Investigations in Cyber-enabled Education: Merging indigenous and non-indigenous knowledge in a prototype course on snow and global climate

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Abstract: (75-150 words) This poster shares the findings of a study conducted on a prototype online professional development course for teachers. The course was developed using a professional development design framework created to enhance educators' ability to provide science, technology, and math (STM) instruction. Research occurred in Alaska, where great distances separate schools and indigenous students make up much of the student population. The course merged indigenous and western science knowledge. It included six units of online lessons, discussion questions, and an online learning community for communication among educators or between educators and scientists. Interactive multimedia and digital scientist lectures were developed to share within the forums. Findings indicate that the prototype was successful in improving teacher content knowledge, online STM workforce skills, and STM teaching self-efficacy.

Introduction

The Investigations in Cyber-enabled Education (ICE) program was designed to clarify the constructs of a professional development design framework created to enhance educators' ability to provide science, technology, and math (STM) instruction. The ICE framework seeks to provide online professional development and cyber-enabled scientist-teacher partnerships that are sustainable, affordable, replicable, and broadly accessible to teachers in all parts of the U.S. including rural and disadvantaged areas far from research centers. It involves STM scientists in a continuum of K-12 teacher professional development. Research was focused in Alaska, where geographic barriers hinder in-person professional development efforts and much of the student population is indigenous.

The Problem

A high percentage of STM teachers in U.S. secondary schools instruct out-of-field (meaning they lack appropriate credentials) and the highest rates of out-of-field teaching occur in high poverty schools with high minority student populations (Ingersoll, 2008). In Alaska, indigenous residents compose nearly one-fourth of the statewide student population (Hill & Hirshberg, 2006) and 40% of the student population in rural areas far from research centers (Alaska Department of Education and Early Development, 2007).

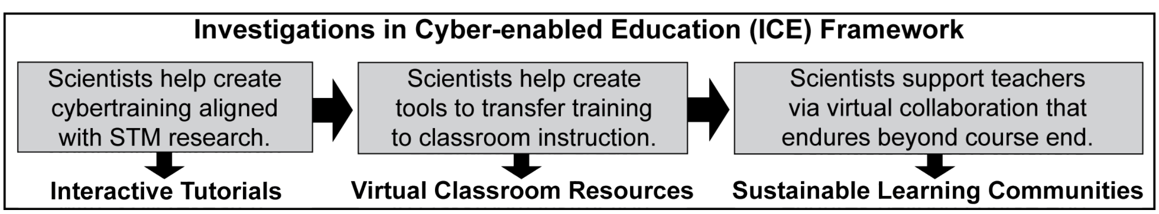
Much of rural Alaska is accessible only by boat or plane, necessitating teacher interest in online professional development opportunities. Locally relevant online STM professional development that includes indigenous knowledge and resources designed for Alaska Native students is hard to come by. ICE sought to address this dearth with a prototype ICE framework course on the role of snow in global climate.

Indigenous Alaskans have interpreted and adapted to climate change since the last ice age. Their observations are shared at scientific and cultural conferences. Despite its global importance, climate science is missing from most public school curricula (National Oceanic and Atmospheric Administration, 2009). In Alaska, climate changes are "significant, accelerating, and unlike any in recorded history" (National Research Council, 2004). In the Arctic, average temperatures have increased at almost twice the rate of the rest of the world (Arctic Climate Impact Assessment, 2004). Warming is most noticeable in the cryosphere, the frozen portions of Earth scientists believe are key indicators of global climate change (Goodison, 2008). Major components of the cryosphere (snow cover, sea ice, and permafrost) are undergoing dramatic change as a result of recent climate trends (Intergovernmental Panel on Climate Change, 2007; National Snow and Ice Data Center, 2007; Osterkamp, 2007; Perkins, 2007; Stroeve et al., 2008). Climate changes are affecting animals, plants, and lifestyles in the Arctic. Climate literacy is critical for all U.S. citizens, but is of particular interest to indigenous residents, whose cultures, languages, and subsistence lifestyles are inseparably tied to the land. Changes in land mean changes in generational wisdom about thriving and surviving.

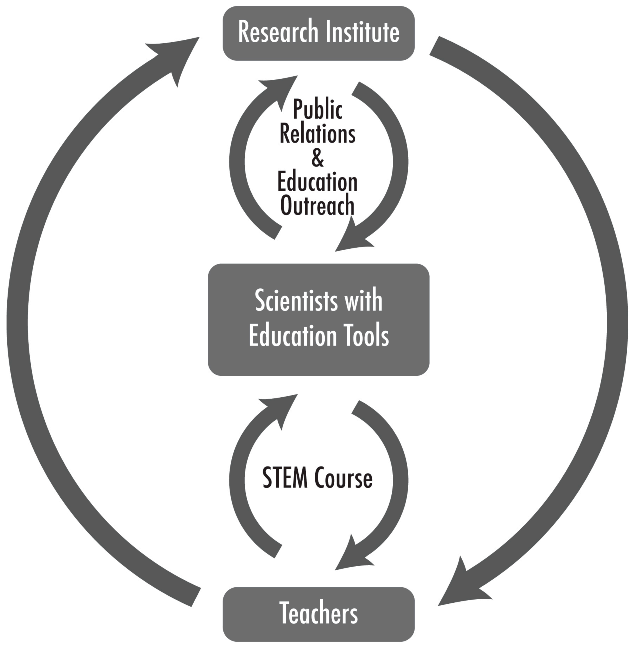
Scientists from a wide range of disciplines are studying climate change in an effort to better understand its drivers, processes, and impacts. Most scientists provide K-12 education outreach as an ancillary part of their job, or as a mandatory component of grant-funded research projects. Many struggle to find ways to share their research at the K-12 level. A framework for scientist involvement in professional development that results in sustainable, nationally accessible, cyber-enabled partnerships with educators can significantly broaden the education outreach potential of scientists' research.

The ICE Framework

The ICE framework provides a platform for collaboration among STM scientists and educators. It involves STM scientists in a continuum of K-12 teacher professional development. Involvement begins as scientists help develop materials for an online course for teachers, and continues as scientists help create tools to facilitate transfer of teachers' cyber-training to classroom instruction. It culminates with on-going scientist and teacher communication via an online "Sustainable Learning Community" during course content instruction and as teachers transfer learning to practice.



The ICE framework is part of a larger reciprocal model connecting research institutes with teachers in an ongoing cycle of perpetual benefit to both. The cycle provides institute scientists with a continual outlet for educational outreach and teachers with a continual source of cutting edge STM resources, information and training relevant to their area. The ICE reciprocal model involves research institute scientists and education outreach staff in the creation of STM education tools, which provide a foundation for online STM professional development courses for teachers.



The reciprocal model improves upon the old paradigm, in which information and communication were unidirectional, originating with the research institute, being transferred to teachers, then being communicated by teachers to students and other teachers. The new model allows for long-term collaboration between teachers and scientists. Involvement in ICE professional development is beneficial for scientists as well as teachers. Scientists can use the education tools developed under the ICE model for research institute purposes (such as to enhance their own instructional endeavors, make classroom presentations, illustrate ideas for the layperson, and describe complex content to funding agencies). Scientists also use the tools as the content for ICE online STM professional development courses for teachers. The tools lay a foundation for online scientist teacher collaboration, and help teachers transfer training to the classroom. Online professional development courses, such as those designed using the ICE framework, promote equal access to quality education for all teachers, including those in disadvantaged or rural locations often populated by high percentages of minority students (Appana, 2008; Dykman & Davis, 2008; Lim et al., 2008; Zhang et al., 2006).

The Study

The ICE framework was used to develop a prototype online professional development course for educators. Open-source Moodle course management software was used to create the online interface that provides course resources, assignments, online Sustainable Learning Community discussion forums and assessments. The prototype course features 6 units of instruction related to snow and global climate. This approach, in which core subjects (such as science, technology and math) are taught using a unifying theme (such as climate), was selected because it aligns with the interconnected indigenous worldview, in which the parts cannot be separated, but must be understood in relationship to the whole (Kawagley & Barnhardt, 1999). The course embeds indigenous and non-indigenous knowledge of weather and climate change and is place-based ensure relevance to indigenous Alaskans when teachers transfer training to their classrooms. Each unit includes a web-based technology lesson, a list of questions to guide teacher exploration of the topic and prompt teacher-scientist collaboration, and 10 multiple choice assessment questions. For teachers in rural or disadvantaged areas, online education enables multimedia incorporation and flexible, unlimited access to imagery, web resources, video, and other visual aids shown to increase minority student STM achievement (Kawagley, 2006; Starnes, 2006).

Although all six units are place-based and incorporate resources appropriate for transfer to classrooms of Alaska Native students, one unit of the prototype course provides direct instruction related to indigenous climate knowledge. It explores indigenous observations of climate changes and their affects on cultural practices and lifestyles. The online lesson for this unit features scientific literature linking climate research to indigenous experience. A geo-referenced database of indigenous climate observations and experiences, complete with links to indigenous organizations and related video and other online publications is accessible through a Google Earth map layer associated with the lesson. In the lesson, course participants used Google Earth to compare indigenous observations with regional weather station data. Prototype course multimedia related to indigenous knowledge explores the similarities and differences between western science and indigenous knowledge and how experts in both ways of knowing and learning contribute to climate studies. It also shares generational knowledge of weather and climate from indigenous people in the far north, and features a variety of traditional technology developed for survival and comfort in snowy regions are evident in tools used today. An interactive "Impacts on Communities" multimedia experience shows how climate change is impacting travel, local infrastructure and subsistence activities of indigenous communities in the circumpolar north. A related digital lecture provides specific examples of the relevance of traditional climate knowledge to indigenous lifestyles, discusses the indigenous worldview of Inupiat hunters, explains that to find true value in local observations, we must understand when, where, how and why the observations were made, and explores considerations that lead to successful collaboration between indigenous experts and western scientists.

Course materials and communication venues within the Sustainable Learning Community underwent formative testing with small groups of diverse Alaska educators to inform revisions and ensure that course components were usable, engaging, informative, accessible, grade-level appropriate, and operating in consonance with development team vision. After revision, summative testing of the prototype course occurred in two trials with 80 educators from Alaska and other snowy regions of the United States in each trial. Educators were randomly assigned to two groups before the trials. Both groups (Treatment A & Treatment B) participated in the prototype ICE framework course with identical scientist-developed online lessons, discussion questions and assessments and an online Sustainable Learning Community supporting collaboration among teachers. The Treatment B group additionally had access to communication with a scientist network within the Sustainable Learning Community. A moderator facilitated communication between scientists and teachers within the discussion forums using an online database of questions and scientist responses. Responses included media-rich resources such as interactive multimedia aligned with the topic and digitized scientist lectures by scientists in the network. When a teacher asked a question that had not yet been answered by a scientist, the moderator contacted one of the scientists participating in the project and requested an answer to the question. The response was supplied within the discussion forum and the question and answer were added to the database.

Findings and Products

Quantitative data from both trials indicate that educators learned and improved as a result of completing the ICE framework courses, and there was no statistically significant difference between the performances of the two groups (Treatment A and Treatment B). Qualitative analyses are underway to determine the extent to which each treatment fostered discussions that demonstrated higher order thinking, and describe if and how this thinking was evidenced in teacher-developed lesson plans for transferring training to K-12 classrooms.

Educator content knowledge improved: Educators in both groups demonstrated statistically significant increases in STM climate knowledge as measured by pre- and post-assessments.

Educators report improvement in online STM workforce skills: Educators in both groups showed significant improvement in personal perceptions of their online STM workforce skills related to studying snow and global climate as measured by pre- and post-survey subscale. Perceptions of skill levels are corroborated by performance data. Both groups demonstrated proficiency in online STM workforce skills targeted by the prototype course, as measured by average scores over 80% on skill-based online lesson assessments, including the online lesson specifically targeting indigenous climate knowledge.

Educators report enhanced STM teaching self-efficacy: Educators showed significant improvement in STM teaching self-efficacy as it relates to snow and global climate. This was measured by responses on a subscale of pre- and post-survey questions.

Educators report increased plans to teach about climate-related STM content and skills in their classrooms: Educators showed significant improvement between pre- and post-surveys on three of four questions targeting teacher intentions of using the knowledge and skills gained during participation in the ICE framework course.

In addition to these research findings, the project resulted in several lasting products available for use by K-12 teachers and the general public to understand the role of snow in global climate including indigenous perspectives. Products include online lessons, interactive multimedia and digital lectures. Data used within the lessons and images used within the multimedia are place-based for Alaska, but the concepts are transferable to other snowy regions. Six unit themes guide content. Unit 1: “Snow and Climate” provides participants with foundation knowledge on the role seasonal snow cover plays in global climate. Unit 2: “Studying Snow Cover” immerses users in the methods and reasons for studying and understanding snow cover extent. Unit 3: “Snowfall and Snow Depth” explores how snow data is collected, analyzed and used. Unit 4: “Temperature and Wind” explores how wind and temperature data are collected and impacts of these factors on the snowpack. Unit 5: “Climate Projections” is focused on the processes and outcomes of using climate models to project future climate. Unit 6: “Indigenous Climate Knowledge” features indigenous observations of weather and climate changes and their affects on culture. Online lessons associated with each unit train users to access, analyze, and interpret data related to the unit topics. Most data are provided within Google Earth map layers, and data for 20 Alaska locations is included, though the lessons generally focus on only a few locations. This ensures that educators in indigenous communities across the state can find data for a location in their region, making the project more relevant and the resources more useful in far-flung Alaska classrooms. More than 30 online interactive multimedia activities provide content knowledge related to the Unit themes. Eight digital lectures that are segmented for easy browsing and skipping discuss the unit topics in greater depth, and cover related topics such as weather hazard mitigation. All resources are designed for transfer to the K-12 classroom, with an emphasis on classrooms containing indigenous learners, and are accessible on the ICE website at: cyberenablededucation.org.

Conclusions

Analyses of the prototype course outcomes indicate that the ICE framework can be used to create effective professional development that enhances teacher content knowledge, online STM workforce skills, STM teaching self-efficacy and inclination to teach about course-related STM content and skills in K-12 classrooms, including rural Alaska classrooms with high percentages of indigenous students. Educator communication with the scientist network during course implementation did not significantly impact course outcomes, indicating that this final stage of the framework may require modification to enhance its benefits to educators.

The ICE prototype course focused on snow and global climate, but the framework could be applied to course development in other subject areas as well. The prototype course merged indigenous and non-indigenous knowledge of weather and climate in online lessons, multimedia and digital lectures created for the course. Similar care should be taken to ensure that the course topics addressed during future development are relevant to the populations served. Educators in rural and urban Alaska and in snowy regions of the contiguous U.S. were successful in the prototype course, indicating that it is broadly accessible.

Future research is recommended to determine the extent to which participating educators act upon their stated intent to transfer training to their K-12 classrooms after course end. The research should explore and define the resources and support necessary to facilitate the transfer, and the impact that ICE framework professional development for educators has on the diverse K-12 students in their classrooms.

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