

The Pathway to Achieving Classroom Equity: Computational and Critical Thinking
through Storytelling and 3D Models

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Abstract

This manuscript is part of a larger project and is an inter-disciplinary effort, dedicated to discovering answers to the following questions: 1) *Do storytelling and story making serve as effective means to teach computer science to middle school youth?* And 2) *Can the integration of computing skills into the core middle school curriculum increase instruction and student learning of these skills?* A description of how our project supports equity in the classroom introduces the reader to a new teaching concept that combines Indigenous narrative “Storytelling” with computer science components. We achieved the integration of CS and Storytelling through lesson plans developed utilizing the Understanding by Design (UbD) framework, to best capture the intended results. To answer the question of instruction effectiveness, best practices, and integration of cultural materials, we found it essential to discuss team alignment with the Montana Indian Education for All (IEFA) Act, tenets of Tribal Critical Race Theory (TribalCrit) (Brayboy, 2006) and the 7 Essential Understandings. Likewise, teacher positioning in classroom and pedagogies that reflect current education transformation trends, are essential topics in our discussion.

Keywords: computer science, storytelling, culturally responsive teaching, Indigenous

The Pathway to Achieving Classroom Equity: Computational and Critical Thinking Through Storytelling and 3D Models

This manuscript is part of a larger project and is an inter-disciplinary effort, dedicated to discovering answers to the following questions related particularly to Indigenous¹ and Rural middle school students: 1) *Do storytelling and story making serve as effective means to teach computer science to middle school youth?* And 2) *Can the integration of computing skills into the core middle school curriculum increase instruction and student learning of these skills?*² We have aligned ourselves with the implementation requirements of the Indian Education for all Act (IEFA), a result of Montana state constitutional law.

The Storytelling project integrates American Indian stories into school curriculum, through lesson plans. The lesson plans are designed to meet various content domains, and are developed with a computer science component and a traditional indigenous way of transmitting knowledge “Storytelling”. Thus, one of the main goals of the Storytelling project is to encourage computational thinking during middle-school years, allowing students to consider computing-related remote jobs at some point in their lives. We recognize that computing careers are not a usual career-trajectory for members of American Indian communities, and the lack of trained individuals in technical fields, like computer science, is a result of this trend. For this reason, we are working to introduce lesson plans into the classroom, with teacher participation, that support systems of equity through Culturally Responsive Teaching (CRT)³ (Castagno & Brayboy 2008). The integration of these lesson plans, that merge computer science components with traditional Indigenous ways of transmitting knowledge via “Storytelling”, is accomplished by utilizing Alice⁴, a drag and drop software program.

Problem Statement

In order to avoid a deficit model discourse, the authors avoid implementing statistics that fault marginalized populations for a phenomenon that is rooted in paradigms of colonization, blame, and inappropriate aggregation that unfortunately essentializes indigenous peoples (Walter & Anderson, 2013). Institutions are called upon to address the very statistics that they produce. The colonial statistics show that American Indian high school completion rate is 24 percentage points below that of White students, and American Indian students make up 27% of the total dropouts in grades 7-12⁵. The statistics continue to drive researchers who are interested in

¹ Within this article we use terminology that includes American Indian, Indian, Native and Indigenous to refer to individuals whose ancestors have inhabited what is now called North America for thousands of years, no political connotation or exclusion of other indigenous nations are intended.

² Strategies: Using Storytelling to Improve the Pipeline for Rural and American Indian Students Entering CS.

³ Not to be confused with Critical Race Theory.

⁴ Alice – Tell Stories. Build Games. Learn to Program. (n.d.). Retrieved from <http://www.alice.org/get-alice/alice-2>

⁵ OPI (2017) Dropout-and-Graduation-Report [PowerPoint Slides]. Retrieved from <https://www.umt.edu/sell/cps/MDUC/Dropout-and-Graduation-Report-2015-2016.pdf>

equitable education to look at education reform as a means to achieve success as defined by both education systems and marginalized communities, in this case, the Indigenous nations of Montana. The turning point that marked a new position for indigenous narrative, happened with the passing of a Montana state law known as the Indian Education for All Act (IEFA), which mandates the integration of indigenous narrative and culture into its school curricula. The convincing testimony in 1972 at the Montana Constitutional Convention by Earl Barlow⁶, a Piikani (Blackfeet) tribal member, describing the need for integration of American Indian education into existing school curricula, was a notable contribution towards the passing of the IEFA mandate in 1999. Barlow's testimony and the enduring presence of Montana's tribes served as impetus for change deep from within a Westernized and Eurocentric culture. Since that time the support and collaborative efforts to implement the IEFA initiative have grown into a standard practice as schools across Montana provide teachers access to resources for the integration of American Indian source materials into lesson plans. Teacher participation and training play a crucial role in our effectiveness and ability to sustain momentum toward equity in the classroom. One challenge that arises is the integration of school curriculum, educational policy, teachers' schedules, multiple pedagogical stances and teaching methods. An unexpected challenge that became a benefit to the Storytelling team was how the respect for relationship dynamics was brought to our awareness. Subsequently, the research not only represents the technical component of introducing computer science into middle-school classrooms, but also illuminates questions of equity in the classroom on a curricular level. This manuscript will describe the phenomenon that motivated the creation of this project, how the implementation team addresses issues of equity, and concludes with a discussion illuminating IEFA and its pedagogical reformation, through the project goals.

REVIEW OF LITERATURE

A review of past and current pedagogies and theoretical studies that identify CRT methods and principles provide a base for our understanding of matters concerning classroom curriculum, and teacher positioning. One important caveat with respect to using storytelling to teaching computing is that indigenous thinking and oral storytelling are circular compared to the linear Western thinking and organization of written discourse (Fixico, 2013) (Piquemal, 2003). Furthermore, storytelling for indigenous communities is dynamic and interactive with storyteller and listeners alike participating in an event of (re)creation (Blaeser & Vizenor, 1999). In recognition of these differences between Indigenous and Western storytelling, our curriculum aims to be flexible and acknowledge Native learners' unique perspectives (Dalton, Dorman, & Byrnes, 2018; Freire, 1970; Rendón, 2009). Likewise, works by current scholars collectively express a fundamental truth about cultural responsibility and social justice, that cannot be ignored; when teaching in a classroom that represents diversity the "learner" must be respected for individual lived experiences (Smith, 2003; Gay, 2013). Authenticity is critical while creating teacher-student relationships and environments that encourage teachers to learn from students. These studies contributed to our understanding of CRT and methodologies. They also enabled us to ponder and discuss what happens during the teaching process. In order to achieve equity in the classroom, educators must understand the importance of relationships and the two-way flow of

⁶ Earl J. Barlow papers, 1937 and 1972-2005 PDF. (n.d.). Retrieved from <http://archiveswest.orbiscascade.org/ark:/80444/xv71929>

information to be effective teachers of American Indian students. This is true regardless of student race/ethnicity or cultural background. The essential message is that the learning process benefits educators and students simultaneously when the educators align themselves with CRT principles. A review of the current IEFA requirements and implementation methods identify a pedagogical framework executed in a way that brings STEM to indigenous and rural learners. IEFA is designed to implement American Indian ways of knowing, cultural and individual differences in teaching through seven essential understandings.

1. Tribal Diversity
2. Indigenous Identity Location
3. Pre-“discovery”
4. Treaty Processes
5. Federal Policy
6. Indigenous Curriculum
7. Tribal Sovereignty Variability

The 7 Essential Understandings work as a core component of IEFA, and were developed by a group of Indian teachers and represent broad concepts common to Montana tribes (Elser, 2010). The timeline from when it became law to present implementation levels shows a gradual transference of responsibility from policy makers to teachers. Elser (2010) developed ‘A Practical Guide for Montana Teachers and Administrators Implementing Indian Education for All’ called the “The Framework”. Elser (2010) states:

The work of classroom teachers is complex and multifaceted. Teachers must focus on the needs of individual children using continual cycle of instruction and assessment...Now, beyond knowing the learner, the content, the standard and the instructional methods, teachers must learn and teach the Essential Understandings Regarding Montana Indians (p. 4).

This comprehensive document offers details on practice and procedures, along with templates and examples of how to implement IEFA materials into the curriculum. Elser (2010) further explains that the theoretical foundations for IEFA are informed by the cultural approaches designed by Banks (1997) and the 7 Essential Understandings Regarding Montana Indians. Banks’ (2010) strategies include two theoretical models that are specifically mentioned and integrated in the IEFA implementation requirements. First, there are four approaches to multicultural education implementation; 1) Contributions, 2) Additive, 3) Transformation and 4) Social Justice. The second model presents five dimensions of multicultural education; 1) Content Integration, 2) The knowledge construction process, 2) Prejudice reduction, 3) Equity 4) Pedagogy, and 5) an Empowering school culture and social structure.

RESEARCH METHODOLOGY

Krippendorff (1989) states that content data analysis is an important tool used to infer contextual meanings from unknowable data points. It also allows for a systematic, rigorous

approach to analyzing documents (Marsh, 2006). Hence, content analysis is the appropriate research method(s) for this study, which includes American Indian stories. Content data analysis requires the breaking down of appropriate stories for project purposes. Overall, finding culturally relatable stories that successfully represent all Montana tribes without inappropriately essentializing any of these tribes, stands as the primary concern for the research team. The story selections are defined by the following steps: 1) read the story in its entirety, step 2) identify specific elements within the story, such as a) setting, b) main characters, and c) descriptive language, that can be used to capture the core message of the story. Identifying key components that can be translated / created into 3D models is essential at this level of analysis. A spreadsheet matrix was developed to archive the stories that are identified as being useable for 3D model development and to be used in the ALICE platform. This spreadsheet is a collaborative tool, shared with team members via Box, and utilized to collect feedback from the 3D model developers. Special headings identifying each unique element of the story, and it organizes the information for ease of utilization. Once these steps have been executed, the story is then integrated into a new lesson plan. Assessments for content standards requirements, and evaluation for desired outcomes is an integral part of the process during lesson plan development.

Integration.

At the onset, Tribal culture, traditions and diversity presented team members with a challenge during story selection. It was clear that a deeper understanding of the tribes represented in Montana, was necessary. This discovery motivated team members to research for resources that best explained acceptable practices. The ambition was to identify stories that met culturally acceptable practices, as well as computer science parameters; this is an essential part of the project. Thus, the responsibility to maintain story integrity and diversity included sensitivity to cultural nuances. This was made possible by aligning researchers with existing tenets of Tribal Critical Race Theory (TribalCrit) (Brayboy, 2006), 7 Essential Understandings and the IEFA mandate. The understanding is to not further marginalize students when encountering multicultural narratives by being culturally/tribally specific and aware of contemporary Indigenous realities. The result, was increased team awareness and a framework for lesson plan development that better represented the original intention of the project, solidified the reason for teacher training, and allowed for personal development. Thus, respect towards the cultural uniqueness and diversity of each tribe is vital while engaging in story selection.

The Teacher

The path to implementation and a more equitable student experience is not without its unique challenges. In response to IEFA implementation, some teachers feel that it can be a distraction from efforts to improve student achievement (Elser, 2010). Culturally responsive pedagogy methods and practice also require additional time and effort, more specifically for those teachers who struggle with the topic of culture difference, not knowing how to handle classroom tension when certain topics arise from conversations surrounding historical facts or non-facts. Another area of concern involves established systems that resist critical change. Teachers are central figures in the process and practice of delivering equitable curriculum, however, they may find themselves in a delicate position within their economically privileged school systems, if indeed they are a vocal agent for change. Aligning ourselves, Educators and Administrators, with pedagogies and lesson plan frameworks that support, encourage, and

promote reciprocal teacher/student relationships is essential in creating a space that is safe and productive for teachers and students alike. We hope that by creating this connection between teachers and students, we can bring material to students that is relatable and relevant, to their own cultural background and lived experiences and indigneous people.

The lesson plans developed as a result of the aforementioned process cannot succeed without the full participation of the teacher. The teacher's position on the implementation of IEFA practices and equity pedagogies impacts not only the classroom but undoubtedly the curriculum. Understating that classroom environments are contingent on teacher disposition is part of the process of adapting our lesson plans appropriately. The project is intentional about not creating new requirements for middle school teachers nor add to their workload. Therefore, we propose the introduction of computer science and computational thinking by integrating it into the curriculum through IEFA. Aligning the introduction of these new lesson plans with IEFA systems that are currently in place is intentional about being less stressful and cumbersome for the teacher. The success of the Storytelling project hinges on our ability to foresee barriers teachers may encounter while implementing our lesson plans. In order to facilitate teacher introspection, we have adopted the Understanding by Design (UbD) framework that is presently the method of choice for preparing preservice teachers. The Framework teacher guide, focusing on methods, strategies and practice also assists teachers with integration of Indigenous material. The teacher (as a human being) who holds biases unknown to them, may at times react to an unknown topic by avoiding it. Dr. Geneva Gay, in "Teaching to and Through Cultural Diversity" makes a poignant statement about resistance to engaging in CRT. "The point made is that resistance manifests itself as doubts about validity and as anxieties about anticipated difficulties with its implementation" (Gay, 2013, p.56). She further states that some teachers will erroneously equate CRT with being racist and discriminatory by highlighting differences. The argument for bringing this to our awareness, is to become watchful of teaching methodologies that discourage teacher involvement with students at a level that is more personable and responsible. Teachers can be described as a conduit whereby equity enters the classroom. Paulo Freire (1998) stated "the focus should be on the teacher", he continues, "...Teaching is a human act and a form of intervention in the world" (p. 49). Naturally, teachers who struggle with cultural sensitivity and depth of understanding, will settle for topics that are "safe" about cultural diversity...and will ignore troubling issues like inequalities, injustices, oppression" (Gay, 2013, p. 57).

Transforming Pedagogies

Homogenous systems are currently being challenged, changed or replaced with pedagogies that work towards diversity inclusion (Gay 2010); a call for kinder, more humanized ways of teaching is circulating in scholarly works. A review of these current pedagogies, that seek to transform the classroom methods of teaching and impact our schools and communities, not only served for personal edification - it also contributed to the development and conceptualization of alternative solutions. Thus, the underlying purpose of our study is to bring to our awareness alternate paths, that are more congruent with Indigenous ways of knowing. Rendón (2010) comments on Descartes' philosophical stance of "I think, therefore I am" as contrasted with "I belong, therefore I am" (Moodie). She further expounds on the ontological stance of belonging and being connected to others and to the world is a thread of thought found in expressions such as the American Indian articulation "to all my relations" (p.67).

Pedagogies that support the transformation of education speak of wholeness, reveal the need for contemplative education, mindfulness, and new approaches that introduce meditative methods for teachers to discover inner biases and deal with emotional reactive tendencies. This work is imperative in teacher training, with greater impact for those teachers who become part of a multicultural classroom. Teaching does not exist outside the realm of human interaction. In support of this concept, Rendón (2010) in *Sentipensante Pedagogy* describes her teaching model as based on integration and consonance, representing the union of sensing and thinking processes and the balance between inner and outer knowing. Actively incorporating the “whole” person concept into our teaching methodologies will inevitably humanize interactions in the classroom. This is how equity enters the classroom. Teacher-student relationships need to be treated as people who “belong” within the same learning space. “Belonging” in the sense of when individuals belong in a community.

PRELIMINARY CONCLUSIONS

Computer science is shown to be one of the fastest growing job sectors worldwide; while graduating numbers are not enough to satisfy the number of jobs that will become available, if things remain as they are. A primary goal for this project is to introduce middle-school students to the field of computer science. However, as a by-product of this introduction, is a potential increase in job opportunities for American Indian students in the future. The Storytelling project may help answer the lack of job opportunities within marginalized communities in rural areas of the state that are the result of colonial systems. This inequity has persisted for generations. A viable solution is to introduce computer science to middle-school students and hope to see an impact by providing an avenue for employment where previously there were few. This solution is achieved through an innovative approach using ALICE. We strive to find narratives and stories that motivate and evoke a desire in middle-school students to consider a career that involves computational and critical thinking, with anticipation that rewarding career choices are made by these students, once they reach college age. Rural communities will also benefit from our current efforts to incorporate computational and critical thinking into the classroom.

Though, the primary task is to identify workable/replicable material from a computer science viewpoint. The process starts with awareness that the messages and symbols introduced by American Indian stories are rich with cultural and historical information. Thus, respect for cultural identity and life experiences of different tribes and individuals cannot be discounted. Subsequently, thoughtful consideration of cultural charged material is achieved through becoming familiar with the IEFA requirements⁷, to help avoid unintentional bias in our material. The positive, long-term, impact of this introduction will not be limited to the student alone, as we anticipate the economic well-being of rural communities will benefit from skilled workers in the workforce. The results could mean the survival of communities otherwise destined to languish in comparison to larger metropolitan communities.

⁷ This is possible via the Office of Public Instruction (OPI) website <http://opi.mt.gov/Educators/Teaching-Learning/Indian-Education>. The database collection holds 140 culturally appropriate vetted stories. They are divided into four levels I-IV. Lesson plans, guides and worksheets are made available for instructors to implement in their curriculum.

References

- Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational psychologist*, 28(2), 117-148.
- Bauman, R., & Sherzer, J. (Eds.). (1989). *Explorations in the Ethnography of Speaking* (Vol. 8). Cambridge University Press.
- Blaeser, K. M., & Vizenor, G. (1999). Writing voices speaking: Native authors and an oral aesthetic. *Talking on the page: Editing Aboriginal oral texts*, 53-68.
- Brayboy, B. M. J. (2005). Toward a tribal critical race theory in education. *The Urban Review*, 37(5), 425-446.
- Castagno, A. E., & Brayboy, B. M. J. (2008). Culturally responsive schooling for Indigenous youth: A review of the literature. *Review of Educational Research*, 78(4), 941-993.
- Dalton, J. E., Dorman, E. H., & Byrnes, K. (Eds.). (2018). *The Teaching Self: Contemplative Practices, Pedagogy, and Research in Education*. Rowman & Littlefield.
- Fixico, D. (2013). *The American Indian mind in a linear world: American Indian studies and traditional knowledge*. Routledge.
- Freire, P. (1970). *Pedagogy of the oppressed* (MB Ramos, Trans.). New York: Continuum, 2007.
- Gay, G. (2010). *Culturally responsive teaching: Theory, research, and practice*. Teachers College Press.
- Gay, G. (2013). Teaching to and through cultural diversity. *Curriculum Inquiry*, 43(1), 48-70.
- Krippendorff, K. (1989). Content analysis. In E. Barnouw, G. Gerbner, W. Schramm, T. L. Worth, & L. Gross (Eds.), *International encyclopedia of communication* (Vol. 1, pp. 403-407). New York, NY: Oxford University Press. Retrieved from http://repository.upenn.edu/asc_papers/226
- Peat, F. D. (1994). *Blackfoot physics: A journey into the American Indian worldview*. Red Wheel/Weiser.
- Piquemal, N. (2003). From Native North American oral traditions to Western literacy: Storytelling in education. *Alberta Journal of Educational Research*, 49(2).
- Rendón, L. I. (2012). *Sentipensante (sensing/thinking) pedagogy: Educating for wholeness, social justice and liberation*. Stylus Publishing, LLC.
- Smith, G. H. (2003). Indigenous struggle for the transformation of education and schooling. *Transforming Institutions: Reclaiming Education and Schooling for Indigenous Peoples*, 1-14.
- Walter, M., & Andersen, C. (2013). *Indigenous statistics: A quantitative research methodology*. Left Coast Press.