a superior civilization. Often other societies have been judged, by this view, to be incapable of thinking critically and objectively, or having distance from ideas and emotions (Smith, 1999). Writing, and especially writing theory, are very intimidating ideas for many Indigenous students.

Unfortunately for a learner with a certain style, for example an Indigenous learner, the majority of learning materials delivered by dominant educational means are delivered in an established, colonial, standardized way (Aikenhead & Elliott, 2010; Battiste, 2002). Learners become frustrated, alienated, and have a higher failure rate when the schooling imposes criteria that are oriented to white society without regard to Indigenous people’s cultural and community traditions (Aikenhead & Elliott, 2010; Wotherspoon & Schissel 1998). Many members of Indigenous communities feel a very strong connection to their traditional lands and as a result do not want to move to urban areas to pursue further education. They have a desire to remain, to learn, to interact, and to give back to their communities. They define themselves in relation to their home environment (Turner et al., 2000). There is a need, then, to look at alternative ways in which to provide learning opportunities for this style of learner. Culturally focused education is an area of research that provides insight into alternative methods of learning for Indigenous learners.
2.3 CULTURALLY FOCUSED EDUCATION

Research shows that Indigenous knowledge, culture, and community all have a place in the education of minority peoples, offering an alternative to narrowly focused scientific disciplines, which may neglect the interconnections of natural phenomena (McRae, 2018, Breidlid, 2009). As researched and stated by Paciotto (2010), the seminal ethnographic works of Scribner and Cole (1981), Street (1995), and Heath (1983) have paved the way for the reconceptualization of literacy as culturally and socially situated in a way that often intertwines oral and written traditions. Paciotto (2010) analyzed these seminal studies and states that their work has unveiled the multi-dimensionality of literacy practices as uniquely shaped by community contexts resulting from and influencing social development and individual improvement in distinctive ways, debunking the myth of the “great divide” among literate and non-literate communities. The literacy is non-conventional and linguistic in nature. Carol Leclair (Metis Scholar) (from Dyson, 2006) reflects on the relevance of oral information sharing and gathering in the form of a “potlatch”. She says:

"I’m told that Potlatch is a Chinook word meaning ‘to give.’ I can think of Potlatch metaphorically as a Haida information technology, a kind of ‘data storage’ through family-owned dances, objects, stories, songs and ceremonies. Many witnesses confirm and preserve an organic process."

Many of these information sharing processes are conducted in local languages, which juxtaposes with current educational paradigms as the majority of language contact situations are typically complicated by the overpowering pre-existence of formal education in majority or dominant languages (Paciotto, 2010). With this in mind, there is a movement in cultural education towards the concept of experiential learning. Experience-based education presents the laying of individuals’ openness to knowledge through the agency of the land (Birrell, 2006). In other words, it is through the land and living on it, walking on it and tending to it that one learns and acquires knowledge, not by sitting in a classroom talking about it. It is a different worldview, one in which place and an individual’s relationship to it have higher importance. According to McKnight, Hoban, and Nielson (2011), Aboriginal epistemologies involve knowing about your place with, and on, the land through developing, maintaining and nourishing respectful relationships in relation to all the connecting entities of creation.

As Manuelito (2005) states, community-based education is unique because it gives colonized people the opportunity to express and operationalize self-determination. In the past, this has been seen as a double-edged sword as colonizing societies have used education as a tool to “re-educate” in the dominant culture. In her studies of Indigenous communities in America, Manuelito (2005) re-
veals that Indigenous epistemologies remain largely absent in the educational system of Native Americans. Leclair also states that one of the issues is the resistance by Indigenous people to the storage of information by technological means. She says:

“Historically, potlatch ceremonial material has been confiscated and sold to collectors worldwide. This could be analogous to computer hacking and theft of data. We know how difficult a process of repatriation of cultural materials continues to be. I imagine the repatriation of information will be very difficult.” (Dyson, 2006)

Therefore, initiatives designed with Indigenous peoples in mind must consider incorporating a well thought-out and lengthy trust-building component.

Following the concept of inclusion, a number of researchers have identified the need for learners to participate actively in the pursuit of their educational goals (Lave & Wenger, 1991; Lee, et al., 2005; McGloughlin & Lee, 2010). Constructivist theory is a paradigm that has been proven to be effective in a cultural context, particularly where the learners can create their own personal knowledge to provide context and authenticity of learning (Zualkernan, 2006; Brown, Collins & Duguid, 1989; Herrington & Oliver, 2000). Constructivist theory allows for the generation of authentic tasks and learning situations. Abrami, Bernard, Wade, Schmid, Borokhovski, Tamin, and Newman (2008) determined that increasing student interaction with content was the most effective method of enhancing student performance. Using this as a focus of curriculum development, the next step in the development process would be not just to provide additional content, but also to provide culturally relevant content for learners. The Participatory Design (PD) framework, which allows for users to play a more active role in the design of the curriculum, is a framework which shows promise around social and cultural inclusion in education. In order for participatory design to work effectively, the process must be fully democratic (McIver, 2003). An example of a project in this domain is the Sura Ya Ukimwi project (Duveskog et al., 2009) that used participatory design to create web-based culturally relevant content to promote HIV/AIDS education to high-risk youth in Tanzania. The authors concluded that the actual participatory design process is more important than the production of the materials themselves.

There is a need for an interesting and meaningful pedagogy that bridges new values with the old and sets the former knowledge and skills in the context of the new (Thomas, 1997). Additionally, little or no research has been performed into melding existing information and research findings on learning cultures into teaching strategies and styles. Indigenous knowledge has been characterized by some as inefficient, old-fashioned and unscientific, and relegated to the realm of insignificance (Breidlid, 2009), and there are skeptical researchers who take the position that Indigenous knowledge should not be deemed relevant. This leads to Indigenous communities becoming wary of sharing important knowledge with people who are
not members of a community. Sen (2005) observes that access to outside members creates ample opportunities for illicit access to and misuse of this traditional knowledge. Therefore, the ethics and privacy issues for usage of Indigenous knowledge must also be taken into account (Raseroka, 2008; Sen, 2005; Hunter, Koopman & Sledge, 2003) as there is the possibility of misuse and misappropriation of this information. An issue identified by researchers is the lack of training in cultural diversity for educators. Philpott, Sharpe, and Neville (2009) and Manuelito (2005) identified this as a development of critical importance for e-teachers who are increasingly seen as essential participants in the academic careers of students. Understanding how Indigenous communities organize learning, and the philosophical stance behind learning processes, can help expand educators’ approaches to teaching and learning, as well as expand the learning possibilities that Indigenous learning practices can offer to all students (Urrieta, 2013). A second issue lies in the realization that only a fraction of students remain in school long enough to experience e-learning (Philpott et al., 2009).

Kinuthia (2007) identifies five challenges to the facilitation, recognition and validation of the legitimacy of Indigenous knowledge as a pedagogical, instructional and communicative tool due to:

- Indigenous educators being discounted as having valuable expertise;
- an underlying fear that introduction of Indigenous content is potentially identifiable with the dominant Indigenous group;
- the notion that diverse cultures with differing opinions can create conflict;
- the fact that introduced systems of education may not allow for cultural differences, as acknowledged by both Indigenous and non-Indigenous educators; and
- the limits of oral knowledge transition to literate forms.

As an example, the lack of variance in Canadian Indigenous education is clearly defined by Haig-Brown (1995) when she states:

“Mainstream education for the most part, has paid little attention to First Nations people’s lives and histories: but First Nations students need the tools mainstream education offers in order to improve their lives”.

This is a double-edged sword in an Indigenous context as the educational systems do not integrate Indigenous lives and culture, nor is there the digital communications infrastructure to support distance learning in many of these communities. More recently, Indigenous scholars have highlighted the fact that this lack of variance still exists (Battiste, 2002; Johnson et al., 2014). Furthermore, these cultural values and traditions, oral in nature, are disappearing with the extinction of the languages in which they are deeply associated. With this in mind, international
agencies, such as the United Nations Development Program (UNDP), promote ICT as a way in which to preserve this knowledge, and to facilitate access to education for remote populations (Clothey, 2015). Sen (2005) and Raseroka (2008) have identified ICT as an important way in which to gather Indigenous knowledge that may be used assist the process of preserving and utilizing this knowledge beyond person-to-person interactions.

However, Indigenous knowledge about the land and environment often contrasts sharply with Western scientific knowledge (Aikenhead, 1997), and the belief that this “science” has its own culture (Aikenhead, 2001; Bang & Medin, 2010). Yet Indigenous knowledge does not exist as an “either/or” division with Western knowledge and there are pitfalls in classifying them in this way, as this may establish superior-inferior relationships (Aikenhead & Michell, 2011). This supports more of a “both/and” outlook as opposed to an “either/or” outlook.

With this in mind, some researchers state that there is a critical demand to bridge different knowledge traditions, to construct methods that allow us to work productively between these traditions (McRae, 2018; Sillitoe & Marzano, 2009). Some ways in which this may be accomplished are discussed next.

2.4 BRIDGING KNOWLEDGE SYSTEMS

The concept of bridging knowledge systems has been a key theme for some time (Rathwell, Armitage & Berkes, 2015; Nakata, 2007; Berkes 2009; Reid, Berkes, Wilbanks & Capistrano, 2006). Bang, Marin, Faber and Suzukovich (2013) identify linkages between Indigenous knowledge systems and Western scientific knowledge. Reid et al. (2006) conceptualize the interfacing of Indigenous knowledge and Western science as “bridging”; Nakata (2007) refers to the area in between the two knowledge systems as “the cultural interface”. Combining these two terms (“bridging” and “cultural interface”), we can say that we are attempting to bridge knowledge systems by providing a culturally relevant interface. It is in this area where we find gaps in the research. Firstly, finding clarity on the appropriate settings and how they facilitate knowledge system bridging requires more research (Weiss, Hamann & Marsh, 2013). As Nakata (2007) observes, Indigenous learners are already familiar with the complexities of the cultural interface and curriculum design should build on this. Pumga, Wyeld, and Adkins (2006) identify the fact that collaborative techniques (i.e., building knowledge through community) require more research, and pedagogical methods and best practices for applying the human and social components in education have to be identified (Stone et al., 2002; Tatar, Gray & Fusco, 2002). Lastly, there is a lack of research in the realm of bringing together Indigenous knowledge and Western knowledge in a formal manner (Hartnell-Young & Vetere, 2008), or the inclusion of contextual knowledge, for example,
Indigenous knowledge, into an instructional framework (Mattila & Fordel, 2007; Ogata and Yano, 2004; Botha, Traxler & Ford, 2008).

So with the knowledge of leveraging ICT as an important tool in preserving Indigenous knowledge, and having identified gaps in the research around bridging knowledge systems, the next step is to identify what ICT approaches may be effective for incorporating Indigenous knowledge into education for Indigenous learners.

### 2.5 ICT APPROACHES FOR INDIGENOUS EDUCATION

After determining the relevance of social and cultural inclusion in education, the next step is to identify the relevant ICT research that has been performed within this domain. Kitchenham (2013) performed a literature review study on educational technology and the preservation of Indigenous language and culture in a Canadian context, noting that the potential for using ICT for the preservation of Indigenous language and culture is immense, yet there is still “a dearth of studies” that have examined relationships between Indigenous learning and educational technology. Clothey (2015) notes that there are still significant challenges with regard to using ICT for Indigenous education, identifying that the digital divide (those that have access to ICT versus those that do not) still exists for Indigenous populations and that, even where ICT exists, the resources available are not culturally appropriate. Some studies have suggested that Indigenous peoples are utilizing ICT to focus on the development of online communities and interfaces to tell stories and construct representations of self (i.e., Iseke-Barnes & Danard, 2007; McLoughlin, 1999). Raseroka (2008) notes that the development of ICT is a significant tool for the capture of predominantly oral-based Indigenous knowledge to facilitate both its preservation and access beyond person-to-person communication. According to Sen (2005), ICT can provide a multi-layered approach to the management of Indigenous knowledge. From a software perspective, management should aid in storage and retrieval, as well as enable traditional owners to describe, contextualize and annotate resources in their own words, languages, and perspectives. Tools should be built on standardization for easy portability and interoperability between disparate data stores.

Robbins (2006) demonstrates the importance of using ICT for contextual cultural learning in the South Pacific with 12 different Indigenous groups (that are part of the University of the South Pacific). The idea of contextualization is discussed, alluding to the method of designing educational materials (for example, multimedia) so that teachers and learners can create the cultural context from their own experiences, for example, in the form of a virtual peer, self-test, wiki, or digital scrapbook. Learners and teachers create these materials on the fly (for example, via a wiki). Successful implementation requires the participation of both parties to work effec-
tively. Donovan (2007) provides a comparative analysis of Australian Aboriginal pedagogy and ICT pedagogy, which is shown in Table 2.2.

Table 2.2. Aboriginal and ICT Pedagogy Comparisons

<table>
<thead>
<tr>
<th>Aboriginal Pedagogy</th>
<th>ICT Pedagogy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning through experiencing concepts</td>
<td>Learning through experimentation</td>
</tr>
<tr>
<td>Peer or group learning</td>
<td>Can allow for group space</td>
</tr>
<tr>
<td>Space for own investigation</td>
<td>Allows learner to investigate in their own time</td>
</tr>
<tr>
<td>Adapt to local context</td>
<td>Learning may be contextualized</td>
</tr>
<tr>
<td>Community can direct aspects in their local practices</td>
<td>Learning may be flexible and can be adapted to specific outcomes</td>
</tr>
</tbody>
</table>

Donovan (2007) also attests that the flexibility of ICT tools has been noted by several theorists, which allows for contextualization of learning materials to configure learning outcomes to fit individual needs, that ICT tools can also be used to support the mobile or transient state of living of many Aboriginal students in contemporary Aboriginal society. Centrally stored information may be accessed and updated from multiple access points. ICT approaches can support Indigenous students’ lifelong education through distance education programs. Some specific ICT approaches that may be used to bridge knowledge systems in the support of Indigenous education are discussed next.

### 2.5.1 Fuzzy Logic Bridge

Indigenous scholars are often bemused by the engrossment of Western scientists with the need to quantifying all things (Berkes & Berkes, 2009). There very little accountability in Western science for the effects that a human being has on their natural surroundings. Indigenous knowledge systems seem to build holistic pictures of the environment taking in to account a large number of variables qualitatively, while science tends to focus on a small number of variables quantitatively. Indigenous knowledge systems value a full understanding of the environment, how to identify and analyze signals from the environment, and the relationships within, including the relationships involving human beings (Berkes & Berkes, 2009). So moving forward, any framework devised should contribute a degree of quantification for a knowledge system that contains a significant amount of qualitative data.

Recent advances in qualitative software for use in Indigenous knowledge research, in agent-based, and artificial intelligence (AI) software that provide reasoning capabilities, suggest some potential ways of bridging knowledge systems (Sillitoe & Marzano, 2009). According to Berkes & Berkes (2009), Indigenous knowledge
approaches complex systems by using simple prescriptions consistent with fuzzy logic. Zadeh (1984) concisely describes fuzzy logic as "a logical system that aims at the formalization of approximate thinking". As Freiberger and McNeill (1993) also concisely state, “the application of fuzzy logic provides the ability to map linguistic expressions on to numerical variables, or practical knowledge onto hard data, thus integrating both qualitative and quantitative information and bringing these two worlds into sync”. What is gained through “fuzzification” is greater generality, higher expressive power, an enhanced ability to model real-world problems and, most importantly, a methodology for exploiting the tolerance for imprecision – a methodology which serves to achieve tractability, robustness and a lower solutions cost (Klir & Yuan, 1995). Logically, then, from this perspective, clarifying how fuzzy logic may be leveraged to develop an inclusive framework is a useful next step. In the broadest of strokes, fuzzy logic provides a quantitative measure to a qualitative way of thinking. With fuzzy logic, things need not be precisely defined or quantified before they can be considered mathematically; the model does not need precise inputs.

Examples of fuzzy-logic systems are demonstrated by Mackinson (2001) who incorporated Indigenous oral wisdom from fisher people and incorporated it into a fuzzy logic expert system used to predict the patterns of herring shoals, and by Grant and Berkes (2007) as well as Deepananda, Amarasinghe, Jayasinghe-Mudalige, and Berkes (2016), who created a similar expert system to simulate the fisheries in Grenada and Sri Lanka respectively. These systems, however, have been devised for purely scientific research. With regard to fuzzy logic in education, examples exist that demonstrate the potential of expert systems as a way in which to apply fuzzy logic in online and blended learning environments (Hadjileontiadou, Dias, Diniz & Hadjileontiadis, 2015). However, additional research on how to leverage fuzzy logic to incorporate Indigenous knowledge into educational curriculum is required.

2.5.2 Digital Storytelling Bridge

Storytelling is an ancient human endeavour (Miller, 2008) and is deeply rooted in the rich oral histories and practices of many Indigenous communities (Cunsolo Wilcox, Harper & Edge, 2013). Traditionally for Indigenous peoples, storytelling in an Indigenous educational context has allowed learners to explore personal roles and make sense of their lives as well as assisting in developing a sense of community (Duveskog, Tedre, Sedano, & Sutinen, 2012). Narrative and story-based methods are particularly beneficial and respectful strategies for engaging in research with Indigenous communities and in Indigenous contexts. For educators, digital storytelling provides an engaging way to bring lessons about community, culture, local values, and traditions into the classroom (Skouge & Rao, 2009). Iseke & Moore
(2011) use digital storytelling as a way in which to strengthen community relationships. Working together with young community students, elders and community members were interviewed in order to depict the Indigenous history of an area. From this, Indigenous worldviews challenged the exclusively scientific knowledge represented in the school science curriculum. This storytelling aids in “negotiating social priorities and contemporary community needs, expresses community viewpoints, and safeguards community values and norms” (Iseke & Moore, 2011).

Digital storytelling provides a wide array of methods for gathering knowledge, for example, standard audio and video, multimedia publication and collaborative software (Skouge & Rao, 2009). Digital storytelling may be used as a method to praise both an individual as well as a community. Digital storytelling gives an individuals the opportunity to work collaboratively with others, to tell their stories, to listen and to learn (Cunselo Wilcox et al., 2013). This methodology allows Indigenous peoples to manage, on their own, the images and structure that challenge the stereotypes and misrepresentations of Indigenous peoples in dominant society (Leavy, Wyeld, Hills, Barker, & Gard, 2007). Duveskog and Sutinen (2013) provide an implementation of this ideal, utilizing a digital storytelling platform to create locally-based content that was used to facilitate in HIV/AIDS education and counselling for Tanzanian students. Their research highlighted that the inclusion of authentic, culturally-relevant, self-owned stories of students removed some of the barriers (for example, theoretical, technical and cultural) to learning. Digital storytelling as a methodology for creating participant-created story-centred narratives is a desirable approach, as it avoids many of the issues associated with interview-based narrative (Cunselo Wilcox et al., 2013), such as the danger of objectifying and further alienating marginalized communities.

Recent initiatives in mainstream education involving digital storytelling include, firstly, the PoliCultura tool, designed to incorporate digital storytelling into the classroom for school-age children. Through the framework, students are able to navigate territory using various kinds of devices (like their mobile phones or digital cameras) to gather content that may then be refined in the classroom (di Blas & Paolini, 2013). Secondly, a similar design to the one we propose is provided by Scanlon, Woods, and Clow (2014). The learner is able to support their learning by providing content via a mobile device named iSPOT that allows learners to co-design educational activities and pedagogy together, specifically through location-based activity and mobile learning. Their mobile app showed how online communities of practice can be extended and connected to physical locations, providing more contextual learning opportunities. These two initiatives provide a very useful perspective on creating location-based tools to support learning, however, the main disadvantage of these approaches from our perspective is that these two initiatives do not involve the incorporation of a different worldview paradigm into the design and implementation of the learning activities. Further issues to implementing digital storytelling, along with other ICT approaches, are discussed next.
2.5.3 Issues regarding ICT Approaches

The proper protocol for gaining the trust of an Indigenous community for the purpose of engagement in ICT initiatives can be a lengthy one (Srinivasan, 2007). This may include observations of community practice, attending meetings and functions within the community, and meeting with community members, particularly with Elders, to build bonds of connection and trust. As Srinivasan (2007) puts it:

“These steps helped reach an acceptance level wherein I was seen as not simply there to study the reservations but also to work to create a system to be authored, designed, and operated by them.”

Additionally, there are some issues regarding ICT learning approaches such as digital storytelling. Firstly, there is the issue of ownership of the content that is created. Indigenous peoples themselves have repeatedly claimed that they have fundamental rights to Indigenous knowledge because it is necessary to their cultural survival (Mauro & Hardison, 2000). Unfortunately, this belief often runs counter to national and international laws and policies that may be based on concepts of Western science, for example, intellectual property must be “tangible” (Ngulube, 2002). The UN Declaration on the Rights of Indigenous Peoples (2008) underscores the fact that Indigenous peoples have the right to own and control their cultural and intellectual property. However, this continues to be an area fraught with difficulties for many reasons, such as an inherent mismatch between the nature of intellectual property rights regimes and that of traditional knowledge, lack of an effective international framework, and alleged lack of will on the part of developed countries (Sarma & Barpujari, 2012). Due to this disjoint, it is imperative that Indigenous rights to intellectual property or Indigenous knowledge be clarified and documented from the start of any knowledge gathering process. This process should clearly identify and document who has permission to use and/or re-use the content.

Secondly, many teachers who teach within Indigenous communities are not Indigenous. McKnight et al. (2011) observe that non-Indigenous educators should expand their knowledge of Indigenous practice. There are examples of this knowledge being taught but currently the bulk of this teaching is performed through traditional lectures and tutorials as part of a teacher’s pre-service education rather than in an experiential format. Additionally, this kind of approach puts an increased burden on teachers and course creators, who have to design supplementary learning materials to augment course content. With this in mind, ICT tools may ease the burden, for example, by providing a process to store, manage and implement reusable learning objects that are experiential in nature, such as digital stories. This is supported by Raseroka (2008) who notes that ICT is a powerful tool for the
management of oral-based Indigenous knowledge beyond just person-to-person communication. One of the issues identified by Loewen et al. (2016) with the presentation of the I-SLATE framework was the concern that using ICT to deliver learning:

“would take away from ‘actually connecting with the land and with the community’ and that any tool developed ‘must support students to engage directly with their environment and their community’”.

One way in which ICT may support this very important realization is through mobile technologies, for example using location-based services to provide knowledge on-site.

2.6 MOBILE AND DISTANCE TECHNOLOGIES FOR INDIGENOUS EDUCATION

Many Indigenous people in remote, rural communities lack satisfactory Internet access. Kim (2009) identifies that in underserved areas of Internet access, the delivery of information via an inexpensive mobile device is a favorable alternative. The use of mobile devices and the apps that they come with is transforming human experience (Collins, Durington, Favero, Harper, Kenner, & O’Donnell, 2017). Hartnell-Young and Vetere (2008) note that creating narratives that intertwine traditional literacies (for example, oral traditions) with new literacies (for example, storytelling via a mobile phone), has the potential for crossing boundaries between school and social contexts. This provides the potential for students to incorporate their authentic and unique experiences into the curriculum. An added benefit to this process is that, if desired, the knowledge may be taken from the curriculum to a wider social platform.

Towards the concept of student engagement and involvement, Looi, Seow, Zhang, So, Chen and Wong (2010) state that the portability and versatility of mobile devices has significant potential in promoting a pedagogical shift from didactic teacher-centred to participatory student-centred learning. With the new model, teachers act as facilitators and learning partners rather than sole experts possessing all the knowledge. Under their model, students go out into the world and acquire knowledge using devices and share that knowledge with others. This fits well with a constructivist Indigenous learner paradigm, where the learner is involved with the construction of knowledge. The difficulty here is that the teacher-centred model is ingrained in many students’ psyche as well as the educational structure of many institutions. Looi et al. (2010) identified the focus of their research as being to “bridge the chasm” between formal and informal learning methods, reasoning that there is a large gap in research in this area.
With regard to place-based approaches using mobile devices, Dyson, Litchfield, Lawrence, Raban, and Leijdekkers (2009) explain how mobile devices may enhance experiential learning, specifically in mobile-supported fieldwork. With Indigenous learners, this is a promising avenue as it may allow for experiential learning to occur on the land, in a place where the learner is most at-ease, for example, on traditional hunting grounds. A mobile device that has audio, video and camera functions may be used to create content in this informal environment. Additionally, mobile devices may provide other community learners with access to these materials from within their community, a desirable result for many. Edmonds and Smith (2017) present the benefits and implementation strategies of integrating location-based mobile learning games (LBLMGs) to enhance educational experiences. LBLMGs bring together four trends in eLearning: mobile learning, digital storytelling, gamification, and location-based learning. Participants in the study learned by playing and by designing the games in which they participated. Results of their study of 500 participants indicated that both the playing and the self-designing of LBLMGs can deliver active, engaging and authentic educational experiences for students. LBLMGs can enhance the students' learning from the environment and with each other (Edmonds & Smith, 2017).

As an alternative approach, when developing educational materials for mobile devices, a simple approach is recommended, one that promotes the idea that learning is mediated through mobile technologies, which are in themselves interwoven with other learning tools (Sharples, 2007), for example, introducing a single dimension of mobile technology (such as a video recording) and perfecting it over time. Naismith, Lonsdale, Vavoula, and Sharples (2004) state that we need mobile learning (m-learning) that places the student at the centre of the learning process, promotes collaboration, provides an understanding of the authentic context of knowledge, and encourages independent learning behaviour, enabling students to become lifelong learners.
3 RESEARCH DESIGN

This chapter aims to, firstly, provide the overall research approach used; secondly, explain the research context, including a detailed description of the philosophical approach, design context, research design, and research methods; and thirdly, explain how each of the papers relates to the overall research questions of the thesis. Building on the work of Creswell (2013) and Mertens (2008), this research consists of four main components: the philosophical worldview, the design context, the overall research design, and the specific research methods that translate the approach into practice. Each of these components is discussed in the following sections.

3.1 PHILOSOPHICAL WORLDVIEW

The philosophical assumptions of this research originate from a mostly transformative worldview. What can be said with some certainty is that this philosophical perspective aligns the research away from the more traditional post positivist worldview, which is seen as the conventional domain of what has been referred to as the “scientific method” (Creswell, 2013). What is meant by “mostly” transformative is that overall the research aim from the beginning has been to benefit marginalized individuals; indeed, the origin of the research began from observations of inequities based on race, culture and ethnicity. However, as the research has progressed, it has, by the very nature of the research and interactions with participants, become interwoven with a constructivist paradigm. For example, in this worldview, the researcher may focus on specific contexts in which people live and work in order to understand the historical and cultural settings of the participants. For me as the researcher, it is my intention to make sense of (and to interpret) the meanings others have about the world (Creswell, 2013), and to formulate our framework and approach based on input from others who are more knowledgeable than I am in specific aspects of this enquiry.

3.2 DESIGN CONTEXT

For the first four papers in this research (Paper I – Paper IV) the design context was theoretical in nature and consisted of a literature review, narrative inquiry from existing literature, and refinement of the main research questions (RQ1-RQ3). Defining the interdisciplinary approaches to be incorporated in the research was a valuable first step, and was accomplished in Paper I. An initial framework design was designed and presented in Paper II.
Moving forward from this point, the focus shifted to within the framework, to formalizing a more specific ICT approach to allow for the incorporation of Indigenous knowledge and thought into a Western Eurocentric educational paradigm. From further research, in the form of a more focused literature review, and in consultation with Indigenous knowledge experts, a relevant approach was found and revised to incorporate fuzzy logic thinking into the approach.

The approach used in Paper IV was to show proof of concept of our framework by incorporating sample data into our theoretical system. The results of this process are presented in Paper IV.

In Paper V further small refinements were made to the framework originally designed in Paper II and further refined in Paper III and Paper IV. At this point, the framework was given a name, the I-SLATE framework. From the I-SLATE framework, two case studies were created, along with prototype tools to support the case studies, by showing proof of concept of our framework and approach. At this point of the research, it was determined that qualitative research using one-on-one interviews was the best method for acquiring rich qualitative data in order to find strengths, weaknesses and additional benefits of the framework and approach.

And finally, in Paper VI, working from the qualitative data acquired in Paper V, we were able to complete an additional iteration of our framework, dubbed the I-DIGEST framework, for the purpose of exploring alternative ICT approaches to best solve the problem identified at the beginning of our research. As with Paper V, the I-DIGEST framework was used as the basis for creating a case study example using an ICT approach suggested by participants in Paper V as a valid approach, namely digital storytelling. A case study approach was implemented and then presented to Indigenous knowledge and education experts for feedback. The results of the feedback are presented in Paper VI.

### 3.3 Research Methods and Design

Based on the foundation of this research arising from and subscribing to a transformative worldview, which in this case is built on the foundation of constructivism, a qualitative research design approach using open-ended interviewing as a data retrieval method has been implemented. This is in order to evaluate a case study approach, which provides an in-depth analysis of the ICT approaches used in this research. This approach is outlined in Creswell (2013) as a valid qualitative approach for scientific inquiry, providing room for the researcher to be innovative and to work within researcher-designed frameworks, which account for a large portion of the original work in this thesis. As described in the introduction of the dissertation, this is the domain that I am most familiar with from personal experience and curiosity, where one-on-one interviews, preferably face-to-face, are a comfortable venue for myself in which I feel confident in acquiring rich qualitative data.
The methodologies used are derived from the existing body of literature on qualitative methodologies as they relate to transformative and constructive paradigms (Creswell, 2013; Mertens, 2008).

For Paper I, Paper II and Paper III the research methods used were primarily in the analysis of previous literature, to identify whether gaps existed in the research, and to determine if there were answers to our primary research questions. Creswell (2013) uses the term “emergent design”, the idea that some or all phases of the research process may change or shift after the researcher enters the field and begins to collect data. In the case of this research, due to the multiple perspectives and the complexity of the issues, the process of acquiring a holistic account of the research problem took more than two years to complete and included multiple levels of abstraction, from the bottom up, in order to provide a complete picture.

For Paper IV a case study approach was provided to show proof of concept of the framework designed in Paper III. A case study example was implemented based on knowledge extraction from previous literature. From this knowledge, a theoretical representation of the expert system was provided using fuzzy logic techniques, thereby validating the approach and paving the way for further research to implement the framework in a more empirical fashion.

For Paper V, data collection, analysis and interpretation, and interviews were performed for the purpose of eliciting rich qualitative data on the framework and ICT approaches presented. These interviews were performed as one-on-one open-ended interviews, conducted in a face-to-face setting where possible, and by email/Skype/Internet where this was not possible, for example, due to geographical distance, time, and availability constraints. The questions were designed in a way to evoke answers that would best extract the knowledge and experience of each of the participants. Six participants (two males and four females) took part in this study. These participants were asked to analyze and provide feedback for the two case studies presented. The case studies were designed to simulate a fuzzy logic approach and were populated with data from pre-existing knowledge sources. For the actual interviews, three of the participants were Indigenous and three were non-Indigenous. As this research process involves both Indigenous and non-Indigenous educators interfacing between two different knowledge systems, it was important to involve Indigenous and non-Indigenous participants. All participants chosen are considered to be extremely-qualified in the educational technology and education domains.

The framework and the supporting ICT approach, in the form of prototype tools, were then iteratively revised from Paper V to Paper VI according to the feedback provided and the resulting analysis on whether the framework and approach provided solutions to the original research problem defined in Section 1.1, “Problem Statement”.

For Paper VI, data collection, analysis and interpretation, interviews were performed for the purpose of eliciting rich qualitative data on the framework and ICT
approaches presented. The ICT approaches for Paper VI were in the form of a case study, specifically, a course created from pre-existing Eurocentric knowledge, with ICT prototype tools created to allow for learners to add to the curriculum by including relevant and authentic learning objects, in the form of digital stories. Validation of the approach was provided through interviews, consisting of open-ended questions, similar to Paper V. Interviews were conducted in a face-to-face setting where possible, and by email/Skype/Internet where this was not possible, for example, due to geographical distance, time, and availability constraints. The questions were designed in a way to evoke answers that would best extract the knowledge and experience of each of the participants. Ten participants took part in this and were asked to analyze and provide feedback for the case study and ICT approach presented. The case study was designed from pre-existing knowledge sources in order to best represent an actual meaningful course.

The data acquired from the interviews in both Paper V and in Paper VI were then compiled and organized using the same method, Creswell’s (2013) qualitative approach to data analysis and interpretation, specifically the process of coding the data to identify themes to be used as findings for this phase of the research. These themes are presented and summarized in Section 4, "Summary of Findings".
4 SUMMARY OF FINDINGS

This section highlights the research reported in the original publications (Paper I – Paper VI), from analysis to design to implementation and finally, to the evaluation of the results.

4.1 ANALYSIS

In Paper I the focus was on identifying the current and relevant literature on how ICT may aid in the gathering, storage, retrieval and inclusion of cultural knowledge in education. From this literature review, some issues and gaps associated with current approaches were identified, specifically in the area of bicultural learning, which is the idea of intertwining Indigenous pedagogy with Western Eurocentric pedagogy. Our findings indicated that though research had been performed in this domain, it had not been applied in a reusable manner, and not via distance education technologies, which were deemed to be important, as many Indigenous community members feel a very strong connection to their traditional lands and have a desire to stay within these communities rather than relocate to urban areas to pursue further education. From this position of knowledge, an interdisciplinary approach is reported on and formalized, shown previously in Figure 2.1, with the purpose of identifying individual knowledge experts to connect all of the pieces of this puzzle in a cohesive fashion.

The novelty of these findings is that this approach is a step towards the integration of Indigenous knowledge into education, providing Indigenous learners with learning materials that are authentic and adaptive to their learning environments, as technological innovation may be used to provide cultural relevance and mobile devices may be leveraged to provide formal and informal learning opportunities. Additionally, as a standardized approach was identified as beneficial, all research was undertaken with reusability and interoperability in mind.

Before moving on, a short discussion on research worldview and our position within this discourse is warranted. As explained by Mertens (2010), the transformative paradigm, with its associated philosophical assumptions, provides a means of framing ways to address intransigent societal and individual challenges through the valuing of transcultural and trans-historical stances. These principles help to shape the qualitative research design used in this thesis. In this style of research, the transformative worldview, built on the foundation of constructivism, is used by authors to engage the participants as active collaborators in their inquiries ( Creswell, 2013). From this point forward, throughout the rest of the publications, this approach has helped to shape the research agenda.
4.2 DESIGN

As is common with framework design, the generation of the framework in this research involved several iterations. From Paper I, the next step was to provide a thicker lens toward defining and formalizing a framework that takes into account all of the interdisciplinary components defined in Paper 1. The original framework design for this research (presented in Paper II) is shown in Figure 4.1.

Through an extensive literature review process (see Section 2 of this dissertation), the findings indicated the need to first put the Indigenous knowledge into a meaningful knowledge structure by engaging with the community of focus, for example, using participatory design (PD) as a methodology (Duveskog et al., 2009). An ontological model was initially identified as a method for categorizing and storing this information. Due to the dynamic nature of the knowledge being stored, it was also identified that the community of focus (for example, an Indigenous community) should be able to access and collaborate on the knowledge contained. The novelty of this approach lies in the categorization of the knowledge, as this was identified as being missing in previous literature. The additional integration of this knowledge into a standardized learning management system, such as Moodle, coupled with the novelty of categorization, ensures that, if desired by the communi-
ty of focus, the knowledge is reusable, interchangeable and interoperable. Additionally, this model provides the potential to bridge the gap between remote and rural Indigenous communities and educational resources.

After presenting the framework from Paper II, through informal feedback acquired from discussions and reviews of the framework from knowledge and educational experts, and from a growing corpus of research, it was decided that an ontological approach may not be the best approach, therefore more research was required to identify what approach may work best for a holistic-thinking community. The findings of the literature review research for Paper III identified that ontological approaches proved too rigid for our framework, and at the other end of the spectrum, “folksonomic” approaches were lacking in precision, hierarchy, and scalability. From this we deduced that a novel approach was needed, using fuzzy logic as the methodology to incorporate the knowledge of holistic thinking learners into formalized Western Eurocentric (reductionist) education. Figure 4.2 diagrams our approach as published in Paper III.

**Figure 4.2. Model of proposed framework (Revised from Mackinson, 2001) from Paper III**

Local knowledge experts provide knowledge in the form of practical data. This data is usually in a form that is relevant to their environment. The type of knowledge retrieved will depend on the communities involved. Example data that may be retrieved from this process may include oral knowledge (for example, stories) as well as other practical knowledge that may be a part of day-to-day observations. Hard data may come from a set of ontologies. This knowledge is used to complement scientific data and data derived from other sources, including data mining, various social media sources, etc. Once all data sources are available, the various stakeholders may be consulted and all of the various sources of knowledge may be used to define the linguistic variables, conditional variables and linguistic connectives for the specific domain. Through the application of these fuzzy logic techniques in a case study example, it was shown that fuzzy logic, through the creation of a simple expert system, provided a way of incorporating Indigenous knowledge, as standalone knowledge or as a parallel to scientific knowledge, into
the learning curriculum in a formalized way. Through the creation of a simple system, our findings showed that this approach was technically feasible, and that further research was warranted.

In Paper IV, the frameworks from Paper II and Paper III were combined into a new iteration of the framework, shown in Figure 4.3. The novelty of the research here is that it provides new possibilities for Indigenous knowledge to be collected, stored and presented in an authentic and relevant format for each respective community.

![Diagram of proposed framework from Paper IV and Paper V](image)

Figure 4.3. Diagram of proposed framework from Paper IV and Paper V

The inclusion of community at the start of the research design is shown as Step 1 in Figure 4.3. Berkes and Berkes (2009), state that the co-production of knowledge is a useful way forward, and that this knowledge production should always be preceded by trust building and the development of working relationships with knowledge holders. From this position, the next step is to identify the participants, collaborators and contributors. These are the people who will be involved in the co-creation of this authentic knowledge. Examples of the people who will play an important role include community leaders, holders of knowledge, and those willing to share knowledge that they have. A disadvantage to this process is that in order to obtain a deep set of knowledge from all of these important contributors, it can be very time-intensive. The next step, shown in Figure 4.3 as Step 2, is the knowledge co-production process. Participatory design techniques following a community of practice learning approach have been successful (Mcgloughlin, 1999). A reason for following this practice is that it may ensure that the pedagogy and epistemology
lines up with the needs of the community. Once the knowledge is gathered, it must be determined how the knowledge will be disseminated and stored for the purpose of implementing it into a learning system. As an example, a system may include the logic provided by the use of IMS LD Level B to allow for the presentation of a culturally relevant learning object to the user at run-time according to the preferences provided by the user (Koper & Burgos, 2005). The logic may take the form of IF/THEN/ELSE logic which is similar to the function of fuzzy logic rulesets. Further details of the framework may be found in Paper V.

In Paper VI, using the results provided from Paper V, the I-SLATE framework was revised and renamed the I-DIGEST framework. This framework is shown in Figure 4.4.

![Figure 4.4. I-DIGEST framework introduced in Paper VI](image)

The five main phases of the I-DIGEST framework are as follows:

1. **Knowledge gathering** – With digital storytelling, knowledge is gathered from various sources, for example, multi-media sources. Digital storytelling is the process of recording one’s own personal story using their own voice. It may be created with video, art, overlays and text with the result being a short movie. Knowledge holders, knowledge sharers and community leaders play an integral role in the knowledge generation process, which, in order to acquire a depth of knowledge, is time-consuming and intensive (Srinivasan, 2007).

2. **Knowledge building** – Once the personalized content is created, it may be entered into the knowledgebase (referred to as the Digital Story Repository in Figure 4.4) and used within appropriate content by associating each digital story with relevant course content. The result is that authentic and suitable content is added to the learning content. This knowledge may then be managed locally according to each community’s needs and desires. Localized control helps assure the community that the materials are shared appropriately.
3. **Learning Design** – The digital stories may then be converted to reusable learning objects. Using a standardized method (for example, IMS-LD or SCORM) will help ensure that learning objects are reusable. The next phase, Phase 4 (the ICT Implementation Phase) outlines how tools may be created to simplify the input process for creating learning objects.

4. **ICT Implementation** – ICT tools may be designed to simplify the creation and addition of content (for example digital stories) within both formal and informal learning settings. An important discovery in our research (Paper V) was that digital tools used for the gathering of knowledge should not discourage the opportunity for learning on and from the land. Mobile devices have been identified as a useful tool to allow for knowledge gathering and input into a learning system (Dyson et al., 2009). This allows for learning opportunities to occur in the environment that a learner is most relaxed and comfortable in. Mobile devices may be used to create digital stories. For example, a simple digital-storytelling app may be designed to allow the learner to create, edit and view a digital story (shown in Figure 4.4).

5. **Tool Creation** – Tools may be designed, for example, as a web-based and/or mobile app) to allow knowledge holders to input their knowledge. Additionally, if a mobile app is used, place-based learning may also occur by allowing the addition of location using GPS coordinates.

For Paper IV (unnamed framework), Paper V (I-SLATE framework) and Paper VI (I-DIGEST framework), the framework revisions provided were then implemented by applying the framework to real-world scenarios. The implementation process for these three papers is discussed next.

### 4.3 IMPLEMENTATION

After refinement of the framework in Paper III, the next step was to test the functionality of the still-unnamed framework by applying it to real-world scenarios. In Paper IV, the implementation of the framework was provided in the form of fuzzy logic rulesets, which were seen as a way in which to represent qualitative knowledge (for example, Indigenous knowledge) in a quantitative manner (Berkes and Berkes, 2009; Mackinson, 2001). The reasoning for this was to provide interdisciplinary cohesion (the “glue”) between Indigenous thought (holistic thought, deemed to be more qualitative) and Western Eurocentric thought (deemed to be more quantitative). A case study example was provided in the form of salmon harvesting for First Nations people in British Columbia, Canada. The purpose of this case study was to show how ICT may be used to create a tool that may be used to incorporate holistic thinking in to learning. With this tool, inputs are provided by the learner and through logic, the effects of salmon harvest health on the well-being of a community are simulated. An example of this process is
shown in Figure 4.5. Using fuzzy logic and a weighting system to each factor deemed important for the harvesting of salmon, a set of fuzzy logic rulesets were created.

The fuzzy logic rulesets (shown in the top left of Figure 4.5) for each weighted factor are combined and the resulting logic produces an output. The combined logic may be thought of as a kind of fuzzy logic expert system. For each linguistic value, there is an associated learning object or objects. In the example in Figure 4.5 we can see that for the linguistic value of “Harvest Health = moderate” there are two associated learning objects (LOID 3 and 4). We can add to this system by creating multiple outputs with more rulesets, combining them together for more complex simulations. From an initial ruleset a fuzzy rule base is created that acts as the inference engine, stepping logically through the rulesets. In our example, the initial result is in the form of a quantitative value. This value is then mapped to a qualitative value, “harvest health”, with an associated quantitative “weight”. Each weight is then calculated and the result then averaged to find the quantitative result. This result is then “defuzzified” to a qualitative value. In this way, the framework may provide a possible interface between two ways of thinking, the ability to represent qualitative thinking using fuzzy logic, and to combine representations of qualitative thinking in a quantitative manner. Further details are provided in Paper IV.

In Paper V, further refinement of the framework occurred, leading to the creation of the I-SLATE framework. The addition of prototype tools simplified the pro-
cess of ruleset creation and associated learning objects. As with Paper IV, fuzzy logic rulesets were incorporated to simulate holistic thinking for Indigenous learners. The two case study examples showed the implementation of fuzzy logic rulesets, enabling the representation of qualitative thinking in a quantitative manner. The resulting “defuzzified” qualitative values represent holistic thought and allow for the retrieval of authentic learning objects, for example, objects that have been created using the skills, values, problems, issues, and cultural traditions of a community. To determine the efficacy of our approach, the case studies were presented to both Indigenous and non-Indigenous experts in the educational and educational technology sectors for feedback. Further details of the implementation may be found in Paper V.

In Paper VI, following the feedback acquired from the interviews in Paper V, further refinement of the framework was needed, leading to the creation of the I-DIGEST framework. From the expert interview feedback analyzed in Paper V, it was shown that there may be resistance from communities to any ICT tools and initiatives that take away from opportunities for place-based learning to occur on traditional lands. Therefore, any tool used to augment learning must build on the principles of supporting learners to engage directly with their environment and their community. With this in mind, the I-DIGEST framework implementation was aided by designing location-based tools for web-based and mobile devices to allow for the incorporation of digital storytelling into Western Eurocentric curricula. The original content of the course was created in an LMS following conventional Eurocentric design principles. To complement this pre-set knowledge, location-based tools, in the form of a GPS-enabled map (available from within the LMS and as a mobile app, shown in Figure 4.6) was provided to allow for the addition of knowledge in the form of a digital story (as text, audio, and/or video).

Figure 4.6. Methods for adding a digital story to a course using (a) web interface, (b) mobile application interface
The rationale for using mobile technologies is that they increasingly empower other potential learning solutions via conceptual models that are interactive, ubiquitous, and convenient. An example of how mobile devices are assisting in the incorporation of Indigenous knowledge into learning is provided by Carew, Green, Kral, Nordlinger, and Singer (2015). In their research, the authors give reference to how mobile devices provide multiple services to assist remote Indigenous learners, specifically the ability to record new content on their devices from remote locations that they can sync with an online dictionary, thereby adding to the knowledge base. Additionally, current mobile device technology allows for multiple tasks, for example, a particular app “enables a user to share audio over local networks, listen to recordings made by others, record translations, and add metadata” (Gawne, 2015).

In the case of the I-DIGEST framework case study, the output is a digital story that provides local insight, knowledge, and context on the significance of each of these plants in a material, cultural and authentic way. The digital story may then be associated with the learning object already created for that plant in the course curriculum. Once created, the digital stories become part of the knowledge base and according to the rules set out by the community and individual, they may be shared with other learners (using the ICT tools outlined previously). Further details of the implementation phase can be found in Paper VI. As with Paper V, to determine the efficacy of our approach, the case studies were presented to both Indigenous and non-Indigenous experts in the educational and educational technology sectors for feedback. The results and analysis of the interviews for Paper V and Paper VI are presented in Section 4.4.

4.4 EVALUATION

Following the publication of Paper III, the next iteration of the framework was considered to be mature enough to implement using real-world scenarios. Starting with Paper IV, case study examples were introduced to simulate the framework. The next step was to find ways in which to receive feedback on research through expert interview analysis and comments. Interviews were performed with expert analysts with the purpose of providing feedback on our latest framework design and prototype implementation. The end goal of this process was to try and find answers for RQ3.

In Paper IV, the outcomes from the design of the learning content showed that authentic learning towards a particular subject or object may differ greatly from one community to the next. In order to implement an accurate representation of holistic thinking within our expert system design, the outcomes showed that these contextual differences must be identified beforehand. Further findings in Paper IV indicate that, in order to provide authentic learning opportunities, learning design must occur with community involvement at the forefront. This issue was addressed in
the next iteration of the framework by incorporating knowledge gathering during the first step.

Starting with Paper V, expert interviews were undertaken with the intention of soliciting feedback on the I-SLATE framework and approach. Both Indigenous and non-Indigenous experts were contacted for feedback. For Paper V, there was a total of six respondents and for Paper VI there was a total of ten respondents. One of the most important findings identified through the expert interviews in Paper V highlights a crucial weakness of the fuzzy logic approach: this framework incorporates fuzzy logic experts as the creators of the logic (through fuzzy logic rule sets) for the expert system, which means that the interpretation of the system as a whole, the holistic expert system, is determined by someone who does not necessarily have sufficient depth of Indigenous knowledge or the requisite trust of the community to provide an accurate interpretation. This was not seen as an acceptable risk, with an overriding fear of how knowledge may be interpreted by an “outsider”. Three of the six expert participants realized this to be a major concern, and from this feedback, it was determined that alternative ICT approaches to support the framework were required.

With Paper VI, following the completion of the interviews to provide expert feedback on the efficacy of the I-DIGEST framework, strengths, weaknesses and opportunities were identified.

Strengths of the I-DIGEST framework and approach are that, firstly, it builds an inclusive and respectful process for knowledge sharing. Secondly, as noted by Srinivasan and Huang (2005), approaches that hold promise are those that allow communities to work together to construct and record knowledge about their lives and to jointly reflect. The ability to contribute a unique point of view and incorporate it into the learning journey by correlating it with established curriculum is the base of Phase 2 of the I-DIGEST framework. Thirdly, from an Indigenous point of view that prescribes to oral traditions to pass down knowledge, a tool such as the I-DIGEST framework allows for an authentic avenue of expression in education. Lastly, a standardized approach, supported by Sen (2005) and Hartnell-Young & Vetere, (2008), was recommended by participants as it allows “access for a wider audience, and therefore more accessibility”. This lends weight to the acceptance to Phases 3, 4 and 5 of the I-DIGEST framework as in these phases, ICT approaches and tools were devised with standardization in mind to allow for accessibility and reusability of knowledge.

Some weaknesses identified include, firstly, establishing that the appropriate educators and knowledge experts are included in the design and delivery process. This is not a trivial process and is therefore considered as a possibly significant weakness. This is further supported by Bang, et al. (2013), who observe that the design of learning environments and the development of technologies must centrally involve Indigenous communities as decision makers. Secondly, the dearth of training in cultural diversity may be an issue (Philpott et al., 2009; Manuelito, 2005).
Additional research into ways to approach this issue are needed. Lastly, participants have identified privacy, security, and ethical issues as problematic. Research by Raseroka (2008) and Sen (2005) supports this concern, identifying the possibility of misappropriation and exploitation of the knowledge and content.

Some opportunities provided by participants include, firstly, that the frameworks may be beneficial for international students who, in the participants’ experience, enter the learning setting feeling precluded right from the beginning. Any tool or framework that allows them to integrate relevant stories and materials into the learning environment, “can assist in this process”. Secondly, one participant identified a Canadian First Nations art gallery exhibit that promoted the idea of the importance of “place” as a possible channel for using the I-DIGEST framework. Tools created using the I-DIGEST framework (such as those created in Paper VI) would allow for the creation of individual digital stories to complement the exhibit by contributing location-based knowledge for each narrative, producing a depth and abundance of data that had not been shared previously. Thirdly, there should be a method to allow for the creation of digital stories from urban locations, to allow a relocated or migratory community member to tell their stories from a remote location. Lastly, a local university expressed interest in this sort of framework and system as it would be a terrific starting point for providing additional learning objects, in the form of digital media (digital storytelling, audio, imagery) for a local Indigenous plant garden. One participant who evaluated the I-DIGEST framework noted that the combination of trust building, consultation and the ability to incorporate location-based information as part of the framework would allow the local plant garden to “expand” out into the natural landscape. As an example, a learner could be in the garden observing and learning about a particular plant and the system would be able to provide a digital story and the location of that plant in the natural landscape from the perspective of an Indigenous knowledge expert.

With regard to possible “threats” (this SWOT analysis term is perhaps a little strong; maybe the term “obstacles” would be more appropriate), using the last example of opportunities where the I-DIGEST framework could be implemented to provide authentic learning in an Indigenous plant garden, the trust-building and community consultation process may be very time intensive, sometimes in the magnitude of years (Srinivasan, 2007). For some, this may certainly be a barrier to implementing such a model. Secondly, there is some resistance from Indigenous scholars who believe that many Indigenous communities have been “over-researched” and that asking a community to commit more time and energy to research projects that too often have been exploitive in nature is too much to ask. As Cochran, Marshall, Garcia-Downing, Kendaldeepan, Cook, McCubbin, and Gover (2008) observe, there is an Alaskan native saying that “researchers are like mosquitoes; they suck your blood and leave”. To overcome this obstacle, PD methods must be used at the beginning and the proper amount of time must be allocated during
this process to ensure that there is adequate trust in the researcher(s) before proceeding to the next steps.
DISCUSSION AND CONCLUSIONS

This section highlights the important findings of the research reported in this thesis and the limitations of the research, and provides some possible directions for future research that covers one or more of the interdisciplinary domains included in this thesis.

5.1 DISCUSSION

The transfer of knowledge within the design and implementation of educational material created from a Western paradigm is often met with distrust and skepticism by Indigenous learners. The demand for approaches that provide engaging learning opportunities for Indigenous learners is increasing and promising approaches that engage communities to create and document information about their lives and collectively reflect on this (Srinivasan & Huang, 2005) warrant further research.

Additionally, research shows that such approaches should be implemented at a deeper level than much of the research has provided. Henderson (1996) refers to this by the term “soft-multiculturalism”, which occurs when there is an avoidance of contentious questions of equity and justice, for example, when there is an instructional design preference for focusing on traditional Indigenous lifestyles, rather than the more complex contemporary issues, for example, land rights, and recognition of Indigenous law and punishment. By positing our research within a transformative worldview, and by incorporating community knowledge and perspectives into the design of learning objects, our approach allows for a deeper perspective than “soft-multiculturalism”. Finkelstein and Cassell (2014) provide the argument that educational technologies are well placed to intercede differing cultural expectations as they can provide a neutral platform where teachers and students can discuss the difficult discussions involving political and cultural ideals.

As Indigenous communities reconstruct and rejuvenate, it will become more imperative that technologies are repatriated and designed for authentic knowledge creation as well as for knowledge distribution. Epistemological in nature, these concerns require more research in understanding their part in the educational journey. This will require that the design of learning environments and the development of technologies must centrally involve Indigenous communities as decision makers (Bang et al., 2013). An advantage of the frameworks (I-SLATE and I-DIGEST frameworks) and ICT approaches presented in Paper V and Paper VI are the support for both soft-multiculturalism and a platform for adding, disseminating and storing community-created knowledge that is identified by location and by
theme, owned, secured and accessible only to relevant community members and stakeholders for viewing, collaboration, and deeper discussion, if warranted.

Most important is the question of how this research may be used to benefit a community of Indigenous learners. As pointed out by Duveskog et al. (2013), storytelling has been used in many different industries, such as the entertainment industry, but has been afforded a marginalized role in our educational systems. For Indigenous learners, digital storytelling, combined with ICT approaches, provides a possible way in which to create relevant dynamic learning environments, but this must be approached in a thoughtful and respectful manner. The design of learning environments and the development of technologies must centrally involve these Indigenous communities as decision makers (Bang et al., 2013). The I-DIGEST framework provides the process by which this may occur. For example, let us start with an idea posited by Salazar (2007), who observes that ICT can, and has been, serving community needs from cultural recuperation, revival, and political mobilization, to questions of cultural autonomy and Indigenous rights to artistic and intellectual property. As revitalization and regeneration within Indigenous communities continue, these community needs and the ways in which they may be actualized should be at the forefront. A missing piece in this process is how ICT may support this revitalization and regeneration in an educational context. Following the I-DIGEST framework, the location-based knowledge that may be acquired through the digital storytelling process may assist in initiatives such as language revitalization and also in the identification, storage, and dissemination of digital stories related to traditional land usage. Srinivasan (2007) addresses this by asking, “How can community-driven information systems negotiate new relationships between the disenfranchised and governmental/transnational/corporate institutions?” Within this discourse, it is useful to identify a venue or modern day situation where our research may provide some answers.

A very divisive project in northern British Columbia, Canada, within the last five years is the Enbridge Northern Gateway pipeline. Enbridge’s proposed project involves building an 1170km pipeline from the community of Bruderheim, Alberta, to the northern British Columbian coastal town of Kitimat, the town in which I was born. The proposed pipeline route directly affects the traditional territory of 45 First Nations (the name for Canada’s Indigenous peoples) communities. The Joint Review Panel (JRP), established by the Canadian Environmental Assessment Agency (CEAA) and the National Energy Board (NEB), and mandated by the Minister of the Environment, was responsible for assessing the environmental effects of the proposed project as it relates to the Canadian Environmental Assessment Act of 2012. Part of this process was to consider comments from the public and Aboriginal peoples, through community information sessions, and to provide ways in which these people may participate in the joint review process. As part of the JRP community sessions, community members told stories about how the pipeline would adversely affect their livelihoods – livelihoods that involve extensive usage
of their traditional territories in the form of food gathering, medicine gathering, and other traditional practices. These stories were included within the literature of the JRP recommendations, but for First Nations communities, this is not an effective medium for learning about what other communities had to say regarding the effects of the proposed pipeline. Moreover, the information was not presented in a comprehensive fashion, only piecemeal as it was compiled in documents for each community. The I-DIGEST framework could have functioned as a way in which to compile the stories told within the JRP process in a central repository, potentially assigning the stories to place, providing a comprehensive educational platform in which any of the 45 Indigenous communities directly affected may view, interact, and comment on the stories told by other community members. This information may have also been associated with knowledge about the pipeline, thereby providing a bridge between two different agendas, and between two different paradigms. An additional view may be easily implemented within the I-DIGEST framework, allowing anyone external to the communities affected to view this information, to learn not only about the economic benefits of the pipeline, but also the foreseen effects of the pipeline on each community, specifically how each community subsists off the land, interacts with the land, and is spiritually connected to the land. It is important to note here that the ideas presented are a vision of how the framework and approach presented in this research may assist Indigenous communities, however, this would need the support of all stakeholders involved, from government officials to Indigenous decision makers, and as this is a multi-party, multifaceted endeavour, it will be a lengthy process, taking perhaps many years and therefore is outside of the scope of this research.

As mentioned previously in this research, having the support of educators is an integral component of any sort of new approach to learning and as such, for any approach to gain traction and then to maintain momentum, they must be included in the development process. The education experts interviewed within this research highlighted the complexity of implementing an approach such as ours and noted that the tools to simplify an implementation would be essential to success. For example, taking advantage of external tool implementation (through IMS-LTI functionality) to integrate automated evaluation techniques within a standard LMS, such as Moodle, a familiar interface for many educators, was looked upon favourably by the expert interview participants. Additionally, it is relevant to provide an educational methodology to standardize an approach towards “educating the educators” about beneficial ways of using the framework and approach presented in this research. For example, such a methodology should include:

1. Education on conceptual differences regarding worldviews, for example, holistic vs. reductionist and how different learners fit within these paradigms. Some of this research has been undertaken previously, for example, by McAuley (2009) who explores the potential of knowledge building technologies to support bicultural learning experiences for Aboriginal students.
His research provides insight into how knowledge building can work in a community. He worked from the document “Piniqaqtavut”, which is a locally developed document with the outcomes of adding on to and advocating the continuing growth of Inuit language and culture as well as supporting young Inuit as they build the knowledge, skills and approach needed to survive and flourish in the modern Canadian and global context.

2. Guidelines for ensuring usage of protocols and techniques for garnering trust and engaging communities in the learning process, for example, participatory design (PD) techniques. These guidelines and protocols may differ significantly from community to community and therefore, sufficient time and energy must be allocated to ensure best practices are followed.

3. An introduction, demonstration, and instructions on the usage of the ICT tools created to allow for the implementation of the framework (such as the digital story creation, sharing, and viewing tools). This may take many forms, such as an online video tutorial, workshop, and written guide.

4. Instructions and guidelines for the learners on how to create a digital story and what the components of a digital story consist of. One of the experts interviewed in Paper VI addressed this as a concern about the implementation of this methodology, for example, the creation of a best-practices guide that highlights relevant steps and components to successful completion.

This is not a comprehensive list, merely a set of guidelines towards enabling successful implementations of authentic and relevant learning. Every community is unique and must be approached as such.

A philosophical question that has risen throughout the process of this research is that of, “Do we really need ICT to improve our lives?” I have seen this question answered on both sides of the spectrum, from “It is not useful if it takes us away from the land” to “If we don’t embrace it, we will be left behind“. From this perspective of polarity, an important question to ask is, “Does ICT support the community in what they believe in and what they deem is important?” Bang at al. (2013) bring forth the concept of engaging an Indigenous community with “original technologies”. These are identified as technologies that are deeply embedded in an Indigenous community and may be used by Indigenous learners to rethink how they use those technologies, shifting to become developers and producers of technology, not just consumers. Learning environments should be created to immerse Indigenous learners with these original technologies, allowing for the shifting of ontological assumptions that technologies are Western. These assumptions consistently ingrained in learning environments. An example of this was provided to me by an Indigenous educator in one of the expert interviews, who, in describing ICT usage within a remote Indigenous community, gave an example of how ICT may be used to support the practice of fishing within a community. Fishing and the technologies employed for fishing have been around since time immemorial, and the
harvesting of fish for many communities is the focal point of food gathering activities each year. The tools and technologies have changed with “modernization”, and Indigenous communities have intelligently adapted to these changes. She observed a student using the CAD software on a computer to render a three-dimensional part and once finished, print it off on a three-dimensional printer. This student then used this part to restore his family’s boat back to working condition so that they could fish again. This is merely one example of how ICT may provide educational opportunities for Indigenous learners, highlighting situational authenticity as a catalyst for learning. The tools and technology are a part of a knowledge-making practice and do not contain the knowledge itself (Bang et al., 2013). In this way, the framework and tools created in this research provide a way in which to incorporate Indigenous knowledge into learning for Indigenous learners.

Lastly, it is important to highlight how the approach in this thesis is different from previous approaches. This approach provides research on approaches where Indigenous knowledge may contribute to education in ways that are relevant and authentic to the learners who are contributors. Following the words of Nakata (2007) the research is “presented as a scholarship that is intended to investigate theoretical, conceptual, and methodological approaches to learning by addressing issues identified by Indigenous people.” This research differs from other prevailing educational approaches in that it harnesses ICT to shape the educational structures of mainstream hegemonic education.

This approach is informed by both Indigenous and non-Indigenous educational and educational technology experts and is presented as a guide to solving the main research problem, to determine what methodologies are relevant, and what types of relationships are important to ensure success in addressing and solving the problem in a knowledgeable, relevant, respectful, and authentic manner.

5.2 LIMITATIONS OF THE RESEARCH

Many Indigenous communities in Canada, and more specifically, in British Columbia, have had the opportunity to participate in research undertaken by scholars, with the intention to further the scholarly knowledge base, often with unfavourable results in the minds of the subjects of that research, the members within the communities. As Smith (1999) directly states:

“the word itself, ‘research’, is probably one of the dirtiest words in the Indigenous world’s vocabulary”.

The stories about research, and particularly about researchers, are intertwined with stories about other forms of colonization and injustice. As one who grew up on the periphery of Indigenous communities, I have an understanding of the sensi-
tivity and hesitation of communities towards an external researcher such as myself and, as such, I have tried throughout this process to be as non-invasive as possible, and to be clear that what I am positing within my research is one possible path towards providing more relevant learning opportunities for Indigenous learners. As I discovered early on in this research, there is very little literature that includes all of the interdisciplinary domains identified in Paper I of this thesis.

5.3 CONCLUSIONS

Conclusions reached in relation to each of the three thesis research questions are as follows:

(RQ1) What is the current educational model for Indigenous learners? Is this model working? Why or why not?

Through a comprehensive literature review, the research within this thesis identified the current educational model for many Indigenous learners worldwide as an imposed model consisting of Western Eurocentric curricula. Many Indigenous learners within this model find the material irrelevant, leading to lowered motivation and ultimately lower success within this model. From the research and reflections of prominent Indigenous and non-Indigenous scholars, it is clear that the current model encountered by many Indigenous learners is not working.

(RQ2) What kind of theoretical and practical framework is appropriate for understanding the process of Indigenous knowledge transfer in the context of an Indigenous community?

A framework for representing ways in which Indigenous knowledge may be incorporated into learning for Indigenous learners worldwide can be of great utility. Within this research, a framework was proposed, starting in Paper II, and this framework has been revised and adapted from Paper II to Paper VI. These revisions and adaptations have been methodically implemented through qualitative methods, such as case studies and expert analysis and feedback, to best represent ways in which Indigenous knowledge may be incorporated into the learning process for Indigenous learners.

(RQ3) Is there an alternative learning path that Indigenous learners may follow that provides cultural relevance and authenticity, leading to higher levels of interest and engagement?

Both of the ICT approaches presented in the course of this research – fuzzy logic and digital storytelling – assist in the inclusion of Indigenous knowledge in learning, allowing for authentic and relevant learning for Indigenous learners. However, the fuzzy logic approach is more problematic as there are issues around trust and interpretation of the knowledge provided by community members,
particularly if the designers of the expert system are not community members. Digital storytelling provides for a more seamless inclusion of Indigenous knowledge and thought in educational curricula as there are parallels to traditional practice in many Indigenous communities, for example, the oral tradition of storytelling. In its simplest sense, ICT may provide a way in which to capture and store these stories for future generations of learners, providing that community concerns regarding ownership, storage, interpretation, and usage of these stories are addressed.

5.4 FUTURE PERSPECTIVES

The research in this thesis not only covers a potential framework and approach to providing authentic and relevant learning opportunities for Indigenous learners, but also provides opportunities for future research. Different approaches are required to convey knowledge to the educators of the students. Finding opportunities to apply the frameworks and ICT approaches in other educational environments is possible next step. Additionally, applying the final version of our framework (the I-DIGEST framework) and tools to an Indigenous community to create digital stories to augment learning would be useful as it would present empirical data to endorse this framework. Lastly, many Indigenous languages in North America are under threat of extinction. Therefore the conservation and rejuvenation of these languages are the focus of effort from communities, governmental agencies (tribal and federal) and scholars (Bang et al., 2013). We see this research as a possible methodology – a standardized and transparent methodology – for assisting in the creation, storage and dissemination of these very valuable sources of Indigenous languages and knowledge.
6 BIBLIOGRAPHY


For Indigenous learners worldwide, access to authentic learning is paramount. This dissertation provides some insight into how modern technologies may be used to provide authentic and relevant learning for Indigenous learners. A framework was developed and used within case studies to solicit feedback on its efficacy. An iterative process was used which allowed for a final version, the I-DIGEST version that elicited positive results and many suggestions for possible future areas of application.