

Solar-Powered Shadow Puppetry in High School Science Classroom

“Illuminates” a Navajo Student Energy Forum

Key words:

education outreach, alternative energy, applied theatre, forum theatre, solar education, shadow puppets

Introduction:

Enacting an energy forum using solar-power illuminated shadow puppets can serve as an effective method for actively engaging Navajo students in understanding the applicability and relevance of alternative energy in their lives and their communities. This article focuses on an education/outreach project that took place over the course of two days in a science classroom at _____ High School (_HS) in _____, New Mexico with predominantly Navajo students. Solar powered shadow play is achieved by manipulating shadow puppets between a solar-powered light and a cloth screen, such that the shadows are cast onto the screen. The audience, on the other side of the screen, can view the shadows that are cast by the puppets and can easily hear the voice given to the puppet by the performer. Puppets are created to represent various stakeholders in energy issues within the students’ own community, such as the Coal Burning Plant Owner or the Voice of the Children. The drama improvised by the students through the shadow puppet characters is an Energy Forum seeking to resolve an energy issue that is identified by the students as being relevant to their community. This art form literally uses solar power to illuminate myriad perspectives surrounding energy access, use, impact and governance. Not only do students get hands-on experience with solar technology, but they are also engaged in high-level learning and critical engagement through the act of identifying, researching and

dialoguing various views surrounding energy access. This method can be used to satisfy core requirements within the science curriculum that requires students to apply what they have learned about alternative energy in the classroom to their own lives.



“Teaching our young generations about energy efficiency and renewable energy is not only a critical component of “environmental literacy,” it has also become a matter of national security and economic stability. In times of recession, political instability, and fluctuating energy prices,

it is essential that we understand the role energy has in our lives so that we can become proactive change agents towards a more sustainable energy future' (Ford 2002, p.2). On the Navajo Nation this is especially true since so much of the current economy is based on extraction of energy resources—namely coal and uranium-- and the generation of energy from these resources. Jobs and revenue from energy production are central issues in the Navajo Nation. Energy mining and production is likewise responsible for devastating environmental and health damages, such as contamination of water tables, pollution, and scaring of the land from strip mining. Also energy-generating stations from coal, such as the 2,250-megawatt Navajo Generating Station, near Page, Arizona create massive amounts of air pollution (Hurlbut & National Renewable Energy Laboratory 2012). There are citizen advocate groups, such as the Black Mesa Water Coalition, that are encouraging the adoption of more renewable energy development that they claim will supply just as many jobs and as much revenue as coal (Black Mesa Water Coalition 2014). Multiple studies have found astonishing potential for both solar and wind energy production on the Navajo Nation (Johns 2013).

Awareness and education about renewable energy is essential to begin making this shift to clean energy. Although there are many clean or alternative energy-curricula available, such as Solar in the Schools (Solar Energy International 2013), the U.S. Department of Energy Solar Decathlon (U.S. Department of Energy 2013) and - more specific to the New Mexico area - a list of possible activities in New Mexico Energy and Sustainability Education Directory (Ford 2002), we were not able to locate any that utilized theatre, which is a dynamic form of active learning (Gressler 2002). Research shows that active learning helps develop critical thinking (Bonwell & Elison 1991), which we believe will serve the Navajo youth as they apply what they learn about

alternative energy in their high school science courses to the energy challenges they identify in their own lives.

The medium of shadow puppet theatre was chosen for several reasons. First of all, using a solar-powered light as the light source gives students direct experience with this alternative energy technology. They gain hands-on experience with the use, strength and applicability of a small-scale solar powered light. The shadow puppet performance could also be understood as a sort of microcosm of our solar system. The sun's energy - represented by the solar-powered light - is the source of nearly all other energy forms, just as the solar powered light is the source of illumination that makes the entire show possible. As stated in the Michigan Environmental Education Curriculum, 'All the energy in oil, gas, and coal originally came from the sun, captured through photosynthesis. In the same way that we burn wood to release energy that trees capture from the sun, we burn fossil fuels to release the energy that ancient plants captured from the sun. We can think of this energy as having been deposited in a natural solar power bank over millions of years' (Michigan Environmental Education Curriculum 2013). This could be likened to the battery that collects the energy from the sun through the solar panel and stores that energy to later power the solar-powered light. This comparison between the sun's energy and solar shadow puppet theatre could serve as a compelling introduction by the teacher as to why this form is an appropriate and effective medium through which students can actively explore alternative energy forms, especially solar energy.

While performing behind the shadow screen, students are unseen by their audience, which seems to lessen the self-consciousness of the students and allow them to be more expressive than they may be if in full view. Also, the use of puppets can make it easier for otherwise reserved people (which is how the teachers described their Navajo students) to be expressive. There is a

separation between the self and the puppet as the performing body, which can give the experience that it is the puppet, not the person, actually performing. Also, the physical dexterity required to effectively manipulate a puppet is consuming and can leave little room for self-consciousness. Our final reason for utilizing solar-powered shadow puppetry is that the elements for performance are capable of creating an enticing visual spectacle, yet are inexpensive, compact and accessible, such as the solar-powered light, a sheet of white cloth, and recycled cardstock for making the shadow puppets.

This project was developed through a cooperative effort between the University of _____, a non-profit organization Eagle Energy, a Navajo environmental group Eastern Navajo Uranium Workers (ENUW), and _____ High School, especially one specific science teacher. Funding for this project was from the University of _____'s Outreach Program. Author #1, Assistant Professor of Theatre at the University of _____, specializes in the use of applied theatre for clean energy awareness and presented her shadow puppet theatre musical, *Clean Energy Access: The Musical* for an all-school assembly at _____ HS in April of 2012 just one month before the intervention that is the subject of this article. Author #2, a Ph.D. theatre student at the University of _____ and a high school teacher, joined Author #1 in designing this project in the spring of 2012. John-David Johnson - who had years previously taught in a grade school in the Navajo Nation and is also a Ph.D. theatre student at the University of _____ -, assisted in implementing the education/outreach project, primarily serving as the facilitator during the Energy Forums. Navajo Eagle Energy staff members advised the conception, development and execution of much of this project. The University of _____ team was present in two of the science teacher's classrooms - consisting of 65 students total - for two consecutive days in May of 2012 at the completion of their study of alternative energy. Students ranged in age from 15-20 years. We

documented this project by having Author #1 take notes during the session and through photography. Author #2 wrote about her impressions afterward the sessions. We also conducted a key informant interview with the science teacher before and after the project.

Site and Population Description:

The Navajo Nation, otherwise known as *Diné Bikéyah*, or Navajoland, extends into the Southwestern US states of New Mexico, Arizona and Utah, covering over 27,000 square miles and is North America's largest native community (Iverson & Roessel 2002). Due to multiple factors, economic hardship is pervasive throughout the nation. According to the most recent data available through the Navajo Nation, in 2001 the unemployment rate was 42.16%, per capita income was \$6,625, and 42.9% of the population were living below the poverty line (Navajo Nation Economic Development 2013). The website for Eagle Energy claims that about 38% of households in the Navajo Nation lack electricity, and 'despite requests for modern, grid-based power, the remote location of many Navajo households makes electricity extremely expensive, forcing many people to rely on wood and kerosene for energy' (Eagle Energy 2013a). In homes without access to electricity, kerosene is primarily used for illumination at night. An array of risks are associated with fuel-based lighting which includes burns, indoor air pollution, and non-intentional ingestion of kerosene fuel by children (Mills 2012, p.2).

(Map 1 Near Here)

This education/outreach project took place in _____, New Mexico, which is in the Eastern Agency. Due to the various ways of allotting and classifying Navajo Land within the designated reservation boundaries, the Eastern border became a patchwork of reservation and non-reservation land, known as a ‘checkerboard area’ (Wilkins 2003, p.58). _____ falls within that checkerboard area, such that _____ High School is actually a New Mexico district school rather than a Bureau of Indian Education School. In 2012 school officials at _____ High School reported that there were 353 students at their school and that 93% of them were Navajo. Additionally the most recently available information indicated that 17% of the students lived in homes that did not have access to electricity. School officials noted that many more students in homes *with* access to the electrical grid may lack financial resources to consistently pay their electrical bill and, thus would also be without access to electricity intermittently.

Education/Outreach Goals and Theoretical Foundation:

Our main goal was to develop an education/outreach activity for a high school science classroom using solar-powered shadow puppet theatre as a tool for students to explore the applicability and relevance of alternative energy in their lives and their community. We designed this two-day project for students to actively consider energy issues that they identified from a variety of perspectives. This all took place within the classroom and was primarily focused on the process of performing the Energy Forum, rather than creating a polished finished performance.

We aligned our goals for this activity with several benchmark-learning objectives from the New Mexico Grades 9-12 Science Standards for instruction in alternative energy (New Mexico 2003), especially Strand III Science and Society in which 9-12 Benchmark I states ‘examine and

analyze how scientific discoveries and their application affect the world, and explain how societies influence scientific investigation and applications' (New Mexico 2003, p.13).

Additional goals include leading students in evaluating the influences of technology, such as petroleum and nuclear energy, on their society and in describing how human activity affects health and the environment. This project also invited students to describe how scientific knowledge helps decision-makers with local, national, and global challenges; explaining how societies can change ecosystems; and describing how environmental, economic, and political interests impact resource management and use in New Mexico (New Mexico 2003, p.13).

There is currently legislation in New Mexico to adopt the Next Generation Science Standards (National Research Council 2014b), which is a Carnegie Foundation-funded attempt to update national standards for science education. Future work with in New Mexico would need to align with those standards if they are adopted. However, even the Next Generation Science Standards could still be easily aligned with this project, namely PS3.D: Energy in Chemical Processes and Everyday Life, ESS3.A: Natural Resources , ETS1.A: Defining Engineering Problems (National Research Council 2014a).

In designing how to achieve these goals, we grounded ourselves in the educational theories of Brazilian Paulo Freire, author of *Pedagogy of the Oppressed*. Freire questions the 'banking concept of education' in which knowledge is deposited into students' minds (Freire 2000, p.72) by oppressive educational systems that treat students as objects. In contrast, Freire advocated for a problem-solving style of education that encouraged dialogue between teachers and students, and that engaged students in critical thinking. Freire insisted that a dialogic relationship between teacher and student is necessary for transformation to a critical consciousness. Our goal was that

our central activity--the Energy Forum-- would facilitate this dialogue between students and their teacher.

We also sought to align our work within Navajo values,--primarily led in this by our Navajo partners-- and to lead students in problem-solving abilities in the context of culturally relevant experiences and topics related to alternative energy. Through our Energy Forum, we designed the student experience so that students would face both positive and negative consequences of interactions between various stake-holders in the Energy Forum so that traditional Navajo notions of *Ke*, kinship solidarity and social harmony, would be included in the process (Austin 2007, p.12). In our design of this educational outreach project we strove to achieve the conditions described in the article “Classroom Inquiry and Navajo Learning Styles” such as “where talk is shared *between* teachers and students, where the expression of students’ ideas is sought and clearly valued, where student’s social environment is meaningfully incorporated into curricular content, and where students are encouraged to use their cultural and linguistic resources to solve new problems” (McCarty et al. 1991, p.53).

Our choice of a forum was greatly influenced by Augusto Boal (1931-2009), a theatre scholar and practitioner who was heavily influenced by Freire’s work. In his book *Theatre of the Oppressed* (Boal 1985) Boal advocates for a consciousness-raising form of theatre that encourages dialogic opportunities for communities not usually engaged in critical analysis of their own lives, or the structures that influence and limit their lives. In this form of theatre, the interactive process is more important than the resulting product. Indeed, in many cases as with this activity, there is no culminating public performance; it is the benefits from engagement in the process through which the learning objectives are realized. Boal’s methods include Forum Theatre in which those who witness a scene are encouraged to critique the solution offered and

suggest better versions that are then acted out either by the actors or the spectators. Given that we were working with shadow puppets rather than live actors, we adjusted Boal's basic idea for Forum Theatre.

Education Outreach Design and Outcomes:

We met with the principal of _____ High School and arranged for several aspects of our outreach in the schools: an all-school assembly performance of *Clean Energy Access: The Musical* performed by _HS and University of _____ students on April 20, 2012, a solar lights check-out system through the school library so students could check out a small-scale solar-powered light to take home for a week (Eagle Energy 2013b), and an interactive solar-powered shadow puppet Energy Forum with _HS science teacher May 17 and 18, 2012. This article focuses solely on the last aspect of our outreach efforts. However, it should be noted that all _HS students who attended school on 20 April 2012 - which included the students in the science classes we worked with - witnessed the performance of *Clean Energy Access: The Musical* and were introduced to the artistic medium of shadow puppet theatre and how it could be used to explore energy issues. The student response to this performance was extremely positive, likely because it included several _HS students in the cast and a popular football player in the lead role as the Sun. The library solar light check-out system was intended to make solar technology available for students to experience and to use with their families at home. Unfortunately, the solar lights checkout system through the _HS school library was not operative when we did the Energy Forum. Even though Eagle Energy volunteers had delivered the solar lights to the school librarian weeks earlier and explained how students could check out the lights, the work had not yet been done to allow the lights to be checked out.

Author #1 and Author #2 had provided the science teacher with a Home Energy Survey that we designed for the students to complete with their families to assess their current energy needs, access, use and their desired energy access and use. The survey was specifically designed to be gender sensitive to consider both genders' perspective and values regarding energy use and access (see Appendix 1). In addition to filling out the survey as homework, each student was to check out a Nokero solar-powered light (Nokero 2013) to take home for their family to interact with, use, and consider its appropriateness for their energy needs. An Eagle Energy volunteer had delivered the lights to the science teacher two weeks prior to our visit. Our hope was that this would engage multiple families throughout the area to engage with the issue of energy access and possible clean energy solutions. Our intention was for students to complete the surveys before we arrived so students could use the results of the Home Energy Survey as material for the Energy Forum they would be performing in class. This survey was intended to be a mechanism, in part, for including and honoring the traditional gendered knowledge of the community members who have generations of experience and expertise of energy issues in the area (Wildcat 2009). When we arrived for our first day in the classroom, we learned that very few students had completed any part of the Home Energy Survey, likely because it was not being graded, even though we had previously been assured that it would count towards students' grades. This was probably due to the fact that we came to visit their classes so close to the end of the school year. Therefore, we had to rely on the students' knowledge of their energy access concerns since we would not be able to draw upon the responses to the surveys.

The instructional process for day one focused on preparing the students to participate in the Energy Forum on day two. In order for this to successfully occur, we chose to begin our workshop with several ice-breaker/theatre games, to help the students become more comfortable

using their voices and bodies in the learning environment. We began with the Name/Action Game in which participants stand in a circle, and take turns saying their name while also doing an action. The game is completed when each participant can say the name and while doing the action of the other participants in the group. Although most of the students seemed initially reluctant to actively participate - especially the female students -, the student engagement in the class activity was aided by the enthusiastic participation of what one might describe as the 'class clown'. The planned ice breaker/theatre games during the introduction period seemed absolutely necessary, and for both classes we found that it took more 'warming up' than expected to help the students become more outwardly expressive.

Author #2 introduced how the students would be performing an Energy Forum using shadow puppets. Because many students were not familiar with the term 'forum', we found it helpful to spend roughly ten to fifteen minutes brainstorming definitions for this word. With the desire to help students see the value of theatre and open forum discussions, Author #2 decided to provide a brief background regarding the work of Augusto Boal. Some students seemed intrigued by this, especially when they connected his work to how many of them feel when they are not able to share their voices on important issues in their community. During this period of the workshop, we tried to emphasize the idea of rehearsing democracy, and the value of rehearsing the expression of various stake-holders' perspectives in a respectful forum where all could have their views and values considered.

The students' ideas were written on the board and the class came to a consensus on their class definition of 'forum'. Also valuable was a discussion on the necessity of forums related to energy issues. Author #2 asked why the classroom should have a forum on energy and what aspects of energy should be considered? With coaching from Author #2, the students were able

to generate the following questions for possible use during their Energy Forum that would occur the next day.

1. What forms of energy will contribute to the economy of our community?
2. How will forms of energy effect our environment?
3. How can we best use our natural resources to benefit our community?
4. What forms of energy currently exist in our community?
5. What type of energy suits the geography?
6. What are the local resources?
7. What is the cleanest form of energy for the community?
8. What is the safest?
9. What is the most economic?
10. What is the best?

Each class successfully identified specific energy issues relevant to their community and their lives. The first class chose to consider a 5% tax increase to create a local solar energy farm. The second class chose to consider the economic value of mine work and the health risks for workers and the environment. In order to dramatize a forum considering these issues, Author #2 led the students in creating the 'guest list' for their Energy Forum that was not limited to human members of the community. What follows are some examples of the types of guests that were represented: Conservationist, Solar Energy, Wind Energy, Fossil Fuels, Oil, Coal, Nuclear Energy (see Figure 2), Natural Gas, Biomass Fuel, Hydro Power, Business Owners, Grandparents, Politician, Mine Worker, Teacher, Children's Advocate, The Poor, Student, Neighbor, Mine Owner, Developer, Construction Worker, Scientist, Environmentalist, Children, Parents, Home Owner, and Refinery Representative. The students cast themselves (and

sometimes each other) in the roles of those ‘invited’ to the forum. Students were asked to consider their character’s objectives, agendas, values, experiences, and reputation in relation to this energy issue. We told them they could create a cheat sheet to assist them while performing their puppet during the actual forum. We gave students guided time in class to form groups to discuss and consider what they would have their character say during the forum.



Though we had intended to lead the students in creating their own shadow puppets this first day, we simply did not have enough class-time to supervise that process. Author #1 had created shadow puppets for some of the characters that we anticipated using, and during the evening of the first day, Author #1, Author #2 and Johnson made shadow puppets for the rest of the guests identified by students. We simply drew an outline of each character on the cardboard, cut them out, and taped them to wooden skewers to both support them and to have a handle with which to

manipulate the puppet. We attached articulated, jointed arms to some of the puppets so that they could gesture by moving a wooden skewer attached to the hands. Some even had an articulated jaw so that the puppet's mouth could be opened by pulling down with a string (see Figure 3).



Day two of the workshop began by giving each student the shadow puppet for her or his character and allowing each student a bit of time to rehearse manipulating the puppet and plan what the character could say. Author #2 acted as the moderator in front of the shadow screen

who announced the beginning of the Energy Forum and reminded everyone of the issues to be considered. She stated the goal of the forum and explained how various guests would be invited to debate this issue in groups, explaining that at the completion of the forum that the class would gather to discuss possible resolutions to the issues and next steps for action. Two people held up the shadow screen that was approximately 8 feet wide and 5 feet high so that the bottom of the screen touched the floor. Another person held the solar-powered light aimed at the screen about two feet from the screen on the opposite side from the audience. Behind the screen, Johnson then took over moderating the dialogue between characters and facilitated the conversations by posing questions.

Applied theatre practitioner Michael Rohd describes a good facilitator as someone who is energized and enthusiastic about the process, a good listener, non judgmental, deepens the discussion, and moves the event forward through questions (1998, pp.113–114); qualities that Johnson brought to the facilitation. The conversations between stakeholders flowed improvisationally with Johnson sometimes allowing the random combinations of characters to discuss the issues, and, at times, purposely pulling in a specific character to further the discussion. Although prepared with talking points, students responded extemporaneously in the discussion, relying on all they had learned of alternative energy through their class. This improvisational structure seemed to require that the students stay alert to the forum since they knew they could be called to perform at any time. It also required them to speak extemporaneously which demonstrated their level of understanding of both the issue and their character's perspective on the issue. Johnson did not provide answers or solutions to issues being discussed, but, rather, attempted to lead only with questions. Here is a sample of the dialogue

between an Environmentalist and Coal from the first class on the proposed 5% tax increase to create a local solar energy farm:

Environmentalist: It could save us a lot of pollution into the air.

Moderator: And who pollutes?

Environmentalist: Coal.

Moderator: She's calling you out, Coal. What do you have to say about that?

Coal: I provide jobs.

Environmentalist: You kill bunnies. (big laugh from the class)

Coal: A lot of miners depend on me for work, and I'm a local resource; I don't have to be shipped in.

Environmentalist: Even though you are local, you are still bad for the environment and getting you out of the earth destroys a lot of our land.

Coal: Why change if it is working now? Besides, the taxes would be hard for people in these tough economic times.

It was also during this session that we observed the value of humor in the classroom. In using the shadow puppets, the students seemed to be able to let the joy of being creative come through, and many of their insecurities and anxieties seemed to disappear during the session. Johnson infused a playful and challenging energy into the conversations that kept the discussions lively. Once the conversation was engaged between characters, it tended to continue, but getting it

going took a persistent and spirited effort from Johnson. Here is a conversation on the same issue between multiple stake-holders:

Moderator: Nuclear, what do you think about this solar farm?

Nuclear: Hey, I'm clean. Use me instead.

Moderator: Children, do you want to say anything to that? Is there anything wrong with uranium extraction or nuclear energy?

Voice of the Children: You contaminate the water and cause birth defects.

Wind Energy: Stick your head out of the window, and you'll see how windy it is here.

Solar Energy: But it's sunny more than it's windy.

Moderator: Could we propose a hybrid?

Voice of the Children: Yeah, the energy farm could maybe be both wind and solar.

It seemed important to have Johnson behind the screen with the students to keep them focused and on task, since they might otherwise have felt like they were hiding from their teacher's supervision and could just goof around with the puppets. The Energy Forum in the second class included a debate between a Politician and a Mine Worker about the economic value of mine work and the health risks for workers and the environment. The students seemed to be especially concerned about the environmental repercussions of mines and the shortened lives of mine workers. There was also a conversation between a Teacher and the Environment. The Teacher wanted the community to stop using coal and wanted more solar energy in the community. The Environment wanted to warn the forum audiences about the death of fish, to

remind them about jobs in solar industry, and encouraged them to start doing little things to help the environment. Overall, the Teacher and the Environment were in agreement on most issues. This scene demonstrated how stakeholders could also share common values and agendas instead of only holding opposing values and agendas.

As each Energy Forum concluded, Author #2 asked the class to think about the value of forums, especially about how a forum allows communities to create true dialogues and examine various points of views on important energy issues. Author #2 asked the students from the first class to consider what else they would want to know about the tax increase for the solar energy farm before they would support it with their vote. Their questions included: How many jobs would it create? Would those jobs have benefits? What would the salary be? Would they be sustainable jobs? Could there really be a hybrid system with wind and solar? How much space would the farm take and where would it be? Would it destroy our beautiful views? How much would it cost the community overall? What about tribal and zoning laws? How long would it really take to build it? The class came to an agreement that the forum process is a helpful way to approach an issue, and many of the students said like they would like to have the opportunity to use their voices in a true forum someday.

The science teacher had been present in the classroom observing most of the time we were working with his classes but intervened only to answer a few questions directed to him by Author #2. In an interview with him after the entire project was complete, he said that the level of participation in the class impressed him. He was especially surprised that several students who had not spoken the entire semester performed their character in the Energy Forum when behind the screen. He agreed that the medium of shadow puppet theatre seemed to be uniquely effective in providing a means of expression for students who he identified as otherwise shy or

reserved. He also felt that the use of solar energy in the shadow puppet theatre setup supported the students' inquiry into alternative energy.

Lessons Learned and Recommendations:

Although our intention was that the Home Energy Survey results could be used to develop the content of the Energy Forum, this was not possible, nor had students taken the solar lights home. Regardless of these deviations from our design, students were still able to identify relevant local energy issues. It is our belief that this process would have been enhanced by the following conditions: a comprehensive system in place at the cooperating school for students to check out solar lights, the science teacher requiring the completion of the Home Energy Surveys, and for all aspects of the Energy Forum (including the Home Energy Survey, light check out and participation in Energy Forum) to be part of the assessment for the class unit on alternative energy. It seems imperative that a local person with a vested interest in the goals of the intervention work closely with the schools to be sure all elements of the design are being realized in a timely fashion in order to maximize the benefits of this education/outreach project.

The outreach efforts between the University of _____ and Eagle Energy are currently moving to the former Bennett Freeze area (Minard 2012) near _____, Arizona where there is significantly less energy access than in _____, which will likely increase the usefulness and local relevance of this education/outreach program. We are partnering in this effort with the Environmental Education Outreach Program through the Institute for Tribal Environmental Professionals at Northern Arizona University, which also ensures there will be local people who share the same goals as this educational outreach and can check in regularly to ensure all portions of the project design are being executed.

When we introduce this project in that area, we hope to offer professional development training for science teachers to use solar-powered shadow puppets to engage students in an Energy Forum. This training could convey the following: the benefits of the medium of solar-powered shadow puppets for an Energy Forum, guidelines for leading students in setting up an Energy Forum, practical instruction for the shadow puppet medium, and techniques for facilitation. This would allow the teachers to determine how many classes they can dedicate to this kind of a project to suit their schedules and needs. Having this project take place over more than a two-day period could significantly deepen the lessons learned from it for students.

The science teacher we worked with on this project recommended that we supply Energy Forum kits to encourage adoption of this education/outreach by science teachers. These could simply include one eight by five foot piece of white muslin cloth, wooden skewers to serve as handles for the recycled cardboard shadow puppets, and an inexpensive solar powered light such as the the d.light S2 (d.light 2013) which sells for under \$15USD. To gather the cardboard needed to construct the shadow puppets, students could be encouraged to save the cardboard from cereal boxes in the weeks preceding. This reusing of cardboard could be included in the discussion of how resources are managed to increase sustainability efforts in their community. Instead of having students make separate “cheat sheets” to help them remember their character’s primary objectives, students could write notes directly onto the shadow puppet for greater ease and convenience.

We recommend the development of more formal assessment tools for student involvement in this education/outreach so that science teachers will be more likely to include this activity within their formal class plans. This could include assessing the completed Home Energy Surveys, the student’s ability to identify multiple talking points for their character about the given energy

issue, their committed participation in performing their character, and a written summary of how the Energy Forum advanced the classroom community in considering their energy issues.

When possible we recommend that this project be offered along with an all-school assembly performance of *Clean Energy Access: The Musical* and with the solar-powered light library check-out program. *Clean Energy Access* introduces the medium of solar-powered shadow puppet theatre and exposes students to the performance conventions. The library check out programs helps to sustain and support the impact of the effort. At _HS, Author #1 successfully worked with the drama teacher with the production of *Clean Energy Access: The Musical* to include _HS students in the performance. Therefore, we recommend exploring possible collaborations between the drama departments of the participating schools, in which high school drama students may assist with the Energy Forum project within the science classrooms. This would allow for both an interdisciplinary and interscholastic approach to this project.

Since the time this project was implemented in New Mexico at __High School, Author #1 implemented a similar project with solar-powered shadow puppet theatre for the youth group that is part of the Grupo Fenix Solar Center in Totogalpa, Nicaragua (Grupo Fenix 2014) for them to tell the story of how solar energy has helped them to transform their lives and their community. Youth participants, who ranged in age from 18-25, were incredibly receptive to this form and successfully created a performance for their community at the completion of a two-day intensive workshop. Special attention was dedicated to capacity building for the youth group members so they gained the skills and experience to replicate the process of creating a solar-powered shadow puppet performance on other issues they identify as important to their community. The experience reiterated the dynamic match between this unique artistic medium and the subject of renewable energy.

Conclusion:

Improvisation in the classroom requires active engagement and puts students in the place of author and critic of proposed new realities for energy in their community. It is not a frivolous activity that has no place in a serious science course, but a valuable tool for students to apply scientific learning to their own society. In her book *Theatre Games for the Classroom*, Viola Spolin wrote, 'Theatre-game workshops are designed not as diversions from curriculum, but rather as supplements, increasing student awareness of problems and ideas fundamental to their intellectual development' (1986, p.2). Although the theatre scholar may feel little need to justify the inclusion of theatre in an educational setting, it is often necessary to explicitly identify and describe benefits of theatre activities to teachers of science. The medium of solar-powered shadow puppet theatre can serve as a uniquely effective medium to enact an Energy Forum since it allows increased expressive freedom, reinforces energy issues through its metaphoric qualities, gives hands on experience with solar technology, and encourages critical student engagement. The solar-powered shadow puppet theatre Energy Forum illuminates the exploration of alternative energy on the Navajo Nation.

Appendix 1: Home Energy Survey

1. What forms of energy do you use in your house? How do you use these energy forms?

_____ Electricity

_____ Kerosene

- _____ Propane
- _____ Solar
- _____ Batteries
- _____ Wind Energy
- _____ Other (Please describe)

2. What are the problems you or your family experience when you don't have access to energy? (Tell your story, give details)
3. How could access to energy solve some of these problems?
4. Ask a female member of the home where and why energy is needed the most.
5. Ask a male member of the home where and why energy is needed the most.
6. Ask an elder in your home how they feel about energy from the sun, uranium, coal, kerosene, and propane.
7. Ask up to four members of your home to share their reactions to the solar-powered light. What problems could it solve? How could it be useful? Identify your family members by age and gender.
8. What do you think is the most important issue related to the energy industry?
9. How has the energy industry impacted your life, your family, your community (Your health, your access to clean water, your land, your economic situation, etc.)
10. Do you have any cultural beliefs that are related to energy use?

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