Learner-Centered Education Program

Arizona Board of Regents

INSTITUTIONAL SUPPORT FORM

Proposal Title: Indigenous Geology: Development and Assessment of a Culturally-Resonant, Place- Based Model of Geology Education for American Indian Pre-Service Teachers

Institution: Arizona State University DEPT/Unit: Dept of Geological Sciences

Multi-Campus/University Projects
(check other campuses or universities participating)

_X_ ASU Main ___ UA

___ ASU East ___ UA South

___ ASU West ___ NAU

List other participating agencies:

ASU Department of Elementary Education

ASU Department of Curriculum and Instruction

Briefly describe the program and the development plan.

The program encompasses design, development, implementation, assessment, and dissemination of an introductory undergraduate geology course that integrates culturally-responsive and place-based content and pedagogy, to enhance its relevance and interest to American Indian students in Arizona, principally pre-service teachers.

Funding Category

Indicate a primary (P) and, if applicable, secondary (S) funding category:

Professional Development	_____	Program or Course Development/Modification	_P___
LCE Research	_____	Improved Assessment of Learning Outcomes	_S___

Authorizations

Project Director

Signature: _____

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_____

Signature

Official Authorized to Enter into Contractual Obligations

Signature _____

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Indigenous Geology: Development and Assessment of a Culturally-Resonant, Place-Based Model of Geology Education for American Indian Pre-Service Teachers

Abstract

The proposed project encompasses design, development, implementation, assessment, and dissemination of an introductory undergraduate geology course that integrates culturally-responsive and place-based content and pedagogy, to enhance its relevance and interest to American Indian students in Arizona, principally pre-service teachers. It supports the Learner-Centered Education initiative by piloting an innovative culture-rich approach to enhance the Earth science literacy of American Indian teachers (and later, their students), and by providing previously unavailable assessment research data on the effectiveness of culturally-moderated science teaching at the undergraduate level. The completed Indigenous Geology course will serve as a template for further research and curriculum development.

Identification of Need

Rapidly-increasing American Indian student enrollments at all three Arizona universities (*e.g.,* an 87% increase from 1992 to 2002 at Arizona State University) indicate that these institutions are assuming a major role in educating the next generation of Native leaders. However, the majors and career paths chosen by these students do not always correspond to the most significant needs of their communities. Lack of expertise in the geosciences is a prime example. Tribal agencies that manage land, water, and mineral resources are dominated by non-Native professionals (Riggs and Semken, 2001). This expertise gap is not narrowing: even compared to other minority groups, American Indian students have low enrollments in undergraduate and graduate programs in geoscience (Riggs and Semken, 2001). This underrepresentation exists even though most traditional Native cultures are strongly linked to the Earth, and American Indian peoples possess deep empirical knowledge of Earth processes and systems (*e.g.,* Rock Point School, 1982; Semken and Morgan, 1997).

Native underrepresentation in geoscience undoubtedly begins at the K-6 grade level, with teachers who are inadequately prepared to teach Earth science and who exhibit little enthusiasm for it (Trend, 2001; Trundle *et al.*, 2002). Arizona universities can respond to this challenge, as a significant number of American Indian students choose majors in Education (*e.g.,* 14% of Native students at ASU in 2002). A majority of these students at ASU are members of the Navajo Nation, who plan to return home in response to high demand for bilingual-bicultural educators.

Navajo and other American Indian students' disinterest in natural science has been attributed in part to cultural discontinuity, in which mainstream content and pedagogy appear irrelevant or improper to indigenous students with extensive prior knowledge of nature (Aikenhead, 1997; Kawagley and Barnhardt, 1999). Native educators and scientists (Cajete, 1994; Stephens, 2000; Deloria and Wildcat, 2001) offer an *Indigenous* model of science teaching, which incorporates ethnoscientific knowledge and pedagogy derived from traditional culture, and which draws subject matter from indigenous homelands. The model has been

implemented on a limited basis at tribally-controlled colleges (*e.g.,* Semken and Morgan, 1997), but not at larger and more diverse institutions such as ASU. More importantly, the effectiveness of the Indigenous model for American Indian students, and its impact on other students, have not yet been rigorously tested at the undergraduate level.

Accordingly, we propose to: (1) design and implement an Indigenous introductory-level geology course at ASU, based on traditional Navajo educational philosophy, incorporating Navajo geological knowledge, and focusing on the geology of the Navajo Nation and surrounding regions in Arizona; (2) develop and apply instruments to assess the effectiveness of the Indigenous science model; and (3) provide for dissemination of the study results and curriculum materials at other Arizona universities and colleges, as well as to the geoscience-education community as a whole via publications and the internet.

We will design an introductory geology course that is unique among Arizona universities, strongly resonant for Navajo students, yet fully accessible to other students. The uniqueness begins with organization of lesson topics according to the Navajo ethnoscientific model of dynamic interactions between Earth (Nohosdzáán) and Sky (Yádilhil) that have formed and shaped their home landscapes. This model has direct parallels in Earth system science (Semken and Morgan, 1997). Nohosdzáán processes are internal, and include volcanism, mountain-building, and folding of rocks; Yádilhil processes are external, and include runoff, erosion, and sediment transport. The geological evolution of northern Arizona and environs will be presented as an ongoing interaction between these two natural systems. Twelve places with great cultural significance to Navajos will be chosen to exemplify these dynamic processes, and the landforms and materials they create; *e.g.,* San Francisco Peaks and Ship Rock to illustrate volcanism; Monument Valley to illustrate sedimentary strata and erosion; the San Juan River system to illustrate surface-water resources. Field trips and virtual field trips (incorporating 3-D images, maps, and actual specimens) will be developed for each place. Geologically-related issues of importance to Navajo and other Native peoples, such as coal and uranium mining, and groundwater quality, will constitute a major part of the curriculum. The class will be presented in a studio format (Cummings *et al.,* 1999), where learners move seamlessly between interactive lectures and inquiry-driven lab exercises in a classroom environment designed to evoke Navajo Nation geology and relevant cultural icons. Navajo terms for geological features and materials (Blackhorse *et al.,* 2003) will be introduced in tandem with terms in mainstream use.

Our assessment instruments will include pre-tests and post-tests of student attitudes toward learning and teaching geology and of their performance in the subject, as defined by a set of subject-matter competencies found in the national and state standards and the content of the course (incorporating Indigenous and mainstream geological knowledge). These will be developed early in the project and include multiple formats, such as choice of answer with student-generated reasons to check for conceptual understanding, concept maps to assess relational understanding, and multiple-choice questions to check for factual knowledge. Classroom and field observations of students will also be used to determine the effect of the Indigenous geology approach on student interest. Both quantitative and qualitative analysis will be used to

determine the impact of the course on attitudes and intentions and changes in understanding from pre- to post-tests.

Technical Needs

The capital equipment and facilities requirements of this project can be met by use of existing infrastructure in the ASU Department of Geological Sciences. These include networked computers, digital projectors, laboratory supplies, field equipment, and field vehicles. A teaching lab in the Department has already been set aside for this project. Standard software products (word processors, spreadsheets, web browsers) and visualization software (GeoWall) already in use at ASU will be used. Course materials will be placed on an ASU website for general access as they are developed and tested.

Work Plan

Task	*Where and how task will be accomplished*	*Principal responsibility*	*Estimated time*	*Timeline for task*
Milestone 1: compile data for design of Indigenous Geology curriculum				
Compile place-based geological data for course development	ASU and Navajo Nation; Collect images, samples, and other data in the field; research web and library; consult with Navajo Nation agencies	Semken	100 hours	Spring 2004
		Geol Sci grad student	400 hours	
Compile culturally-resonant materials for course development	ASU and Navajo Nation; Field, web, and library ethnographic research; report to team	Manuelito	100 hours	Spring 2004
Milestone 2: develop curriculum materials and prepare for course				
Write 12 place-based lesson modules	ASU; design PowerPoint slides, web materials, class handouts	Semken	120 hours	Summer 2004
		Geol Sci grad student	400 hours	
Develop field and virtual field and lab exercises	ASU; organize images; design visualizations, design class handouts	Reynolds	140 hours	Summer 2004
Create course website	ASU; download and organize texts and images	Geol Sci grad student	40 hours	Summer 2004
Review all materials for cultural appropriateness	ASU; review written and digital materials; consult with colleagues	Manuelito	160 hours	Summer 2004
Outfit laboratory classroom for course	ASU; create a place-resonant studio learning environment	Geol Sci grad student	40 hours	Summer 2004
Milestone 3: develop assessment instruments				
Develop course competencies	ASU; plan and compile competencies in geology and culture	Semken	40 hours	Summer 2004
		Reynolds	20 hours	
		Baker	20 hours	
		Ed. grad student	80 hours	
Develop instruments to measure student learning and confidence	ASU; learning to be assessed with respect to competencies	Baker	60 hours	Summer 2004
		Ed. grad student	400 hours	
Milestone 4: offer Indigenous Geology course to American Indian pre-service teachers at ASU				
Teach Indigenous Geology course	ASU; Semken will be lead instructor	Semken	120 hours	Fall 2004
		Reynolds	20 hours	
Administer pre- and post-tests; conduct classroom and field observations	ASU; follow assessment protocols developed for project	Baker	40 hours	Fall 2004
		Semken	20 hours	
Milestone 5: analyze assessment data				
Data compilation and analysis	ASU; using assessment research protocols	Baker	40 hours	Spring 2005
		Ed. grad student	400 hours	

Milestone 6: disseminate results and curriculum materials to Arizona universities				
Deliver presentations at Arizona universities and colleges	UA, NAU, Diné College, Northland Pioneer College, Coconino, Maricopa, and Pima County CC Districts	Semken, Reynolds, Baker, Manuelito, grad students	16 hours	Spring 2005
Prepare manuscripts for publication	ASU; Journal of Research in Science Teaching; Journal of Geoscience Ed; Journal of American Indian Education	Semken, Reynolds, Baker, Manuelito, grad students	160 hours	Spring 2005

Key Personnel

- Principal Investigator: **Steven C. Semken**, Ph.D., Assistant Professor, Department of Geological Sciences, ASU, semken@asu.edu, 480-965-7965. Expertise in American Indian geoscience education, curriculum design, and regional geology.
- Co-Investigator: **Dale R. Baker**, Ed.D., Professor, Department of Elementary Education, ASU, dale.baker@asu.edu, 480-965-6067. Expertise in science-education research.
- Co-Investigator: **Stephen J. Reynolds**, Ph.D., Professor, Department of Geological Sciences, ASU, sreynolds@asu.edu, 480-965-9049. Expertise in regional geology, geological visualization technologies, and science-education research.
- Co-Investigator: **Kathryn Manuelito** (Navajo), Ph.D., Assistant Professor, Department of Curriculum and Instruction, ASU, kathryn.manuelito@asu.edu, 480-727-7235. Expertise in Navajo culture and language, and teacher preparation.
- One **M.S. student in Geological Sciences** and one **Ph.D. student in Education.**

Expected Results and Outcomes

The project will result in a completed ASU course by fall 2004, and a compilation by spring 2005 of the curriculum materials and teaching guidelines necessary to offer a similar introductory Indigenous Geology course at any college or university, as well as quantitative data and analysis on the effectiveness of this culturally-resonant, place-based approach for American Indian and other students at the lower-division undergraduate level. These resources will be disseminated in Arizona in the late spring of 2005, by means of workshop presentations at UA, NAU, Diné College, and the Arizona-based community colleges that serve large numbers of American Indian students (including, but not limited to, Northland Pioneer College, Coconino County Community College, and the Maricopa and Pima Community College districts). The course materials will also be disseminated via the Digital Library for Earth System Education (DLESE), and the project results will be submitted in 2005 for publication in the *Journal of Research in Science Teaching, Journal of Geoscience Education,* and the *Journal of American Indian Education.* We expect the following outcomes in support of the Learner-Centered Education initiative:

- Our research will demonstrate that an Indigenous approach to geoscience will enhance interest and retention in the subject among American Indian students, and that American Indian pre-service K-6 teachers will be more confident and better prepared to teach Earth science at their grade levels;
- The Indigenous Geology course will be offered regularly at ASU;
- The capstone workshop presentations will enable other Arizona universities and colleges to offer the Indigenous Geology course, or to modify it to make it more relevant to the Native communities in their service areas.

- The completed project will serve as a template for further research and curriculum development in the area of culturally-moderated and place-based science education.

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