A Cognitive Dimensions of Notations Evaluation of the Gwich'in Place Names Atlas Interface.

By

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A thesis submitted to the Faculty of Graduate and Postdoctoral Affairs in partial

fulfillment of the requirements for the degree of

Master of Arts

In

Human Computer Interaction

Carleton Univeristy

Ottawa, Ontario

Abstract.

The cognitive dimensions of notations framework evaluation of the Gwich'in place names atlas interface utilized a modified version of Green & Blackwell's (2000) cognitive dimensions evaluation to evaluate the Gwich'in Place Names atlas' (http://atlas.gwichin.ca/index.html) interface usability. A use-case scenario was used to guide participants through the interface. Following the guided exploration researchers conducted a self -assessment survey and semi-structured interview. All guided explorations were video recorded and coded in order to analyze participants' actions within the interface. These two approaches combined provide subjective and objective evaluations of the Gwich'in place names atlas. The results of both evaluations outlined many usability issues related to the visibility, role expressiveness and viscosity of the interface. Usability tradeoffs were explored based on potential design maneuvers. We found that the cognitive dimensions of notations evaluation and lexicon are an appropriate low-cost, broad-brush evaluation method for online interactive cartographic interfaces.

Acknowledgements

I would like to thank D.R. Fraser Taylor for his help and guidance throughout my tenure at Carleton. I would also like to thank Amos Hayes and the GCRC their support and facilitating this thesis, especially with regards to data acquisition. This process would have been very different and substantially more painful without all of your help.

I would like to thank Rebecca Tranquilli-Doherty for her unwavering support. I truly appreciate your encouragement, guidance and love. Thank you from the very bottom of my heart. I would like to thank my Parents and Brother Ian for their commitment to my various academic pursuits. Your confidence in me is what allowed me to reach this point. Thank you.

Last but not least I would like to that all of the individuals who supported and aided me throughout this journey. Friends, family and participants were all integral pieces in my continued progression.

Thank you!

Sincerely,

Troy Mott

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Introduction.

The purpose of this thesis is to explore the utility of the Cognitive Dimensions of Notations Framework as an evaluation method for online interactive cartographic interfaces. The cartographic interface that is used for this evaluation is the Gwich'in Place Names Atlas. The Gwich'in Place Names Atlas was developed using the Nunaliit cybercartographic framework. Nunaliit was developed at the Geomatics and Cartographic Research Center (GCRC) at Carleton University. The Nunaliit framework operates on open-source licensing software, allowing anyone with access to the Internet to create an atlas free of licensing fees. Nunaliit aims to allow users to easily create narratives and highlight relationships between different types of information using cartography as the foundation from which to tell their story (nunaliit.org). This evaluation will be presented as follows: Chapter 1 looks at the background of computer interfaces and how they relate to interactive cartographic interface development; Chapter 2 looks at the Nunaliit Cybercartographic framework, its foundations and the Gwich'in Place Names Atlas; Chapter 3 reviews the Cognitive Dimensions of Notations framework (CDN), its lexicon and how the framework has been applied to other research questions. This is the first time that the CDN has been applied in the cartographic context.; Chapter 4 examines the evaluation of the Gwich'in Place Names Atlas; Chapter 5 outlines the results and discusses key findings related to my evaluation . Chapter 6 presents a conclusion and Chapter 7 suggests future research directions for the cognitive dimensions of

notations framework and how it could be applied to improve interactive cartographic interfaces in the future.

Chapter 1: Interface and Interaction Design

1.1: Human Computer Interaction & Interface design.

Human Computer Interaction studies the relationship between a computing device and its user. In this relationship there must be a device, a program, or a display that acts as an intermediary between the user and the device. This intermediary is referred to as an interface (Beaudouin-Lafon, 2004). Computer interface research has been thoroughly explored; from early designs of interface metaphor (Smith et al. 1982) to design styles and evaluations (Shneiderman, 1988; Neilsen, 1994) to app interface development (Bernard 2009). Interface design styles in HCI are not simply a central focus of research but should be an integral part of program design. Understanding the way a user interacts with an interface allows the developer to implement the appropriate interaction style. Shneiderman (1988) outlined the predominant interactions styles: Command Line, Form fill-in, Menu selection and Direct manipulation. Each of these interactions styles is best applied in specific use case scenarios. The appropriate use case scenario often revolves around the metaphor being applied to the interface use. A metaphor is an instance of expanding user knowledge or understanding by building on what the user already knows (Wang & Huang, 2000). The most common metaphor applied in computing is the office metaphor (Smith et al. 1982). The office metaphor frames computer

interaction in an office. Users interact with “files”, and “folders” on their “desktop”. The user performs their work on the “desktop” and affects changes and creates “files”, “files” are stored in “folders”. The office metaphor is one that most who have experience with computers are familiar with. The office metaphor is also an example of a “direct manipulation” interface interaction (Shneiderman 1988). The user can drag and drop files and folders. The system creates a direct link between the users’ physical actions and the actions being performed within the interface. The introduction of the direct manipulation interaction style represented a substantial change from the predominant interaction style that came before it: the “command-line” interface, where users entered commands through the keyboard, typing out syntax-specific commands and the computer would execute the command. The shift from command-line interfaces to direct manipulation interfaces changed the way people used computers and how accessible computers were to the average user. That same shift can be seen occurring between traditional Graphical User Interfaces (GUI) and Tangible User Interfaces (TUI). A TUI is a connection between a physical object and the interaction device or digital information (Ishii and Ullmer, 2000). As computing technology has progressed, interface interaction styles and metaphors have advanced as well, blurring the line between physical actions and digital interaction (Maquil et al. 2012). Hybrid User Interfaces (HUI) allows for the implementation of multiple computing components or multiple user interfaces (Bani-Taha, 2014). The continuing development of computing technologies will encourage continued innovation in user interface interaction. The realm of cartography has progressed in much the same way, from paper maps to interactive

mapping software that allows users to zoom in and navigate entire areas from ground level. The utility and variability of maps and mapping improves and increases with every technological advancement.

1.2 Cartographic interface design.

The world of cartography has explored different interface design styles and mapping metaphors. Traditionally maps were static and almost exclusively displayed geographic information (Roth, 2013). The introduction of digitally visualized cartographic data began a revolution in Geographic Information Sciences (GISc) (Roth, 2013). Computerized Geographic Information Systems (GIS) allowed users to be more active in the acquisition of information while at the same time including more specialized data in the cartographic design process (Roth, 2013). This was achieved by allowing users to affect and manipulate visible information, highlighting the information relevant to their focus, and make aesthetic design decisions to create more visually stimulating maps depending on the design goal. This paradigm shift in the use and production of maps saw the map user take an active role in the creation and alteration of maps, effectively making each map user a mapmaker. The conceptual shift in map design also introduced new forms of mapping such as conceptual maps. These are maps that are not necessarily projections of the earth or reflect traditional geographic accuracy but rather exist to display information simply using cartographic frameworks as the foundation for these displays. The Canadian risk of homelessness atlas (http://gcrc.carleton.ca/homelessness) uses maps and graphs to represent Canada's

population that is at risk of homelessness (Lariaut, T & Taylor D. F.). It uses conventional maps (Image 1.) as well as conceptual maps (Image 2.). A conceptual map is an image that uses cartographic convention as its scaffolding but does not necessarily display information using traditional cartographic visualizations.

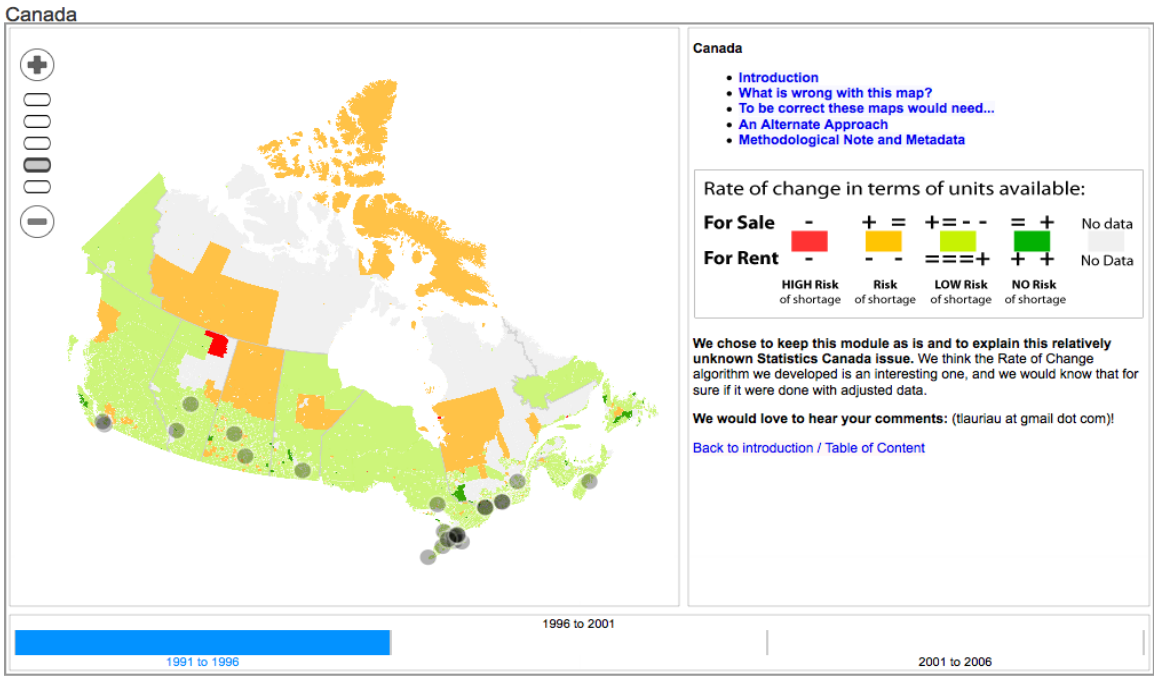

Image 1.1: Canada's Risk of Homelessness interactive atlas displays major cities and the populations that are at risk of homelessness on a conventional interactive map interface.

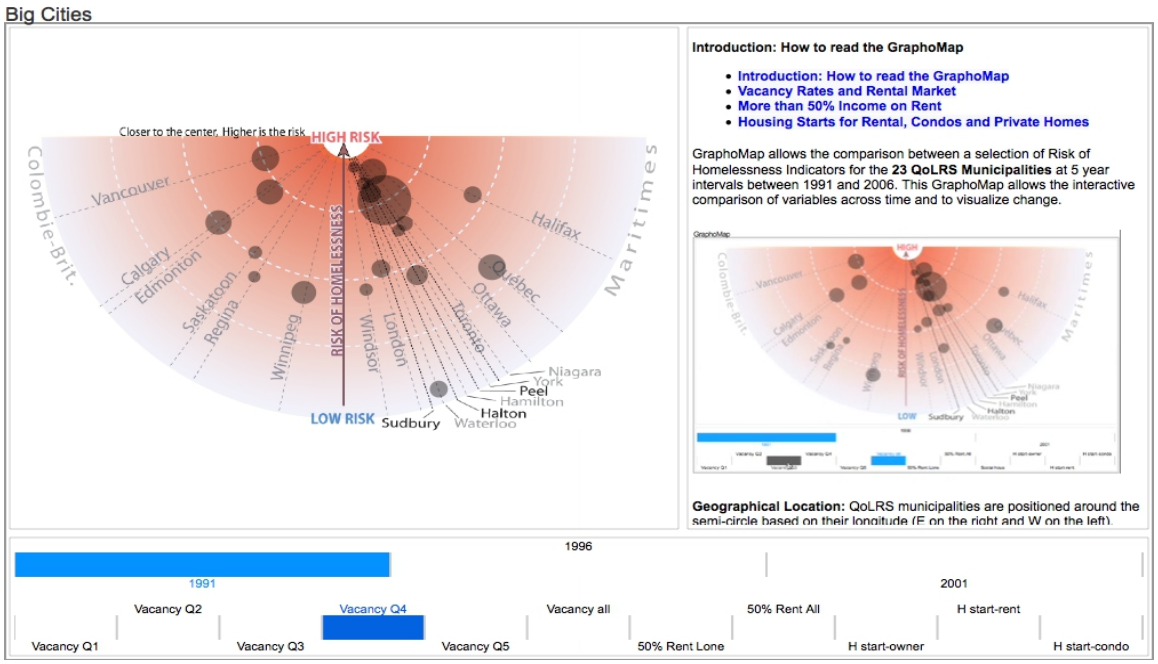

Image 1.2: Is a conceptual map of canada's risk of homelessness, highlight the population and factors related to risk of homelessness while using loose geographic framework to convey the relationships.

With this newfound interactivity came the exploration of different mapping metaphors. Cartwright (1999) explored 9 different map metaphors for online media: the Storyteller, The Navigator, the Guide, the Sage, the Data store, the Fact Book, Gameplay, the Theater and the Toolbox. He found that applying the appropriate metaphor to the map allows users to access and understand the geographic information in a more accessible way, ultimately improving usability. The use of metaphor when interacting with a digital map requires an appropriate intermediary to allow for the user to interpret and affect change in the map.

A cartographic interface is a set of digital tools through which the cartographic interaction occurs (Roth, 2013). Map use scenarios vary substantially depending on the map type and idealized user demographic.

> "Digital cartography interaction cannot occur without implementing some sort of cartographic interface and the utility and usability of the cartographic interface is determined by the kinds of quality cartographic interaction provided through it." (Roth, 2013)

The types of interaction provided by a given interface depend greatly on the goals of the designer and the narrative that is being relayed. The importance and validity of a map can be mitigated by an inappropriate or ineffective interface; for that reason it is important for mapmakers and designers to be very thoughtful and deliberate when designing. Mapping is no longer simply an interpretation of geographic information but rather a way of telling your story. This is particularly the case with cybercartography which will be described in Chapter two where story telling has become a central component of both cybercartographic theory and practice.

1.3 Interactivity and Interactive Cartography

The definition of interactivity in human computer interaction is a moving target. Early research into interactivity focused on human cognition; researchers examined how people intake and organize information. Research discovered that individuals organize the world into *schemas.* (Quiring, 2009). "…a network of interrelated elements that defines a concept for some individual." (Crocket, 1988) Quiring (2009) applied schema theory to computer interactivity. He discovered interactivity is typically analyzed as an attribute of one of three schemas: (1) Technical systems which analyze the technical attributes of a system (e.g. responsiveness, Selection options, spatial independence); (2) Communication

processes which look at the dialogue between the user and the system. This attribute is typically defined by two-way communication between the system and the user; and (3) User perception, the degree to which the user perceives the system to be interactive (e.g. activation and speed) (Quiring, 2009).

When Roth (2015) conducted semi-structured interviews with 21 GIS professionals, the majority of respondents agreed that for a cartographic interface to be considered interactive the user must be able to manipulate the map, change, alter or manipulate the information contained within the map and the map must respond to user interactions in a timely manner. Research into system response speed has been explored in a number of HCI studies. The typical response speed heuristics are: (1) 0.1s feels as though the system responds immediately, (2) 1.0s avoids interrupting the users' thinking process and (3) 10+ seconds response often results in the users' attention being diverted elsewhere (Nielson, 1993; Roth, 2013; Roth, 2015). Increased system response speed improves system usability and reduces obstruction of the users' cognitive processes. Roth's (2015) survey found that GIS professionals required aspects of each of the 3 interactivity schemas proposed by Quiring (2009), as outlined above, to consider a system to be truly interactive. They required the system to be responsive, include selection options, encourage bi-directional communication and the perception that they system is responding to requests. This would suggest that a successful interactive cartographic interface should include all of these features regardless of the goal or purpose of the atlas itself.

Increased interactivity in cartographic interfaces can facilitate the display of large amounts of information without overloading the users' cognitive capacity (Harrower & Sheesley, 2005; Roth, 2013). Harrower & Sheesley (2005) suggest designers implement panning which is the ability to reposition or re-center the map on the screen and zooming allows users to change the scale of the map, making it bigger or smaller; allowing users to focus on specific areas of the map rather than the entire atlas at any given time. Implementing "semantic zoom" (as the user zooms in on the map more information becomes available) can help to reduce user strain (Cooper & Reimann, 2003; Harrower & Sheesley, 2005). The success of an interactive online cartographic interface depends on identification target user group, choosing the appropriate interaction metaphor and a usable interface design.

Chapter 2: The Nunaliit Framework and the Gwich'in Place Names Atlas

2.1. Cybercartography

Cybercartography is a framework proposed by Dr. Taylor of the Geomatics and Cartographic Research Centre at Carleton University. The theory of cybercartography is defined as "the organization, presentation, analysis, and communication of spatially referenced information on a wide variety of topics of interest and use to society in an interactive, dynamic, multimedia, multisensory and multidisciplinary format" (Taylor, 2003). Cybercartography was initially built around seven elements: (1) Cybercartography is multisensory; (2) it uses multimedia and new telecommunication technologies; (3) it is highly interactive and engages the user in new ways; (4) it is applied to a wide range of topics of interest to the society.

(5) It is part of an information/analytical package; (6) it is multidisciplinary and (7) it involves new research and development partnerships. (Taylor, 2005). These seven ideas were expanded on by Taylor (2012) and six key ideas were added to the cybercartographic framework as a reflection of the original seven elements: (1) Individuals use all of their senses while observing what is around them: cybercartography explores the use of all five senses in its cartographic representations. (2) Individuals have different learning preferences and prefer to teach and learn in different formats. Cybercartographic atlases provided teaching and learning opportunities in a variety of different formats. (3) Educational theory suggests individuals learn best when they are actively involved in their learning so engaging the user requires careful planning and implementation of interactive engagement. (4) Cybercartography allows people to tell their own stories by inputting their own data in an open source framework that does not require any special knowledge to enter information. (5) Cybercartography allows the presentation of different narratives on the same topic, providing a nuanced view of facts, affording the user greater understanding of the complexities associated with a given topic. (6) Cybercartography allows users to create their own maps and include or exclude data as they see fit, in effect 'democratizing' mapping (Taylor, 2014). Cybercartography goes beyond GIS technologies and has a different focus. It allows the map user to become the mapmaker and truly allows individuals to build substantial narratives from any perspective on a solid and well-established cartographic foundation.

2.2 Cybercartographic atlas development

" There is no such thing as an objectively good dialog box – the quality depends on the situation: who the user is and what his background goals are." (Cooper & Reimann, 2003) This is true of all interface development. For this reason much of the cartographic interface design literature (Cartwright, 1999; Edsall, 2003, Cooper & Reimann, 2003; Harrower & Sheesley, 2005; Roth, Ross, MacEachren, 2015) calls for a user centered design (UCD) approach. The cybercartographic framework and initial maps were constructed by the CGRC using an iterative UCD approach, focusing on user goals. A UCD design approach allows developers and designers to evaluate their product based on user interactions and adjust the product during the development process. The original cybercartographic mapping design analyses were done for two atlases: the map of Antarctica and the Canada's Trade with the World atlas. Atlas development involved a series of meetings between the development team and the stakeholders to establish *design principles and guidelines*. During these meetings three goals were established for the atlases: 1) the goals and functions of the atlases, 2) the scope and content of the atlases and 3) the target groups for the atlases. It was decided that the target population for the maps was high school students and design decisions were based on that level of education (Rasouli, 2005). Defining the "user" of on-line products is a difficult task and education level was felt to be an acceptable approach with grade 10-12 as a surrogate for the general population.

Final testing of the atlases was done using undergraduate students because it was deemed that their level of comfort with computers and their exposure to the material was similar to upper level high school students (Bani-Taha, 2015).

The early atlases covered UCD in 5 sections: User Needs Analysis (UNA), user Interface requirements (UI), Hierarchical Task Analysis (HTA), Initial conceptual designs and low-fidelity prototypes, and Heuristic Evaluation (Rasouli, 2005).

The user needs analysis was done using semi-structured interviews to reveal potential issues that user groups might have with cybercartographic atlases. Text books and published high school curriculums were also explored in an attempt to accurately frame the atlases (Rasouli, 2005).

The user needs analyses employed four sets of questions. Which questions were used depended on whether the respondent was a teacher or student and whether their focus was on the Antarctic atlas or the Canada's trade with the world atlas. The questions established the users' comfort with computers, the Internet and their education level. The questions also addressed the types of assignments students were completing and the resources available to them in the classroom (Rasouli, 2005). The results of the UNA indicated that there was a lack of informational resources for students and teachers at the time and that the students had limited access to "engaging" electronic resources.

After the UNA was completed for the Antarctica Atlas and the Canada's Trade with the World Atlas, researchers developed the User Interface design requirements list. This UI design requirements list provided designers with a "usage context, technological constraints, curriculum requirements, and best practices." (Khan et al.

2004) This acted as a checklist for the designers to go back to throughout the design process (Rasouli, 2005).

The Hierarchical Task Analysis was done in order to provide designers with a specific list of steps that users would take to complete a given task within the atlas. To do this, users' actions were recorded by keystroke (Rasouli, 2005) which ensured that all of the steps involved and actions required to perform a given task were included the interface.

Using the UNA, UI requirements and HTA, the development teams developed low and high fidelity prototypes, exploring a number of different metaphors, checking them against the stated goals of the UNA and ensuring they conformed as closely as possible to the UI requirements. The development team was split into two independent groups that worked in parallel, allowed for the greatest diversity and exploration of different possible implementations of design ideas (Rasouli, 2005). The requirements for the interfaces, above the agreed upon foundations set out by the UNA, UI requirements and HTA, were: 1) present information in different media such as text, pictures, videos and graphs, 2) Show prognostic information regarding trends and 3) do so in an interactive and engaging way, as well as facilitate exploration (Rasouli, 2005). All prototypes were evaluated using heuristic evaluations to ensure that all of the goals were being met. The heuristic evaluation was done by members of the faculty of Psychology and Human Computer Interaction departments at Carleton University Human Oriented Technology lab (HOTlab). The usability issues were rated from severe to minor, allowing the design team to attack issues in order of importance. (Rasouli, 2005; Khan et al. 2004).

2.3 Nunaliit Framework

Since the development of cybercartographic theory and its application in the Antarctica Atlas and Canada's Trade with the World Atlas, the theory and practice of cybercartography has continued to evolve and more recently has focused on the "implementation of traditional knowledge and its representation in cybercartographic form" (Taylor, 2014). A framework focused on traditional knowledge allows the creation interactive cartographic interface narratives centered around the multifaceted indigenous history, culture and languages in hopes of capturing and preserving the essence of an 'indigenous way of knowing' (Taylor, 2014). "The Nunaliit Cybercartographic Atlas Framework is an interactive data management platform for collecting, relating, presenting, and preserving information and its content, with a particular focus on using maps as a unifying framework (Hayes, Pulsifer & Fiset, 2014). The purpose of the Nunaliit framework is to allow users to interact with multiple forms of media without having to re-format or relocate the data elements (Hayes et al. 2014). Nunaliit is open source, meaning that anyone can use it or contribute to it free of licensing charges or fees. Allowing mapmakers and knowledge holders access to, not only the framework, but the underlying code, allows them to alter the narrative of their given atlas to accurately reflect their point of view. Open source software is computer software that is produced with an open-source license. This means that anyone can access, use, change and distribute the software to anyone for free (Pankaja & Mukund, 2013). The alternative to Open source software is proprietary software that is licensed with

exclusive rights to the copyright holder. Meaning in most cases that it can't be accessed, altered or distributed without the copyright holder's permission. Proprietary software usually employs usability experts and product testing to ensure the product functions the way it should. The software is usually directed at a specific user group for a specific purpose so user manuals and help is readily available for usability issues that a user might encounter (Pankaja & Mukund, 2013). Open source software can provide flexibility to customize a system but has been criticized for its shortcomings in terms of its usability (Pankaja & Mukund, 2013). The argument has been made that open source software has a higher potential to improve quality and develop faster because the software is available to more people (Aberdour, 2007). So although usability is not necessarily prioritized the way it would be in proprietary software the usability issues in an open-source system, if substantial, could be addressed fairly quickly because of the potentially large number of users and developers. Because Nunaliit is licensed as open-source the usability of the system, if found to be problematic could be altered.

Early applications of the Nunaliit cybercartographic framework are the Arctic Sea Ice Atlas and the Pan-Inuit Trails Atlas. Both of these atlases focus on indigenous knowledge and tell their particular story from an indigenous perspective, provide a space to preserve indigenous knowledge, quality learning environment for future generations.

2.4 Gwich'in Place Names Atlas

The Gwich'in Place Names Atlas (GPNA) (http://atlas.gwichin.ca/index.html) is the next step in the progression of Nunaliit cybercartographic atlases. The GPNA was created by the GCRC in association with the Gwich'in Social and Cultural Institute (GSCI). The Gwich'in Atlas is a record of over 900 place names in the Gwich'in territory. The atlas outlines territorial boundaries, historic, social and cultural landmarks in an effort to preserve the Gwich'in culture and language through recordings, stories and images collected by the GSCI. Data collection spanned from 1992-2012, during that time 74 Gwich'in elders were interviewed about the communities and traditional land use (http://atlas.gwichin.ca/index.html). The atlas content and focus was driven by the GSCI. The atlas is a zoom-able and pan-able map with interactive data points containing information about the specific locations. The atlas contains images of elders, geographic locations, historical maps and documentation that capture some of the Gwich'in history and culture. The atlas also provides audio recordings of elders reciting place names in the traditional Gwich'in language. The audio recordings combined with the geographic information and atlas visualization gives users an interactive and informed look at Gwich'in history. The Place Names Atlas project helped to promote and conserve the Gwich'in language by increasing awareness and bring Gwich'in youth and elders together to discuss their cultural heritage (Aporta et al. 2014). Semantic zoom, layer isolation and imbedded media are all intertwined throughout atlas, allowing the user to move, manipulate and search information throughout the atlas. The atlas contains translations of traditional Gwich'in place names as well as names for locations. This has the

potential to allow users to make connections to traditional Gwich'in locations using westernized names and landmarks, facilitating learning for those who aren't native Gwich'in or Gwich'in speakers. I have chosen the Gwich'in Place Names atlas as the focus of my user interface evaluation because it is a good representation of an interactive cartographic interface. The Gwich'in place names atlas is an interactive, multimedia product that creates a narrative around the Gwich'in language and culture. Because the GPNA is created using open-source software it is also a suitable example of an atlas that could potentially be created by a private individual with limited time and resources, for this reason we have chosen to employ the Cognitive Dimensions of Notations framework to evaluate the GPNA. The CDN evaluation should provide a light-weight, broadly applicable evaluation allowing for easy implementation and communication about the usability of the interface as a whole, outlining major and minor usability issues and introducing language that allows both users and developers to communicate clearly about usability issues and their trade-offs. The evaluation should also reveal areas where the existing interface can be improved.

Chapter 3: Cognitive Dimensions of Notations Framework

3.1 Cognitive Dimensions

The Cognitive Dimensions of Notations (CDN) framework is a "lightweight", "broad brush" approach to computer software evaluation (Green, 1989). It is lightweight because it is not conceptually difficult to comprehend and it is fairly simple to implement. The complexity of implementing the CDN is much lower than other evaluation methods. A developer or designer is capable of applying the CDN framework. The results of a CDN evaluation are easily interpreted and, perhaps more importantly, discussed using the CDN lexicon. It is a "broad brush" approach because it does not do an in-depth analysis of any one system but instead evaluates the functioning of the system as a whole. Some evaluation methods focus on and outline very specific elements of the system that are ineffective or highlight aesthetic issues related to interface function (Carol, 2003). The CDN evaluates the system as a whole and highlights broad usability issues.

A "cognitive dimension" is a name given to a concept or aspect of a products' design that, perhaps, hasn't been fully defined or explored (Blackwell & Green 1998). The CDN framework is a discussion tool that introduces a lexicon (language referring to specific concepts) that allows developers and non-experts to easily discuss aspects of a system or product's usability.

The cognitive dimensions of notations framework also requires the developer or evaluator to take into account the information artifacts (e.g. heater displays, watches) or the notational system (e.g. word processors, computer aided design

tools) that they are working with in a system (Blackwell et al. 2001). The way a user communicates or interacts with an information artifact or notational systems is through a "*notation*", "a notation comprises the perceived marks or symbols that are combined to build and information structure" (Green & Blackwell, 1998). Lastly the CDN framework looks at the *Medium* in which the notation exists. "The notation itself is imposed onto a medium, which may be static of dynamic depending on the system." (Blackwell & Green, 1989) A medium may display several notations at once. For example: a computer with several windows running different editing software. The computer is acting as the medium and the different types of information being edited or displayed in each window are the notations. There are currently 14 cognitive dimensions; each defines a concept related to system evaluation.

Table 3.1 Cognitive Dimensions

Abstraction	Changes the Notation, almost always through expansion
Hidden Dependencies	Important Links between entities are invisible
Premature Commitment	Constraints on the order of doing things
Secondary Notation	Extra information in means other than formal syntax
Viscosity - *Repetition Viscosity* - *Knock-on Viscosity*	Resistance to change - *Single goal-related operation requires an undue number of individual actions* - *One change 'in the head' entails further action to restore consistency*
Visibility	Ability to view components easily
Closeness of Mapping	Closeness of representation to domain
Consistency	Similar semantics are expressed in similar syntactic forms
Diffuseness	Verbosity of language
Error-proneness	Notations invite mistakes
Hard Mental Operations	High demand on cognitive resources
Progressive Evaluation	Work-to-date- can be checked at any time
Provisionally	Degree of commitment to actions or marks
Role Expressiveness	The purpose of a component is readily inferred.

Table 3.1: Green's 14 cognitive dimensions of notations and definitions. The left column shows the name of the individual CDs. The right column shows the definition of the dimension itself.

The CDN evaluation is designed to be broadly applied and has the capacity to evaluate static (e.g. code, mock-ups) or dynamic (e.g. interactive, high-fidelity prototypes) programs as whole, rather than individual aesthetic aspects of a system. CDN can also outline the "trade-offs" of a system when evaluating design decisions. A trade-off is the result of changing one or more cognitive dimension (design maneuver) and (intentionally or unintentionally) affecting another aspect of the system's function (Green, 1989; Green & Blackwell, 1998). Green (1989) refers to the cognitive dimensions as being "pair-wise independent" meaning that the concepts are not directly dependent on each other but affecting one dimension will cause the effects of another dimension to shift. An example of a pair-wise independent trade-off is: making a system more viscous (more resistant to change). A highly viscous system requires the user to perform multiple steps to achieve a task that is only one mental step (repetition viscosity) e.g. shifting page order in a formatted document. Moving the pages requires re-numbering and re-organizing the entire document. The viscosity of the document is high because it requires multiple steps to perform a single action. The system does however give the user complete control over the formatting document. To alter the viscosity of the system the developer could implement an auto-formatting feature that automatically adjusts page numbers and references. This is great until the user wants to move a document feature without re-numbering or re-referencing. The system is now acting on behalf of the user. The automatic re-formatting of the document could open the

user up to errors if they fail to recognize the issue, increasing the “error proneness” of the system (The likelihood that the user will make a mistake).

Allowing the user (especially novice users) to easily make changes easily (low viscosity) without warnings can lead to errors. Increasing the viscosity of the system can cause frustration for users, forcing them to perform extra actions. No dimension is by definition “good” or “bad” the quality of a cognitive dimension and the degree to which it affects a system is dependent on the goals of the designer and the user group. If the designated user group is highly experienced and consists of experts the system could allow for more flexibility and open itself up to a higher degree of error-proneness because the developer can assume the users are capable of fixing mistakes or accept the risks because of the increased flexibility the lowered viscosity allows. If the system is designed for novice users the developer may want to increase the viscosity, reducing the movement of users but decreasing the error-proneness. High or low degrees of dimensions are not good or bad, rather dependent on the goals of the developer.

3.2 Cognitive Dimensions of Notations Applied.

The CDN framework and evaluation has been applied to several systems: visual programming languages (Green & Petre, 1996), Theorem proving assistant programs (Kadoda et al. 1999), and high-level agent programming languages (Cohen et al. 2012).

Green & Petre (1996) performed an in depth evaluation of three different visual programming languages (VPL): Basic, Prograph and LabVIEW. Green and Petre (1996) explored each VPL and produced a CDN analysis of each system; they found the CDN approach provided an easy to use, and quickly implementable framework that effectively evaluates the functionality of the different VPLs, while at the same time outlining their strengths and weaknesses depending on the task being performed.

Kadoda et al (1999) reported on theorem proving programs. They created a questionnaire based on Green's (1989) Cognitive dimensions. The questionnaire focused specifically on dimensions that the researchers felt were relevant, rather than including all of 14 dimensions. Kadoda et al. (1999) adapted questions and language from the original framework and applied it to the Theorem Proving Assistant (TPA) domain. The researchers then sent their questionnaire to experienced developers and users of Theorem proving programs. Because TPAs are so specific and used by such a specific sect of the academic population they were not able to create results that were as detailed as the evaluation done by Green & Petre (1996); however, Kadoda et al. (1999) found that the CDN framework functioned as a valuable discussion tool when dealing with theorem proving programs.

In response to the Kadoda et al. (1999), Green & Blackwell (2000) created a cognitive dimensions questionnaire that allowed developers and users to evaluate any system. The questionnaire included all of the cognitive dimensions, instead of only dimensions developers felt relevant. They felt that an adaptation of the framework or lexicon could lead to evaluator bias; by creating an all-encompassing

questionnaire they were better able to capture the true nature of a given program. Green & Blackwell (2000) admit that their questionnaire is more complicated and potentially more difficult for the user to implement because it introduces some of the CDN lexicon to the user and employs it in the questionnaire.

Cohen et al. (2012) adopted the approach of Kadoda et al. (1999), adapting the cognitive dimensions of notations questionnaire to their own program: an evaluation of a high-level programming language. Cohen et al. (2012) then defined a threshold of concern, prioritizing usability issues by the frequency of user error. In their research Cohen et al. created a Likert scale evaluation of the system and engaged in an observational evaluation of their system. By relating their observations to the Likert scale results the researchers were able to establish which interface issues were most problematic. Cohen et al. (2012) found the CDN evaluation model they employed was a useful tool in evaluating the usability of their program.

3.3 Cognitive Dimensions Concerns.

Dagit et al. (2006) outlines the benefits of employing the CDN framework and warns against potential evaluation breakdowns with the framework if not thoughtfully implemented. One potential breakdown of the CDN framework is new interpretations of existing dimensions. This can cause individuals who are familiar with the traditional definitions of the dimensions to encounter a discrepancy in

understanding, leading to misinterpretation of the findings and a breakdown of the CDN lexicon. Dagit et al. (2006) found that *"CD's are not useful as a tool for acceptance"*. The Cognitive dimensions of notations framework defines system issues and trade-offs, it is easy for the designer to interpret a "no flaw" finding as the absence of an issue. Dagit et al. (2006) found that this issue can occur when designers become too familiar with their system and don't notice the "work-arounds" (actively avoiding known errors or inconveniences in the system) they have developed to avoid issues. The avoidance of a system flaw does not mean that one does not exist. Having designers who are not associated with the project evaluate the system can mediate this issue. If the CDN evaluation is employed as a broad evaluation of usability issues and the lexicon is used and not adapted to reflect the goals of the evaluator, the evaluation can be a very effective method for evaluating interface usability.

The CDN evaluation framework has not been applied to online interactive cartographic interfaces and this thesis is, to our knowledge, the first attempt to do so. I feel jethat by applying the CDN evaluation to the Gwich'in place names atlas I will be able to outline the utility and versatility of the CDN evaluation. In my evaluation of online interactive cartographic interfaces we employed the approach used by Kadoda et al. (1999) and Cohen et al. (2012). I chose to focus on six cognitive dimensions (Visibility, Role Expressiveness, Hard Mental Operations, Viscosity, Consistency, Error Proneness) I felt these dimensions were the most relevant to interactive online cartographic interfaces. Because the visibility, role

expressiveness and consistency of tools and displays effect how individuals access and interpretation of interface aspects we felt they were especially important when assessing online interactive cartographic interfaces. The viscosity and error-proneness of the system can cause user frustration or enjoyment of the system and be a determining factor in the usability of the system as a whole. The cognitive stress placed on the user is an important factor in the user's effectiveness within the interface. For these reasons we chose to restrict our interface evaluation to six of the 14 dimensions proposed by Green (1989). We used domain-specific terminology, rather than introduce participants to a new lexicon. We felt introducing new language into an exploratory interface evaluation could be overly difficult and taxing on the user.

Chapter 4. Methodology

The objective of this chapter is to outline the study methods employed to test the viability of the cognitive dimensions of notations framework in evaluating online interactive cartographic interfaces. All of the questionnaires and procedures received Ethics approval from the Carleton University Research Ethics Board.

4.1 Outline

In this study I employed an objective and subjective approach to interface evaluation. Subjective data is primarily an observation of the impression of an experience. Objective data is not a reflection of the participants interpreted experience but rather a statistical evaluation of their performance or experience (Hubpages, 2013). A guided exploration of the GPNA helped participants explore and experience different aspects of the atlas interface. The guided exploration was a use-case scenario that framed the participants' interactions within the interface and highlighted different tools in the interface in hopes of increasing user engagement. The participants' performance using the guided exploration was evaluated objectively by analyzing and coding the video recording of the participants actions within the interface. The subjective evaluation consisted of a participant self-response survey and a semi-structured interview that explored participant experience within the interface. The evaluation results can be applied to future atlas deployments and the evaluation technique can be employed to establish usability issues in a timely and cost-effective manner.

Nielsen (1994) explored effective heuristic evaluation techniques for human computer interaction usability testing in terms of the most efficient and cost-effective ways of identifying usability issues within computing. In his study Nielsen (1994) found that 19 evaluators [Users] identified 16 usability issues. Because evaluators often found the same errors, increasing the number or evaluators produced diminishing returns. Nielsen (1994) suggests using fewer evaluators and performing more in-depth evaluations. For this reason we chose to evaluate a small number of participants (12). This number is slightly higher than Nielsen's suggested 3 to 5 participants, but we felt it was important to have more participants because the cognitive dimensions of notations evaluation technique has not been applied to interactive cartographic interface evaluation. Because Nunaliit is open-source software and mapmakers may have varying degrees of experience in software design it is important to create evaluation methods that impose minimal restraints on the developer. For that reason Neilsen's (1994) evaluation heuristic, employing fewer participants is preferable for the evaluation of future Nunaliit atlas deployments. Previous work related to cartographic interface evaluation has explored a number of approaches. Richmond and Keller (2003) evaluated whether online tourism sites met user expectations by employing online user surveys. Leitner and Buttenfield (2000) had users perform specific tasks within the interface to evaluate the effectiveness of embedding attribute certainty information in map displays. Harrower et al. (2000) used focus groups to understand how novice users understood and interacted with geovisualization tools. In an examination of digital mapping companies' development and testing methods Nivala et al. (2007) found

the companies typically used use-case simulations and different layouts for the user interface followed by an informal interview. A small user sample was typically used due to time and money constraints. Because the cognitive dimensions of notations is fairly quick and requires little monetary investment to implement it is practical for implementation. We also chose to use a use-case scenario and specific use tasks to evaluate the functionality of the interface. With the exception of using the CDN for the usability evaluation out methods are in line with geovisualization and cartographic interface usability evaluations. Commonly used usability evaluations involve the use of focus groups (Harrower et al. 2000, Bani-Taha; 2014). Focus groups generate large amounts of subjective data about the system (Robinson et al. 2005) however it requires a group of users to be in the same place at the same time which can be difficult with time and resources are limited. Similar amounts of subjective data related to the system can be generated by using verbal protocol analysis (VPA). Which requires users to "think aloud" as they work through the system (Robinson et al. 2005). Because of our limited resources and the intended application of the CDN evaluation for open-source online cartographic interfaces we felt that employing a use case scenario, recorded, using VPA would be more practical than assembling focus groups.

4.2 Participants.

Twelve individuals participated (6 male, 6 female). Participant education level ranged from 1st year undergraduate students to 1st year Masters students. All user

testing, evaluation and interviews were conducted at the Carleton University Usability Lab. Male Participants had a mean age of 24.5 years (Standard Deviation: 3.209). Female participants had a mean age of 24 years (Standard Deviation: 3.286). In our examination of the Gwich'in Place Names Atlas we chose to have participants identify their gender to analyze any potential gender differences related to usability. Previous research (Dabs et al; 1998, Goldstein et al; 1990, Sandstrom et al; 1998, Astur et al; 2016) have found gender differences in map use related to way-finding as well as mental map rotational abilities. If a substantial and meaningful difference was recorded related to differences in use by gender there could be considerable design considerations and alternate sets of trade-offs depending on the gender of primary user groups.

Tabe 4.2. Participant Metrics

Male Participants	6		
Mean Age	24.5		
Age Standard Dev	3.209		
Use of Online Maps	Occasionally: 1	Often: 5	EveryDay: 0
Use of Nunaliit	Yes: 1	No: 5	
Use of GIS	Yes: 0	No: 6	
Designed Online Maps	Yes: 0	No: 6	

Female Participants	6		
Mean Age	24.0		
Age Standard Dev	3.286		
Use of Online Maps	Occasionally: 0	Often: 3	Every Day: 3
Use of Nunaliit	Yes: 0	No: 6	
Use of GIS	Yes: 0	No: 6	
Designed Online Maps	Yes: 0	No: 6	

None of the participants with the exception of one male had any experience with the Nunaliit framework or GIS mapping technology. All participants reported having

experience with some form of online mapping software and use varied from occasional to every day. Female participants reported using some form of online mapping software more frequently than males. It should be noted that none of the participants was a native Gwich'in speaker.

Each participant was given a $5 Tim Horton's gift card as a token of appreciation for his or her participation in the study. Participants were contacted through direct email (Appendix A) or personal interaction (Appendix B) . The size of the samples is reflective of HCI heuristic evaluations (Nielson, 1994) that emphasize the importance of focused and in-depth testing with smaller rather than massive sample sizes.

4.3 Procedure.

Upon arriving at the Carleton University usability testing lab, participants were greeted by the researcher and shown into the testing room. Each participant completed a consent form (Appendix C), and the researcher explained the purpose of the study along with how data would be stored. All participants were informed that they were free to withdraw from the study at any time during the evaluation without penalty; they were also able to withdraw from the study until July 1, 2016 by contacting the researcher directly.

Upon completing the consent form general metrics were taken to record participants' age, level of education and familiarity with interactive online mapping environments (Appendix D). Participants were shown the guided exploration. The exploration was given to the participants on paper and on the computer. This was

done because the cognitive processes involved in recording information are not the focus of the study so the comfort of the participant was given priority.

The guided exploration (Appendix E) was employed to give participants the opportunity to explore the Gwich'in place names interface in a specific use-case scenario. Participants were aware that their onscreen actions and audio were being recorded for later evaltuation. The exploration and tasks were created to highlight usable features of the interface and encourage participants to employ different search techniques within the atlas.

The guided exploration of the Gwich'in Place Names atlas lasted approximately 45 minutes, after which participants completed the self-response survey followed by the semi-structured interview. The self-response survey questions (Appendix F) were created based on the questionnaire created by Cohen et al. (2012), which used a Likert scale questionnaire that highlighted specific cognitive dimensions. Cohen et al. also employed domain specific language that helped to facilitate the user's experience when completing the questionnaire. Relating experiences to the language used in the evaluation, rather than introducing a new lexicon and potentially complicating the evaluation process. The semi-structured interview questions (appendix G) were designed around Cohen et al. (2012) dimensions of concern questions and Blackwell & Green's (2000) Cognitive Dimensions of Notations questionnaire. The questions were primarily designed to address individual cognitive dimensions. In keeping with Cohen et al. (2012) and Kadoda et al (1999) the questions were designed with ease of use in mind. The questions used general and domain specific language that made the questions more understandable

to the participant, allowing for a more comfortable conversation when elaborating on points during the interview.

The implementation of a semi-structured interview is not un-common in the evaluation of cartographic devices (Bani-Taha, 2014; Roth, 2015). The interview also gave researchers more insight into participant decision-making and interpretation of interface feedback, allowing for a more in-depth understanding of usability issues and potential trade-offs.

At the end of the interview participants were asked if they had any suggestions or changes they would immediately make to the interface. Once the evaluation and questionnaires were completed participants were asked to contact the researcher with any concerns or questions about the research.

4.4 Subjective Evaluation.

The subjective evaluation of the Gwich'in Place Names Atlas was done through semi-structured interviews and participant self-response surveys (Bani Taha 2015; Roth, 2015). The interviews followed a pre-defined set of questions asked by the researcher to the participant. The interview questions and semi-structured interviews as a whole allow for participants to explore their answers, not confined to Likert scale responses or a stiff response structure, the researcher was able to explore participant responses farther, going "off-script". This expansion invites the participant to share their experience fully.

Participants completed a short self-response survey consisting of five, 5-point Likert scale questions. These questions limited participant responses but evaluated

specific interface criteria on a defined scale. This functioned to establish the participants' feelings about the interface before speaking with the researcher. Participant responses to the semi-structured interview questions and self-response survey were recorded. The scaled responses were evaluated and provided a clear representation of participants' feelings about their interactions within the GPNA. The semi-structured interview responses were recorded and separated into themes related to different cognitive dimensions.

Issues that occurred with the most frequency were deemed to be the most problematic. The combination of the self-response survey and semi-structured interview provide a clear picture of participant usability concerns. Subjective evaluation techniques have accused of lacking scientific rigor, providing results with no tangible proof. To ensure my use of the CDN evaluation was providing accurate results I chose to employ a objective evaluation.

4.5 Objective Evaluation.

The objective evaluation of the GPNA evaluated participants' on-screen actions during the guided exploration. The researcher coded the actions of the participants; noting how they chose to navigate the interface, issues they encountered and website functionality issues. The structure of the guided exploration was such that different questions were most efficiently answered by employing specific interface functionalities. The researcher also helped participants by providing hints on how to complete tasks if the participant was having too much trouble or unable to complete a task. Neilsen (1994) encourages researchers to help participants who are unable

to complete a task, by providing the user with hints or tips the user is better able to fully experience the usability of the system in question.

The guided exploration data was recorded and evaluated; objective results for male participants, female participants and combined results. The usability issues were assigned levels of severity and prioritized (Cohen et al. 2012), severe (40% or more participants encountered this issue) Moderate (30% - 40% of participants encountered this issue) Minor (20%-30% of participants encountered this issue). If less than 20% of participants encountered an issue it was deemed a non-issue. Positive responses to interface functions were also recorded. By employing Cohen et al. (2012)'s dimensions of concern paradigm I was able to clearly identify major usability issues. My threshold for acceptability is higher than the one used by Cohen et al. (2012), however the Gwich'in Place Names Atlas user base is much broader than the user base for Cohen's system.

Participants were asked what they would change about the interface based on their experiences. These responses were recorded and separated by theme and frequency, outlining apparent user preferences for online interactive cartographic interfaces. All participant responses and study results were compiled and evaluated to provide a usability analysis of the GPNA. This evaluation highlights key usability concerns experienced by the participant population. It also provided an exploration of the CDN's applicability as online interactive cartographic atlas usability evaluation. The lack of understanding relating to the language itself caused specific issues for many participants. An evaluation of native Gwich'in speakers could produce slightly different results, specifically related to searching of alternate names and

identification of specific search criteria. Our atlas evaluation still highlights key interface usability issues and outlines issues for non-Gwich'in speakers that could make the interface more accessible and provide a better platform for learning the Gwich'in language.

Chapter 5. Results and Discussion

This chapter presents the results obtained from the cognitive dimensions of notations evaluation of the Gwich'in Place Names Atlas Interface. Results are separated into three sections: first, the objective results, analysis and discussion showing participants' video analysis performance within the Gwich'in Place Names atlas, second, the subjective analysis presenting the participants' self-response survey results and the results of the semi-structured interviews. Last, we will examine and discuss user suggestions for interface improvement.

5.1 Results: Objective Analysis

Participant video analysis was done by reviewing the guided exploration recording and noting key interactions within the interface. Interface interactions were then analyzed based on their relevance to the Cognitive Dimensions of Notations framework and prioritized based on the frequency of the action. The participants were asked to speak out loud as they worked through the guided exploration. Participants expressing their thoughts and frustrations with the system as they went helped the researcher to understand what the participants goal was at any given time and establish whether an action within the interface was effective or not.

During the video analysis the researcher was able to establish whether an interface interaction was positive or negative based on the participants' stated goal, the goal of the questions in the guided exploration and the video recording of the onscreen actions. Results were separated into Male, Female, and Combined results. A full list of gender specific results can be found in Appendices H & I

Table 5.1. Video Analysis Results (Total participant population)

Common Themes (All)	Frequency	CD	+ / -
Skim/ignore opening blurb	25.00%	Role Expressiveness	-
Use of map immediately	16.67%	Role Expressiveness	
Immediate user of search bar	41.67%	Role Expressiveness	
Trouble locating gull lake	58.33%	Viscosity/Visibility	-
Quickly parse information	58.33%	Visibility	+
Trouble locating areas on map	25.00%	Visibility	-
Correctly identifying tile functions	33.33%	Consistency/visibility	+
Incorrectly identify tile function	25.00%	Consistency/visibility	-
Identification and use of layers	8.33%	Visibility	+
Misuse layers/no use	58.33%	Visibility/ Role Expressiveness	-
No understanding of groups	33.33%	Role Expressiveness	-
Correct use of tools	8.33%	Visibility/Role Expressiveness	+
Activates "link header" correctly	8.33%	Visibility/Role Expressiveness	+
Activates link header, unaware of function	8.33%	Visibility/Role Expressiveness	-
Inefficient use of hover/search exploration	50.00%	Viscosity/Visibility	-
Trouble locating fort McPherson	16.67%	Visibility	-
Frequent use of browser back button	16.67%	Visibility/Viscosity	
Mutes audio	16.67%	Viscosity	
Discovers tools through researcher hint* (F1)	66.67%	Visibility/Viscosity/Hard Mental Operations	-
Attempts to click the "Group Name" tile	25.00%	Role Expressiveness	-
Re-searches terms rather than use of buttons	25.00%	Viscosity	-
Attempts to use PDF maps	33.33%	Role Expressiveness	-
Misidentifies Data	41.67%	Viscosity	-
Uses help menu to solve Nav Problem	25.00%	Role Expressiveness	+
Misunderstands Top Nav bar function	33.33%	Visibility/Role	-

Expressiveness

Major issue (+40%)
Moderate issue (30%-40%)
Minor issue (20%-30%)
Acceptable (-20%)
Positive

Table 5.1 displays the usability factors observed across the entire participant population. Major issues are defined as negative usability factors experienced by +40% of participants. Moderate issues are negative usability factors experienced by 30-40% of participants. Usability issues experienced by 20-30% of participants define minor issues. All issues experienced by less that 20% of participants were deemed acceptable. Positive results are usability features that participants were regularly able to navigate and utilize.

Actions are highlighted by the degree to which they affect the functioning of the interface. Major issues indicated issues that were encountered by more than 40% of participants. The cognitive dimension(s) that aligns with the individual action are listed next to the action frequency and the overall affect of the action (+/-) indicates whether the action is positive of negative in terms of interface usability. The presence of neither positive effect nor negative effect on interface usability is indicated by a blank space.

The remainder of this section will focus on the major usability issues outlined in the evaluation, the reason for the issue and the potential fixes or trade-offs related to changing the specific usability feature. The nature of the CDN evaluation is such that major design maneuvers will ultimately change the functionality of the interface as a whole, as a result minor usability issues will likely shift. For this reason I have chosen to focus solely on major issues.

5.2 Major Issues.

5.2.1 Gull Lake (58.3% of user population)

Issues related to the locating Gull Lake arose because the system allows the user to search terms in Gwich'in or English. The English terms are typically the alternate name or the translation of a traditional Gwich'in place. "Gull Lake" is listed as an alternate name for "Gwi'eekajìlchit Van". When "Gull Lake" is entered into the search bar no alternate names are listed in search results, only Gwich'in names, and this presents a problem for users who do not speak or understand the Gwich'in Language. It forces users to guess which of the search results is "Gull Lake" (the westernized name for the location).

The second issue with locating the "Gull Lake" is: if "Gull Lake" is queried in the search bar, along with the fact that results that appear are exclusively in the Gwich'in language, "Gwi'eekajìlchit Van" appears third in the search results (Image 5.2.1). This forces the participant to systematically sift through incorrect search results to find the information.

Participants were able to locate "Gull Lake" by zooming in on the Ehdiitat region of the Gwich'in Territory, hovering over the map and clicking different locations until they arrived at the correct lake (Image 5.2.2). Location names that appear when hovering over the map are exclusively in Gwich'in. Finding "Gull Lake" using hover & click with no previous knowledge of the region or the Gwich'in language did eventually work in some cases but it was very inefficient. Individuals who experienced no difficulty locating Gull Lake were able to hover & click on the lake

quickly through luck or by accident; no system was used to identify the correct result. The issue of results appearing exclusively in the Gwich'in language present issues for non-Gwich'in speakers, however Gwich'in speakers may not encounter the same issues related to the identification of "Gwi'eekajìlchit Van" or the hover & click overlay. The order of search results, though it would present a less substantial issue for Gwich'in speakers, could still impede search efficiency.

CD Evaluation.

Visibility: The search results do not display alternate names or translations of Gwich'in place names in the search results. Because users are unable to relate their search criteria to the results, the usability of the system and the efficiency of the user are compromised. Users are forced to guess their way through the map in order to find the correct result. Alternatively they must systematically examine each search result and explore information to find the alternate name and ensure it is, in fact what they are searching for. The limited visibility of information reduces system usability considerably for non-Gwich'in speakers. The same issues may not be as prominent for users with an understanding of the Gwich'in language.

Viscosity: These results also present issues with repetition viscosity because the system forces the user to complete a number of sequential actions before their desired task can be accomplished. Forcing the user to guess their way through the map, learn the Gwich'in Language or systematically search through results reduces user efficiency and system functionality.

Increasing viscosity can, in some scenarios help to reduce user error by introducing a small amount of redundancy and encouraging the user to perform tasks that can be helpful to their long-term success. However in this use-case scenario the viscosity of the system is too high, forcing users to repeat steps unnecessarily and encouraging user error and frustration rather than reducing the error rate.

Trade-offs.

Increasing information visibility in the search results and in the hover over-lay could cause the interface to appear cluttered and require a re-organization of the interface as a whole, dedicating more space to query related results and covering more of the map with overlay information. However our results suggest that this briefly reduced map visibility could elevate substantial novice and non-Gwich'in speaking user frustration. Employment of a more effective semantic zoom (Harrower & Sheesley, 2005) could also improve visibility and user understanding of the interface. If "Grouping" (Territorial divides) were more clearly marked and locations contained within those groupings were more clearly illuminated with increased aspect ratio, this could increase user understanding of the area and territorial divides, there-by improving the usability of the interface.

Increasing visibility could also reduce the viscosity of the system (a beneficial trade-off). Because users can better understand and relate to the information being displayed in the interface the number of steps required to complete a given goal should be reduced. This could also (indirectly) alter the error-proneness of the search system. Because visibility was increased and viscosity was reduced error-

rates should decline related to basic search tasks, specifically within a non-Gwich'in speaking population.

Image 5.2.1. Search Results for Gull Lake.

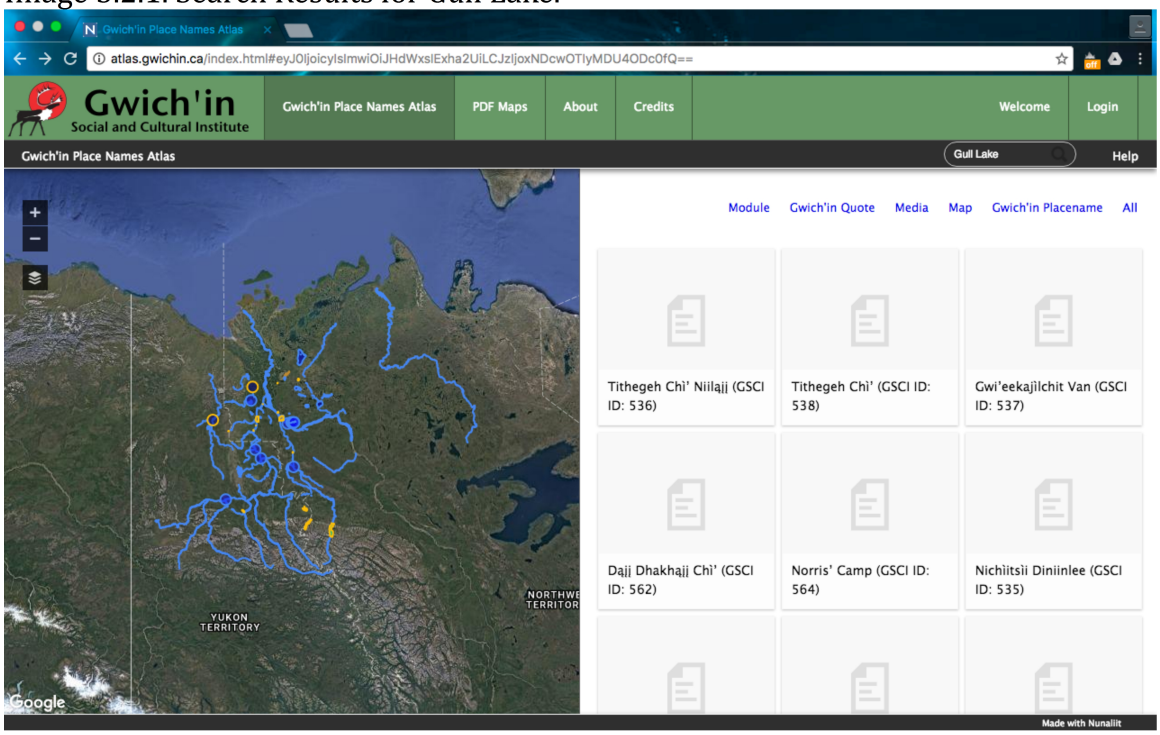

Image 5.2.1 displays earch results for "Gull Lake". No indication that the search results are related to the search query. "Gwi'eekajìlchit Van" is the third result listed, forcing the user to click through the first two results to arrive at their desired destination.

Image 5.2.2. Hover overlay of Gull Lake

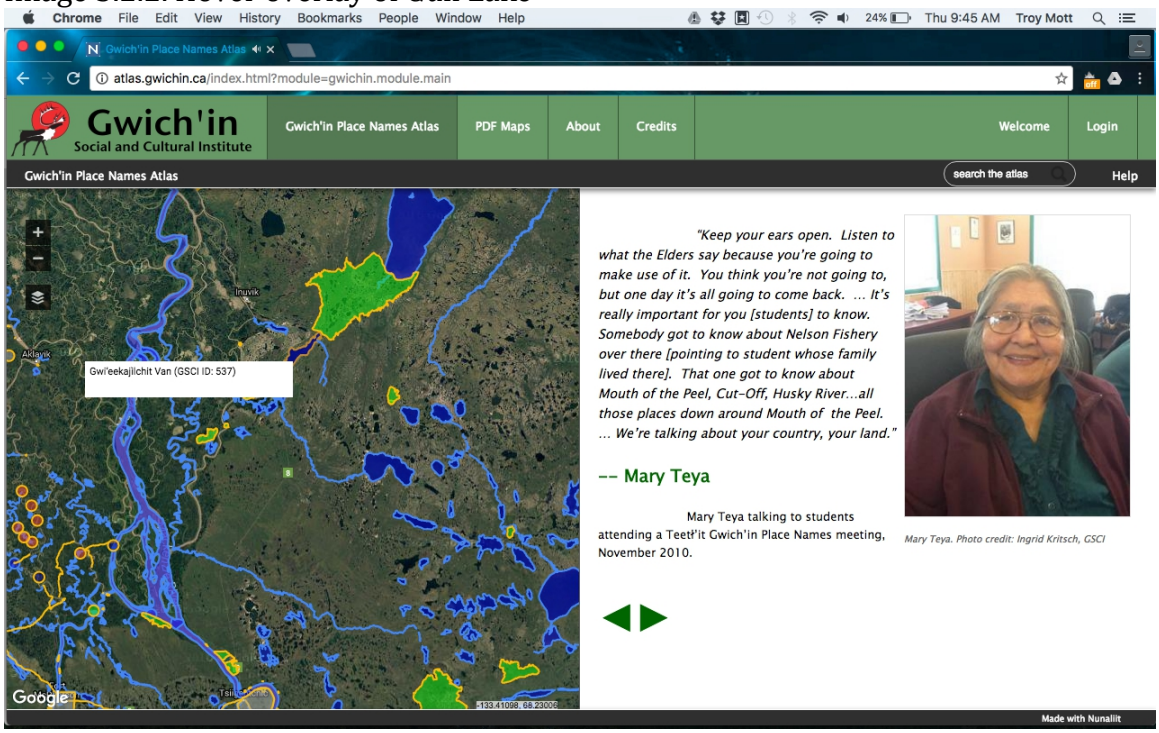

Image 5.2.2 The Hover overlay indication of "Gwi'eekajìlchit Van": participants have to click to find alternate name or any related information for this location.

5.2.2. Misuse/No Use of Layers (58.3%)

Participants rarely opened and adjusted the "layers" tool in the Gwich'in Place Names Atlas. Three questions in the guided exploration specifically lent themselves to the use of layers to identify location types:

1c. Please choose a few locations of your own that would be good to visit, keeping in mind you're located in Inuvik. Provide their Gwich'in name, alternate name and any other relevant information you might include in your presentation. Please provide the type of location (Water, land, Man-Made, Trail, Camp.)

2c. What is the name of the "historic" site closest to Fort McPherson?

2d. Please choose a few “Water” locations to visit, keeping in mind you’re located in Fort McPherson. Provide their Gwich’in name, alternate name and any other relevant information you might include in your presentation.

Each question indicates different types of locations exist, and questions 2c and 2d require the participant to identify specific location types. Participant non-use of the layers tool was due to a lack of visibility and role expressiveness. The users, in some cases didn’t know the tool was available or they didn’t know its function (both were confirmed in semi-structured interview). Both of these problems present substantial usability issues.

CD Evaluation:

Visibility: participants were unaware that the tool or option existed. The majority of participants were unable to find and/or recognize the significance of the tool without a hint from the researcher. This indicates that the button was not clearly enough displayed or the colour coding of different location types within the interface was unclear, leaving participants unaware of the existence of separate layers.

Role Expressiveness: Some participants noted seeing the button but did not know what it did and were hesitant or unwilling to open the tool. This uncertainty hindered efficiency and the effectiveness of the interface.

Once participants were made aware of the layers feature, whether through researcher hint or the help menu all were able to manipulate and toggle layers on and off, indicating a general blindness to the tool function or the tool itself.

Trade-offs.

Increasing the visibility of the layer tool or increasing the visibility of individual layers to highlight the existence of a difference in location-type could increase user efficiency. The knowledge and understanding of system tools could help users to identify specific information more quickly and easily. A potential tradeoff of increasing visibility is the error-proneness of the system could increase. Increased visibility could highlight the layers tool to the point that it is distracting from natural or defining map features or blinding the user to other informational factors related to a given data point.

Increased role expressiveness of the layer tool can improve usability and increase user engagement. Increasing or emphasizing different layers, highlighting the fact that different area-types exist, can subtly increase role expressiveness. Creating pop-up information overlays or providing a use tutorial in the interface would overtly increase role expressiveness of map tools. The introduction of a tutorial or pop-up overlay would increase the viscosity of the system by forcing experienced users to skip through a tutorial or close the overlays.

In the current atlas deployment the layers tool was not well recognized or understood. The inability to successfully access or understand tools diminished user

enthusiasm and enjoyment of the interface. This would suggest highlighting key tools and functions of an interactive interface is critical to interface success.

Image 5.2.3. Gwich'in Place Names Atlas Layers Tool.

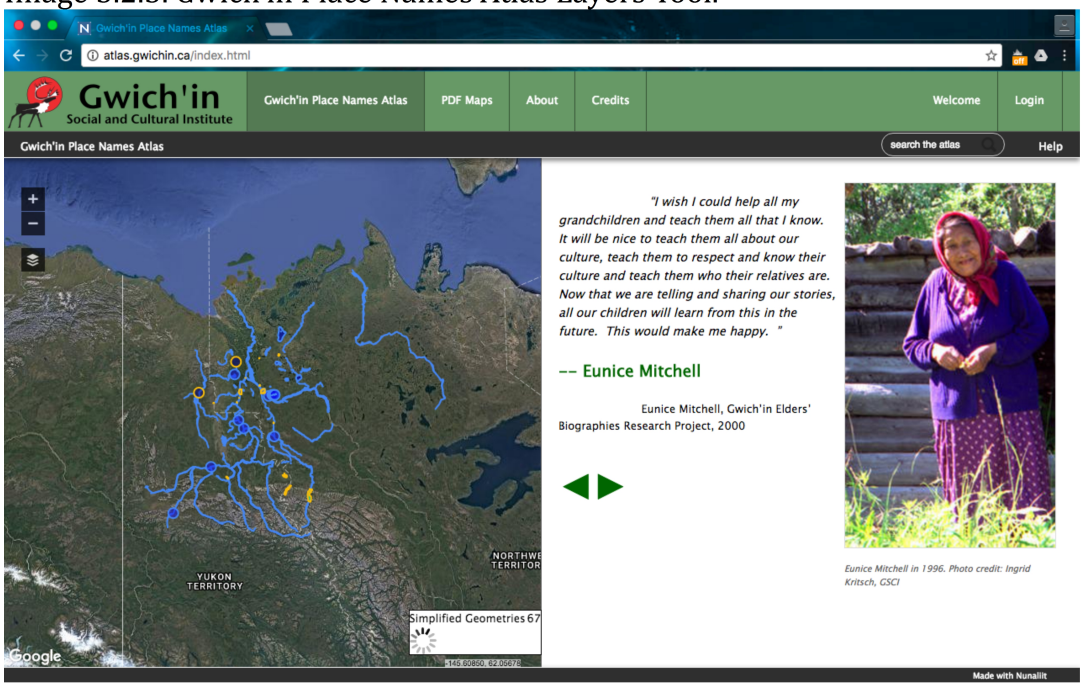

Image 5.1.3. The arrow indicates the location of the default activate layers feature.

5.2.3 Inefficient user of Hover & Click Exploration (50%)

Use of the Hover and Search exploration technique is done by visually exploring the map and hovering the curser over artifacts, allowing for an information overlay to pop-up indicating the name of the artifact. This is very effective when exploring the map, however it is inefficient when specific search criteria are given. In the case of specific search criteria, the more effective method of retrieving information is through implementation of the search bar. Participants frequently resorted to the hover & click search method when specific search criteria were given. This was done for a few reasons: frustration with search results (re: Gull Lake) and or the disconnection between search results and physical location on the map. When

search results are explored, the physical location of the information artifact is not clearly highlighted. Because the location is not clearly highlighted the user has to rely on the information provided by the search results to identify the physical location of an artifact. It is possible to center the map on the desired location on the map, however the user has to open the “Geometry” and click “find on map” (Image 5.2.4 & 5.2.5). Very few users discovered this feature.

CD evaluation:

Viscosity: Because participants used the hover & click search method more frequently than the search bar when specific search criteria was available the viscosity of the system was deemed to be a negative contributing factor in the usability of the GPNA. Rather than searching the desired information the user felt they had to hover over the map and click on entities until they found the desired location. This could potentially force the user to perform substantially more actions than necessary.

Visibility: Frequently, when the hover & click search method was employed participants would click the same location several times when searching specific criteria. The limited visible information in the hover overlay reduced the users’ abilities to relate their geographic location to the information they desired.

Trade offs

Increasing information visibility can reduce the error-proneness of the system. Users would be able to relate the information they are searching for to the information they are looking at in the interface. Increasing the visibility of the map can reduce the viscosity of the search system. Users are able to see the entity on the map thereby reducing the perceived need to perform the hover & click search method.

Clearly outlining the most efficient approach for users to employ while exploring and searching an interactive interface can reduce hard mental operations and improve user efficiency. High viscosity and low visibility can create a frustrating user scenario where it is difficult to create changes and users are unable to see the tools available.

5.2.4 Discover tools through researcher hint (66.67%)

This issue occurred when participants were "stuck" (unable to find the solution to a problem) and only occurred when the participant directly solicited aid from the researcher. Neilsen (1994) endorses researchers helping participants when they are unable to perform a usability task.

> "answering the evaluators' questions will enable them to better access the usability of the user interface with respect to the characteristics of the domain"

Researcher aid was required as a result of viscosity, visibility and hard mental operations. Participants were unable to complete tasks because of issues like: perusing material searching for answers in the wrong part of the website, inability

to view tools, and inability to navigate search results. Each participant who required researcher aid experienced slightly different issues but the majority of hints were related to the activation and deactivation of the zoom feature and layers. Issues related to researcher hints will be addressed in more detail in the subjective evaluation of the interface.

5.2.5 Misidentification of Data (41.66%)

Misidentification of data within the Gwich'in Place Names Atlas was primarily due to issues of visibility. When participants searched locations or location data they would frequently find the correct location or use the most efficient search method however participants would misidentify the data being requested. Data misidentification occurred because participants had not zoomed in close enough, panned to the correct area of the map or activated a tool/function of the interface.

CD Evaluation.

Visibility: Interface visibility presented a substantial issue in the misidentification of data. This frequently occurred because participants were unaware they needed to zoom, pan, or activate the layers tool in order to view the data required. The low information visibility and limited locational information visible to the user when searching data caused users to overlook or misidentify relevant information.

Trade-offs.

Increasing informational visibility runs the risk of cluttering the interface and increasing error-proneness, especially for novice users. The current causes of misidentification of data are, generally, related to users overlooking the available data or being unable to locate the data required. Clearly identifying the users' map location and the type of location they are highlighting could dramatically reduce the misidentification of data due to low visibility.

The majority of usability issues observed in the video analysis were related to Visibility, Viscosity and Role Expressiveness. There were observations related to hard mental operations as well, however, due to the nature of the Cognitive Dimensions of Notations altering the dimensions related to major usability issues within the GPNA should alter the frequency of moderate and minor usability issues. The reduction of viscosity and increases in visibility and role expressiveness of the tools and search function should eliminate some of the usability concerns that were brought to light in this evaluation. The reduction of viscosity could lead to increased user error rate or an increased number of hard mental operations, forcing the user to keep track of more information as they progress through the interface. Increased role expressiveness could create viscosity issues for experienced users who do not require explicit instructions about tool function. The objective analysis of the Gwich'in place names atlas does show than an adapted application of the Cognitive Dimensions of Notations framework can be applied to interactive online cartographic interfaces, especially when employed with a use-case scenario that encourages users to explore and employ different functionalities of the interface.

5.3 Results: Subjective analysis

The subjective evaluation examined the feedback from self-response surveys and semi-structured interviews. The results of the self-response surveys explored the feedback of participants based on a 5-point Likert scale ranging from “Strongly Agree” to “Strongly Disagree”.

Table 5.3.1 Participant Self- Response Survey Results.

It was easy to find specified locations on the map (e.g. cities, landmarks)	Strongly Agree:0	Agree:2	Neutral: 4	Disagree: 6	Strongly Disagree:0	Agree =16.6% Neutral= 33.3% Disagree= 50%
I found it difficult was to isolate layers & find specific types of locations (e.g. lakes, historic sites, natural landmarks)	Strongly Agree:0	Agree: 8	Neutral 1	Disagree:1	Strongly Disagree: 2	Agree=66.6% Neutral=8.3% Disagree=8.3% Strongly Disagree=16.6%
You had trouble searching the things you wanted.	Strongly Agree 3	Agree: 1	Neutral:5	Disagree: 2	Strongly Disagree: 1	Strongly Agree:25% Agree: 8.3% Neutral: 41.6% Disagree: 16.6% Strongly Disagree: 8.3%
It was easy to keep track of what you were doing and where you were in the interface	Strongly Agree:0	Agree: 6	Neutral: 5	Disagree 1	Strongly Disagree:0	Agree= 50% Neutral 41.6% Disagree: 8.3%

You were able to move around the menus the way you wanted	Strongly Agree: 3	Agree: 5	Neutral 2	Disagree 1	Strongly Disagree: 1	Strongly agree: 25% Agree: 41.6% Neutral 16.6% Disagree: 8.3% Strongly disagree:8.3%

Table 5.3.1 shows participant responses to the self-response survey.

Items for the self-response survey were created based on the questionnaire used by Cohen et al. (2012). The questions address different aspects of the Cognitive Dimensions of Notations framework. Item 1 “It was easy was it to find specified locations on the map (e.g. cities, landmarks)” Focused on interface visibility. The ability to see and understand what and where locations are on the map is essential to understanding map function. The majority of participants (50%) disagreed with the statement. This suggests that there is an issue with the visibility of the mapping interface, as half of participants found it difficult to find location data on the map. Item 2 “I found it difficult was to isolate layers & find specific types of locations (e.g. lakes, historic sites, natural landmarks)” addresses Role Expressiveness. 66% of participants found it difficult to isolate layers and use tools related to data isolation, suggesting there is an issue with the role expressiveness of accessible tools in the interface. Item 3: “You had trouble searching the things you wanted” indicated that the viscosity of the search system is acceptable because 41.6% of participants felt the system performed as expected. It should be noted that 25% of participants strongly agreed with this statement; this is cause for moderate concern and should be addressed in later iterations. Item 4: “ Was it easy to keep track of what you were

doing and where you were in the interface" shows that the majority of participants (50%) agreed that it was easy to keep track of what they were doing while using the Gwich'in Place Names atlas interface, suggests that the interface does not impose too many Hard Mental Operations on the user. Item 5: "You were able to move around the menus the way you wanted" suggests that most participants (41.6% agree, 25% strongly agree) found that navigating the map using zooming and panning was fairly intuitive and doesn't seem to present any major issues for users, navigational viscosity was not a major concern.

The findings of the self response survey suggest that users found issues with the visibility and role expressiveness of the Gwich'in Place Names atlas however there weren't major concerns related to Viscosity or Hard mental operations. The self-response survey findings are in line with the objective findings; the majority of usability issues within the Gwich'in Place Names atlas interface are visibility and role expressiveness issues. The lack of identification of major viscosity issues by participants, as stated in the concerns related the CDN evaluation (Chapter 3.3), does not necessarily reflect a non-issue in the system, rather just a non-identification of a major issue related to search viscosity. Participants' understanding of the interface and the issues they encountered will be addressed in more detail later in this chapter.

Results of the semi-structured interviews were separated into three categories: female (Appendix J), male (Appendix K) and all participant responses (Table 5.3.2) . Seven themes were created, reflective of participant responses to the CD focused questions in the semi-structured interview: 1) Zoom 2) Grouping, 3) Search, 4)

Highlight, 5) Back Button, 6) Sound and 7) Tools. Some issues overlap e.g.: "If I searched something and it was wrong, I had to re-search it. No obvious "back button". This user statement deals with the frustration of having to search items several times because the search criteria or the results appeared incorrect and the apparent lack of a "back button" that would allow the user to easily undo their previous action. This problem outlines a viscosity issue. Users are forced to re-start an action rather than simply "stepping back". Each theme represents a problem mentioned by the participants. The issues surfacing with the greatest frequency are the issues users claimed to have the greatest difficulty using. The areas that received the greatest amount of feedback were "search" and "tools". Participants felt that the usability issues related to the viscosity and visibility of the search and search results created problems. The visibility and role expressiveness of the available interface tools created usability issues as well.

The findings of the self-response survey and the semi-structured interview aligned very closely with the results of the video analysis, showing that users had issues with the visibility, role expressiveness and viscosity of the system. The Gwich'in Place names atlas forces users to execute an excessive number of steps to perform, what users feel, should be simple navigational or data-search tasks. Issues with visibility are related to the map and the relationship between the displayed data and the map. Users found it difficult to keep track of where they were on the map when addressing information accessed through the search query bar. Another visibility issue is related to panning and zooming. Users had trouble zooming the correct amount and panning the map to the appropriate section of the map because they

had issues establishing where they were “located” in the mapping interface. The issue of Role expressiveness was most apparent when activating the layers and relating it to the mapping area. The majority of users were unaware that the layers tool was available or how it worked.

Table 5.3.2 Thematic Semi-Structured Interview Results.

Zoom	Grouping	Search	Highlight	Back Button	Sound	Tools
"Mostly Easy. Autozoom takes you away from where you were.	Search results for grouping not easy to find	Search was more useful with correct accets. Search was too sensitive to case etc.	Fort McPherson question, could not find the name for the town because it's only accessible through the layer overlay.	"If I searched a location and it was wrong I had to re-search it" "No Obvious Back Button"	Only when scrolling names were being said. The audio seemed random	"Hard to Isolate layers "never done it before" (Required Researcher Hint**)
Lose perspective Distance	The grouping icon looked clickable but wasn't while other tiles were…	Search results for grouping not easy to find	having the selected feature unmistakeable higlighted would be very helpful.	The back feature didn't really work just ended up re-searching.	Not sure why the audio was enabled. It was talking but clicking the icon did nothing.	Straight forward, tiles were fine.
Sorting through the map it was difficult to deal with the Zoom	Grouping Wasn't clear	"If I searched a location and it was wrong I had to re-search it" "No Obvious Back Button"	When zoomed out highlight not obvious		Sound	(Didn't realize there was a zoom option (no use of layers))
Lag - Especially when zooming.	Discovery Process.. No idea what "group" was until prompted. (by researcher)	Didn't show the english translation or alternate information at all.	there were lots of clickable options when searching but not much to distinguish between options		Surprised by the auto name feater, not bad just surprising	"Not Really" didn't always display clickable tiles on side (didn't understand the layout)**
Zooming on the map, clicking.. There was some Lag, may be a function of the Wifi	No understanding of why grouping tile had no info on grouping	Had to search Alternate Name.	(Didn't realize there was a zoom option (no use of layers))		The sound was annoying. Couldn't figure out why it kept going off.	"Can't think of anything, group titles were a bit redundent in the tiles."
Must be very specific with the zoom.	Grouping had to leave page to find info	No idea if the search result when searching the western (alt name) was a relivant result.	More apparent highlighting in the map		"is it clickable? Is it activated by a hover function?"	The tiles on the Right side of the interface seemed inconsistent.
When zoomed out highlight not obvious	The groupiong feature wasn't perfectly clear.	*Some Indication of why search results are related to search.*	Map & Search seemed independent. It was difficult to relate what you were reading about to the map		The redundant audio icon. Sound played anyway.	Prior to researcher hint about toggling layers was an option it never occurred to participant
When hovering and clicking locations on the map I would repeatedly zoom and click the same location.	selected group, assumed groups were geographically related, clicked on icon and used selection to verify assumption.	Always re-type searches (in day to day use)	When hovering and clicking locations on the map I would repeatedly zoom and click the same location.		Speaking the name, the audio Icon and the Tile.	Looking for water… didn’t know I could specify without the "Help Section"
Found the zoom Laggy.	"Can't think of anything, group titles were a bit redundent in the tiles."	Took learning time to understand the search menu	Repeatedly clicked the same point (the points were so small and no name was available.		The sound was annoying, there was no alt name or other info in search results and the layer learning curve	Before using layers it was unclear & overwhelming

Map was horrible. Map was hard to navigate, didn't respond as quickly or the way I Wanted it to	the grouping was strange. (not a clickable tile)	Search should give you what you want when you already know what you're looking for. The Information didn't appear in the search and the information didn't appear to be in order.			Repeating Audio was annoying. At first it ws distracting and interrupting.	Layers… Wasn't sure what would happen if I tried them
Not sure why it shifted my search area to Alberta.	When dealing with grouping, I had to remember why they seemed to be grouped	Always want to use the search tool. The search tool should should give you all the information you want right away			Name outloud… Just moving triggered audio, annoying. It would trigger when just passing over a location on the map.	Didn't realize Layers were there or a clickable option.
At first I didn't zoom enough	In the grouping I got confused by what all the boxes meant	Rarely got the info in search or it's not prioritized				Didn't realize tiles were clickable options
		It was busy, when you search you get a lot of options				Didn't realize there was a Top Nav Bar
		Searching for specific locations (searching for a group) Looking for a list of names and the reason for the grouping. (*unable to see all info*)				Top Nav. Info should have been in the Text "It seems like just another way for someone to get lost"
		No, The alternate name search. When searching an alternate name only the Gwich'in name appeared.				
		A few, Search was "good" - Struggled to find the speaker in the audio file at first.				

Table 5.3.2 The thematic organization of semi-structured interview results from the entire participant population. Most participant responses are paraphrased however, some responses are directly quoted for clarity.

5.3.1 Search.

During 12 semi-structured interviews participants mentioned the search function 16 times (15 negative). The frequency of negative comments related to the search function and its results indicate a substantial usability issue related to the function of the interface's search function. This result, when combined with the results of the

objective analysis suggest that the conclusions established related to search viscosity and visibility are correct and represent a substantial impediment to usability. The results of the self-response survey showed that half of the participants claimed to have no issue with the search function and 25% of the participants had substantial issues with the search function. This discrepancy could be accounted for by the individuals who frequently used the hover and click search technique rather than the search bar, meaning they encountered fewer usability issues specifically related to the search function because they interacted with it less frequently.

5.3.2 Tools

The use of tools and issues related to tool function were mentioned 14 (13 negative) times in 12 interviews. 7 of the comments related to being unaware or unable to activate the layers tool. The other 6 negative comments were related to the functioning of the search result tiles and the navigation bar (Image 5.3.1). The lack of understanding related to layer activation echoes the results of the objective evaluation indicating a lack of visibility related to essential navigational data-isolation tools within the interface. Issues related to interactive search-result tiles and the navigation bar were noted in the video analysis, with 25% of participants misidentifying tile function and 33% of participants misunderstanding the use of the navigation bar. A 20% error rate was deemed, for this iteration of the Gwich'in place names atlas evaluation, to be acceptable, and 30% error rate was seen to be representing a moderate concern. With alterations to major interface usability

components of the atlas these error rates are likely to change based on the design maneuvers implemented.

Image 5.3.1. Interactive Search Result Tiles

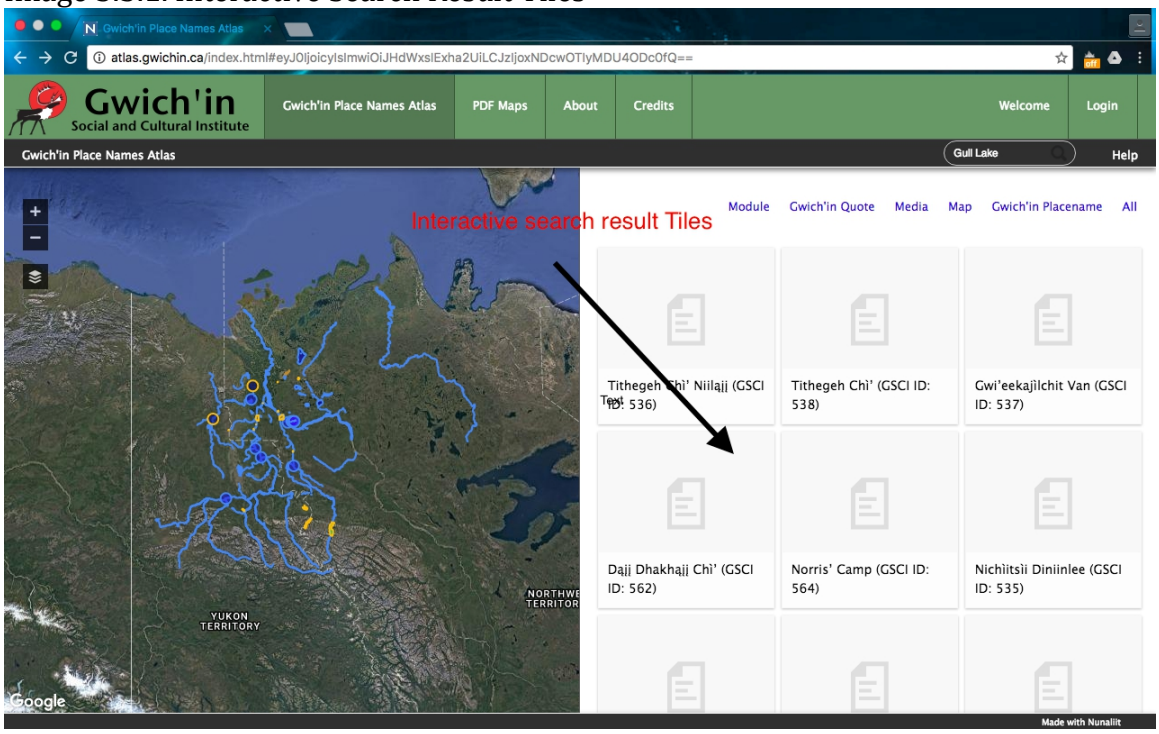

Image 5.3.1 shows interactive search result tiles, a feature that that was mentioned 6 times by participants when recounting usability issues related to tools.

The results of the subjective analysis, consisting of the self-response survey and the semi-structured interview, support the findings of the objective analysis. The combined results of these two evaluations suggest that a cognitive dimensions of notations evaluation of an online interactive cartographic atlas is an effective assessment of usability issues and user tendencies. The implementation of the CDN lexicon can help to sharpen the communication between developers and evaluators by giving names to specific usability issues, thereby heightening the accuracy and productivity of evaluations and subsequent re-designs.

5.4 Participant Feedback

Participants were asked what changes they would make to the interface, if given complete control. The most frequently occurring comments were related to the visibility of the system. “The search results didn’t highlight the area of the map the information was focusing on.” The majority of test participants mentioned the disconnection between the map and the search results. Role Expressiveness was the second most mentioned issue within the interface. Five out of the 12 participants mentioned some type of tutorial or pop-up user guide; displaying different tools and their functionality would have increased the usability of the Gwichi’in Place names atlas. The third most suggested improvement was the visibility of alternate names and searchable information in the search results. Participants mentioned the inability to distinguish between search results, especially when the search query was related to an alternate name or piece of information. Participant responses suggest the inclusion of alternate names, translations or other relevant search information into the search results themselves. The lack of visibility regarding this information creates a major usability issues (re: Gull Lake). Subsequent user comments related to system usability relate to visibility, viscosity and Role Expressiveness (Table 5.4.1). Participant suggestions align very closely with both the objective and subjective analysis results. The similarity between all three evaluations solidifies the findings that there are considerable visibility, role expressiveness and viscosity issues within the Gwich’in Place names atlas and the Cognitive Dimensions of Notations framework is an applicable evaluation method for online interactive cartographic interfaces.

Table 5.4.1. Participant Interface Suggestions.

Visibility	Role Expressiveness	Visibility	Role Expressiveness	Visibility	Viscosity	Visibility/R.E.
Make the map follow selections. Make the location you're reading about more apparent.	A tutorial bubble with a dismiss option.	Alternate name in search "Any searchable info should appear in results."	*Sound*	a less overwhlming menu of icons.	Go back to search results to search results after a button is pressed. "a more apparent step-back"	*Make layers more apparent*
know exactly what you were looking for it was tough. Found things by random clicking and luck.	Provide tutorial or info	Assumed the first search result was the correct one..In the inteface this is rarely the case.****	Audio file.. Make it an option… not automatic	How much of screen was occupied by icons that were irrelevant.	Better back button.	*Didn't notice or use layers
Didn't really use the map but the questions didn't really require it	A legend or navagation tutorial at start	Search isn't the focal point (Should be)	More obvious sound control "want to know why I'm hearing the sound"	change the layout. It's currently overwhelming.		
start of search results more obvious on map.	Need a legend that's apparent.	better layed out search results.	Audio… too much.	Tiles: Search info was an overload		
Highlightin selections more clearly even when zoomed out	Wasn't totally clear how to use the map, A tutorial would be helpful	Both names available when searching and exploring				
Make the map bigger						
Some more obvious geograpic Landmarks.						

Table 5.4.1. The thematic organization of participant suggestions to improve the Gwich'in Place Names atlas in order of most frequently too least frequently mentioned

The thematic evaluation of participant suggestions to improve the interface serves as a starting point for potential design maneuvers. Although participant suggestions do not necessarily take into account the goals of the atlas and the potential ramifications of the changes they suggest, they do provide valuable insight in terms of frustrations users experienced and how they might remedy the issue.

Chapter 6: Conclusion.

The goal of this thesis was to examine whether the cognitive dimensions of notations evaluation is a viable evaluation technique for online interactive cartographic interfaces. The cognitive dimensions of notations framework and

lexicon aim identify difficult usability issues that have not been fully defined or are not well understood. The CDN framework allows skilled users, developers, stakeholders and novice users to have meaningful and productive conversations about the functionality and trade-offs of a system. The CDN evaluation examines the functionality of the interface as a whole, rather than looking at specific aesthetic components.

Chapter 1 explored interface interaction from the HCI perspective, addressing different interaction styles (GUI, TUI, HUI) and the development of user interface metaphor. Map and atlas development and usage have shifted in the digital age. Initially created as a reference tool, maps have become interactive environments where users can manipulate and alter data, inputting information to create narratives that reflect the users point of view. Mapping in the digital era has allowed map users to engage in a bi-directional dialog with the information, effectively making the user a mapmaker.

Chapter 2 examined cybercartographic theory, the creation of the Nunaliit cybercartographic framework and the role it played in the creation of the Gwich'in Place Names atlas. The Gwich'in Place names atlas is an inventory of over 900 traditional place names, accompanied by stories and recordings of pronunciation by Gwich'in elders. Because of its high level of interactivity and complexity we felt the Gwich'in Place Names Atlas would be ideal for assessing the Cognitive Dimensions of Notations Framework's applicability as an evaluation method for online interactive cartographic interfaces.

To establish the applicability of the CDN framework to online interactive cartographic interfaces Chapter 3 examines the CDN framework, lexicon and it's previous applications. Proposed by Green, the Cognitive Dimensions of Notations provides a "light-weight", "broad-brush" evaluation of interface usability. The CDN framework also introduces a novel lexicon for addressing and communicating ideas and issues that have not been fully addressed or well defined by traditional usability evaluations. The evaluation gives valuable information about usability themes and broad issues that affect the functionality of the interface an entire entity, rather than individual aspects.

Chapter 4 addresses our methodology in the creation, adaptation and application of the CDN evaluation (Cohen et al. 2012; Blackwell & Green, 2000). The evaluation consisted of a guided exploration, a self-response survey and a semi-structured interview. The guided exploration was video recorded and coded to examine user actions while interacting with the interface. The coded evaluation provided objective data, outlining the percentage of users that committed usability errors and the causes of those issues. The self-response survey and semi-structured interview results were compiled and thematically organized based on user feedback frequency. This evaluation method is in line with Cohen et al. (2012) who outlined the cognitive dimensions of concern for system evaluation related to their high-level coding language.

We encouraged participants to offer suggestions for possible interface improvement in future iterations. The results of participant responses were also recorded and organized thematically.

The results in Chapter 5 showed that the Gwich'in Place Names Atlas has substantial usability issues related to its visibility, role expressiveness and viscosity. Major visibility issues highlighted by the evaluation were related to searching alternate names. The Gwich'in Place Names Atlas allows the user to search alternate names and translations of locations but gives no indication of which search results are related to the search criteria. This lack of visibility caused users to misidentify search results and key data. A second key visibility issue was the relation between the search results and the map itself. Users found it difficult to relate the information they were looking at to the corresponding data point in the map. The disconnection between the data and the map reduced efficiency and made data searches more difficult. The limited Role Expressiveness of tools caused users to overlook key tools and misunderstand tool functionality such as zoom, and layers; this was found to reduce efficiency and increase user confusion and frustration with the system. The high viscosity of the system, especially related to search and navigation left users blindly searching the system for answers, attempting to work around what should have been the obvious and most simple solution. The high repetition viscosity in the system caused user frustration and dramatically reduced search efficiency.

The self-response survey and semi-structured interview provided a subjective evaluation of the interface, allowing for user feedback and reflection on the usability of the Gwich'in Place Names Atlas interface. The results of both the self-response survey and the semi-structured interview echoed the results of the video analysis. The subjective analysis showed that users recognized issues with interface visibility, role expressiveness and viscosity. Participants noted their frustration with the role

expressiveness of tools related to map function, search functionality and a substantial disconnect between the search results and the map itself. This subjective data indicates that the video analysis and usability issues addressed in the objective evaluation sketch an accurate picture of usability issues .

Participant suggestions for the interface were also recorded and the visibility, role expressiveness and viscosity of the system were highlighted a third time with regards to system usability. Participants suggested a variety of usability alterations that would make the Gwich'in place names atlas more user friendly, improve functionality or learnabilitiy of the system. Participant suggestions are addressed and expanded on in Chapter 7 below on future work.

The Cognitive Dimensions of Notations evaluation of the Gwich'in Place Names atlas showed the applicability of the CDN framework for online interactive cartographic interfaces by implementing a objective and subjective evaluation of the interface. The results of the objective evaluation aligned closely with the usability issues identified by users in the subjective analysis of the system. This indicates that the cognitive dimensions of notations evaluation employed to evaluate the Gwich'in place names atlas is a functional and applicable interface evaluation method. I have outlined the major usability issues related to visibility, role expressiveness and viscosity in the atlas and identified potential usability fixes and tradeoffs based on hypothesized design maneuvers. The strength of the CDN evaluation for interfaces is its flexibility. An individual can evaluate the overall functionality of almost any interface for any number of different user groups. The CDN evaluation will still provide functional, applicable and implementable evaluation of the systems

usability strengths and weaknesses with very low cost to the developer, evaluator or user.

Chapter 7: Future work

This chapter aims to outline the limitations of our Cognitive Dimensions of Notations evaluation of the Gwich'in Place names atlas as well as explore future applications of this research.

The evaluation of online interactive cartographic interfaces is an essential step in the design and development of successful mapping software. As with other design disciplines within human computer interaction interactive cartographic interface design should be iterative and occur frequently. The CDN evaluation allows for quick, low cost, broad evaluation interface usability that can be employed at any stage of development. The CDN framework also provides the distinct advantage that it gives users and developers a common language to discuss usability issues and potential design maneuvers.

For a more accessible design and usability evaluation, especially for the open-source community, a broadly applicable cartographic interface evaluation should be adapted. Blackwell & Green (2000) attempted to create a broadly applicable CDN evaluation; by their own admission the evaluation was difficult to employ for some users and required an understanding of the CDN lexicon. Where we worked to design a brief guided exploration of the Gwich'in Place Names atlas specifically, future efforts could aim to create a broadly applicable evaluation of interactive mapping interfaces, providing all map designers with a quality evaluation of their system at minimal cost.

Specifically regarding the Gwich'in Place names atlas, future iterations should address design issues related to the visibility, role expressiveness and viscosity of the atlas. Future testing should include Gwich'in speaking participants; this could provide insight into the usability of the atlas from a broader perspective. A single researcher performed the video analysis; other usability evaluations (Cohen et al. 2012) have multiple evaluators examining video recordings, allowing for an interrater reliability evaluation.

Future research should look to create a detailed and broadly applicable evaluation for interactive cartographic interfaces. This would reduce the time required to perform usability evaluations and improve the general usability of cartographic interfaces. Future research should also look to create a detailed list of tradeoffs based on developer design maneuvers, a list of the tradeoffs for design maneuvers within interactive cartographic interfaces could reduce the development time and help to reduce major usability issues early in the design process.

Participant responses to the question of "ways to improve the interface" focused mostly on the visibility of the relationship between the search results and the map itself. Clearly highlighting map features that are being addressed in the search results will help users to better understand the relationship between the stories, information featured and the geographical location being referenced. This will also help to facilitate the efficiency of map navigation as well as hover click exploration. Users will have more information available to relate to specific locations. Improved

map visibility, especially when related to search results should improve the understanding of the narrative of the atlas.

Increasing the role expressiveness of tools in the atlas will facilitate map exploration and increase exploration efficiency. Access to and understanding of the layers tool allows users to isolate specific location types as well as view the atlas through a variety of cartographic visualizations. The majority of participants in our study were either unsure of how the layer feature worked or completely unaware of its existence.

One of the central comments related to role expressiveness is the creation or introduction of some type of site orientation or pop-up overlay available to the user that outlines the functionality of each tool. The inclusion of an orientation or informative overlay would run the risk of mildly annoying experienced users but it would greatly facilitate and improve the experience and efficiency of novice users.

The functionality of a use and usability evaluation relies heavily on designers and developers actually using the evaluation. If an evaluation seems overly complex or time consuming, regardless of its potential utility, developers will be less inclined to employ it. For this reason it is essential to create a usability evaluation that is not just functional but easy and practical implement. Interactive cartographic interfaces, as discussed earlier in this thesis, need to respond quickly, be easy to manipulate and respond as expected. In order to achieve this goal, developers need to observe their user-group interact with the interface itself at different levels of development. This will help to identify substantial usability errors and avoid large re-designs after

deployment. The CDN evaluation has the potential to identifying key design maneuvers and their trade-offs early in the design process, facilitating thoughtful design; reducing the time and cost required to create a successful, interactive narrative.

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Appendix A: Participant Email Invitation to participate.

Carleton UNIVERSITY
Canada's Capital University

CUREB Clearance #:16-088_____

Letter of Invitation: Cognitive Dimensions of Notations evaluation of the Nunaliit Cybercartographic Atlas

Title: A Cognitive Dimensions of Notations evaluation of the Nunaliit Cybercartographic Atlas Interface

Date of ethics clearance: 04/01/2016

Ethics Clearance for the Collection of Data Expires: N/A

04/01/2016

Dear Sir or Madam,

My name is Troy Mott and I am a Master's student in the Human Computer Interaction Department at Carleton University. I am working on a research project under the supervision of Prof. Fraser Taylor.

I am writing to you today to invite you to participate in a study on the Cognitive Dimensions of Notations evaluation of the Nunaliit Cybercartographic Atlas Interface. This study aims to assess the ability of the *Cognitive Dimensions of Notations* to evaluate the usability of the *Nunaliit Cybercartographic Atlas*.

This study will be done in English and involves a guided activity/exploration of the *Gwich'in Place Names Atlas* and a semi-structured interview lasting approximately 60 minutes. With your consent, your on-screen actions will be recorded using screen capture software called Ishowu. This software also records audio during the screen recording which allows the researcher to compare the reasoning of the user to the onscreen actions. Once the recording has been transcribed, the audio-recording and screen capture video will be destroyed. After completing the guided exploration the researcher will

conduct a semi-structured interview to explore your experience win the Atlas.

You will have the right to end your participation in the study at any time, for any reason, up until (July 1, 2016). If you choose to withdraw, all the information you have provided will be destroyed.

As a token of appreciation, you will receive a $5 Tim Horton's gift card. This is yours to keep.

All research data, including audio-recordings, screen capture video and any notes will be encrypted. Any hard copies of data (including any handwritten notes or USB keys) will be kept in a locked cabinet at Carleton University. Research data will only be accessible by the researcher and the research supervisor.

This ethics protocol for this project was reviewed by the Carleton University Research Ethics Board, which provided clearance to carry out the research. Should you have questions or concerns related to your involvement in this research, please contact:

CUREB contact information:
CUREB-B contact information:
Dr. Shelley Brown
Chair, Carleton University Research Ethics Board-B
613-520-2600 ext. 1505
Shelley.Brown@carleton.ca
Research Compliance Office
Carleton University
511 Tory Building
Carleton University
613-520-2600 ext. 4085
ethics@carleton.ca

If you would like to participate in this research project, or have any questions, please contact me at TroyMott@cmail.carleton.ca .

Sincerely,

Troy Mott

Appendix B: Participant personal interaction correspondence

Personal Interaction Script.

I would like to invite you to participate in a usability study. The study will take approximately 1 hour to complete and we will provide you with a $5 Tim Hortons Gift Card. The study aims to evaluate how well the *Cognitive Dimensions of Notations framework* can be applied as a usability evaluation of *Cybercartographic Atlases*.

The evaluation will consist of a guided exploration of a cybercartographic atlas and a semi-structured interview. The experience will be audio recorded and your on-screen actions will be recorded so the researcher can evaluate the functionality of the interface and how the evaluation criteria apply.

My email address is troymott@cmail.carleton.ca if you have any questions or would like to participate please don't hesitate to contact me.

Thanks,
Troy Mott

Appendix C: Participant Consent Form

Carleton UNIVERSITY
Canada's Capital University

Consent Form

Title: A Cognitive Dimensions of Notations evaluation of the Nunaliit Cybercartographic Atlas Interface.

Date of ethics clearance: 04/01/2016

Ethics Clearance for the Collection of Data Expires: N/A

I _____, choose to participate in a study on "*A Cognitive Dimensions of Notations evaluation of the Nunaliit Cybercartographic Atlas Interface*." This study aims to explore the ability of the *Cognitive Dimensions of Notations* to evaluate the usability of *Nunaliit Cybercartographic Atlases*. The researcher for this study is (Troy Mott) in the department of Human Computer Interaction working under the Supervision of Dr. Fraser Taylor at Carleton University.

This study will be conducted in English and involves a guided activity/exploration of the Gwich'in place names atlas and a semi-structured interview lasting approximately 60 minutes. The guided activity is a fictional scenario designed to encourage you to interact with the atlas in a way that would be typical of users in a research scenario. With your consent, your on-screen actions will be recorded in an effort to examine the interactions with the atlas and the reasoning behind the actions. You will be recorded using screen capture video recording software called Ishowu. This software records the screen only and anything said during the recording. After completing the activity the researcher will go through a questionnaire/semi-structured interview to gauge your interpretation of how well the atlas worked. Once the recording has been analyzed, the audio-recording and screen capture video will be destroyed.

You have the right to end your participation in the study at any time, for any reason, up until July 1, 2016. You can withdraw by phoning or emailing the researcher or the research supervisor. If you withdraw from the study, all information you have provided will be immediately destroyed.

As a token of appreciation, you will receive a $5 Tim Horton's gift card. This is yours to keep, even if you withdraw from the study.

All research data, including audio-recordings and any notes will be encrypted. Any hard copies of data (including any handwritten notes or USB keys) will be kept in a locked cabinet at Carleton University. Research data will only be accessible by the researcher and the research supervisor.

Once the project is completed, results of the semi-structured interviews will be kept for five years and potentially used for other research projects on this same topic. At the end of five years, all research data will be securely destroyed. (Electronic data will be erased and hard copies will be shredded.)

If you would like a copy of the finished research project, you are invited to contact the researcher to request an electronic copy which will be provided to you.

The ethics protocol for this project was reviewed by the Carleton University Research Ethics Board, which provided clearance to carry out the research. Should you have questions or concerns related to your involvement in this research, please contact:

CUREB contact information:

CUREB-B contact information:
Dr. Shelley Brown
Chair, Carleton University Research Ethics Board-B
613-520-2600 ext. 1505
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Researcher contact information:
Name Troy Mott
Department: Human Computer Interaction
Geography

Supervisor contact information:
Name Dr. Fraser Taylor
Department:

Carleton University
Tel: [redacted]
8232
Email: TroyMott@cmail.carleton.ca
fraser.taylor@carleton.ca

Carleton University
Tel: 613-520-2600 x
Email:

Do you agree to be audio-recorded: ___Yes ___No

_____ _____
Signature of participant Date

_____ _____
Signature of researcher Date

Appendix D: Participant Information

Gwich'in Place Names Atlas Evaluation

Please provide the following information:

Gender:

Age in years:

Highest/Current level of education:

How often do you use online Maps (e.g. Google maps)

Never	Rarely	Occasionally	Often	Every Day

Have you ever used Nunaliit Before? Yes___ No___

Have you ever used GIS mapping software before? Yes___ No___
If yes, in what capacity? :

Have you ever designed online mapping software? : Yes___ No___
If yes, in what capacity?

Appendix E: Guided Exploration

Guided Exploration

Please Go to the Gwich'in Place names atlas Website. : http://atlas.gwichin.ca/

Scenario:
You and some classmates are headed to the Gwich'in region of the Northwest Territories on a student exchange. The goal of the trip is to experience the Gwich'in language, culture and some historical landmarks.
While in the Northwest Territories you will be expected to give presentations about your experiences to different groups of elders and respected community members along your trip. You will also give a presentation about your entire experience to a group of your peers upon returning to Ottawa. In order to prepare for your trip you will be using the Gwich'in Place Names Atlas to pick out some landmarks and historically significant locations to visit while in the Northwest Territories. The website will give you the proper spelling and pronunciation of the locations as well as some historical information. In each presentation you will be expected to reference Water, Land, Trail, Man-Made, Camp, and Historical Landmarks.

At each stop you will be visiting some pre-planned locations chosen by the elders. You also have the option of choosing some other locations that seem interesting. Please provide 2-3 additional Gwich'in landmarks you would like to visit at each designated stop along your trip.

1. Your trip begins in Inuvik. The elders have insisted you visit:

1a. Nihtak please provide the translation and the location
translation:
Location:

1b. Gull Lake. Please provide:
Gwich'in Name:
Location:
The Gwich'in elder speaking in the Audio File:

1c. Please choose a few locations of your own that would be good to visit, keeping in mind you're located in Inuvik. Provide their Gwich'in name, alternate name and any other relevant information you might include in your presentation. Please provide the type of location (Water, land, Man-Made, Trail, Camp.)

2. The second and final stop on your journey is Fort McPherson.

2a. What is the Gwich'in name for Fort McPherson & why is it such an important location for the region?
Gwich'in Name:
Regional Importance:

2b. While in Forth McPherson. You will visit Eneekaii Van please note the speaker in the audio recording.

2c. What is the name of the "historic" site closest to Fort McPherson?

2d. Please choose a few "Water" locations to visit, keeping in mind you're located in Fort McPherson. Provide their Gwich'in name, alternate name and any other relevant information you might include in your presentation.

3. Trinzhoh belongs to a group called Teetl'it. Please outline a few other locations in this grouping, their names, their alternate names, the elder speaking their Gwich'in name and relevant information about the location; state why they are grouped.

Appendix F: Self- Response Survey

It was easy to find specified locations on the map (e.g. cities, landmarks)	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I found it difficult was to isolate layers & find specific types of locations (e.g. lakes, historic sites, natural landmarks)	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
You had trouble searching the things you wanted.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
It was easy to keep track of what you were doing and where you were in the interface	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
You were able to move around the menus the way you wanted	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

Appendix G: Semi-Structured Interview Questions

Semi-structured Interview

CDN Evaluation of Gwich'in Place Names Atlas.

Is it easy to see all the parts of the map you need to see at any time?

Very Easy	Easy	Neutral	Hard	Very Hard

Were there any operations that seemed overly difficult or that were difficult to keep track of in your head?

None	Very Few	Neutral	Many	Almost All

Was it easy to understand what each feature did and its purpose (e.g. tools, layers, buttons)?

Very Easy	Easy	Neutral	Hard	Very Hard

Was there ever a time where you were unable to see all of the information you needed at one time?

Never	1-3 Times	4-6 Times	7-9 Times	+10 Times

When selecting one feature did it ever unexpectedly affect another part of the map or experience? Was it clear that the two features were connected?

Very Regularly	A few times	No more than expected	Almost never	Never

When working inside the map were you ever forced to plan your actions ahead of time?

+10 times	9-7 times	6-4 times	3-1 times	Never

Were there any elements of the atlas that appeared to perform similar functions?

None	1-3	4-6	7-9	+10

If yes was it apparent? Please do your best to name them.

Was it easy/hard to move around the interface? Were there any impediments?

Very Difficult	Fairly Difficult	Average	Easy	Very Easy

Did you find you find yourself making small mistakes that frustrated you or made you feel stupid?

None	1-3 times	4-6 times	7-9 times	+10 times

Were there any mistakes that were very easy to make?

Can you think of any obvious improvements to the system? What are they?

Appendix H: Results: Female Video Analysis

Female Video Analysis Results

Common Themes (Female)	frequency		CD	+ / -
skim/ignore opening blurb	3	50.00%	Role Expressivness	-
use of map immidiately	2	33.33%		
immidiate user of search bar	2	33.33%		
trouble locating gull lake	4	66.67%	Viscosity	-
quickly parse information	2	33.33%	Visability	+
has trouble locating areas on map	2	33.33%	Visability	-
correctly identifying tile functions	2	33.33%	Consistency/visability	+
Incorrectly identify tile funcion	3	50.00%	Consistency/visability	-
identificaiton and use of layers	1	16.67%	Visability	+
misuse layers/no use	3	50.00%	Visability	-
No understanding of groups	3	50.00%	Role Expressivness	-
Correct use of tools	1	16.67%	Visability/Role Expressiveness	+
activates "link header" correctly		0.00%	Visability/Role Expressiveness	+
activates link header, unaware of function		0.00%	Visability/Role Expressiveness	-
inefficent use of hover/search exploration	3	50.00%	Viscosity/Visability	+
trouble locating fort mcpherson		0.00%	Visability	-
frequent use of back button	1	16.67%		
Mutes audio	1	16.67%	Viscosity	
Discovers tools through researcher hint* (F1)	5	83.33%		-
Attempts to click the "Group Name" tile	1	16.67%	Role Expressivness	-
Re-searches terms rather than use of buttons	2	33.33%	Viscosity	-
Attempts to use PDF maps	3	50.00%	Role Expressivness	-
Misidentifies Data	5	83.33%	Viscosity	-
uses help menu to solve Nav Problem	3	50.00%	Role Expressivness	+
misunderstands Top Nav bar function	2	33.33%	Visability/Role Expressiveness	-
Major issue (+40%)				
Moderate issue (30%-40%)				
Minor issue (20%-30%)				
Acceptable (-20%)				
Positive				

Appendix I: Results: Male Video Analysis

Male Video Analysis Results

Common Themes (Male)	frequency		CD	+ / -
skim/ignore opening blurb	5	83.33%	Role Expressivness	-
use of map immidiately	3	50.00%		
immidiate user of search bar	3	50.00%		
trouble locating gull lake	3	50.00%	Viscosity	-
quickly parse information	5	83.33%	Visability	+
has trouble locating areas on map	1	16.67%	Visability	-
correctly identifying tile functions	2	33.33%	Consistency/visability	+
Incorrectly identify tile funcion		0.00%	Consistency/visability	-
identificaiton and use of layers		0.00%	Visability	+
misuse layers/no use	4	66.67%	Visability	-
No understanding of groups	1	16.67%	Role Expressivness	-
Correct use of tools		0.00%	Visability/Role Expressiveness	+
activates "link header" correctly	1	16.67%	Visability/Role Expressiveness	+
activates link header, unaware of function	1	16.67%	Visability/Role Expressiveness	-
use of hover/search exploration	3	50.00%	Viscosity/Visability	+
trouble locating fort mcpherson	2	33.33%	Visability	-
frequent use of back button	1	16.67%		
Mutes audio	1	16.67%	Viscosity	
Discovers tools through researcher hint* (F1)	3	50.00%		-
Attempts to click the "Group Name" tile	2	33.33%	Role Expressivness	-
Re-searches terms rather than use of buttons	1	16.67%	Viscosity	-
Attempts to use PDF maps	1	16.67%	Role Expressivness	-
Misidentifies Data		0.00%	Viscosity	-
uses help menu to solve Nav Problem		0.00%	Role Expressivness	+
misunderstands Top Nav bar function	2	33.33%	Visability/Role Expressiveness	-
Major issue (+40%)				
Moderate issue (30%-40%)				
Minor issue (20%-30%)				
Acceptable (-20%)				
Positive				

Appendix: J: Results: Female Semi-structured Interview

Grouping	Search	Highlight	Back Button	Sound	Tools	Changes
When dealing with grouping, I had to remember why they seemed to be grouped	Search should give you what you want when you already know what you're looking for. The Information didn't appear in the search and the information didn't appear to be in order.	Map & Search seemed independent. It was difficult to relate what you were reading about to the map		Repeating Audio was annoying. At first it ws distracting and interrupting.	Prior to researcher hint about toggling layers was an option it never occurred to participant	A tutorial bubble with a dismiss option.
In the grouping I got confused by what all the boxes meant	Always want to use the search tool. The search tool should should give you all the information you want right away	When hovering and clicking locations on the map I would repeatedly zoom and click the same location.		Name outloud… Just moving triggered audio, annoying. It would trigger when just passing over a location on the map.	Looking for water… didn't know I could specify without the "Help Section"	Didn't enjoy the experience in the interface.
	Rarely got the info in search or it's not prioritized	Repeatedly clicked the same point (the points were so small and no name was available.			Before using layers it was unclear & overwhelming	Make bot names available,
	It was busy, when you search you get a lot of options				Layers… Wasn't sure what would happen if I tried them	Audio file.. Make it an option… not automatic
	Searching for specific locations (searching for a group) Looking for a list of names and the reason for the grouping. (*unable to see all info*)				Didn't realize Layers were there or a clickable option.	Make the map follow selections. Make the location you're reading about more apparent.
	No, The alternate name search. When searching an alternate name only the Gwich'in name appeared.				Didn't realize tiles were clickable options	*researcher comment
	A few, Search was "good" - Struggled to find the speaker in the audio file at first.				Didn't realize there was a Top Nav Bar	*Didn't notice or use layers
					Top Nav. Info should have been in the Text "It seems like just another way for someone to get lost"	*Didn't look at other search result options and didn't answer questions correctly because of it.
						Assumed the first search result was the correct one..In the inteface this is rarely the case.****
						Pretty Good
						Wasn't totally clear how to use the map, A tutorial would be helpful
						Help had all of the info
						Search isn't the focal point (Should be)
						Need a legend that's apparent.
						Make the map bigger
						change the layout. It's currently overwhelming.
						Both names available when searching and exploring
						Audio… too much.

Appendix K: Results: Male Semi-Structured Interview.

Zoom	Grouping	Search	Highlight	Back Button	Sound	Tools	Changes
"Mostly Easy. Autozoom takes you away from where you were.	Search results for grouping not easy to find	Search was more useful with correct accets. Search was too sensitive to case etc.	Fort McPherson question, could not find the name for the town because it's only accessible through the layer overlay.	"If I searched a location and it was wrong I had to re-search it" "No Obvious Back Button"	Only when scrolling names were being said. The audio seemed random	"Hard to Isolate layers "never done it before" (Required Researcher Hint**)	Alternate name in search "Any searchable info should appear in results."
Lose perspective Distance	The grouping icon looked clickable but wasn't while other tiles were…	Search results for grouping not easy to find	having the selected feature unmistakeable higlighted would be very helpful.	The back feature didn't really work just ended up re-searching.	Not sure why the audio was enabled. It was talking but clicking the icon did nothing.	Straight forward, tiles were fine.	Go back to search results to search results after a button is pressed. "a more apparent step-back"
Sorting through the map it was difficult to deal with the Zoom	Grouping Wasn't clear	"If I searched a location and it was wrong I had to re-search it" "No Obvious Back Button"	When zoomed out highlight not obvious		Sound	(Didn't realize there was a zoom option (no use of layers))	*Sound*
Lag - Especially when zooming.	Discovery Process.. No idea what "group" was until prompted. (by researcher)	Didn't show the english translation or alternate information at all.	there were lots of clickable options when searching but not much to distinguish between options		Surprised by the auto name feater, not bad just surprising	"Not Really" didn't always display clickable tiles on side (didn't understand the layout)**	How much of screen was occupied by icons that were irrelevant.
Zooming on the map, clicking.. There was some Lag, may be a function of the Wifi	No understanding of why grouping tile had no info on grouping	Had to search Alternate Name.	(Didn't realize there was a zoom option (no use of layers))		The sound was annoying. Couldn't figure out why it kept going off.	"Can't think of anything, group titles were a bit redundent in the tiles."	a less overwhlming menu of icons.
Must be very specific with the zoom.	Grouping had to leave page to find info	No idea if the search result when searching the western (alt name) was a relivant result.	More apparent highlighting in the map		"is it clickable? Is it activated by a hover function?"	The tiles on the Right side of the interface seemed inconsistent.	If you didn't know exactly what you were looking for it was tough. Found things by random clicking and luck.
When zoomed out highlight not obvious	The groupiong feature wasn't perfectly clear.	*Some Indication of why search results are related to search.*			The redundant audio icon. Sound played anyway.		Better back button.
	selected group, assumed groups were geographically related, clicked on icon and used selection to verify assumption.	Always re-type searches (in day to day use)			Speaking the name, the audio Icon and the Tile.		Didn't really use the map but the questions didn't really require it
	"Can't think of anything, group titles were a bit redundent in the tiles."	Took learning time to understand the search menu			The sound was annoying, there was no alt name or other info in search results and the layer learning curve		Provide tutorial or info
	the grouping was strange. (not a clickable tile)						More obvious sound control "want to know why I'm hearing the sound"
							start of search results more obvious on map.
							Some more obvious geograpic Landmarks.
							Highlightin selections more clearly even when zoomed out
							Tiles: Search info was an overload
							better layed out search results.
							A legend or navagation tutorial at start
							Sub sections.. Groupings.
							Make layers more apparent