1MINING AND ENVIRONMENTAL EDUCATIONAL MODULES FOR

TRIBAL COLLEGES

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Abstract
American Indian lands contain a vast amount of renewable and non-renewable resources that have consequently been mined (Smith and Frehner). Therefore, it is understandable that tribes are concerned about environmental impacts from mining and their ability to minimize and mitigate these impacts. This has created a need to better understand mining and its environmental impacts. The University of Arizona Superfund Research Program has developed educational modules for tribal colleges focusing on environmental impacts of mining, remediation of mining wastes, and sociocultural impacts of mining. These educational modules are independently packaged units of study designed to enhance the learning process and can be modified and adapted to different learning scenarios and objectives. In addition to providing specialized knowledge, the modules feature hands-on activities, incorporation of technology, student involvement, discussion, and exchange of ideas. Modules are being designed to incorporate traditional ecological knowledge and approaches that promote effective science learning for native students. These modules can be used as stand-alone units or to augment existing associates of science programs (e.g. biology, chemistry) currently offered at tribal colleges. They can also be modified for use in K-12 education or for non-tribal audiences.

Introduction
Resource development, such as mining, has had tremendous environmental, social, and cultural impact on tribal communities. By law, mining companies conduct environmental assessments to determine the magnitude of anticipated effects, however, environmental assessments do not adequately account for the social and cultural impacts of mining. Tribal communities are deeply connected to the environment, not only for sustenance, but also the environment can define their identity and shape their culture and traditions. Thus, social and cultural consequences are an important component of a complete evaluation of mining impacts on tribal communities.

Today, tribes are asserting their sovereignty and governance regarding mining through negotiation and tribal consultation. Tribes are beginning to play an active role in the decision-making process because they are aware of the potential negative and positive impacts of mining and are working to regain control of tribal natural resources. Unfortunately, the majority of tribal communities’ past experiences with mining have been traumatic. Tribal communities blame development ventures and governments for targeting and exploiting their rich natural resources. The high commodity cost of these natural resources has often motivated companies to initiate development quickly without taking the time to engage and consult tribal communities as partners (Smith and Frehner). This mixture of historical experiences and corporate exploitation has created heightened tensions between mining companies and tribal communities. As a result, tribal communities are now working together to define what proper consultation is under the UN Declaration on the Rights of Indigenous Peoples. It is imperative for tribes to understand important aspects of tribal consultation, negotiation, and mineral rights so they can make informed decisions about resource development.

Methods
Four educational mining modules are being developed for tribes in Arizona including: (I) Copper mining and processes; (II) Environmental impacts of mining; (III) Remediation; and (IV) Socio-cultural impacts of mining. Each module includes: 1) an instructional guide that has a summary, objectives, and background information, supplemental materials, and lists other available resources such as available media such as video or other technological learning tools; 2) a powerpoint presentation that parallels the instructional guide which the instructor can use and modify; 3) a hands-on learning activity with discussion questions; and 4) an excerpted lecture for immediate use in a classroom. The modules also incorporate suggestions for field trips to mining sites on or near tribal lands as a basis for
discussion and study. Each module contains basic information for students who have no background on mining processes.

The modules described here were created for a specific tribal college in Arizona but can be modified for other interested tribal audiences. We began by gathering existing data and maps regarding mining activities on tribal lands in Arizona. The modules were then developed in a series of steps.

The first step was to choose the module topics. The topics for the modules were developed based on consultation with tribal colleges and their needs and interests. We also solicited feedback from local and state mining institutes and agencies.

Following identification of the module topics, the next step was to perform a literature review of each topic. This was used to prepare a written description and powerpoint presentation on the module topic that was targeted to a community college level audience. The instructional guide is a written description meant to supplement the powerpoint presentation for the students and to serve as background material and a guide for instructors.

The third step was to identify university, industry and tribal experts in the field of mining, mining engineering, geology, and tribal mining issues to serve a technical review committee (TRC). The TRC was asked to review the written and powerpoint components of the module and provide feedback. Based on the feedback, the modules were refined and improved.

The fourth step was to develop hands-on activities to accompany and supplement the module topic. Each activity was developed to complement the information presented in the module. Step by step illustrated instructions for each activity were included and supplemented with discussion questions.

The fifth step of module development was to incorporate native science, indigenous learning methodologies, and tribal culture. This includes native ways of knowing, using analogous examples of scientific concepts, land-based learning, and tribal language. A tribal language and culture expert was contacted to provide a review of the modules and provide expert advice on incorporating native ways of knowing and traditional ecological knowledge.

The final step, once the modules were completed, was to present an excerpt of the modules to a tribal community college class. Instructor feedback was solicited and student learning was evaluated using pre- and post-presentation evaluation using a clicker system to allow anonymity.

During this process, it was important to have consistent communication with the tribal college for guidance and input. Meetings were held with the tribal college to ensure that the modules fit the educational needs of the students.

The copper mining and processes module is nearing completion. A committee comprising of mining and environmental experts from the university, industry, and tribal sectors has technically reviewed the module. An excerpt of the module was presented at the tribal college in an existing environmental science course. We are currently working to further incorporate native science and indigenous learning into the module. The environmental impacts of mining, remediation, and sociocultural impacts are in various stages of development and will be completed by early 2015.

Mining Modules

The following sections give a brief introduction to the learning objectives and content for each of the four modules.

Copper: Mining and Processes Module

Copper mining is important in Arizona and has affected tribal nations. The copper mining educational module provides information for tribes regarding copper mining and copper processing. The learning objectives of this module are to: 1) Understand basic information about copper, occurrence, and use; 2) Learn the history and current status of copper mining in the United States, Arizona, and on tribal lands (Fig. 1); 3) Understand the five stages of copper mining including prospecting, development exploration, exploitation, and closure; and 4) Understand different types of copper processing for oxide and sulfide ores.
The hands-on activity for this module is “The Chemistry of Copper Electrolysis” (Fig. 2 and 3). The learning objectives of this activity are to: 1) Apply basic chemistry principles to understanding the process of electrolysis, and: 2) Understand how electrolysis is used in the processing of copper ores. As can be seen from Fig. 2, the materials needed for this lab are accessible and low cost. Fig. 3 shows some of the illustrations that accompany the lab to ensure that the setup is easy to follow.

Examples of multiple choice questions used in the pre- and post-test evaluation include: 1) What property is copper best known for?; 2) What is copper used for?; 3) What is the average worldwide consumption of copper?; 4) What State produces the most copper?; 5) Which of the following is a method to purify and refine copper to the 99.9% level?

Environmental Impacts Module

Mining is an essential, often overlooked, aspect of our modern culture and though mining plays a vital part in our current technological society, many people fear mining. This fear often comes from a misunderstanding of the associated environmental risks mine sites pose and from the media’s portrayal of a select few mine sites related to environmental degradation. Though there are a few, rare instances of mishandling of mine sites, today many environmental impacts related to mining are minimized as a result of well-designed and well-operated mines in conjunction with more strict mining regulations. The majority of environmentally harmful mine sites are termed ‘legacy sites’. These sites that were in operation prior to more stringent policies and regulations and this legacy serves to tarnish the image of more modern mining operations.

The learning objectives for this module are to: 1) Understand basic information about the environmental impacts of mining; 2) Learn the history of environmental impacts related to mining areas in the United States, Arizona, and on tribal lands; and 3) Understand the physical, chemical, and social impacts mining has on the environment. This module describes common environmental effects associated with mine sites, such as acid rock drainage and dust emissions, and illustrates how legacy and modern mine sites differ in terms of the impact of these effects. In addition to this, the module also introduces ways in which modern mining companies combat and plan for the environmental impact of mines, attempting to minimize their footprint for the present and the future. From mine planning to hazard assessment to remediation, a course of action is set out years or even decades in advance of any actual mining activity and throughout the mine life, and even afterwards, strict regulations are implemented and followed. In summary, the module explains possible environmental impacts, but also ways companies are striving to minimize or eliminate them in our modern society.

Remediation Module

The environmental impact, degradation, and hazards of mining are dependent on the type of mining, environmental setting, and mined materials. Mining can adversely affect plant and animal life, putting human and environmental health at risk. Today, steps are taken throughout the life of a mine, from planning to feasibility studies, to ensure that a blueprint is in place for limiting environmental degradation and ensure remediation is done properly.
The learning objectives for this module are to: 1) Define ecosystem and ecosystem services; 2) Define remediation in the context of mining and understand its importance to the community; 3) Understand different available remediation methods and techniques; and 4) Understand the physical, chemical, and biological aspects of remediation.

Ultimately, the goal of the remediation process is to attain a self-sustaining and self-repairing landscape. Remediation stabilizes disturbed lands against the hazards of wind and water erosion often with intended re-use in mind. Examples of remediation approaches used in the mining industry include vegetative covers, landscape design and treatment of impacted surface and groundwater.

Sociocultural Impacts Module

Repercussions of the mining industry are not only economic and environmental but also social and cultural. For instance, an influx of male workers can lead to social problems due to inadequate infrastructure, services, education, health and growth of prostitution and bars. The cultural strain and stress on Indigenous communities tends to be more severe than in non-Indigenous communities due to lack of resources (McMahon and Remy).

The learning objectives of this module are to: 1) Identify social and cultural impacts of mining; 2) Understand the effects of mining, both positive and negative, on communities; and 3) Recognize impacts from mining unique to Indigenous communities.

Sociocultural impacts change the interaction between people (social) and the collective set of values, knowledge, attitudes, and language (cultural) of a community. Different mining-induced sociocultural impacts can occur during each of the phases of mining from prospecting and exploration through development, exploitation and closure. The well-being of a community is holistic and key impacts of mining that are felt by people include health, water, air, legal, land, political, and overall well-being (Figure 4).

Figure 4: Mining-Induced Sociocultural Impacts and Components of Well-Being

Conclusion

Our audiences, both Indigenous communities and the mining industry, have indicated the importance of developing informational materials on mining that are accessible and relevant to Indigenous communities. This has led to the development of four mining modules that can be used as stand-alone educational units to supplement environmental science, chemistry or social science curricula at the community college level. The modules could also be combined into a semester long class on mining, its benefits and consequences. These units could also be adapted for K-12 use. Finally, the modules will be available on-line for the general public to access at: http://superfund.pharmacy.arizona.edu/.

Appropriate inclusion of the social and cultural impacts of mining, in particular for Indigenous audiences, can lead to a better informed community. A well-informed community can make better choices about whether or not to allow mining on their lands and can develop more sophisticated ways to take advantage of the benefits of mining and minimize the negative aspects of mining.

References

