An Old Method New Again - Rethinking Nation Building in a Digital Age: Piloting Cognitive Apprenticeship in Indigenous Nation Building

“The essence of the instrumental method relies in the functionally different use of two stimuli, which differentially determines behavior; from this result the mastery of one’s own psychological operations.” L.S. Vygotsky

“How do the immature skills and characteristics of newborns transform so quickly to those of a being with impressive human capacities? Answers to these questions have to do with the nature of human nature, the nurture of human nature, and the nature of human nature....” B. Rogoff

“The building blocks provided by the OER [Open Educational Resource] movement, along with e-Science and e-Humanities and the resources of the Web 2.0., are creating the conditions for the emergence of new kinds of open participatory learning ecosystems that will support active, passion-based learning: Learning 2.0” J.S. Brown, R.P. Adler

Introduction

Towards the end of 2005 and still relevant today, Business Week magazine asked, is the U.S. losing its competitive edge in engineering? That same year, the National Science Foundation (NSF) reported the U.S. graduated 66,133 engineers and 50,564 computer scientists compared to India's 350,000 and China's 600,000. The following year, 2006, NSF reported a modest 3% increase to 68,121 in engineering graduates and decrease in computer science by 15%. Today the statistics have changed little and the trend continues. The U.S. is graduating fewer STEM degrees and outsourcing is the norm. Thomas Friedman's book, "The World is Flat", observes that the world has shrunk by the ubiquitous-ness of technology. This phenomenon has caused a new complex historical socio-economic digital divide, especially within the U.S.'s K-16 pipeline. To make matters worse, the socio-economic divide is exacerbated by this phenomenon within the underrepresented population, especially within the Native American Community. In 2006, NSF's latest statistics show only 353 and 228 Indigenous Americans graduated with engineering and computer science degrees respectively. These figures represent 0.0053% and 0.0045% of the total engineering and computer science degrees awarded respectively. Since the Native American population is one percent of the total U.S. population, one would expect at least one percent within each of those disciplines. These two percentages presents a dismal picture with strong need to increase Nation Building numbers of human intellectual capital within the Native American communities.

Considering the above facts, three questions are asked concerning Nation Building:

• “How can Indigenous Nations enter into this increasing competitive technology driven market?”

• “How can Indigenous Nations influence technology fluency by human capital building within their communities?”

• “What theory, method and practice in secondary and post-secondary academia can be implemented without cultural loss and offer sustainability?”
In an attempt to answer these questions, the aim of this research is to introduce the Cognitive Apprenticeship approach that may provide answers in a quest to “Rethinking Nation Building in the Digital Age” by re-introducing “An Old Method New Again” – Cognitive Apprenticeship.

Cognitive Apprenticeship

Cognitive Apprenticeship supports a “master-apprentice” connection for successful learning. This method of apprenticeship education has been in practice in Indigenous communities throughout the world for centuries compared to our recent public educational experiments and practice. From my previous research piloting and re-introducing this approach in formal and informal educational settings, it has created a real and relevant STEM experience. It also helped address broader pipeline issues by engaging technology, education, especially cultural influence, building 21st Century Skills for tomorrow’s Nation Building and workforce needs.

Previous work with Math, Engineering, Science, Achievement (MESA), Engaging Computer Science in Traditional Education (eCSITE) and my current work with the Office of Diversity, Equity and Community Engagement (ODECE) through the Indigenous Alliance Computer Build, I engaged in Cognitive Apprenticeship methods as modeling, coaching, scaffolding, articulation, reflection and exploration. My main objective has been to bring computer technology and computational thinking like experiences into Native communities by teaching Indigenous youth to build interfaces, webpages and build a computer. The Cognitive Apprenticeship approach has provided middle and high school students with actual experience working with professionals and academia. It also provided a real experience of a career in STEM. The Cognitive Apprenticeship approach worked as a catalyst to increasing interest in math, physics and sciences through a computational science discipline. The Cognitive Apprentice approach also enables a sustainable infrastructure necessary for intellectual capital building in Indigenous communities without loss of culture. In fact, it is in agreement with Indigenous approaches espoused in Indigenous communities and academia. Since working with MESA, eCSITE, my work has impacted Middle and High School students in developing interest in STEM and careers. My work with ODECE has impacted approximately 40 students and early participants have enrolled in the University of Colorado.

As part of novelty and innovation, I introduce Cognitive Apprenticeship as an overall structure to make education meaningful for today's 2.0 students. Cognitive Apprenticeship extends the capacity of formal and informal education by providing a framework designed for the learning environment in content, method, sequence and sociology. I also extend the Cognitive Apprenticeship model by integrating indigenous history, culture and relevant experiences, to build positive life-skills, positive self-identity and positive self-attitudes. The extended design also includes fostering a historic socio-cultural context for personal achievement and effectiveness, and to influence a post-secondary decision in cultural based projects.

Cultural based projects (e.g. creating a touch screen by Indigenous people, provide culturally correctness by providing a new voice from the Indigenous community for stereotyped dioramas) also serve as a platform for 21st century skill building and human capital development. Implementing a Cognitive Apprenticeship model and cultural based projects, both complement
each other by addressing development issues within Indigenous communities such as formal and informal education, technology advancement, social change, globalization, environmental issues, health and business. It can further address self-efficacy (Bandura, 1997) and technology and social inclusion (Warschauer, 2003), communication technology for development (Unwin, 2009), multimedia for learning (Mayer, Clark, 2011) and computational thinking (Wing, 2010). Most importantly, it may help address the drop-out crisis within Native American communities in design.

With help from iSTEM, my interest is to extend research in Cognitive Apprenticeship to include elements of Indigenous culture, a historic socio-culture context, technology fluency, influence post-secondary educational decisions and visions, and to extend Dr. William Demmert’s (1934-2010) Culture Based Education and his concern on limited research on Indigenous students working with computational technology (Demmert, 2001).

**Theoretical Framework**

I find that the Cognitive Apprenticeship framework supports a “master-apprentice” connection for meaningful learning. This method of apprenticeship education has been a practice in Indigenous communities throughout the world for centuries compared to our recent public educational experiments and practices. From my previous research piloting and introducing Cognitive Apprenticeship approach in formal and informal education settings, it has created a real, relevant STEM experience. Cognitive Apprenticeship also helps address broader meta-cognitive need in pipeline issues by engaging technology, education, cultural influence, building 21st Century Skills for tomorrow's workforce needs. With my concern for Nation building and human capital development, Cognitive Apprenticeship ties in with both the constructivist and constructionist theoretical models to build mastery skills like a professional within the field of computational science within a cultural paradigm.

This theoretical framework also supports Collins, Brown and Newman, Cognitive Apprenticeship processes, Rogoff's apprenticeship thinking and influence of culture, Albert Bandura’s theory of modeling and Vygotsky, question on “What is the relation between human beings and their environment, both physical and social?” Their research resonates with Native American cultural educational approaches rather than the “stand and deliver” method that is so prevalent in our current educational system. Finally, Richard Mayer's multimedia learning theory and principles also may provide a framework to ensure transference of knowledge and content via multimedia within the classroom environment. As an addition for novelty, cultural context within the environment will be studied “in cultural proximity” much like Vygotsky's “zone of proximal development.”

The framework of Cognitive Apprenticeship for designing the learning environment will be employed to inform the work and to answer research questions. The learning environment framework may include as informing transfer of cognition:

- Context – domain knowledge, heuristic strategies, control strategies, learning strategies
- Methods – modeling, scaffolding, articulation, reflection, exploration
- Sequence – Increasing complexity and diversity, global skills before local
- Sociology – situated learning, culture of practice, motivation, cooperation, competition

Within the constructs of piloting Cognitive Apprenticeship, Vygotsky, Rogoff, Piaget and Papert provides a framing of the activity for each approach. Each researcher will help bring to light an understanding how humans create and construct meaning and knowledge, interpret meaning
and artifacts in cognitive transfer of knowledge through hands-on activities. This is my main interest in building Indigenous technology fluency within culture.

As stated above, my novel and innovative research will extend the Cognitive Apprenticeship model by integrating indigenous history, culture and relevant experiences to build positive life-skills, positive self-identity and positive self-attitudes. The extended design also includes fostering a historic socio-cultural context for personal achievement and effectiveness and to influence a post-secondary decision in cultural based projects.

**Research Questions**

In regard to Cognitive Apprenticeship, several research questions arise:

- Can the Cognitive Apprenticeship framework enacted as a strategy in curriculum be effective for encouraging more participation of Indigenous students in STEM related activities and in decisions for post-secondary education?
- Can the Cognitive Apprenticeship framework enacted as a strategy in curriculum create mastery, sustainability and reframe cognitive paradigms for Nation building?
- What are the cognitive influences on Indigenous students on identity, meaningful learning, and positive life-skill development, fostered in a historic socio-cultural context and conducted by an Indigenous professional, integrating a Cognitive Apprenticeship framework?
- What is the value of Indigenousizing Cognitive Apprenticeship in reframing cultural paradigms and in Nation Building in a digital age for Indigenous People living in two world? (“Indigenousizing” or “Indigenousation” is a new term created to mean – An act of incorporating digital practices within indigenous sovereignty rights; to taking ownership, control of technology for development and use within indigenous culture, education, capacity and economic development, cultural restoration, ecological practices, health, language preservation, business and indigenous computational thinking and other practices; to integrate technology in future endeavors for the future of indigenous people)

**Methodology**

From this conceptual learning environment a mixed method approach (Creswell, 2008; Creswell, Clark, 2011) seems more appropriate as a methodology. It offers a way to understand the multiple elements with the learning environment via pre and post surveys, personal interviews to understand the effect of the Cognitive Apprenticeship approach, especially in attempting to understand the influence of culture where measuring culture has been an elusive subject (Cole, 1996). The Cognitive Apprenticeship framework may serve as a measure how the sense of accomplishment has effect on self-worth, self-identity, self-meaning and self-efficacy through the constructs of the Cultural Based Project. Multimedia in the learning environment may also be a method following Mayer’s principles to support and measure effectiveness of cognitive transfer.

Ethnography, writing observations (Creswell, 2008) and Grounded Theory, creating meaning and theory from the environment (Charmaz, 2006; Glaser, 1992) and my personal reflections from a professional perspective (Schon, 1983), video analysis, a Likert style surveys and open-ended question will be incorporated for triangulation.
To ensure correctness in using the mixed method approach I will be working closely with my committee and advisor Clayton Lewis. Sarah Hug, who is on my committee and a member of the ATLAS Research and Assessment Center with also provide input from her specialty in mixed methods, grounded theory, cognitive apprenticeship and ethnography.

Lastly, I have conducted a previous Cognitive Apprenticeship Project with the Denver Museum of Nature and Science in 2010 and 2011 which was video recorded. I will conduct video analysis employing Grounded Theory and it will help inform the next phase of my research.

**Project Timeframe**

![Project Timeframe Diagram](image)

Figure 1 – Proposed Timeline

Figure 1 Proposed Timeline diagram above, shows my proposed timeframe to complete this study. I will defend my dissertation proposal by May 2012. During this time I will also start video analysis of the previous Cognitive Apprenticeship project conducted at the Denver Museum of Nature and Science. Working with ODECE, three computer builds, two in the four corners area and one in Denver, may provide opportunity to research Cognitive Apprenticeship in June 2012.

By summer I’m planning on working with Navajo Technology College by possibly teaching a class and/or conducting seminars for teachers and student employing Cognitive Apprenticeship methods during the summer and fall 2012. I will also continue collecting data, plus continue dissertation writing by incorporating some of the data. By fall 2012 most data collections will be complete, with continued dissertation writing, and data analysis started. If funding permits another computer build, it may be conducted in the fall. By spring, 2013, data analysis and dissertation writing will be complete and will conclude with the defense of my dissertation.

**Impact of Study**

The impact of the study will be beneficial in a number of ways:

- The funding from iSTEM will help further my research for the Summer and Fall 2012 and Spring 2013. It will continue to help understand the dynamics of Cognitive Apprenticeship in successful STEM and Nations Building projects. The research will continue in Native communities, integrating Native culture and Cognitive Apprenticeship. My current funding from ODECE will end May 2012.
- The funding will further support STEM’s education and collaboration between STEM and non-STEM departments at the University of Colorado. The collaboration will include the Office of Diversity, Equity and Community Engagement (ODECE) and the multi-disciplinary ATLAS Institute, of which I’m a PhD student, and the CU Computer Science Department, which I am a member of the Human Centered Computing group.
- The funding will further support building a community by attracting and retaining underrepresented students by employing the successful cutting edge outreach program like the Indigenous Alliance Computer Build at CU for Native American students. This program has been a successful program for the University of Alaska, Anchorage, attracting students...
as well as institutional and private funding. The program has dramatically increased interest in STEM and produced more Native American scientists and engineers than any program in the U.S.. This program is replicable and is currently being implemented at the University of Colorado. Similar replications of the program have had equal success at other Community Colleges and Universities throughout the U.S..

- The funding will continue to further support the STEM educational pipeline by reaching out to underserved Native youth in Southwestern Colorado and within the Denver Metro area, thereby addressing the pipeline issue. In addition, my experience with MESA, NSF GK-12 eCSite and ODECE will add value from cutting edge computational thinking in all subjects. Secondly, my work with iDream employing AgentSheets and AgentCubes as a cutting edge technology will continue to engage and attract today’s students and their interest in technology. Thirdly, my experience in developing a cultural based project like “Native Science @ DMNS” highlights a method that integrates real technology experience, STEM education and 21st Century skills. The institution could benefit greatly by having highly motivated and skilled students in the pipeline that have the ability to solve problems both from within their community and from within the institutional community.

- The funding will help build intellectual technical capital in underrepresented communities such as the Indigenous American Community to help close the growing digital divide as well as strengthen collaboration between CU and CU’s institutes and departments, with those underrepresented communities.

- Lastly, I have previously engaged in state legislation with MESA, getting a bill passed for afterschool programs. With ODECE, I will gain experience at a National level as we propose a need for funding for programs like the Indigenous Alliance in Washington, D.C., by demonstrating a computer build before Senators and Congressional members, April, 2012. This will help showcase University of Colorado’s commitment in relationship to STEM needs.
References


