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# A Multimedia Project Based Learning Course: Morocco

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By

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**Abstract**

This project addresses the lack of diversity in Science, Technology, Engineering, and Mathematics (STEM). Studies show that socially conscious, project based learning courses best encourage diversity in STEM. In response, we developed a prototype multimedia project based learning course. This course provides different perspectives and learning outcomes based on the fog water harvesting project by the Non-Governmental Organization, Dar Si Hmad, in southwest Morocco.

**Acknowledgements**

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**Introduction**

  In an increasingly technologically driven world, the focus on science, technology, engineering, and mathematics (STEM) education is seen as the key to the betterment of humanity. This viewpoint is the driving force behind the push to recruit more students into STEM fields. However, these efforts have not been effective at creating diverse population of STEM scholars. The number of white males in STEM fields greatly outweighs the number of women and people of color. In 2012, 62.9% of STEM bachelor's recipients were white men (National Science Foundation, 2015). The lack of diversity in STEM fields creates an absence of unique perspectives (Yaeger, 2007). In a six year study on retention rates of STEM majors, it was found that 24% of African American, Hispanic American, and Native American students who enrolled in a STEM program graduated from a STEM program within 6 years. This percentage is low compared to 40% of White Americans (Smith, 2000). An additional side-effect of the push toward STEM is an increase in the devaluation of the humanities. There is a lack of cross-disciplinary courses offered to both STEM and humanities students. This results in STEM students becoming less likely to examine their values, with many students actually becoming less ethical during their course of study (Chech, 2013); similarly, humanities students lack scientific literacy (Nelson, 1999).

  Women and students of color are more attracted to courses that involve social awareness. Many of these students leave STEM education because they yearn for something greater than the purely technical approach to problem solving that is the dominant STEM mindset (Brown, 2011). The white, male STEM student, who has come from a background of higher education, has often not had to interact with complex social questions that challenge his ethics and values. When students like this make up the majority, underrepresented populations become alienated from their peers and seek alternative areas of study (Brown, 2011). However, transdisciplinary courses that combat this issue from both sides take far greater effort to design, as they must address the varying backgrounds of their students while also appealing to students by fulfilling degree requirements.

  Courses that provide cultural context and sociological perspectives along with engineering education are more appealing to underrepresented populations (Brown, 2011). The pedagogical idea of Project Based Learning (PBL) is to engage students in real world problems, which allows them to take on interconnected problems that have a bigger picture (Capraro, 2013). Project based learning has a long term impact on student's professional skills, worldviews, and personal development (Rudolph, 2014). Studying abroad has had similar effects on students' outlooks. Courses that combine both project based learning and global travel have students report an increase in cross-cultural understanding—an important skill in an increasingly globalized world (Rudolph, 2014).

  Global project participation is often financially unattainable for low-income students. The Institute of International Education estimates the average cost of studying abroad for a U.S. college student is about $17,785 (Stansbury, 2013). The burden of this cost then either falls upon the student or the institution. Low-income students and community colleges are often unable to support this financial stress. This blocks students of color and students at less wealthy colleges from the global project experience. According to United States Census data, 26.2% of African

Americans and 23.6% of Hispanic Americans live below the poverty line, compared to 10.1% of non-Hispanic White Americans (DeNavas-Walt, 2015). In addition, 51.8% of college students who do not live in a dorm or with family live below the poverty line (Bishaw, 2013).

Offering cross-disciplinary courses, another method that attracts underrepresented populations to STEM, can also be out of a college or university's financial reach. These cross disciplinary, project based, courses require small class sizes and multiple faculty members (Capraro, 2013). Paying salaries to multiple faculty members for one course that is not taken by many students may not be a financially sound decision for a college or university.

In considering these constraints on the success of past approaches, the goal of this project was to develop a modular learning resource that achieves the same learning objectives as project based learning while remaining accessible to underrepresented populations in STEM by simulating an actual, on-the-ground global project. We've called this modular learning resource Global Toolkit. The diversity of concepts, learning objectives, and pedagogical approaches within Global Toolkit engage a wider audience of students than a traditional STEM course. By casting a wide net, Global Toolkit can interest a wider population of students in STEM education. The customizability allows it to work in a wider range of settings than a single syllabus. Global Toolkit will stimulate student interest in STEM and socially conscious engineering, produce well-rounded students in both STEM and the humanities, and increase STEM interest among a more diverse population.

**Background**

      The lack of diversity and general disinterest in STEM is a growing problem that has recently received national recognition. Few American students pursue expertise in STEM fields; that's why President Obama has set a priority of increasing the number of students and teachers who are proficient in these vital fields (U.S. Department of Education). However, there remains a gap between STEM students and humanities students. If we understand nothing but our own field of activity we will not be able to communicate with others (Ruprecht, 1997). In this chapter, we will describe the overall context and background of the issues pertaining to STEM education, as well as introduce some of the problems that face the Berber people of the Ait Bamraane region of Morocco that inspired us to base our modular learning resource around. This chapter concludes with an introduction of the Fog Water Project and why it was chosen as a model for our proposed game.

**The Need for STEM**

      The United States has developed as a global leader, in large part, through the genius and hard work of its scientists, engineers, and innovators (U.S. Department of Education). Although this supports a need for STEM, it fails to identify the pedagogical hindrances that limit the potential in STEM students and STEM involvement as a whole. It is agreed that the humanities could serve as a means for self-development, for posing critical questions, and for broadening technical education in worthwhile ways (Fisher et al., 2010). Yet, traditional pedagogies place STEM and humanities on opposite ends of the spectrum, ultimately disconnecting the two. After providing an overview of the STEM demographics within the United States, we introduce a number of organizations and initiatives that are aimed at promoting STEM education and retention.

<u>Demographics</u>

      In general, students are uninterested in STEM education. According to the Business Higher Education Forum's research into ACT scores survey data, 69% of 12th grade students are not interested in STEM. Of those who do choose to engage in STEM, the majority consists of white males, ultimately limiting the potential for unique perspectives. People of color and women are greatly underrepresented in STEM fields. For example, of all STEM undergraduates in 2011, only 29.3% were non-white identified (National Science Foundation, 2011). Furthermore, women fill close to half of all jobs in the U.S. economy [but] hold less than 25 percent of STEM jobs (U.S. Department of Commerce). There is a clear lack of diversity in STEM fields, which "leaves an untapped opportunity to expand STEM employment in the United States" (Beede et al., 2011).

<u>Support for STEM Education</u>

      To address problems with global competitiveness and lack of innovation, emphasis is being placed on promoting STEM education, especially to underrepresented populations. For instance, President Obama's "Educate to Innovate" campaign will help prepare over 10,000 new

math and science teachers and train over 100,000 existing teachers in order to motivate and inspire students to excel in STEM subjects (Office of the Press Secretary). This will be done through partnerships with major companies, universities, foundations, non-profit organizations and government agencies, such as Intel's Science and Math Teachers Initiative designed to provide elementary school teachers with an intensive 80-hour professional development math course, training more than 100,000 U.S. math and science teachers over the next three years (Office of the Press Secretary). In a letter to President Obama, the presidents of more than 75 major public universities are committing to collectively prepare 10,000 science and math teachers annually by 2015 (Office of the Press Secretary). Worcester Polytechnic Institute, for instance, promotes STEM and humanities through the Great Problems Seminar. These programs seek to bridge the gap between STEM and the humanities while also providing hands on, real-world engineering experiences (Great Problems Seminar, n.d.). Finally, local programs headed by the governors of each state have been implemented in order to promote STEM within their communities, such as press conferences and K-12 school visits (National Governors Association, 2007).

**Educational Gaming**

In order to address the problems with STEM and its traditional pedagogy, we have turned to educational gaming. The video game is a familiar form of interactive engagement: 59% of Americans play video games (Industry Facts, 2015). Games also teach in a unique way that is identified by Ian Bogost as a distinct type of rhetoric, which he calls procedural rhetoric. Procedural rhetoric uses the participatory nature of games to teach about complex situations (Bogost, 2008). We aim to utilize the unique educational value of gaming in order to teach about "complex situations" that embody not only technical skills but also humanistic values targeted towards underrepresented populations. In this section, we discuss the rhetoric behind gaming, followed by current examples of learning through gaming.

<u>Why Games?</u>

We have chosen to teach through gaming for three reasons:

1. Gaming provides an active engagement learning style;
2. Gaming has the potential to teach real-world experience and cultural context;
3. Gaming has the potential to appeal to underrepresented populations.

Gaming stimulates a certain form of engagement that cannot be fulfilled in the traditional style of learning, such as lectures and test taking. In assessing the psychology of learning, Carl Rogers found that learning takes place when a learner is intrinsically motivated to learn and undertakes to learn something on his/her own (Hansen, 2000). Games, generally considered a leisure practice by players and the general public alike, is one form in which the learners or "players" are intrinsically motivated: motivated to complete a level, motivated to solve a puzzle, and motivated to achieve some end goal (Bogost, 2008). They provide "experiential learning," which is learning where interactions and hands-on experience encourages students to form their own connections between the information being taught and the real world application (Hansen,

2000; Canadian Council on Learning, 2009; Soma, 2013). This experiential learning is critical in teaching real-world situations, and considering the lack of interest and retention in STEM fields, gaming proves to be a potential catalyst in promoting STEM through experiential learning. Global travel results in an increase in cross-cultural understanding—an important skill in an increasingly globalized world; however traveling and study abroad programs are not necessarily convenient or plausible for every student (Rudolph, 2014). Games have the capability of providing cross-cultural understanding by simulating the traveling or study abroad experience in a virtual world. Gaming simplifies the real world in order to draw attention to relevant aspects of that world (Bogost, 2008). By utilizing the convenience and relative affordability of games, students are able to obtain the study abroad experience without having to study abroad. Furthermore, a convenient and affordable means of cross-cultural education will appeal more to the general population, particularly underrepresented populations in STEM. Low or no-cost undergraduate research opportunities improve the retention of minority students (Cullinane, 2009). Also, African American and Hispanic youth spend more time playing video games than their white counterparts (Children and Video Games, 2002). Games are able to reach a broader target audience than traditional STEM courses, proving to be effective in diversifying STEM. In addition, by incorporating both STEM and humanities, non-STEM students may also be targeted as an audience and students will be more prepared to handle real-world situations. Courses that provide cultural context and sociological perspectives are more appealing to female and AALANA (African American, Latin American and Native American) students (Brown, 2011).

Examples of Educational Gaming

It is agreed that interactive and hands-on learning is beneficial to students (Brown, 2011; Canadian Council on Learning, 2009; Cullinane, 2009; Hansen, 2000; Holoviak, 2011; McCright, 2012; Soma, 2013). The educational opportunity within gaming has become more and more prominent and has proven to be an effective means of teaching about complex situations. For example, "Half the Sky Movement: the Game" raises awareness of women and girls living under difficult circumstances all over the globe and invites players to become part of the solution (Byrd, 2013). Within a year of its launch date, the game was reported to have 2,795,100 total unique visitors, 1,100,000 total players, and $447,700 in total donations (Byrd, 2013). By educating through gaming the non-profit organization, Games for Change, was able to reach a much larger audience for advocating social change.

Some argue that games, even non-educational ones, can provide important lessons. For instance, Bogost describes how the game *Animal Crossing*, an "animal village simulator," simulates the social dynamics of a small town, such as the redistribution of wealth, in a way even young children can understand (Bogost, 2008). However, others argue the efficacy of educational games only (Carpenter, 2007; Leach, 2013). Nonetheless, there is at least the potential for educational value in gaming, and video games are not just stages that facilitate cultural, social, or political practices; they are also media where cultural values themselves can be represented – for critique, satire, education, or commentary (Bogost, 2008).

**The Ait Bamraane Region of Morocco**

The Ait Bamraane region of southwestern Morocco is an area stricken with a limited supply of water, gender inequality, lack of education, and social and cultural norms and beliefs that complicate instilling change. Economic exploitation of countries in the Middle East and North Africa (MENA) region by western colonists has caused long-standing poverty in the region (Sadiqi, 2011). This is especially apparent in the poverty stricken area south of Morocco (Errazzouki, 2014). There are additional problems of gender inequality, which is often exacerbated during economic downturns, and of low education and literacy (Errazzouki, 2014). In the following sections, we will be discussing the problems that afflict the Ait Bamraane region as it relates to our proposed game.

The Need for Water

The arid climate of southwestern Morocco limits potable water to that collected from rainfall; however, there have been recent droughts in the area. This, combined with corporate-controlled water supplies, makes access to potable water difficult (Sadiqi, 2011; Shiva, 2002). The yearly and regionally fluctuations in Morocco's rainfall are "problematically large," and there is an additional 8% predicted decrease in rainfall between 2020 and 2030 (Terink, 2013). As a result, the daily lives of the people in the villages of the Ait Bamraane region revolved primarily around obtaining water for their families. Even so, they remained well below the minimum of 20 litres per person per day established by the World Health Organization (Reed, 2013).

Gender Inequality

Gender inequality is the reality of all areas within the MENA regions (Sadiqi, 2011). This inequality is strengthened during times of economic distress and in places of poverty, such as the Ait Bamraane region (Errazzouki, 2014). Because much of their time and effort is spent on obtaining water instead of education, it is difficult to escape poverty or question what lies beyond their way of living. Their way of life is suitable for them, and without education or literacy it is unlikely that they would feel the need to change.

Lack of Education

The overall literacy in Morocco, especially the rural areas, is very low. This includes language literacy (Sadiqi, 2011), numeracy, and technological literacy (Dodson, 2014). Once again, education is not a vital component in their lives due to the need for water. This affects how they view life and their overall potential for growth.

Social / Cultural Context

As with any country, Morocco, particularly the Ait Bamraane region of Morocco, has social and cultural norms that may be difficult for outsiders to understand. For example, Berber beliefs and traditions caused villagers to believe that water collected from fog is "dead water"

(Dodson, 2014). They trusted well water, often prone to contamination, over water produced from fog. Also, obtaining water is traditionally left for the women, because fetching water is a household chore (Dodson, 2014). Women were also traditionally limited in who they could communicate with. It is important to understand the social and cultural context in order to see how they may be affected by outside influence, such as NGOs.

## Dar Si Hmad

Founded in 2010, Dar Si Hmad for Development, Education and Culture is an independent, nonprofit organization in Southwest Morocco. Dar Si Hmad (for short) promotes local culture and creates sustainable initiatives through education and the integration and use of scientific ingenuity with the communities of Southwest Morocco (Dar Si Hmad, n.d.). Fog water catchment systems have been put in place by Dar Si Hmad to provide potable drinking water to several villages at the base of the mountain (Brotzen, 2010). Also, a cell phone-based communication system that is accessible for illiterate women is being developed through the research of Leslie Dodson to manage the fog water system (Dodson, 2014).

Dar Si Hmad had to address the problems of the Ait Bamraane region while keeping in mind the social and cultural context of the people. They had to convince the Berber people that fog water was not "dead water" and prove that it was safe. With the implementation of plumbing, Dar Si Hmad had to be careful to keep the control in the hands of the women because plumbing was traditionally seen as a male profession, while fetching water had been the roles of the women. The new technology introduced the necessity of communication between people who were traditionally not permitted to communicate (Dodson, 2014). By working with the people and understanding the cultural differences, Dar Si Hmad was able to implement a fog water system to bring water to the people of Ait Bamraane, creating time for educational opportunities and development.

It is for these reasons that we have chosen Dar Si Hmad's fog water project and the Ait Bamraane region of Morocco as the focus of our game. Both STEM practices and humanistic approaches were required and applied in a real-world situation. Our goal is to simulate this real-world situation in a way that teaches the cross-disciplinary techniques required through a modular learning resource.

**Methodology**

The goal of this project was to develop a modular learning resource named Global Toolkit. The pedagogical approach to develop this modular is using a game comprised of a plot, characters, and a map. With the visits that we made at the project fog site and meeting many Berber rural communities we were able to achieve this goal by actively completing the following objectives and tasks:

1. Provide real world context for the game.
    a. Task: Obtain authentic, personal accounts of the people.
    b. Task: Obtain quantitative data about the impact of the project.
    c. Task: Interview via audio and video, and take photographs to help players visualize the experience.
    d. Conduct research on history of the region to convey the most relevant history in the game materials.
2. Provide real engineering examples and STEM content for the game.
    a. Task: Understand how fog system works and is maintained.
    b. Task: Understand the obstacles and how they were overcome.
3. Provide insight of the engineering impacts on communities in need.
    a. Task: Compose questions for interview discussions focused on their needs.
    b. Task: Observe communities' interaction and their usage of water.

In this section, the tasks completed will be further discussed in support of their objectives.

**Objective 1: Provide real world context for the game.**

We visited DSH in southwest Morocco and met indigenous tribe Berbers, toured their homes and toured DSH's fog water facilities. We met several families from a variety of villages that gave us the opportunity to understand the different social culture. Based off our experiences and interactions we were able to enhance the character's background and type of role for the Visual Novel (VN) and would potentially influence the Role Playing Game (RPG) script for each character. The content can be seen under the "Short Stories of Ait Baamrane (Introduction and Video)" in Outcomes.

We also met and worked with the DSH employees. Engaging in what DSH has done in the past after the completion of the project helped understand how much the project successfully improved the rural communities' life. They provided us with surveys that expressed quantitatively how much has changed in comparison to the surveys taken before the project. The survey had much of the content that led us to develop relative concept physics problems for the "Project Fog" discussed in Outcomes.

When we visited the villages we interviewed, audio and video recorded many families. This was then converted into translated transcripts that essentially became the qualitative data. The experiences learned were used to set up the debate situations for the "Weekly Family Role Playing Activity" and VN plot and characters. This is discussed further under the Outcomes. We also took photographs of the communities' homes and their surrounding environment. Much of the photographs that were used for "Visual Novel Introduction" and "Ethnobotany Introduction" video, and as background images for the "Visual Novel Plot Media" that can be requested by our advisors. The images would also intentionally be used to make the RPG game.

While in Morocco, often times we were able to interact with community members before and after the interview. With the help of our interpreter we were able to ask many rural community members about where their issues really stemmed from. Based off our findings we were able to develop the historical context for the "History of Moroccan Berbers" discussed further under Outcomes. This was briefly summarized and made into a short video that describes the Berber origins and how it has shaped them to their state today.

**Objective 2: Provide real engineering examples and STEM content for the game.**

We explored how the fog system worked and was maintained. We walked with DSH board and group members, engineers, and the the maintenance employees. With their guidance we were able to discover that the fog system was composed of several different material-made parts. By understanding how the system functioned on a daily basis throughout the year we were able to develop parts to the RPG to show a sample of the game shown as "Project Fog Concept Document" under the Appendices 3. Another usage for the understanding fog system and maintenance was to develop "Morocco Water Scarcity" and "GPS Fog Project", created by our advisors, in more details under Appendices 9.i,9.ii. This was used as an in-class group project that critically took into account of the system cost, how it functioned and its upkeep requirements.

During the interviews DSH and the community both expressed obstacles they have overcome. For example, the water coming from fog needed to be mineralized required by law. This was an obstacle for both the rural communities and DSH members since this delayed the delivery of water to the communities and DSH needed to work harder to deliver it. In the future these obstacles would be obstacles a character might overcome in their VN plot, discussed further under Outcomes. These obstacles were not only engineering issues but social too. This enabled us to enhance the game by creating the in-class debate issues with the young woman in the "Weekly Family Role Playing Activities" discussed in the Outcomes.

**Objective 3: Provide insight to engineering impacts on communities in need.**

Within the culture boundaries, an interpreter helped us compile a list of interview questions with respect to the interviewer's gender. These interview questions aimed to promote discussion of the community members' life period before, during and after the project, relevant to their needs. Much of what was discussed during the interviews was how their life has changed substantially now that they don't have the same hardships as they did before the project. Using their experiences we were able express it with the "Kadija's Story Concept Document " in details under Appendices 4. This short novel focuses on a young woman that shows how much of an impact engineering, the fog project, has made in her life.

A lot of our experience relied on observations that improved throughout our visits. One of the things we've noticed was their daily way of using water. Everything revolves around water especially out in the dry deserts. Some ways they used water was to wash their hands because they are their eating utensils, to make bread, tea, tagines, feed their animals, take showers, and so much more. These observations were expressed to enhance the "Weekly Family Role Playing Activity" discussed under Outcomes.

**Outcomes**

After gathering visual and narrative pieces (materials) from fieldwork in Morocco we developed Global Toolkit, an interactive learning module that includes games and classroom activities. This proposed modular learning resource will help bring in new and diverse engineers by providing exposure to engineering problems with a humanitarian approach in a feasible manner.

**Global Toolkit**

Global Tool kit is an educational tool designed to provide teachers with coursework designed specifically to engage students into engineering. There are two components to the Global Toolkit, one of them is a set of in class supplements and the other is online work. A major component of this nontraditional learning method is the use of a visual novel. This visual novel presented through a website which includes multiple menu options to view videos and play mini games. It brings learning in an new, interesting way and is easily accessible. The components of this game all help bring new perspectives to the challenges faced in Morocco. All of the scripts for these games can be found in the appendix. This following are components of the interactive learning module:

**Online Component:**

**1. The Stories of Ait Baamrane**

This is a game that would be the introduction to the engineering problem our group got to see within Morocco. The goal of this game is to show the player the different sides of a problem. It reveals how proposed solutions often result in actions that make big impacts on people's lives.

**1.a. History of Moroccan Berbers**

This is a video that would illustrate the roots of the Berber people. It would help create a feel for what Morocco looks like now. It helps students see the connection between the Berber culture, the people, and the goal of Dar Si Hmad. This video succeeds at presenting the problem in an interesting way. It highlights the story of Dar Si Hmad, its Fog Water Project, and the people whose lives it has changed.

**1.b. Short Stories of Ait Baamrane (Introduction and Video)**

The stories of Hassan Bouzidi, Omar Ali, and Anaruz Masri are told through a visual novel. Hassan Boudzidi is a manager in Dar Si Hmad and hoping to build his career and start a family. Omar Ali is a 14 year old boy who work at the fish market and yearns for an educational opportunity. And Anaruz Masri is a 45 year old man wanting to work for Dar Si Hmad to help support his family. The stories provide context to the problem and different ways of viewing the problem. These stories would follow the history introduction video. Players will have the chance to play out the lives of one of these characters and can go back to view the story of other

characters, if desired. The objective of this game is to see how the characters are affected throughout the implementation of Dar Si Hmad's Fog Net Water System.

The story of Khadija Masri is told through a visual novel game. This game is played from the perspective of a young woman living in Morocco. The player can see how different choices change the young woman's life. Players help Khadija make decisions of either becoming a leader within Dar Si Hmad or being a bystander and seeing how her life changed by an external entity. This game fulfills the objective by positioning the player to make decisions in a new perspective.

**2. Project Fog**

Project Fog is a visual novel game and the script can be found in the appendix. Through this game, the player will be viewing the problem through the eyes of an NGO. The player will be given a short introduction on how the fog net system is built. Afterwards, the player will make decisions to implement a fog water system and watch how people from the community are affected from those decisions. The goal of this game is to push the player to create a solution to a problem yet consider the social aspects as well. This game also has a physics component which brings yet another challenge.

**3. Ethnobotany Video Introduction & Script**

This is an introductory video to an ethnobotany game proposed by an inquiry seminar at WPI. This video highlights the importance of the fruit of the argan tree. It shows how versatile the fruit can be ranging from culinary to cosmetic. This video helps students realize where their products come from and the inequalities that occur between the start of the product (the fruit) to the final distributed product.

**In Class Component:**

**4. Weekly Family Role Playing Game**

This role-playing game is a weekly in class debate. Within these debates, students will have the opportunity to act as community members in Morocco and make decisions relating to the arrival of Dar Si Hmad. This activity succeeds in bring a personal interest to the problem. Through the various scenarios of the debates, students can relate more to the community member's situations.

**5. Syllabus**

The syllabus serves as a guide for teachers to select material to supplement their class. There are various syllabi with different time constraints to allow multiple school systems to use (quarters or semesters). It allows teachers to pick and choose which activities to show students based on what they would like to teach the students.

Global Toolkit helps bring learning about engineering in a fun and nontraditional way. Because of its online component, it is feasible for student to do their assigned work on the go. Both the online as well as the in class component do a great job of challenging students to think about the problem though various points of view. Through the activities they get the opportunity

to see the problem through the eyes of the children and adults of the community, and the directors of the NGO. They learn that all decision have an after effect. In most cases, students are exposed to effects they did not originally consider. Through the use of Global Toolkit, students are learning to think like engineers.

**Conclusion**

As a team, we set out to develop a modular learning tool that would increase STEM diversity and breach the educational gap between engineering students and liberal arts students. Currently, STEM fields are largely dominated by white males leaving many minorities under-represented. In the real world, engineers from diverse backgrounds need to be able to work with society to produce effective engineering solutions. This requires engineers to be able to communicate effectively with people with liberal arts backgrounds, something many engineers have struggled with. Bridging the gap between liberal arts and engineering education as well as attracting women and other races besides caucasians to STEM will make engineering solutions much more effective in the future.

**Overall Project Strengths**

One of the key strengths of this project is the modularity of Global Toolkit. The learning module can have pieces added to or subtracted from in order to fit various curriculums and learning goals. A two week long physics class might choose to use only the physics based portions of the learning module while a semester long inquiry seminar might choose to use all elements of the learning module. The modularity allows Global Toolkit to be applied in many different learning environments to reach to a broader population.

Another strength of Global Toolkit is the use of project based learning. Project based learning in Global Toolkit will engage students in real world problems and have long term impact on students development as people in society. Students will use project based learning to solve sample engineering problems and apply them to society through the learning module helping students develop into well rounded, applied engineers.

**Overall Project Weaknesses**

One of the major weaknesses of this project is the need for students to be able to access technology outside of school. One of our project goals was to develop a learning module that would aid in attracting a diverse population to STEM fields. With some homework assignments requiring students to be able to access the internet on a personal computer, a large portion of the population will not be able to utilize our learning module. Given that 26.2% of African Americans and 23.6% of Hispanic Americans live below to poverty line, homework that requires technology will make this learning module much less effective at attracting under-represented populations to STEM.

**Future Development**

In the future, this learning module needs to be tested, revised, and expanded. Aspects of the project need to be developed from the design we have created and then tested. Testing will likely reveal problems in the design and require changes to be made. From the concept documents, the Visual Novel, Project Fog Minigame, and the other 3 character plots need to be developed. Our concept documents provide a blueprint of a proposed design.

In addition, future development should include more variety in activities to allow educators to be selective in what they want to teach and how the learning module will be used. This includes having more online activities to allow the toolkit to be used entirely online and more in class activities to fill an entire course.

**Appendices**

**1. Interview Transcripts**
**(Placeholder)**

**2. Water Quality Surveys**
**(Placeholder)**

**3. Project Fog Concept Document**
**Name:**
Project Fog

**Concept Proposal:**
The union of two well-known games Learn to Fly[1] and RollerCoaster Tycoon[2] to show the implementation of the fog nets done by Association Dar Si Hmad, a non-governmental organization.

**Tag Line:**
Help bring happiness to villages of Southwestern Morocco with the help of Association Dar Si Hmad through fog net implementation!

**Genre:**
Game will be an arcade type of simulation.

**Target Audience:**
Game can be used for all ages since there is no experience needed.

**Platform:**
This will be a non-graphics intensive flash or java game hosted on a website. Most personal computers will be able to play.

**Concept:**
      The user begins with a simple fog net that connects directly to a house. However, the user is prompted by Moroccan Government officials to first create and execute the mineralization station with their initial given budget. The player will use simple physics calculations to make the best decisions for the progression of the Fog Water Project. The user receives an increase in budget based on how much water is being delivered to each home (increase in happiness levels per community member). User upgrades the nets, water system (pipe, additional pumping stations), mineralization station, etc. The more water being delivered, the higher the regions happiness and the more money the player gets to expand the system.
      Over time however, community members of the village will not be happy if not taken care of and their "happiness" level will go down. When you click on an individual character

(woman), she will say she is feeling jobless. User will then see an option to create a co-op, fog water school or plant additional argan trees. Community member's happiness will go up as more external resources/ opportunities are created.

As the game progresses, the complexity increases. Each problem solved will unlock new challenges and issues for the player to solve.

**Gameplay:**

The game will process within days. Everyday a user signs in, they will notice an increase in happiness and then upgrade and improve their water delivery systems. The user will have to solve physics problems as the game progresses in order to make the best decisions for the community and project.

**Game Summary:**

Game that will expose students to the challenges faced in the fog net system creation. It will not only have a scientific analysis of the pipe placement and water filtration etc. but it will also have a social consideration when happiness levels go down within community members.

**Game Mechanics:**

Selecting initial fog net available
Mineralizing water
Connecting pipes to mineralization station to pumps to individual homes
Collect money from upgrades: new nets, pipes, etc.
Help happiness go up by implementing new programs
Use physics to make the best in-game decisions

**Game World Setting**: Southwestern Morocco

**Appendix:**

1. Learn to Fly: This silly launch game will definitely make you laugh at the bird's attempts at taking to the skies, yet you cannot help but root for the little guy all the same. With gliders and rockets at your disposal, you must help the penguin improve his formula to success in order to finally learn to fly. The upgrade system in the game is more a necessity than a way to make things easier. The real fun begins once you gather enough upgrades to significantly extend the distance which the penguin can travel.
*How this helps*: We will use the action of upgrading cause and effect.
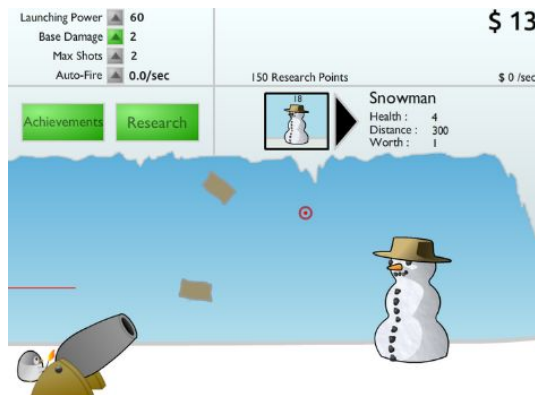
2. RollerCoaster Tycoon: a construction and management simulation video game that simulates amusement park management. There are options of building a number of different structures to please your customers: thrill rides, roller coasters, mild rides, water rides, food vendors, souvenir stands, and even bathrooms.
*How this helps:* We will use the action of placing pipes, along with getting a reaction of how much water is delivered.



**Resources Needed:**

Actual game setting: Stills and videos showing the distance and area from the top of Mount Boutmezguida to the first individual homes
Happiness Reaction Prompts: Survey responses on women reactions to getting water
Lowering in Happiness Reaction Prompts: Survery responses of what women want to do with their free time
Fog nets (Old and New): Stills of the fog nets and the videos of how they work for a prompt after the installation in the game
Mineralization Station: Photos of the station by the school
Mineralizing water: need statistics of levels of minerals going into the water to have different happiness levels revealed based on quality of water.
After decreasing happiness levels:
Co-op: Need pictures of Co-op setup, noise of women cracking nuts, examples of how much argan is collected in a day
Fog water School: Need to see the setup, programs and women's handwriting learning numbers
New School: design classes that could take place there for adults

**4. Kadija's Story Concept Document**

Scene in  Morocco includes her as a 14 year old girl
(Rite of Passage Story)

She is a young girl with the desire to learn more. Whenever she does something seems to stop her in the way. She attempted school before but due to a heart condition, she actually fainted during the walk to school on multiple occasions.

How will she react to not being able to go to school?

1a) Stay at home
When she chooses to stay at home, rather than learn more she gets depressed. She feels as if there is no meaning to her life.

1b) Tell her father she wants to go to school
When she chooses to tell her father that she wants to go to school, he calls a community meeting to place.

Both of these options lead to the introduction of Dar Si Hmad

1a) When she chooses to stay at home. She sees the vans rolling in, Dar Si Hmad logos printed at the side of them. She feels like need to learn more.

1b) When her father tries to tell them about an idea of carpooling the children to school, a new idea is introduced. It is a spokeperson on behalf of Dar Si Hmad.

Choose new option to listen to the ideas of DSH or not:

2a) Participate with  Dar Si Hmad's Ideas
2b) Choose to be an observer

Both of these options lead to being able to see what opportunities DSH brings

2a) DSH presents business plan to the elderly men in the community to approve of. The girl will be standing next to the tent , listening to what is happening (what her dad is saying), eager to know what happens next

2b) By not automatically joining DSH, the family loses out of many opportunities to voice their opinions . The girl sneaks into a fog phone class, where she holds a piece of technology she has never seen before, she is eager to learn more.

Choose whether the girls become a leader in this project or not:
3a) Help her father and her become leaders
3b) Stay back and help from afar

Both of these options lead to more opportunities in the community
3a) As leaders, they voice the community's main concerns
3b) As background people, many of the decisions other people make affect them

Under 3a)
Choose piping
Choose schools
Choose picking local labor

Under 3b)
Pipes were not done correctly and now are piped in the animal shed instead of the living room
Schools open up but are for boys aged 12 and under
External help is brought in, wages go down in the community

Both of these decision lead to seeking help

## 5. Stories of Ait Baamrane Introduction & Script

Short History of Moroccan Berbers:

From the Western Sahara up to the foggy Atlas Mountains, the early Berbers moved, pushed northwards six thousand years ago on endless dry land. The Arab conquest of the 7th century made Morocco an independent power.

Most Berbers converted to Islam but were never fully assimilated, retaining their language and tribal customs. An extensive network of Berber descendants, called the Almohads, gave rise to the Almohad dynasty, which ruled Morocco from 1146 to 1269.

The colonial era in Africa began for Morocco in the 15th century, as the Spanish and then French and British asserted dominance over the country. While resistance against their colonizers never waned, colonial rule didn't formally end until 1956.

After independence, the people of the Berber tribes in the Ait Bamraane region, in the region of the Anti-Atlas Mountains south of Tiznit, found themselves largely neglected by the Moroccan government.

While the majority of Moroccans spoke Arabic, these Berbers spoke Tashlheet.

This language separated them not only from educated and urban Moroccans but also from the government itself. As a result, the Berber communities remained living somewhat out of time, even into the twenty-first century.

Opportunities for education, if any, were limited.

Electricity remained unavailable until the year 2000, and along with it many commodities and services that urban Moroccans took for granted. The people of this region understood that if they had a problem, they would have to solve it themselves; they were not a priority of the Moroccan government.

In recent years, this agricultural community has experienced drought and water scarcity. Faced with dried land and compromised wells, many Berber communities felt they had no choice but to turn to the cities. Of those who stayed, one of the greatest environmental challenges has been water scarcity. Women and children, particularly youngs girls, were responsible for obtaining water and would walk for hours to collect water from wells that could be dry or contaminated. This consumed much of their daily activity, and took away from spending time towards education.

When the Moroccan military established a base on Mt. Boutmezguida in the Anti-Atlas Mountains and built a radio tower, workers on the mountaintop discovered that water, derived from fog, collected on the tower. This discovery, along with scientific experiments with fog in the Chilean mountains, ultimately led to the idea of harvesting and delivering this fog to the Berber communities in the foothills of Mt. Boutmezguida. This idea was conceived by an educated man with ancient roots among the Ait Bamraane people, and led to the formation of the

NGO Dar Si Hmad. This is the story of Dar Si Hmad, its Fog Water Project, and the people whose lives it has changed.

## 6. Ethnobotany Video Introduction & Script

Argan oil is the most expensive edible oil on the planet. It is extracted in a labor intensive process, from the fruit of the argan tree, a desert plant endemic to southwest Morocco. It does not grow anywhere else.
The hard work of extracting the oil is traditionally done by the Berber women who call this area of Morocco home.

First the fruit must be harvested. This is a difficult and time consuming process as argan trees are not suited for traditional farming. It takes 50 years for an argan tree to reach maturity and begin producing fruit. Instead of being planted, the trees grow wherever their seeds land and take root. This means that the women must travel from tree to tree collecting the ripe fruits that have fallen from the trees.

After the fruit is harvested, it is dried in the sun in order to remove the flesh and reveal the argan nut. The women then take the nuts and carefully break them apart one at a time to remove the kernel. The kernel, which is about the size of the nail on a person's little finger, is the only part of the argan tree from which this precious oil can be extracted. It takes around thirty five kilograms of fruit and twenty hours of labor to make one liter of argan oil.

Argan oil has been a part of Berber cuisine for centuries, but in the past decade rising exports of the oil as both a culinary delicacy and a cosmetic additive have increased the price and scarcity. In 2008, there were 29 products on the US market that contained Argan oil. That number leapt to nearly six hundred in just five years.

While a one liter bottle of pure Moroccan argan oil can sell for up to $400.00 USD, the woman who spent days producing it will only make 40 Moroccan dirhams, or $4.00 USD. Some make even less than that. Several NGOs in Morocco have implemented women-run cooperatives, which allow Berber women more agency in monetizing their labor. With the production, and in some cases the sale, of the argan oil in the hands of the women who work so hard to create it, these women gain economic and social power that they did not have previously.

Among more traditional Berber families, the patriarch's income is for the family and for sending the male children to school, while the woman's income is her own and she may use it to send her daughters to school. By creating a mechanism by which these women can earn more money for their work, these co-ops can improve the lives of even more women than just those who work there.

## 7. Weekly Family Roleplaying Game Concept Document

The weekly role-playing debate is an in-class activity that speaks to the human side of the fog project. In these debates students will act as community members and make tough decisions. By taking on roles as poor rural village members, players will be able to relate more intimately to the members' situations.

In preparation for the in-class weekly debates, students will be divided into groups representing a "family" or a "community" and given a weekly conflict. Each student will be assigned a role (i.e. father, mother, male representative of the community) with a brief background that would include their values and beliefs reflecting on the situation. An example of a student's role would be a young woman named Fatima who would like to use a cell phone to

practice her reading and writing skills. However, her Fatima's mother fears she would ruin her image by using a cell phone. These roles will place certain limitations on what he/she may say and require students to view the situation from another perspective. Background information will be provided before the debates to prepare students in positing their arguments on the assigned conflict. Based on the weekly debate (either Small Debate or Large Debate), students will discuss their arguments within their "families" or with other "families." Once a solution has been reached, the class will discuss the debate as a whole to reflect upon the reasons that brought them to their solution. Finally, new roles and conflicts will be assigned each week to give students a broader understanding of each role.

What distinguishes the debate from other activities is how a whole class can be a part of it. When students interact with each other it allows them to learn from each other. It also gives the opportunity to experience different, unfamiliar, social situations. This will encourage them to think critically and be more self-expressive and philosophical. The debate topics explore Moroccan culture, their society and the impacts from the fog water project. Through these topics, students will learn about the values and traditions of South Moroccan communities.

In this activity, students will cover a series of six topics. The topics are divided into small debates, where the students are in family or village units of 3-5 students; and large debate, which involve 4-5 small groups coming together. The small debates center around intra-family and intra-village conflicts. There will be four small debate topics:

1. A young woman wants a new cell phone which will help her stay in contact with friends and get better at reading and writing. Her father worries that she might use the phone to talk to people he doesn't approve of. The family must decide whether to allow the daughter to get a cell phone.
2. A woman who has just gotten water for home usage now has free time. She wants to use this time to work at the argan co-op. Her husband is concerned about her wellbeing traveling to the co-op and also about how others will view the family if she works outside the home.
3. A group of men from the village meet to decide if they want to let Dar Si Hmad use their well water as part of the fog project. Some are skeptical that Dar Si Hmad will even be successful at providing water, while others are eager to help.
4. A mother has been gaining income by harvesting and selling prickly pears at the market. She wants to use her money to send her daughter to school, while her husband thinks that that money should be spent elsewhere. Traditionally, money earned from women's work is hers to spend how she likes, but her husband is still able to exert his influence if he chooses.

   In addition to the four small debates, there will be two large debates. These debates are external to the village and involve the fog project in a more direct way:
1. Representatives from each community must decide whether they trust in Dar Si Hmad's fog project. Many of the community members have not seen the proof of the project and are unsure of how it works. Together they must decide whether they want to provide their labor and resources to make this project workable.
2. Some families in the community want to have water piped directly into their homes because they want to have the same water access as those in the cities. Others are content with the suggested plan of having a central water point. Those in favor of the central

point do not want the monetary cost and responsibility of managing a personal water point.

**8. Syllabus**

2-Week Syllabus

Learning Objectives:
      This course is designed to give students a brief introduction and understanding of what life is like in the developing world. Students will learn about Moroccan lifestyle and culture in comparison to their own and bridge the gap between STEM and the human aspects of science and engineering. In addition to cultural and historical education, basic fluid dynamics, environmental, and civil engineering principles will be introduced.

**Sessions 1-3:**

Class Activities:
·   History Video
·   Visual Novel
·   Weekly Family Role-Playing Activity (Small Debate)

Homework:
·   Project Fog Game
·   Background Research

**Sessions 4-6:**

Class Activities:
·   Water Scarcity
·   Visual Novel
·   Weekly Family Role-Playing Activity (Large Debate)

Homework:
·   Project Fog Game
·   Final Paper

7-Week Syllabus

Learning Objectives:
      This course is designed to give students a brief introduction and basic understanding of what life is like in the developing world. Students will learn about Moroccan lifestyle and culture in comparison to their own and bridge the gap between STEM and the human aspects of science and engineering. In addition to cultural and historical education, ethnobotanical, financial, basic fluid dynamics, environmental, and civil engineering principles will be introduced.

**Sessions 1-3:**

<u>Class Activities:</u>
· History Video
· Visual Novel
· Weekly Family Role-Playing Activity (Small Debate)
<u>Homework:</u>
· Project Fog Game
· Background Research (Student Fog Water Project)

**Sessions 4-6:**

<u>Class Activities:</u>
· Visual Novel
· Student Fog Water Project (GPS)
· Weekly Family Role-Playing Activity (Small Debate)

<u>Homework:</u>
· Project Fog Game
· Background Research (Student Fog Water Project)

**Sessions 7-9:**

<u>Class Activities:</u>
· Water Scarcity
· Student Fog Water Project (GPS)
· Weekly Family Role-Playing Activity (Large Debate)

<u>Homework:</u>
· Background Research (Student Fog Water Project)
· Problem Statement and Solution Proposal (Student Fog Water Project)

**Sessions 10-12:**

<u>Class Activities:</u>
· Water Scarcity
· Student Fog Water Project (GPS)
· Weekly Family Role-Playing Activity (Small Debate)

<u>Homework:</u>
· Background Research (Student Fog Water Project)
· Revised Problem Statement and Solution Proposal (Student Fog Water Project)

**Sessions 13-15:**

<u>Class Activities:</u>

- · Ethnobotany and the Argan Forest
- · Student Fog Water Project (GPS)
- · Weekly Family Role-Playing Activity (Small Debate)

Homework:
- · Background Research (Student Fog Water Project)
- · Project Proposal Essay (Student Fog Water Project)

**Sessions 16-18:**

Class Activities:
- · Ethnobotany and the Argan Forest
- · Student Fog Water Project (GPS)
- · Weekly Family Role-Playing Activity (Large Debate)

Homework:
- · Revised Project Proposal Essay (Student Fog Water Project)

**Sessions 19-21:**

Class Activities:
- · Ethnobotany and the Argan Forest
- · Student Fog Water Project Presentations (GPS)

Homework:
- · Final Paper

Global Toolkit: Morocco
Sample 2-Week Syllabus

This course is designed to give students a brief introduction and understanding of what life is like in the developing world. Students will learn about Moroccan lifestyle and culture in comparison to their own, and bridge the gap between STEM and the human aspects of science and engineering. In addition to cultural and historical education, basic fluid dynamics, environmental, and civil engineering principles will be introduced.

| Class | Activity/HW |
|---|---|
| 1 | **Objectives:** Empathy development, lessons in history and culture<br>**Class activities:** Introduction to Fog Water project, history video, course objectives<br>**Assignment:** Assigned reading on fog water project |
| 2 | **Objectives:** Identify methodological biases in "standard" engineering approaches and personal biases, lessons in history and culture, basic |

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|---|---|
| | principles in mathematics and physics, introduction to proper researching techniques<br>**Class activities:** Brief discussion of social implications with engineering, assign roles for Weekly Family Role-Playing Activity (Small Debate), play Visual Novel<br>**Assignment:** Research for Weekly Family Role-Playing Activity, begin Project Fog game |
| 3 | **Objectives:** Team and communication skill development, empathy development, understand personal reasoning and biases, basic principles in mathematics and physics<br>**Class Activities:** Weekly Family Role-Playing Activity (Small Debate) and debriefing<br>**Assignment:** Project Fog game, research for Water Scarcity activity |
| 4 | **Objectives:** Empathy development, lessons in history and culture, basic principles in mathematics and physics<br>**Class Activities:** Water Scarcity activity and discussion, play Visual Novel<br>**Assignment:** Finish Project Fog game |
| 5 | **Objectives:** Brainstorming, understand personal reasoning and biases, understand impact of decisions (Project Fog game and Visual Novel)<br>**Class Activities:** Discussion of Project Fog game, assign roles for Weekly Family Role-Playing Activity (Large Debate), finish playing Visual Novel<br>**Assignment:** Research for Weekly Family Role-Playing Activity, finish Visual Novel if unfinished from class, Final Paper |
| 6 | **Objectives:** Team and communication skill development, understand personal reasoning and biases, relating course material to personal lives<br>**Class Activities:** Weekly Family Role-Playing Activity (Large Debate) and debriefing, course reflections, Final Paper due<br>**Assignment:** |

Global Toolkit: Morocco
Sample 7-Week Syllabus

This course is designed to give students a brief introduction and basic understanding of what life is like in the developing world. Students will learn about Moroccan lifestyle and culture in comparison to their own and bridge the gap between STEM and the human aspects of science and engineering. In addition to cultural and historical education, ethnobotanical, financial, basic fluid dynamics, environmental, and civil engineering principles will be introduced.

| Class | Activity/HW |
|---|---|
| | |

| 1 | **Objectives:** Empathy development, lessons in history and culture<br>**Class activities:** Introduction to Fog Water project, history video, course objectives<br>**Assignment:** Assigned reading on fog water project |
|---|---|
| 2 | **Objectives:** Identify methodological biases in "standard" engineering approaches and personal biases, lessons in history and culture, basic principles in mathematics and physics, introduction to proper researching techniques<br>**Class activities:** Brief discussion of social implications with engineering, assign roles for Weekly Family Role-Playing Activity (Small Debate)<br>**Assignment:** Research for Weekly Family Role-Playing Activity, begin Project Fog game, play Visual Novel |
| 3 | **Objectives:** Team and communication skill development, empathy development, understand personal reasoning and biases, lessons in history and culture, basic principles in mathematics and physics<br>**Class Activities:** Weekly Family Role-Playing Activity (Small Debate) and debriefing<br>**Assignment:** Project Fog game, play Visual Novel |
| 4 | **Objectives:** Empathy development, lessons in history and culture, basic principles in mathematics and physics<br>**Class Activities:** Water Scarcity activity Lesson 1 Part 1, assign teams for Student Fog Water Project (GPS)<br>**Assignment:** Finish Project Fog game, research for Student Fog Water Project, play Visual Novel |
| 5 | **Objectives:** Brainstorming, understand personal reasoning and biases, understand impact of decisions (Project Fog game and Visual Novel), introduction to methodological approaches<br>**Class Activities:** Discussion of Project Fog game, assign roles for Weekly Family Role-Playing Activity (Small Debate), introduction to project proposals<br>**Assignment:** Research for Weekly Family Role-Playing Activity, finish Visual Novel, research for Student Fog Water Project, Water Scarcity activity Lesson 1 Part 2 |
| 6 | **Objectives:** Team and communication skill development, understand personal reasoning and biases, relating course material to personal lives<br>**Class Activities:** Weekly Family Role-Playing Activity (Small Debate) and debriefing, discussion of Visual Novel<br>**Assignment:** Problem Statement Rough Draft, research for Student Fog Water Project, Water Scarcity activity Lesson 1 Part 2 |

| 7 | **Objectives:** Written/oral communication development, relating course material to personal lives<br>**Class activities:** Problem Statement Rough Draft presentations<br>**Assignment:** Water Scarcity activity Lesson 1 Part 2, Problem Statement Final Draft, research for Student Fog Water Project |
|---|---|
| 8 | **Objectives:** Empathy development, written communication development<br>**Class activities:** Discussion of Water Scarcity activity Lesson 1 Part 2, assign roles for Weekly Family Role-Playing Activity (Large Debate),<br>**Assignment:** Research for Weekly Family Role-Playing Activity, Problem Statement Final Draft, research for Student Fog Water Project |
| 9 | **Objectives:** Team and communication skill development, understand personal reasoning and biases<br>**Class activities:** Weekly Family Role-Playing Activity (Large Debate) and debriefing, Problem Statement Final Draft due<br>**Assignment:** Solution Proposal Rough Draft, research for Student Fog Water Project |
| 10 | **Objectives:** Team and communication skill development, relating course material to personal lives, basic principles in mathematics and geography<br>**Class activities:** Water Scarcity activity Lesson 2 Part 1<br>**Assignment:** Solution Proposal Rough Draft, research for Student Fog Water Project |
| 11 | **Objectives:** Team and communication skill development, relating course material to personal lives, data analysis<br>**Class activities:** Water Scarcity activity Lesson 2 Part 2, assign roles for Weekly Family Role-Playing Activity (Small Debate), Solution Proposal Rough Draft due<br>**Assignment:** Research for Weekly Family Role-Playing Activity, begin working on Final Paper Rough Draft, research for Student Fog Water Project |
| 12 | **Objectives:** Team and communication skill development, understand personal reasoning and biases<br>**Class activities:** Weekly Family Role-Playing Activity (Small Debate) and debriefing<br>**Assignment:** Solution Proposal Final Draft, Final Paper Rough Draft, research for Student Fog Water Project |
| 13 | **Objectives:** Develop an understanding of the effects of the global Argan boom on the Argan forest, understand the impact of Argan harvesting practices and other anthropogenic factors on the Argan canopy, lessons in history and culture |

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|---|---|
| | **Class activities:** Ethnobotany and the Argan Forest Part 1<br>**Assignment:** Research for Ethnobotany and the Argan Forest Part 2, Solution Proposal Final Draft, Final Paper Rough Draft, research for Student Fog Water Project |
| 14 | **Objectives:** Develop a background knowledge and understanding of Argan harvesting and the implementation of the fog nets on the Berber community through the assigned readings, use guiding questions to promote thoughtful reflections on the readings, form an opinion in the context of your character for both of the assigned debate questions<br>**Class activities:** Ethnobotany and the Argan Forest Part 2, Solution Proposal Final Draft due<br>**Assignment:** Research for Weekly Family Role-Playing Activity, Final Paper Rough Draft, begin working on Project Presentations, research for Student Fog Water Project |
| 15 | **Objectives:** Team and communication skill development, understand personal reasoning and biases<br>**Class activities:** Weekly Family Role-Playing Activity (Small Debate) and debriefing, Final Paper Rough Draft due<br>**Assignment:** Project Presentations |
| 16 | **Objectives:** Quantitatively discuss the efficiency of Argan oil production and selling options<br>**Class activities:** Ethnobotany and the Argan Forest Part 3a<br>**Assignment:** Final Paper, Project Presentations |
| 17 | **Objectives:** Written/oral communication development<br>**Class activities:** Student Fog Water Project Practice Presentations (GPS), assign roles for Weekly Family Role-Playing Activity (Large Debate)<br>**Assignment:** Research for Weekly Family Role-Playing Activity, Final Paper, Project Presentations |
| 18 | **Objectives:** Team and communication skill development, understand personal reasoning and biases<br>**Class activities:** Weekly Family Role-Playing Activity (Large Debate) and debriefing<br>**Assignment:** Final Paper, Project Presentations |
| 19 | **Objectives:** Acquire a sense of empathy for Berber women working in Argan cooperatives by simulating the oil-making process<br>**Class activities:** Ethnobotany and the Argan Forest Part 3b<br>**Assignment:** Final Paper, Project Presentations |
| 20 | **Objectives:** Written/oral communication development, relating course material to personal lives |

| | **Class activities:** Ethnobotany and the Argan Forest Part 3c<br>**Assignment:** Final Paper, Project Presentations |
|---|---|
| 21 | **Objectives:** Written/oral communication development, relating course material to personal lives<br>**Class activities:** Student Fog Water Project Presentations (GPS), Final Paper due<br>**Assignment:** |

**9.**

**i.Morocco Water Scarcity**

For this assignment, you will need to visit the folder on MyWPI under "Course Materials" called "Readings on Dar Si Hmad." In the "Audio Narratives" folder, listen to the interviews with Aissa Derham and Jamila Bargach. (Each interview consists of 4 separate audio files plus a transcript. The easiest thing is to listen to the audio files while reading along.) Note: Running time for each interview is approximately one hour, so be sure to plan accordingly.

Open the folder in "Readings on Dar Si Hmad" called "Ait Bamraane Water Use Data" and read both files. One is a spreadsheet of 2011 water use patterns in the villages prior to completion of the fog water project; the other is the transcript of 2015 interviews following the installation of the fog nets.

Now, look at the following indices to see what Morocco's water access looks like from a regional perspective:

1. World Bank Food and Agriculture Organization's *Making the Most of Scarcity* (Appendix: Water Resources Data):
Where does the Middle East and North Africa (MENA) stand relative to other regions of the world?

2. United Nations Key Water Indicator Portal (KWIP):
Select "Morocco" as your country and in the "indicator" box, select "% of population with access to improved water sources." You may look at other indicators, but be sure to look here and take note of what you can discover about water access.

3. Growing Blue's Water Stress Index:
Choose "Morocco" and examine the data, including "Water Footprint per capita."

Next, to help you understand Morocco's water access, compare it to what you know:

4. Calculate your own water footprint using the Water Footprint Network's "Extended Personal Calculator."

5. To make sense of all this information, consider the topic of water access in rural southwest Morocco as the elephant in the parable of the blindfolded men who touch the elephant in

different parts and try to describe the thing in front of them. We would like you to write three separate 250-word essays, each assessing a different point of view.

A.    Write about the view from afar (regional and national data). What light do these big data sets shed on the water issue in Morocco?  What can they tell you about water use and access in this region? What kinds of data are these? How accurate? How representative? How useful? In what particular ways are they useful? (250 words)

B.    Write about the view from the perspective of *either* Jamila *or* Aissa. What do they see? What kinds of data are they giving?  What light do they shed on the water issue in Morocco? What can they tell you about water use and access in this region? How accurate are these data? How representative? How useful? In what particular ways are they useful? (250 words)

C.    Write about the view from the household surveys. Reference several different household surveys in your discussion. What do these data show? What kinds of data are they?  What light do they shed on the water issue in Morocco? What can they tell you about water use and access in this region? How accurate are these data? How representative? How useful? In what particular ways are they useful? (250 words)

D.   In a brief bulleted list, give one *advantage* and one *disadvantage* of each of these perspectives on our understanding of the water problem in this region.

E.    Finally, some analysis and reflections. Given all these data —quantitative data from the UN, the World Bank, and other databases; interviews and quantitative data from private research— what is the "Great Problem" in this region? How would you define the problem?  Be as precise as you can, understanding that "water" is much too vague. How much weight do you give to the aggregated data as opposed to the subjective testimonials of the people involved in the Dar Si Hmad fogwater project? As you write, be sure to use examples (your data) from all the different sources, and to explain how they lead you to your conclusion. (250 words)

**ii. GPS Fog Project**
       In this team assignment you will be proposing a system to deliver fogwater to the people of Ait Bamraane: specifically, the villages of Agni Hiya (15 homes), Timtda (12 homes), and Id Sousane (34 homes). (See maps in "Readings on Dar Si Hmad" folder.) Assume that the average home contains 3 adults and 3 children. You will need to take into consideration the size of your population (including livestock), water use patterns, amount of water collected per square meter of fog net, number of nets needed and square footage, cost of netting, topography, and distance between the fog nets and each village (to determine required length of water pipes). Do you need a pumping station or can you use gravity? Excluding labor for installation, what will it cost to purchase the nets for fogwater collection (see Fogquest FAQs) and the pipes to deliver water to these villages? The cost of the pipes will depend on the materials you use and your source; conduct your own research to identify a source and a cost.
       Write a 7-8 page (double-spaced) project report (plus works cited, to cite all sources you consult). Your report should include the following elements:

*Problem Statement* describing the problem and its impact on the people and environment of these
· villages, including the following information on water scarcity: the average water use per
person per day (includes human consumption and animal consumption) and also per 6-person
family per day and per month (including human and livestock consumption);
· cost of water for a 6-person family and their livestock in a month when there is no well water.

· To be sure your conclusions are transparent, be sure to include and explain all your calculations
and cite all sources for your information.

*Design document* describing basic functions of the fogwater system and means for achieving
those functions, features of the design, and costs.
·      How many fog nets will you install on Mt. Boutmezguida to meet the needs of a village of
60 people plus their livestock?
·      How will you get the water to the villages?
·      What hardware will you use?
·      What will the project cost? (As above, include your calculations and your sources)

*Conclusion* explaining how the design will address the problem. Here you should include
qualitative as well as quantitative arguments about the anticipated effects of this project: How
much money will these fog nets save families in a year of drought during the months of July,
August, and September? Apart from saving them money, how will your fogwater project
improve their lives and the region?

Prepare a 5-minute presentation with visual elements. Report and presentation slides must be
uploaded by 11:00 on Oct. 5. Your team will present its design to the class on either Oct. 5 or
Oct. 7.

You'll need to consult the following sources, all available either through the included links or on
the "Readings in Dar Si Hmad" folder of our course site (in "Course Materials").  Find other
sources as needed.

*Fogquest Fog Collection Manual* (2005)
Fogquest FAQ page
Marzol, "Meteorological Patterns and Fog Water in Morocco and the Canary
Islands"
Marzol & Sánchez Megía, "Fog Water Harvesting in Ifni, Morocco. An
Assessment of Potential and Demand"

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