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STEAM and Environmental Justice in an Interdisciplinary Context

Abstract

This course proposes an interdisciplinary perspective, envisions unique synergies between environmental justice concepts and STEAM projects on mining, and aims to solidify a foundation based on justice, equity, equality, and empathy for STEM students and faculty. Our (S)TEAM made of professors in three academic departments underscores interdisciplinary and diversity connections through an interdisciplinary team-taught course, units on environmental justice related to mining, teaching of literary texts, and STEAM projects. We also involved faculty, alumni, and our campus and city community through STEAM exhibits.

Keywords

STEAM, environmental justice, interdisciplinary teaching

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STEAM and Environmental Justice in an Interdisciplinary Context

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Abstract

We describe a course with an interdisciplinary perspective that envisions unique synergies between environmental justice concepts and STEAM projects on mining, and aims to solidify a foundation based on justice, equity, equality, and empathy for STEM students and faculty. Our (S)TEAM made of professors in three academic departments underscores interdisciplinary and diversity connections through an interdisciplinary team-taught course, units on environmental justice related to mining, teaching of literary texts, and STEAM projects. We also involved faculty, alumni, and our campus and city community through STEAM exhibits.

Course Description

STEAM and Environmental Justice in Mining is a collaborative course taught by professors from three departments, including humanities, engineering design and society, and mining engineering at Colorado School of Mines, a STEM institution. In addition to research excellence and advancements in STEM fields, the university prioritizes discovery and innovation in STEM and seeks to expand course offering and diversify course delivery. We aim to advance the mission of the institution with our interdisciplinary approach which addresses the changing landscape of engineering education and a complex presentation of engineering problems. Through a STEAM teaching approach, our course breaks down traditional boundaries of science and art amplifying the connecting aspects of the students' intellectual capabilities such as imagination, creativity, wonder, and collaboration. Our unifying goal of positive future impact encompasses multilayered and original approaches to solve difficult engineering and environmental problems.

Our course introduces students to situations in which they tell stories on environmental justice not only through technology but also through their artistic vision. One of the learning objectives of the class is to help students create new, visually pleasing, and environmentally just STEAM projects on mining that represent stakeholders equally and equitably. The course raises awareness about environmental challenges; empowers students' self-expression, creativity, and collaboration; promotes a collaborative dialogue on environmental justice, and mining; and develops interdisciplinary approaches for students' understanding of the human-environment relationship.

STEAM and Environmental Justice in Mining envisions unique synergies between environmental justice concepts and STEAM projects about mining and aims to solidify a foundation based on values such as justice, equity, equality, empathy, and social license to operate a mine for STEM students and faculty. Our (S)TEAM made of professors from three departments underscores interdisciplinary connections through units on environmental justice related to mining, air pollution, literary texts, and STEAM projects. We also involved faculty, students, and our campus community through STEAM exhibits. Our ambitious project brings visibility to humanities pursuits in our STEM institution, enhances our own research and teaching agenda, and provides other researchers a novel critical framework for STEM courses on energy and the environment. Our course showcases a model applicable across

departments and lays the groundwork for future collaborations among STEM and humanities faculty, students, artists, activists, environmentalists, and community members.

Course Materials

The course presents a nuanced understanding of mining processes by analyzing the environmental effects of mining on air and water quality, noise, neighboring communities, and individuals. The combination of units on environmental justice theory related to mining and STEAM projects are reflected in our course work and assignments. While each week, instructors took turns lecturing and leading discussions, we also taught classes together and made connections among mining engineering, literature, and environmental engineering. Case studies on mining included:

- Preserving the Hambach Forest vs. supplying electricity in Germany
- The Brumadinho Dam failure in Brazil
- Colorado acid mine drainage and its impact on local communities
- Air pollution from mining affecting communities around the world.

Students also read and analyzed *De Re Metallica*, a 16th-century textbook on geology, mining, and metallurgy by Georgius Agricola, a text translated from Latin into English by Herbert Hoover (the former president who was also a mining engineer) and his wife, Lou Henry Hoover, a Latin scholar. The text is well known for its amazing drawings of prospecting, mining, machinery, and mineral processing. At Colorado School of Mines, students see this book at graduations, where its closing marks the end of the formal ceremonies.

Humanities and the arts create stories that have the potential to illuminate and transform our values and mannerisms. A story about a woman working in a mine and enduring sexism or a Navajo tribe suffering from uranium mining makes us cry, pause, inquire, and investigate ourselves, others, and our surroundings. Meaningful integration of environmental justice in mining practices and literary stories on mining or air pollution provide a wider awareness and a more acute understanding of environmental challenges along with the social and political dilemmas associated with these challenges. Our literary texts included novels such as *Ceremony* by Leslie Marmon Silko, a foray into Native American communities, *Postcards* by Annie Proulx, a story on the American West and the mining of gold, and *Angle of Repose* by Wallace Stegner who details on the adventures of a mining engineer's wife in the towns of the American West. We also discussed the novella, *The Old Man Who Read Love Stories* by Chilean author. Luis Sepulveda, who writes about how indigenous populations of Ecuador are threatened by gold prospectors and developers and the short story collection *Sub Terra: Mining Scenes* by Chilean writer Baldomero Lillo who describes realistically the harsh lives of generations of miners. In the non-fiction book, *Holding the Line: Women in the Great Arizona Mine Strike of 1983*, Barbara Kingsolver explores how women's lives in Arizona mining town were transformed by the strike against Phelps Dodge Copper.

These literary texts also constitute a framework for class discussions and provide a human face on complex environmental dilemmas. In other words, it was easier for students to empathize with people affected by climate change, for instance, when they related to individuals and their stories.

STEAM Projects

In addition to course-specific assignments, we encouraged students to create STEAM projects that visually describe environmental injustices and propose solutions to address and mediate them. Over the course of the semester, students wrote three synthesis responses in which they critically analyzed connections among environmental justice, literature, film, mining engineering, and environmental aspects of mining. They also created a STEAM project which reflected their synthesis connections. The students' research papers answering a research question about a mining issue or a case study about mining also included a STEAM creative component in connection to this research paper.

The students' STEAM projects varied and included: paintings, sculptures, installations, collages, poetry, performances, skits, plays, websites, stand-up comedy, music, knitting, cooking, etc. More specifically, students drew maps and Venn diagrams to illustrate connections among mining and environmental justice; wrote and performed skits to show the social impact of mining; and cooked brownies to indicate technical aspects of mining and shared the brownies to represent miners' work for mining companies. Another appetizing endeavor was fried rice as a metaphor for mining and pollution; the chef asked the other students to separate the ingredients in the rice in an effort to show that it is difficult to separate mining from air and water pollution. One student created a dark skyline and a drew three generations of miners: a darkened grave for the grandfather, a father covered in dark colors, and a son who is nearly white to indicate how over time, the family is tainted and burdened by working in the mine until each person passes away. Another student acted as a mining executive giving a talk on corporate social responsibility at a fictitious Amazonian mining operation to underscore the interest of mining executive in their stockholders, not their stakeholders. Many of our students' STEAM projects were exhibited in our library. These STEAM exhibits reflect the work of a new generation of engineers and informed citizens that will value justice, equity, empathy, and creativity and develop interdisciplinary projects involving the humanities.

Importance of STEAM and Humanities in STEM Disciplines

With the intersection of our disciplines and the infusion of STEAM in the curriculum, we initiated a proposal for a long-term model on the interactions between humanities and STEM disciplines. In their discussions, papers, and STEAM projects, students advocated for the active and constructive participation of stakeholders involved in environmental justice related to mining. Literature and other humanities disciplines helped them tackle environmental debates and transform them. Humanities champions are in a unique position to teach stories about environmental disasters and the marginalization of indigenous and low-income communities and at the same time involve future engineers in being part of just solutions. Students arrive at more complex solutions when they understand social and cultural aspects of engineering problems or environmental challenges faced by local communities.

The stories told by writers and artists have the power to inform, educate, and effect change. Janet Zandy powerfully writes that "No book can reattach the human hand severed on the job, but it can trace the process of dis/memberment and remembering, and see the hand's potential for graceful movement, its delicate rough beauty, and its hidden wisdom" (Zandy, 2004; p.5). Clearly, no book can reattach a severed hand, but a book and a painting, for instance, can tell vivid stories about that hand and body and about the painful process of losing a limb. And books can offer healing practices and make us whole again. Humanities and the arts can enrich students' empathy toward the people involved in

the mining industry; humanities and STEAM projects have the power to sharpen students' understanding of how individuals feel, react to, shape, and politicize energy issues and mining practices. Not only do humanities and the arts – novels, short stories, poems, paintings, sculpture, music, dance, and other art forms – build understanding of situations and empathy, but they are also pathways to encompassing actions and solutions. They impact social consciousness and become part of activism and social change. Thus, by placing characters and main themes in certain historical, social, and cultural frameworks, writers and artists offer various debates and creative solutions about how we view mining and energy consumption. Furthermore, by placing students in situations in which they tell stories on environmental justice not only through technology but also through their artistic vision, our (S)TEAM hopes to raise awareness about environmental challenges and empower students' self-expression, creativity, and collaboration. Informed by humanities and the arts, our future scientists and engineers develop a sensitivity to social impacts regarding complex scientific problems in society and are more likely to develop ideas and solutions that balance scientific progress with equity, social and environmental justice, and sustainability.

Concluding Remarks

We introduced environmental, social, and cultural concepts into our teaching of technical issues such as mining safety and mines design ventilation related to environmental pollution conditions. We infused our curriculum with STEAM inspired learning and projects on environmental justice that offer engineering students opportunities of both self-discovery and discovering multiple perspectives and stakeholders connected to environmental justice. Our vision is not to align humanities and STEAM to mining or STEM, but to underscore the transformative power of humanities and create niches in which humanities disciplines and artistic projects inspire students, faculty, and community members to include values such as justice, empathy, equity, and equality in their conversations about environmental challenges.

Reference:

Zandy, J. (2004). *Hands: Physical labor, class, and cultural work*. Rutgers University Press.