Gamification of the Dar Si Hmad Fog Water Harvesting Project in Morocco:

Creating a Role-playing Curriculum to Integrate STEM and Humanities Content

Authors:
Shaimae Elhajjajy
Haruna Okada
Niang Suan Thang

Advisor:
Dr. Leslie Dodson

An Interactive Qualifying Project

Gamification of the Dar Si Hmad Fog Water Harvesting Project in Morocco

Creating a Role-playing Curriculum to Integrate STEM and Humanities Content

An Interactive Qualifying Project (IQP) Report

Submitted to the Faculty of

Worcester Polytechnic Institute (WPI)

In partial fulfilment of requirements for the

Degree of Bachelor in Science

Submitted on March 24, 2017

Submitted by:

Shaimae Elhajjajy

Haruna Okada

Niang Suan Thang

Submitted to:

Dr. Leslie Dodson

Abstract

Our team created a role-playing curriculum based on the world's largest fogwater harvesting project, pioneered by Dar Si Hmad, a Moroccan NGO. We created processes to gamify a course that integrates STEM and humanities content within the social, scientific and engineering context of the fog project. We developed characters, team activities and assignments to help students better understand social and cultural factors embedded in engineering problems. We also developed material for the NGO to use at the COP22 climate conference.

Executive Summary

Figure 1: Fog nets installed by Dar Si Hmad (Trautwein, 2015)

Introduction:

At an institution such as Worcester Polytechnic Institute (WPI), where the primary focus is on STEM disciplines, role-playing games help showcase the intersection of the humanities *and* engineering, in addition to the importance of the humanities *in* engineering. Aspiring engineers often focus solely on the mathematical and scientific aspects of a problem because that is the method introduced to them at university in traditional classroom settings. Such a technological focus creates an underlying detachment from society where the social, financial, environmental, political, etc. context is often overlooked. A curriculum that incorporates an in-class, location-based, role-playing game can help address this problem by incorporating role-play to integrate the humanities and engineering.

One of the most important ways in which students can profit from gamification may actually be the most overlooked. Acting out a persona, or role, and performing tasks within a realistic context often activates a feeling of *empathy*. This sense of "putting yourself in someone

else's shoes" is a central theme of the gamification process (Schmitz et al., 2015). The wide range of skills and knowledge obtained from a role-playing game, paired with their newly-developed empathic awareness, allows students to take their education to the next level, by helping equip them to tackle interdisciplinary challenges involving engineering and the humanities.

From the comprehension and retention, to the reinforcement of interdisciplinary studies, gamification is able to impart on students valuable lessons from their curriculum (Spires et al., 2016). The introduction of role-playing games provides students with an immersive learning experience that also provides them, perhaps most importantly, with the medium through which they can also experience empathy (Anderton et al., 2016).

Purpose:

The purpose of our project was to develop a role-playing game that incorporates the engineering and humanities within a rich social and cultural environment. By doing so, we were able to extend the work of six different WPI student projects. We believe that a role-playing game centered on the pioneering fog water project in the Berber communities in Southwestern Morocco could help students examine and realize the importance of what they are learning.

Background:

Six past, distinct WPI projects have had influence on our own project, and we were able to extend some aspects of their work through our IQP. These projects include:

Title of Project	**Project Type**
A Multimedia Project Based Learning Course: Morocco	Off-campus IQP, Summer 2015
Social Business Plan and Publishing Proposal for Global Toolkit	MQP, B Term 2015
A Greywater Recycling System to Support a Fog Harvesting Initiative in Aït Baâmrane, Morocco	Off-campus IQP, A Term 2015
Developing a Teaching Game	Humanities Inquiry Seminar, A Term 2015
Developing Promotional Materials for COP22	Off-Campus IQP, A Term 2016
Humanitarian Engineering: Past and Present	Experimental Course, AY 2015-16, AY 2016-17

Table 1: Past WPI projects which have influenced our IQP

Methods:

In order to fulfill our goal of developing a comprehensive, fully-functional role-playing game in the selected Morocco environment, we needed to develop a procedure that would allow us to design characters and associated assignments. The flowchart below serves as a template outlining the process of creating characters and assignments for the purpose of a role-playing game in an academic setting. This template is indicative of the general methods we followed to develop characters and assignments for our project.

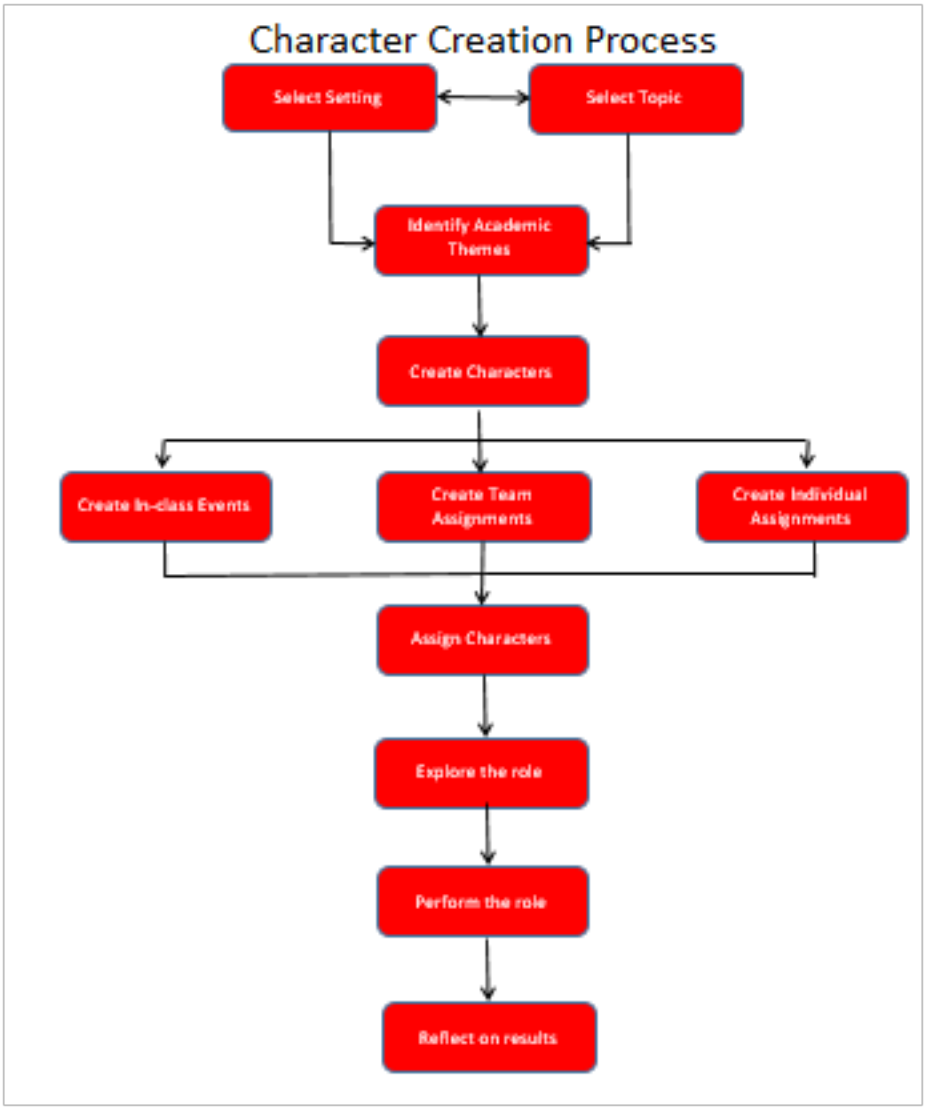


Figure 2: Template for the character creation process

Results:

During A term 2016, our primary focus was on creating material for Dar Si Hmad to showcase at their booth at the COP22 UN Climate Change Conference in Marrakech in November 2016. Our aim was to demonstrate to other NGO's, interested parties, and government

officials the educational opportunities presented by Dar Si Hmad's fog water project through the gamification process we planned to implement over the course of the IQP. We displayed these gamification ideas through three different media: a poster, a short paper and a PowerPoint presentation. This material provided detailed background on the pedagogy of gamification as well as our plans to gamify Dar Si Hmad's fogwater harvesting project by developing a role-playing game.

For the majority of our IQP, we worked as a group to gamify the fogwater project. We created and developed a total of nine characters, each with their own corresponding set of assignments. Each of us created three characters who addressed a diverse range of social and cultural issues within our Morocco setting, and all connected back to the central idea of Dar Si Hmad's fog water harvesting project.

As mentioned earlier, our project was a direct extension of the Humanities Inquiry Seminar in which we continued their work by revising previously-created characters. Those character role sheets were in many different formats and had inconsistent information. We revised those character role sheets using our new template and format, which revealed missing information that can be developed in the future. As we revised those character role sheets using our new template and format, we found missing information in the previously developed characters that needs to be developed in the future.

Analysis:

We were able to create characters that had great depth and through these characters, we addressed issues that remain crucial in the world and remain crucial to our values and beliefs. We were able to develop assignments that required teamwork and character collaborations.

As we developed the characters' backgrounds and their assignments, we encountered some limitations in which the characters might have not been perfectly developed or applicable to reality. The first limitation was our lack of interactions with the communities, the DSH staff, and the fogwater project. The second limitation was having an insufficient period of time for the project to develop more in-depth character roles and assignments. Character and assignment development takes much longer than expected. Since we prioritized quality over quantity, we aimed to develop characters more completely rather than creating a large number of characters with little detail. In the future, we would like to have more time for this process, in order to fully develop the characters richly and with as much detail as possible.

We found that it was challenging to simultaneously meet three main requirements of the role sheets: to meet the needs of the professor, to interest the students, and to maintain the integrity of the characters such that they were realistic within our setting. We needed to make sure that the assignments were effectively addressing the curriculum requirements that a professor would desire for his/her teaching. We also wanted to create characters and assignments that would appeal to potential students who participate in this role-playing game, by developing engaging but relevant activities. Finally, keeping these two points in mind, we also had to make sure that we preserved the authenticity of the characters we developed, while still making them appropriate for both the given setting and the learning outcomes we hoped to achieve.

Recommendations:

A summary of our suggestions for future work on the gamification of Dar Si Hmad's fog water project can be seen below, in Table 2.

Topic	**Recommendation**
Scheduling	Create a timeline for work that must be completed, for better preparedness and organization when gamifying a course
Range of Characters	Develop meaningful and realistic characters and addressing a wide range of topics
Additional Characters	Develop additional characters to enhance this particular role-playing game
Group Work	Encourage students in the gamified class to work in small groups in order to understand the connection between different characters
Culture Day	Throughout the course, have each student pursue a specific cultural or social topic which they share with the class.

Table 2: Recommendations for future work

Conclusion:

Our IQP allowed us to explore and develop an "alternative" pedagogy by integrating a role-playing game with the fogwater project by Dar Si Hmad. We have concluded that the role-playing game could engage STEM and humanities students to better understand both the engineering and human aspects of a complex, open-minded socio-technical issue.

We hope that this role-playing game helps bring awareness of the many social issues embedded in technical problems. We believe that our work, particularly the template and role-sheets, sets the stage for other gamification-based courses at WPI. With some further development of this course, along with the characters and assignments we have created, we hope that future WPI students will have the opportunity to experience an immersive and engaging classroom experience as they learn more about the social, cultural, and engineering implications of Dar Si Hmad's fog harvesting project. With the immersive nature of role-playing games for a curriculum, gamification possesses great potential for being implemented into the curricula of more schools.

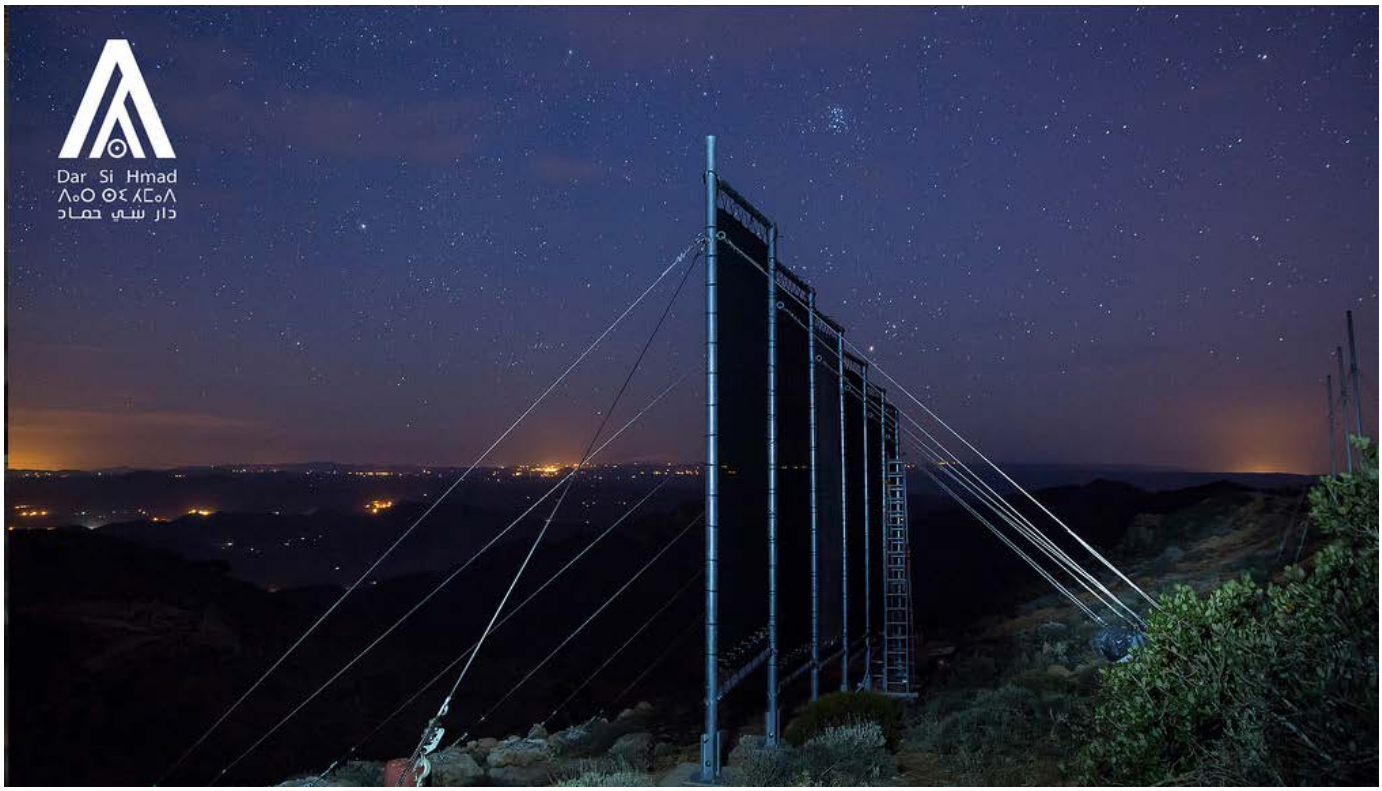


Figure 3: Starry night and nets (Dar Si Hmad)

Acknowledgements

Acknowledgements

We would like to sincerely thank the following people for helping us during our on-campus IQP:

WPI Faculty:

Our advisor Dr. Leslie Dodson, for her endless and invaluable encouragement, support and guidance along the way.

Dr. Kristin Boudreau, for her continuous enthusiasm for our project, and for providing us with resources from her Humanities and Arts Inquiry Seminar, “Developing a Teaching Game.”

Dar Si Hmad Staff and Volunteers

Dr. Jamila Bargach, for allowing us to interview her and providing us with essential information and guidance for our COP22 poster.

Najib Kabir, for conducting and translating interviews with local Moroccans, which helped us to develop authentic characters.

WPI Students:

Rachel Santarsiero, for giving us an insight on what it is like to work with Dar Si Hmad on-site in Morocco.

Stephany Ruiz, for giving us a better understanding of her IQP “Multimedia Project-Based Learning Course: Morocco.”

Authorship

CHAPTER/SECTION	PRIMARY AUTHOR(S)	PRIMARY EDITOR(S)
Abstract	All	Edited by all
Executive Summary	All	Edited by all
Acknowledgements	All	Edited by all
Chapter 1: Introduction	All	Edited by all
Chapter 2: Literature Review	(drafted by section)	Edited by all
2.1 What is gamification?	Niang Suan Thang	Edited by all
2.2 Why gamify?	Shaimae Elhajjajy	Edited by all
2.3 How to gamify?	Haruna Okada	Edited by all
Chapter 3: Background	(drafted by section)	Edited by all
3.1 Dar Si Hmad	Haruna Okada	Edited by all
3.2 History of Gamification at WPI	All	Edited by all
3.2.1 Initial gamification course at WPI	Niang Suan Thang	Edited by all
3.2.2 Multimedia Project-Based Learning Course: Morocco	Haruna Okada	Edited by all
3.2.3 Social Business Plan and Publishing Proposal for Global Toolkit	Haruna Okada	Edited by all
3.2.4 A Greywater Recycling System to Support a Fog Harvesting Initiative in Aït Baâmrane, Morocco	Niang Suan Thang	Edited by all
3.2.5 Developing a Teaching Game	Shaimae Elhajjajy	Edited by all
3.2.6 Fog Water Collection: Developing Promotional Materials for COP22	Shaimae Elhajjajy	Edited by all
3.2.7 Humanitarian Engineering: Past and Present	Niang Suan Thang	Edited by all
3.2.8 Our IQP	All	Edited by all
Chapter 4: Methods	(drafted by section)	Edited by all
4.1 Selecting a setting	Shaimae Elhajjajy	Edited by all

4.2 Selecting a topic	Shaimae Elhajjajy	Edited by all
4.3 Creating a character	Shaimae Elhajjajy	Edited by all
4.4 Identifying academic themes	Shaimae Elhajjajy	Edited by all
4.5 Creating assignments	Niang Suan Thang	Edited by all
4.6 Assigning a character	Niang Suan Thang	Edited by all
4.7 Exploring the role	Haruna Okada	Edited by all
4.8 Performing the role of the character	Haruna Okada	Edited by all
4.9 Reflecting on learning outcomes and role-play	Haruna Okada	Edited by all
4.10 Example	All	Edited by all
Chapter 5: Results and Analysis	(drafted by section)	Edited by all
5.1 Results	All	Edited by all
5.2 Analysis	All	Edited by all
5.2.1 Analysis of and Reflection on Processes and Methods	All	Edited by all
5.2.1.1 Desirable Aspects	Niang Suan Thang	Edited by all
5.2.1.2 Goals Accomplished	Niang Suan Thang	Edited by all
5.2.1.3 Obstacles	Haruna Okada	Edited by all
5.2.1.4 Challenges	Haruna Okada	Edited by all
5.2.1.5 Limitations	Shaimae Elhajjajy	Edited by all
5.2.1.6 Needs	Shaimae Elhajjajy	Edited by all
5.2.2 Individual Reflections	All	Edited by all
Chapter 6: Recommendations and Conclusion	(drafted by section)	Edited by all
6.1 Recommendations	All	Edited by all
6.1.1 Scheduling	Niang Suan Thang	Edited by all
6.1.2 Character Development	Shaimae Elhajjajy	Edited by all
6.1.3 Rubric and Grading System	Niang Suan Thang	Edited by all
6.1.4 Culture Day	Haruna Okada	Edited by all
6.2 Conclusion	All	Edited by all
Chapter 7: References	All	Edited by all
Chapter 8: Appendices	All	Edited by all

Table of Contents

List of Figures and Tables

List of Figures

List of Tables

Chapter 1: Introduction

It is common to perceive the idea of "role-playing games" as games that are normally associated with multimedia digital games. Multimedia and digital role-playing games, commonly known as RPGs such as Dungeons and Dragons, emphasize the development of creativity and problem-solving skills. Another type of role-playing game is called live role-playing game. The live role-playing game differs slightly from digital role-playing games in that the live role-playing games gather players together and the players perform and interact with each other physically without any pre-scripted texts. In the case of a live classroom setting, players would usually collaborate with each other to solve a presented problem. Furthermore, these role playing games, both live and digital, induce a sense of reality and relatability into the concepts being taught. They are live, fresh and improvised, infused with participants' creativity and knowledge. According to education scholars, live in-class role-playing games put into practice a student's problem-solving and technical skills while, at the same time, raising social and cultural issues which the student might not be aware of (Carnes, 2016). This interactive, immersive approach to learning can help make social and STEM-related topics more approachable and relatable, which in turn produces awareness of social and cultural issues alongside technical and scientific issues, which might otherwise be dismissed (Boudreau, 2015).

Despite being a less common pedagogical method, gamification has many beneficial learning outcomes. From the comprehension and retention, to the reinforcement of interdisciplinary studies, gamification is able to impart on students valuable lessons from their curriculum (Spires et al., 2016). The introduction of role-playing games provides students with an immersive learning experience that also provides them, perhaps most importantly, with the medium through which they can also experience empathy (Anderton et al., 2016).

A small group of students and faculty at WPI have begun to explore the use of role-playing games, and there are now several projects that integrate role-play. This IQP gamified a fogwater harvesting project located in southwest Morocco. The fogwater project, run by an independent nonprofit organization named "Dar Si Hmad" is the largest operational fogwater catchment system in the world. As of 2017, it provides potable water to more than 400 rural Berber residents. Dar Si Hmad's goal is to enhance both the fog-collecting net system and villagers' lives side-by-side by creating activities for the villagers to get involved in. Because of the pre-established relationships between Dar Si Hmad and WPI, we found that the fogwater project is ideal to gamify because the project includes both engineering and humanitarian issues.

The purpose of our project was to develop a role-playing game that embeds engineering and humanities content in a rich social and cultural context. By doing so, we were able to extend the work of six different WPI student projects. The goal of our character and assignment creation process was to gamify a curriculum based on the Dar Si Hmad project. We believe that a role-playing game centered on the pioneering fog water project in the Berber communities in Southwestern Morocco can help students examine why what they learn actually matters in the real world.

Chapter 2: Literature Review

2.1. What is gamification?

The primary goal of role-playing games is for students to adopt and "inhabit" a character role that gives them the necessary perspective to tackle complex socio-technical issues and to react as the adopted character in those situations. This interactive, immersive approach to learning allows for many learning opportunities. Firstly, it can help students see that STEM and social topics are compatible with each other and enable them to realize that this compatibility is critical. This is because many students with technical backgrounds often ignore the social issues that are evident in the problem. Using role-playing games helps develop the mindset that STEM and social issues can, and should, be addressed together because that consideration of all major factors including social issues allows students to make better decisions. Furthermore, role-playing games make learning these concepts very much more relatable and interesting. This in turn produces awareness of social and cultural issues alongside technical and scientific issues, which might otherwise be dismissed (Boudreau, 2015).

A role-playing game approach has been shown to be particularly effective because students are required to not only tackle technical issues that arise within role-playing activities such as building prototype fog nets, but also through role-play, they are required to negotiate diverse perspectives while developing sensitivity and empathy towards complex issues raised by the game topic (Bhatt, 2016). Role-playing game developers, such as the collaborative teams of professors and students at WPI, believe that educating engineering students in social and cultural issues plays a vital role in students' future careers (Boudreau, 2015). This goal remains crucial, as detrimental effects have been observed when engineers do not consider social dynamics, but only regard problems from a technical or financial perspective, which, for example, occurred recently in the water crisis in Flint, Michigan in April 2014 (Kennedy, 2016).

The role-playing game curriculum at WPI was initially launched by Professor Boudreau and a group of undergraduates of the class of 2014. The initial game-based curriculum was designed with supervision and assistance from Professor Boudreau, the American Antiquarian Society, the Worcester Historical Museum and WPI's Gordon library. They developed a game set in nineteenth-century Worcester at a time when the rapidly-industrializing New England city faced a large-scale problem with industrial and domestic waste and sewage. Overall, the role-playing game integrates engineering education with the social, economic, social and cultural conditions in that period of time. It includes experiments of sewage water and various filtration and treatment options; data collection and project design alongside lessons and activities that focus on immigration, industrialization, religion and law (Boudreau, 2015).

2.2. Why Gamify?

Gamification is a less-explored pedagogical method compared to traditional teaching techniques in current practice (Randi et al., 2013). Despite its comparatively understated occurrences in academia, gamification presents an abundance of advantages for students, and its

implementation is becoming more prevalent (Spires et al., 2016). It is important to be aware of the unique outcomes and benefits achieved through the gamification of a course that a standard in-class lecture would not provide. These include positive effects on student comprehension as a byproduct of active learning, ability to teach interdisciplinary subject matter, and the introduction of empathy in learning. With the immersive nature of role-playing games for a curriculum, gamification possesses great potential for being implemented on a larger scale. Some of the major distinctive effects of gamification are outlined here.

2.2.1 Comprehension and Retention

The embodiment of a fictional character situated in a real-life environment, or of a character based on the experiences and lives of real people, offers students the opportunity to adopt an identity in a different setting. Carrying out actions and performing activities that would be expected of the character within a certain context allows students to better understand the concepts presented to them, because a more hands-on approach can lead to better comprehension and retention of what they have learned (Schmitz et al., 2015). Through gamification, students become actively engaged in the events of the setting and become immersed in the situation, while remaining in a safe and comfortable learning environment (as opposed to an actual, physical environment). Such role-playing games help to develop a higher and more in-depth level of knowledge and competence than would have been obtained from information on a screen or page, because the concepts are learned in a more interactive manner rather than through instruction-based lectures (Schmitz et al., 2015). By physically performing different actions from the point of view of a character, students are immersed in the simulated world (Schmitz et al., 2015), and thus tend to better retain the content they have learned due to the unique experience gamification provides (Anderton et al., 2016). Additionally, the broad range of settings in which the game can take place means that students are developing skills that can be applied cross-culturally. Exploring an unfamiliar world from the perspective of a realistic character fully engages the students in the curriculum through in-class role-playing activities, teamwork and assignments.

2.2.2 Interdisciplinary Study

Gamification is a promising approach for interdisciplinary study as well. The gamification method is versatile: it can be applied to various fields of study, from health care through CPR training exercises (Schmitz et al., 2015), to counselor education and psychology (Anderton et al., 2016), and from cell biology concepts (Randi et al, 2013) to computer science and art design learning (Spires et al., 2016). As can be seen from this wide range of topics, gamification can be employed in a variety of disciplines and across many majors. Gamifying an otherwise standard curriculum through role-playing and embodying a character in a rich socio-technical context that involves both a complex cultural situation and an engaging engineering problem helps students to understand the importance of social and cultural influences that accompany most engineering problems. In our project, gamification provides students with identities, objectives, and social and engineering dilemma, which then allows them to first scope the problem through personal experiences, then design a solution to fix the problem while keeping that knowledge in mind (Boudreau, 2015). Through character roles and assignments, the role-playing game

can teach students that humanities play a much larger role in engineering than they might realize, and that a valuable collaboration can be forged between the two (Boudreau, 2015).

At an institution such as WPI, where the primary focus is on STEM disciplines, role-playing games help showcase the intersection of the humanities *and* engineering, in addition to the importance of the humanities *in* engineering. All too often, aspiring engineers focus solely on the mathematical and scientific aspects of a problem because that is the method introduced to them at university in traditional classroom settings. Such a technological focus creates an underlying detachment from society where the social, financial, environmental, political, etc. context is often overlooked. A curriculum that incorporates an in-class, location-based, role-playing game can help address this problem by incorporating role-play to integrate the humanities and engineering.

2.2.3 Empathy

One of the most important ways in which students can profit from gamification may actually be the most overlooked. Acting out a persona, or role, and performing tasks within a realistic context often activates a feeling of *empathy*. This sense of "putting yourself in someone else's shoes" is a central theme of the gamification process (Schmitz et al., 2015). During and upon completion of immersive activities, students begin to *feel* for others in various cultures, religions, countries, and societies. The depth with which role-playing games simulate or replicate real-life situations can invoke feelings of empathy in students, including those that contradict their, perhaps unrealized, pre-existing notions and biases (Anderton et al., 2016). The concept of empathy is underrated in that it is not often emphasized in a pedagogical environment, especially those which focus on the technical fields of science and engineering. However, providing students with a significant and meaningful *emotional context* could prove to be invaluable when successfully imparted on the students through the gamification process. Empathy can facilitate new awareness, generate understanding for others, provide for a comfortable exploration of other cultures, and encourage application of the skills they have learned (Anderton et al., 2016). The wide range of skills and knowledge obtained from a role-playing game, paired with their newly-developed empathic awareness, allows students to take their education to the next level, by helping equip them to tackle interdisciplinary challenges involving engineering and the humanities.

More research is needed to more precisely understand the benefits of gamification, particularly non-digital role-playing games. Nevertheless, the advantage of gamification lies in its distinctive effects on students' learning and behavior; past participants in such a curriculum have indicated that they now see the importance of embodiment in education, and taking on such perspectives have influenced their self-awareness, empathy, and overall outlook on the world (Anderton et al., 2016). Immersive learning through embodiment of a role in a multi-faceted, complex environment engages students in their curriculum while imparting in them a sense of empathy and accomplishment, skills that will inevitably serve them well in the future. However, the full impact of the gamification pedagogical approach on learning is still not conclusive, as more research is still required to confirm the correlation between this type of teaching method

and various learning outcomes (Schmitz et al., 2015). Nevertheless, a role-playing game centered on the pioneering fog water project in the Berber communities in Southwestern Morocco could help students examine why what they learn actually matters in the real world.

2.3. How to gamify

Gamification of academic course curriculum is designed to address issues that have significant impacts on a community, community members and other stakeholders. The game design team should ensure that both humanities and engineering contents are included side-by-side in the curriculum by developing a diverse range of stakeholders who play different roles in the issues raised in the setting, or who have personal problems related to the issue or are personally involved in the issue.

The process of gamification begins when an instructor (or students, sponsor organization, or stakeholders) identifies a sufficiently complex socio-technical issue that involves a variety of disciplines, such as engineering, politics, science, economics, and which is an open-ended problem that invites different approaches and solutions. The issue may take place locally or worldwide. Once an issue is chosen, the instructor (or game design team) conducts research on the issue, the community members, and their perspectives before developing characters. The research may include searching historical records, conducting stakeholder interviews, or immersion in the setting to gather as much first-hand information as possible.

After a sufficient amount of research is conducted, the game design team then develops characters derived from community members and other stakeholders who have a distinctive identity and particular characteristics. Along with each character, the game design team also develops his/her background information, assignments, and objectives for individual characters, teams of characters, or the whole group of characters. The number of characters created must be sufficient for the course such that each student is given (or chooses) one character. (Instructors can assign a role to a student, or students can choose to adopt a specific character, or they can randomly select a character.)

Background information on a character provides students with their historical identity, ideology, and the character's authority in the community. Historical and demographic background may include the character's hometown, their past and present careers, and previous experiences of the character in the community. Characters are also given an 'ideology,' which provides students with information on how various issues that come up in the game impact the characters' lives, and what beliefs the characters hold for the issues that occur. Characters' 'authorities' inform students about what influences characters have on the community, and how a character might manage their power in the community (positively or detrimentally). In other words, background information illustrates a character's beliefs, perspectives, and goals towards the game topic and the issues embedded within it. In addition, each stakeholder is given a set of assignments that involve the stakeholder's area of interest and that the stakeholder needs to perform in his/her given assignments (responsibilities). Assignments for each character are deliberately created to ensure that students are able to pursue the objective of the assignments, as well as to get a better understanding of the characters' lives.

Ideally, the role-playing game occurs through the entirety of the term or semester so that students have sufficient time to become immersed into the setting and their adopted characters and complete their assignments. Throughout the course, students are expected to conduct additional research on their adopted character; they learn various science and engineering principles of the issue; and they become immersed in the cultural and social aspects of the community. Additionally, students in their character roles are urged to form alliances with other characters who might support their goals and thereby together exert an influence on community decisions.

Once a significant amount of research is conducted, individuals or teams accomplish the given assignments to ensure that goals (or objectives) are achieved. In-class activities may, for example, involve debates, women's and men's meetings, mass meetings, and votes. Within these activities, individuals and teams can determine best solution for further actions. Tension often arises in the game as other individuals or teams present opposition or competition or contradictions. This tension is welcome, as it allows students the opportunity to compromise, negotiate and devise solutions that consider a wider range of perspectives than they might in a traditional engineering course. Individuals, and teams, must develop well-reasoned and effectively-communicated arguments in order to persuade others to support them. As the role-playing game and activities progress, students are given opportunities to share their opinions on issues and the proposed solutions. They must communicate their argument for or against proposed solutions and they must participate in deciding on the most appropriate solution or solutions.

Chapter 3: Background

3.1. Dar Si Hmad

Dar Si Hmad was founded in 2010 as an independent nonprofit organization that aims "to promote local culture and sustainable initiatives through education and integration of scientific ingenuity in Southwest Morocco" (Dar Si Hmad, n.d.). Dar Si Hmad's signature project is its fog-water harvesting project atop Mount Boutmezguida, located in the Aït Baâmrane territory of Southwest Morocco. In this semi-arid region between the Atlantic Ocean and the Sahara Desert, residents used to fetch water from wells. Since March 2014, water harvested by the fog-collecting nets is the main source of water to households, serving approximately 400 residents.

Figure 4: Construction of the net test collectors (Aqualonis, 2015)

The fog-collecting system is now the largest operational fog catchment system in the world. The initial installation was 600 square meters of nets with nearly five miles of pipeline, providing 6300 liters of water/day, which was more than enough to service 400 residents (Aqualonis, 2015; United Nation Framework Convention on Climate Change [UNFCCC], n.d.). However, the organization is aiming to provide potable water to many more villages, so the

organization and its partners are currently (2017-2018) installing the new generation of high-efficiency nets which are capable of doubling fog water harvested over the same net surface (UNFCCC, n.d).

Before the fogwater project was launched, the communities in the region suffered from water scarcity and its detrimental effects on agriculture, girls' education, community health, and women's lives. In particular, women spent an average of 3.5 hours every day fetching water from open wells. This laborious, time-consuming work was considered a woman's role of nearly every household (Dar Si Hmad, n.d.). Water-hauling and other domestic chores precluded many, if not most, of the young girls in the area from attending school. These are just some of the significant issues related to water scarcity that Dar Si Hmad aimed to solve with its fogwater harvesting project.

Figure 5: Berber woman collecting well water (Aqualonis, 2015)

Dar Si Hmad's goal is to enhance both the fog-collecting net system and villagers' lives side-by-side by creating opportunities for community members to be involved in the project. These activities involved a variety of jobs, including installing and maintaining the nets with DSH staff, taking care of water valves, reporting any problems occurred to the DSH staff, etc. Some activities were created to empower women: despite strong traditional constraints, Dar Si Hmad is leading programs that provide major roles in the community and in the project for women.

As the organization worked on the fogwater project, the curiosity of rural children about fogwater led Dar Si Hmad to create the Water School in which children learn about water and ecological stewardship through activities and games. Dar Si Hmad corroborated with the rural school of the Aït Baâmrane to organize and develop lesson plans of the Water School that could build "a comprehensive understanding of the water economy and how it shapes one's

environment" ("The Water School," n.d.). The primary focus of the lessons is for children to learn the role of water "in an approach that engages their mind, heart, and bodies" (ibid)."The Water School," n. d.). Through these lessons, the children become aware and conscious about sustainable water practices.

Figure 6: A young girl writes in her environmental journal as part of Dar Si Hmad's Water School (Farnum et al., 2016).

Figure 7: A young boy peers through a microscope during Dar Si Hmad's Water School. (Dar Si Hmad, Twitter).

With these life-changing projects, Dar Si Hmad was one of the thirteen winners of the prestigious United Nations Momentum for Change award from the United Nations Framework Convention on Climate Change (UNFCCC) in 2016. This achievement creates many more opportunities for Dar Si Hmad to expand its current fog harvesting project or start new projects.

In conclusion, this game design team sees an excellent opportunity to engage students in humanities and engineering aspects of the fogwater project through gamification. Below, we explain the history of this idea at WPI and describe the gamification of Dar Si Hmad's fogwater project in the Aït Baâmrane territory of Southwest Morocco.

3.2. History of Gamification at WPI

3.2.1 Initial gamification course at WPI (A Term 2014)

Due to the acclaimed success of the role-playing game *Reacting To The Past* which had been first implemented at Barnard College by Mark Carnes. Professor Boudreau saw this as an opportunity to have the same concept of gamification implemented at Worcester Polytechnic Institute (WPI). The fall of 2014 was when the idea was first introduced to the Humanities Department at WPI but it was not until 2016 that this idea turned into an in-class role-playing curriculum.

3.2.2 Multimedia Project-Based Learning Course: Morocco (Summer 2015)

In summer 2015, an off-campus IQP project in the Aït Baâmrane region of southwest Morocco, named a "Multimedia Project-Based Learning Course: Morocco," was created to provide underrepresented students in STEM the opportunity to learn and explore global projects away from project sites. In doing so, they created a preliminary multi-media, project-based learning resource called the Global Toolkit that sought to replicate the same learning objectives as on-the-ground global projects. This toolkit incorporates multimedia from the fogwater harvesting project, including audio, photographs, and video (Claypool et al., 2015). The Global Toolkit is designed to engage students in a wide range of study fields and perspectives on an issue rather than only emphasizing STEM content. It also aims to help increase STEM interest among underrepresented students and diverse populations. The Global Toolkit created in this IQP used the Dar Si Hmad fogwater project as its setting.

The Global Toolkit, as a learning resource, is designed to combine in-class activities and online readings and games. In-class activities will engage students through an in-person role-playing game in which a group of student are assigned to represent a certain set of community members who debate with other groups of students on a given topic. Online readings are designed to provide students with historical background of the setting, the community, the project, and some scientific information. On-line digital games will enable students to get insight into the engineering and social impacts on communities by having the students try to manage real problems faced in the fogwater project.

Figure 8: Fog-harvesting nets atop Mount Boutmezguida (Aqualonis, 2015)

The IQP team worked closely with the DSH staff on site and spent nearly four weeks interacting with community members. While there, they interviewed DSH staff and a wide range of community members. Being immersed in the fogwater project and the Berber culture allowed the IQP team to develop background information for characters for the role-playing game based on community members (Claypool et al., 2015). This visual and narrative information, as well as useful reading materials can help students learn the science behind the obstacles and the historical background of the setting, the community, and the project. The team also developed the objectives and preliminary ideas for online games to give students the opportunity to manage various obstacles. The team drafted and developed the fundamentals and ideas for three components of the Global Toolkit, which need to be fully developed in the future. Through scientific and social consideration portrayed in the Global Toolkit, STEM students will hopefully be better able to be engaged in the engineering and humanitarian issues of a project even if they cannot visit the actual field site.

3.2.3 Social Business Plan and Publishing Proposal for Global Toolkit (B Term, 2015)

In B-term 2015, a WPI student collaborated with the multimedia IQP team and established an MQP project called “Social Business Plan and Publishing Proposal for Global Toolkit” to investigate the potential for the Global Toolkit to be a social enterprise in which the toolkit benefits the communities where it is developed. Specifically, if the Global Toolkit is feasible as a social enterprise where it can generate money, a portion of earnings will go towards building further projects in the community, and the rest will go towards developing future learning modules (Ervin, 2015).

Figure 9: The logo for the Social Business Plan's Global Toolkit (Ervin, 2015)

To investigate the feasibility of the Global Toolkit as a social enterprise and gain an understanding of the market for the Global Toolkit, the MQP student conducted research and developed the social enterprise business model and publishing process before composing a potential business plan and publishing proposal for Global Toolkit (Ervine, 2015). An organizational support model was selected as the social enterprise model because of its capability to provide donations to an organization and its flexibility to be modified based on the beneficiary's project. To generate the greatest impacts out of the Global Toolkit, the Water School project by Dar Si Hmad was targeted as the beneficiary's project. The MQP student provided the related IQP team with a targeted publisher, Pearson Education, that could be a good fit for the Global Toolkit.

3.2.4 A Greywater Recycling System to Support a Fog Harvesting Initiative in Aït Baâmrane, Morocco (A Term, 2015)

This A Term 2015 project was an Interactive Qualifying Project (IQP) completed by a team of three WPI students in Morocco. The goal of this project was to help advance Dar Si Hmad's fog water harvesting project in the Aït Baâmrane region by designing a greywater recycling system to capture and reuse water at the household level. The premise for this project was that introducing a greywater recycling system into the countryside could enable residents to extend their use of fog water (Jefferson et al., 2015). The IQP team created a guide that included three water recycling techniques to introduce the concept of recycling fog water in homes. The group also made a proposal for a recycling system which could be tested at a Dar Si Hmad test house.

Three greywater recycling systems were all considered for the Dar Si Hmad test house: solar distillation, sand, and reed bed filtration. The picture shown below is the representation of the team's project idea.

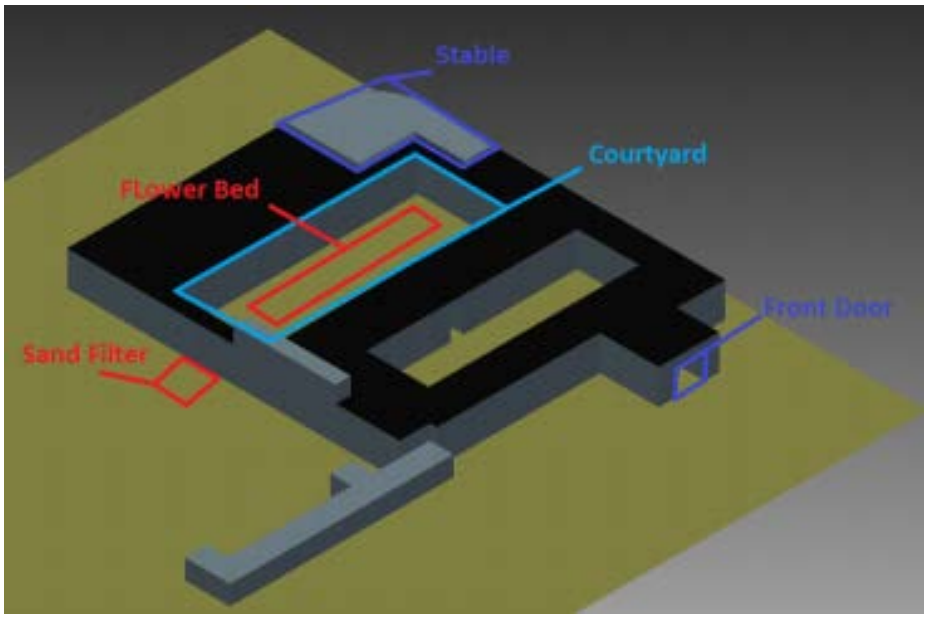


Figure 10: The Greywater recycling system (Jefferson et al., 2015)

The proposed design utilizes a sand filtration system. The team recommended that field tests of various recycling systems in households be performed to determine which community members are open to introducing a greywater system in their home and which system works best in the countryside (Jefferson et al., 2015). This IQP team recommended that Dar Si Hmad receive further input from the Aït Baâmrane people in what they would like to get out of a greywater recycling system. Informing the community that there are other means in maximizing their greywater is a step towards accepting water recycling systems in their villages (Jefferson et al., 2015).

3.2.5 Developing a Teaching Game (A Term, 2015)

During A term of the 2015-2016 academic school year, Professors Kris Boudreau and Leslie Dodson led a Humanities and Arts Inquiry Seminar called "Developing a Teaching Game." Similar to our IQP, the main goal of the inquiry seminar was the "development of an interactive role-playing classroom game for teaching engineering within a complex social context" (Boudreau & Dodson, 2015). Specifically, the focus of that course was centered on the connection between women, fog harvesting, and development projects by Dar Si Hmad, in the poor, rural Aït Baâmrane region of southwest Morocco (ibid). The course consisted of three distinct parts: a team assignment in which groups of four collectively developed a 3-part lecture on a pertinent topic; an individual assignment in which students invented a character role that included activities to be performed; and a personal reflective essay whose purpose was to have

students analyze the role-playing game development process, evaluate their own learning, and describe how the outcome affected them personally (ibid).

The Inquiry Seminar placed great emphasis on the importance of human values such as empathy, compassion, and respect. The course was structured so that STEM-oriented students would come away with a deeper awareness of the role humanistic studies can have in engineering, which they may not have realized before (ibid). Students were required to begin the development of the role-playing game by creating characters and assignments which addressed the water scarcity challenges of the region as well as the work completed by Dar Si Hmad with fog net installation. In order to broaden the scope of the course so that it was not a purely technical approach, the characters and assignments also needed to incorporate other relevant factors that constitute the more humanitarian components. These concepts included, but were not limited to, political, economic, social, cultural, religious, and local historical aspects of the Aït Baâmrane region (ibid). Through the creation of these characters and assignments, students were able to become deeply engaged "intellectually and emotionally in the world of applied STEM" (ibid).

3.2.6 Fog Water Collection: Developing Promotional Materials for COP22 (A Term, 2016)

Another related project was an off-campus IQP which took place during A term of the 2016-2017 academic school year, titled "Developing Promotional Materials for COP22." While the main IQP site was in Rabat, Morocco, the team's project was conducted in close collaboration with Dar Si Hmad and the IQP team traveled to Sidi Ifni, (located on the Atlantic coast in southwest Morocco), which is the gateway to the Aït Baâmrane region where the fogwater harvesting site is located. The primary purpose of that project was to "develop methods to promote the science of [Dar Si Hmad's] fog collection project" so that their subsequent deliverables would give "Dar Si Hmad exposure and potentially [form] new partnerships with other NGOs" (Santarsiero et al., 2016).

Figure 11: Waves of fog rolling over Mt. Boutmezguida (Dar Si Hmad)

More specifically, the team worked to aid in the promotion of Dar Si Hmad's work, which would be showcased at the United Nations Framework Convention on Climate Change (UNFCCC) 22nd Conference of Parties (COP22) that took place in November, 2016 (ibid). To achieve their goal, the team established a technical understanding of Dar Si Hmad's fog collection techniques by physically studying the systems, conducting interviews with Dar Si Hmad employees, and gathering field observations (ibid). They also created and conducted a preliminary botanical survey to observe and analyze plant growth at various elevations, and the effect that fog in the area had on such semi-arid ecosystems (ibid). Finally, they concluded their project by developing creative methods for promoting the NGO's work by communicating fog science and working to improve Dar Si Hmad's Twitter stream and visual rhetoric tools (ibid). The culmination of their work then provided Dar Si Hmad with opportunities to promote their work at the international level and enhance Dar Si Hmad's affiliations with other organizations.

Figure 12: IQP team's final poster design for Dar Si Hmad's promotional material for COP22 (Santarsiero et al., 2016)

3.2.7 Humanitarian Engineering: Past and Present (AY 2015-16 & 2016-17)

In the 2015-16 and 2016-17 academic years, an inter-disciplinary team of WPI faculty co-taught the experimental humanities and engineering course called "Humanitarian Engineering: Past and Present." This two-term experimental course is based on a role-playing game developed by WPI faculty and students to teach engineering within a rich cultural and historical context (Boudreau, 2015). The first term of this in-class role-playing course has its primary focus on engineering, particularly, a nineteenth-century sewerage project in Worcester, MA and it is designed to include science experiments (water sampling, etc.), original research using nineteenth-century technical, historical and cultural material, data analysis (geospatial mapping of nineteenth-century data on pollutants, populations, and sewerage overflows), arguments from data, and cross-cultural communication (Boudreau, 2015). The game opens with a mass meeting which is organized by a Catholic priest from the neighborhood near Water Street where a majority of the occupants are middle-class working immigrants living near the Blackstone Canal. The canal and the Blackstone River carry Worcester's household and industrial waste down to the mill town of Milbury (Boudreau, 2015). Ultimately, the goal of the game is to allow students to experience the world of engineering as a "complicated, challenging, and satisfying enterprise that requires and rewards not only technical expertise, but also sensitivity to human contexts and diverse points of view" (Boudreau, 2015).

The second term of the Humanitarian Engineering class moves from the past to present-day problems of sanitation in the developing world. Student teams choose a location somewhere in the world that has inadequate sanitation facilities and services. They then spend the term investigating the science and engineering involved in sanitation and the thermodynamics of waste as well as social and humanitarian topics such as gender equality and stakeholder analysis (understanding how stakeholder analysis works, how it contributes to the project progress, etc.). In this term, students apply their understanding of complex social-engineering issues, which they developed in the role-playing game, to issues related to international development, social justice and engineering solutions.

Our Morocco role-playing game merges elements of the Worcester role-playing game (such as characters, blended engineering and social activities and homework) with elements from the second-term course that focuses on the developing world.

3.2.8 Gamification of the Dar Si Hmad Fog Water Harvesting Project in Morocco

All of the aforementioned projects have greatly influenced this on-campus IQP. We worked on this project for the first three terms of the 2016-2017 academic school year. As we studied the previous projects, we were able to observe the connections and similarities between that work and our project to gamify the Dar Si Hmad fogwater

harvesting project. Our IQP is different in many ways, although our work extends that of the previous projects and we have incorporated many of the same ideas.

Similar to the Multimedia Project-Based Course project, our IQP aimed to develop a role-playing game that engaged students in the engineering and social contents of a complex socio-technical issue. The Multimedia Project-Based Course team developed the fundamentals/ideas for both online and in-class activities. Our role-playing gamification project, however, puts more emphasis on in-class events in which students are able to interact with other students and the instructor through debates, negotiations, presentations, alliance formations, and discussions. In addition, our goal was for students to be able to become immersed in their adopted characters and the issues by developing in-depth character role sheets with additional resources provided in them. However, we believe gamification, whether it is online or in person, engages students in real world problems, located locally or globally, allowing students to explore different cultures and diverse perspectives.

Our IQP bears a close resemblance to the Humanities Inquiry Seminar, and our project was a direct extension of their initial work. The students in that seminar were able to begin the character and assignment development process. We continued that work by further developing the characters and assignments, as well as creating nine original characters and assignments. However, our IQP is distinct because we have synthesized and incorporated elements from all of the other projects. Furthermore, we developed an expertise in gamification and have provided both "theory and practice" as it pertains to gamification in general, and gamification of the Dar Si Hmad fogwater harvesting in particular.

The off-campus IQP team who wrote "Fog Water Collection: Developing Promotional Materials for COP22" in Sidi Ifni was tasked with developing promotional materials for Dar Si Hmad to present to various NGOs at the COP22 conference. We also performed a similar task, in that we submitted both a poster and a PowerPoint presentation to be showcased at Dar Si Hmad's booth at COP22 in Marrakesh in November, 2016. While that off-campus IQP team focused on fog and botanical sciences, our materials dealt with the gamification process (which incorporated fog science and ethnobotany). Our aim was to demonstrate to other NGO's and participating parties at COP22 that the work of Dar Si Hmad was being used in curricula and other educational projects around the world.

In conclusion, the goal of our project was to develop a project-based role-playing game (in which the characters are based on communities involved in Dar Si Hmad's fogwater project) that addresses social and engineering complexities. In doing so, we extended the work of other WPI projects. We hope our work contributes to other projects that follow this one.

Chapter 4: Methods

In order to fulfill our goal of developing a comprehensive, fully-functional role-playing game in the Morocco setting, we needed to develop a procedure that would allow us to design characters and associated assignments and team activities. The flowchart below serves as a template depicting our approach and outlining the process to create characters and assignments for the purpose of a role-playing game in an academic setting. This template is indicative of the general methods we followed to develop characters and assignments for our project.

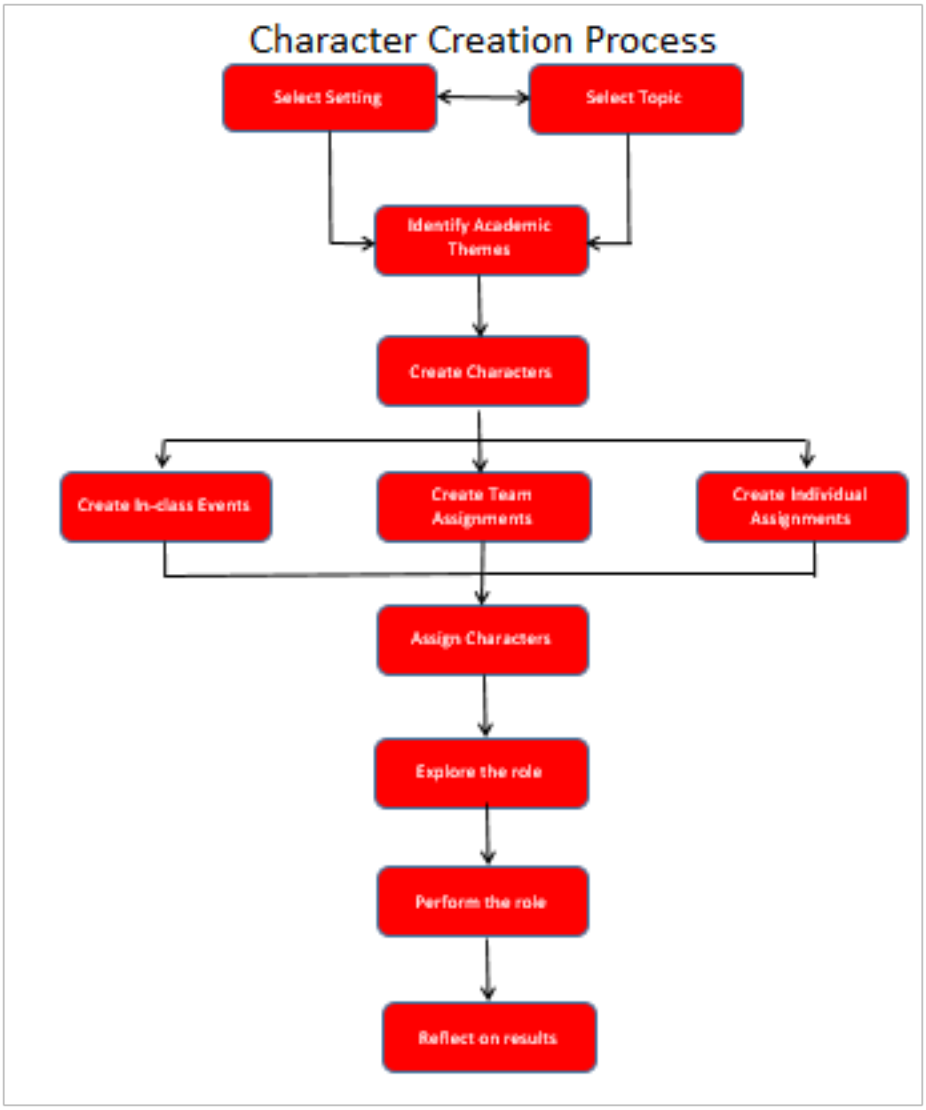


Figure 13: Template for the character creation process.

4.1. Selecting a setting

To begin the gamification process, the instructor, or game design team, must decide on the setting on which to focus the curriculum. The setting should be a place, and can be selected from any location in the world. It does not necessarily need to take place in the present day, as was demonstrated by the Worcester game at WPI in the class "Humanitarian Engineering: Past and Present." This setting should be thought-provoking and relevant, as it will give students the opportunity to address related social, cultural, political, economic, religious, environmental and technological issues that may be present in that setting. The setting will function not only as a geographical and emotional context, but it will also introduce anthropological and ethnographic aspects of the setting as well. As its name suggests, the setting of choice will "set the scene" of the role-playing game and provide a backdrop in which the characters and assignments must be performed.

4.2. Selecting a topic

Following the selection of the setting, an overarching topic should be selected. This should be a topic that plays an important role and has a significant impact on the setting that was chosen. For example, the topic can be a current event that is occurring in that setting, or it could be a ground-breaking and influential project that an NGO is pioneering in that setting, to name a few. Regardless of what the topic is, it must be socially, culturally, and technologically relevant to the people and places involved in that setting. This topic will act as the focal point of the role-playing game, to which all of the eventual characters and assignments will connect back. The idea of selecting a topic may become clearer with an example; see section 4.10.2.

4.3. Creating a character

The next step, in conjunction with the creation of assignments, is arguably the most crucial step in gamification. Developing a well-rounded and balanced character is very important for the advancement of the role-playing game process. Instructors/the game design team should prepare a character for each student, if possible (as well as extra characters for guests, co-instructors, etc.). Each character study must contain a range of information pertaining to the character, such as the character's profile, background, and biography. The character may be based on a real-life person (preferably one who originates from the desired setting), or the character may be fabricated from one's own imagination. Whichever option is favored, however, the character must be involved with both the theme and the setting. In addition, any problems arising from the issues, topics, and/or themes of the setting should be indicated. Providing sufficient and relevant details about this fictitious personality will assist in creating the impression of reality and in providing more depth to the character. A comprehensive character background will help the student to "assume the personality" of the character, by giving the student enough information to imagine and embody the character role.

4.4 Identifying academic themes

Throughout the progression of the character creation process, we discovered that the selection of academic themes related to a character was also a very important step (and one which ultimately eased the process of developing assignments and events. Shining a spotlight on particular subjects proved to be a very helpful step, and aided us greatly when forming background information for each character. Academic themes must relate to the selected setting; in other words, the academic theme must have a connection to the setting and overarching topic, and they must be connected to the character. Academic themes are usually quite diverse and may range anywhere from social, cultural, political, economic, religious, environmental and technological issues pertaining to the setting. When the design team is creating the role-playing game, the academic themes will be determined by the setting and topic. The reason to focus on a specific academic theme (or a few themes) for each character is to enable the student to acquire proficiency, and even expertise, in a significant theme with respect to the chosen setting.

4.5. Creating assignments for the character

4.5.1. In-class events

Because this is an active learning classroom, the instructor or the game design team should create numerous in-class events to provide students the opportunity to perform the roles of their adopted character. In-class events may include discussions, debates, negotiations, and presentations. These events give students the opportunity to interact with other characters, share their thoughts on the issue based on the adopted characters, present their work, and have a better understanding on any presented topic and perspectives. Moreover, they also learn to express themselves better, making them better communicators.

4.5.2. Team assignments

Teamwork in the context of this role-playing game requires collaborating with other characters to achieve a common goal. The goal of team assignments should require contributions from characters from different areas such as when designing a mesh, a materials engineer, a design engineer and a business analyst would come together to make the implementation of the fog net a success. The assignments that we have created incorporate a fair amount of teamwork because we believe that it is important that students develop the ability to work well and at a high level in a team.

4.5.3. Individual assignments

Individual assignments allow students to experience the characters in depth while discovering the character's culture and story in a deeper sense. For example, various individual assignments help the student explore engineering concepts such as programming in Matlab and exploring the types of plants that grow in Morocco according to the weather pattern in Morocco. Other assignments allow the individuals to address social issues such as holding talk sessions and encouraging female empowerment

and learning the Arabic alphabet. Individual assignments help the students acquire skills that are otherwise outside of the student's related major field of study.

4.6. Assigning a character

Assigning a character can be a flexible part of the process. Character assignments can be done by the Professor, or students or professor can randomly assign character roles to students. Team formation may shift throughout the class. Teams may be formed depending on in-class or homework assignments. Throughout the term, there are many opportunities for collaborations between different characters, promoting teamwork

4.7. Exploring the role

Throughout a gamified course, students must conduct additional research on the cultural and social aspects of the setting and the assigned character to better understand the setting, topic and themes from the characters' perspectives. Initial resources should be provided in character role sheets, but each student must also conduct his or her own research on their character, the setting and various STEM and humanities topics. Furthermore, conducting research out of a familiar range of studies is helpful because it allows students to understand the setting and various academic themes based on diverse points of view. Students will become aware of other character's perspectives through in-class activities and homework assignments, which leads to more effective and applicable solutions.

4.8. Performing the role of the character

Along with exploring their adopted roles and the setting through assignments and teamwork, students need to "perform" their roles, through discussions, in-class events, debates, negotiations, presentations, etc. In doing so, students must complete homework assignments that serve as the foundation for character role performances. Assignments are based on characters' backgrounds and circumstances, so students must be concerned about the cultural and social aspects of the community as well as the technical and scientific issues relevant to their character so that their final work is applicable to reality.

Some assignments and in-class activities direct students to form alliances with others characters/students. This allows students to access information and resources performed by other students that are beyond their normal topics of study. Additionally, it gives students opportunities to compromise, negotiate and devise solutions that consider a wider range of perspectives.

Presentation is a crucial component of this course and students are given many opportunities to present their characters' point of view and share their own perspectives and opinions. Assignments and role-performance opportunities enable students to develop well-reasoned, logical arguments that they present in class. In various role-playing activities such as mass meetings, debates, negotiation sessions and poster presentations, students must articulate their point of view on an issue based on the character's perspectives and circumstances.

4.9. Reflecting on learning outcomes and role-play

An important component of gamification is the opportunity to reflect on the role-play process as well as learning outcomes. Reflection can be performed in class as a discussion session or in reflection papers or in online discussions. Students should be prompted to consider the gamification process, assignments, aspects of role-play that were particularly effective and aspects that could be improved, etc. Reflection challenges students to adapt the habit of linking and constructing the meaning of activities from their past experiences (Costa & Kallick, 2008). These meanings of activities constructed by students determine whether or not the objectives of the activities are achieved, and also provide the instructor with ideas on how to improve the game in such a way that learning objectives can be met (ibid).

4.10. Example

While formulas are often very helpful for outlining the general procedure for how to complete certain activities, the purpose and process of gamification is often more understandable via a tangible demonstration. A brief example of our thought-processes during only the character and assignment development process is outlined below, following the aforementioned template. In this section, we have only included examples for the steps that we performed while creating this role-playing game; the steps which don't have examples are to be implemented in a classroom setting with students. The character we chose to demonstrate here is Amina LeBlanc (Appendix A.1).

4.10.1. Selecting a setting

At the commencement of our project, the Morocco fogwater harvesting setting was already selected; it is the foundation for this role-playing game. Throughout the gamification process, we stayed focused on the rural region of Southwest Morocco - specifically the communities directly involved with the fog net project pioneered by Dar Si Hmad. Our setting, or place where the role-playing game would take place, was the Aït Baâmrane area (although we incorporated some surrounding areas which were related and relevant to the fog project). This setting provided a focus, and served as a medium for enhancing comprehension, retention, and empathy in a mixed humanities and engineering project. Our goal was to immerse students in this particular Moroccan backdrop via the role-playing game in order to help them learn humanities and engineering content side by side.

4.10.2. Selecting a topic

Since the setting was chosen to be the Aït Baâmrane region and the specific communities impacted by the work of Dar Si Hmad, we wanted to select an overarching topic that was related to this setting. Our topic was therefore the fog water project pioneered by Dar Si Hmad; this was deemed an appropriate and important overarching topic because it involves both technical and social aspects. Even though we ultimately ended up creating characters which covered a large range of academic themes, they all

connected back to the central topic of fog nets and Dar Si Hmad's fog project. For example, with the character of Amina, her academic theme was materials science (see section 4.10.4). However, this related back to the central topic because she was using her materials science and engineering background to determine which material is most suitable for the fog nets. Embedded within this topic were the social aspects of the fog net technology, which were also integrated into the assignments (see section 4.10.5).

4.10.3 Creating a character

The character chosen for this example is Amina LeBlanc. Her father is French and her mother is a Moroccan immigrant. Although Amina grew up in France, she maintains close ties with Morocco and after she completed university, she accepted a job at Dar Si Hmad as a material scientist conducting research to come up with the most effective choice of fog net material. This character collaborates closely with another character, Peter Trautwein (the industrial designer of CloudFisher nets). Details of Amina's family, education and "origin story" help set the stage for the assignments that are to follow. They also help to create a backdrop for which the human aspects (the character and surrounding environment) and the engineering aspects (the assignments) can be connected in a way that enhances the character's authenticity.

4.10.4 Identifying Academic Themes

The central topic for the character of Amina LeBlanc was materials science. This was selected because it is a branch of engineering which encompasses a wide range of topics and is definitely applicable to Dar Si Hmad's fog water project. Focusing on an academic theme could also help students to integrate their academic background, whether engineering, humanities, or social sciences, with the current fog water situation in the Aït Baâmrane region of Morocco. Materials science is an engineering field which typically deals simply with tangible and technical data; therefore, it was a good opportunity to provoke students to apply their engineering knowledge to a rich social context by completing the assignments. The topic (materials science) allowed humanities and engineering content to intersect (see section 4.10.5).

4.10.5. Creating assignments

This character's set of assignments was developed to ensure that both humanities and engineering contents are included side-by-side in the game. As a material scientist, the character's assignments primarily revolve around learning and employing materials science concepts. The student is required to select the material that is the best for the fog nets based on scientific analysis and calculations. Students use MATLAB for data analysis. A humanitarian-related part of the assignments requires the student/character to be concerned about the people who will consume the fog water and, in that assignment, Amina must take these concerns into consideration when selecting the material. Because the fog nets will directly contact with the fog that will become drinking water eventually, the student must select FDA approved material for use in conjunction with food. Through

this set of assignments, the student will understand both scientific and humanitarian concepts that inform materials selection.

Chapter 5: Results and Analysis

5.1. Results

5.1.1. COP 22

During A term 2016, our primary focus was on creating material for Dar Si Hmad to showcase at their booth at the COP22 UN Climate Change Conference in Marrakech in November 2016. Our aim was to demonstrate to other NGO's, interested parties, and government officials the educational opportunities presented by Dar Si Hmad's fog water project through the gamification process we planned to implement over the course of the IQP. We displayed these gamification ideas through three different media: a poster, a short paper and a PowerPoint presentation. This material provided detailed background on the pedagogy of gamification as well as our plans to gamify Dar Si Hmad's fogwater harvesting project by developing a role-playing game. The poster we sent to Dar Si Hmad for this conference can be seen below.

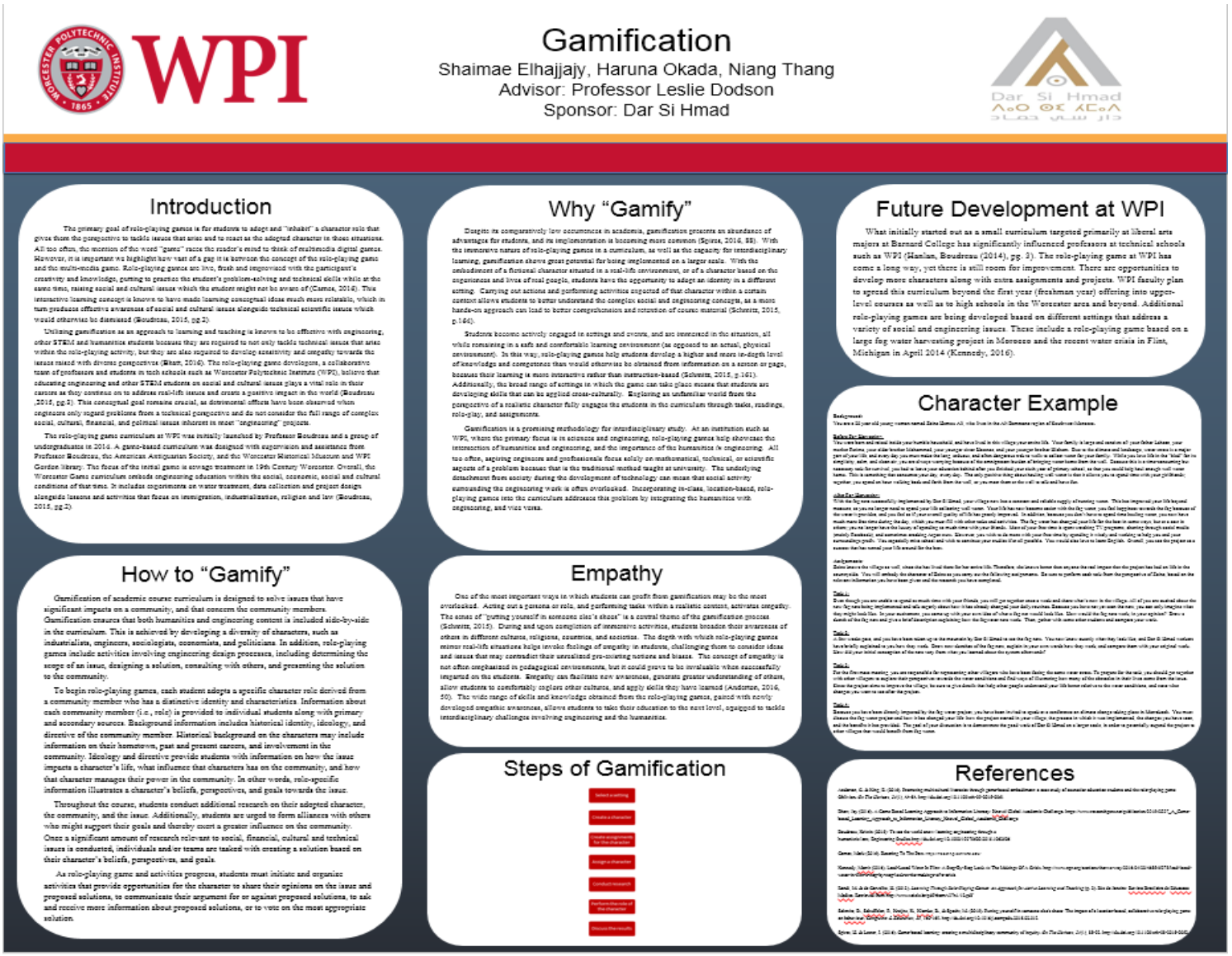


Figure 14: Poster we submitted to Dar Si Hmad to be showcased at COP22

5.1.2. Deliverables

5.1.2.1. Template

Throughout the gamification process, we were able to produce a template, or manual, which details the steps that were required for creating characters and assignments. This template can be seen in section 4, Methods, where we organized these steps into a flowchart. The purpose of designing this template is to help other students who may continue gamifying this course in the future, and to provide them with a step-by-step procedure for how to proceed.

5.1.2.2. New Characters

As a group, we created and developed a total of nine new characters, each with their own corresponding set of assignments (each team member created three characters). These characters addressed a diverse range of social and cultural issues within our Morocco setting, and all connected back to the central idea of Dar Si Hmad's fog water harvesting project. The table below provides basic information on each character, as well as the location in the appendix for the character role sheets.

Character Name	**Academic Theme**	**Learning Objective**	**Appendix Location**
Amina LeBlanc	Materials Science	Apply engineering knowledge to determine which material is ideal for Dar Si Hmad's fog nets.	A.1
Mia Wilder	Naturopathic Medicine	Explore the significance of traditional remedies in Moroccan culture.	A.2
Mohammed Sfoureg	Apiculture	Develop a basic understanding of beekeeping and its importance in Moroccan culture.	A.3
Hakimi Zaineb	Water and sanitation	Bring awareness of clean water to the Berber community	A.4
Jamila Bargach	Project Management	Develop an immersive understanding of how to manage the project	A.5
Peter Trautwein	Industrial Design	Design and construct the experimental nets	A.6
Dave Canmori	Social entrepreneurship	Develop a business plan to implement the fog nets in the region of Addis Ababa	A.7
Vicky Marzol	Meteorology	Explores the climate patterns of regions around Sidi Ifni that make fog harvesting a success.	A.8
Rkia Rahmend	Education Leadership	Explores the education system primarily in Morocco and practice female leadership	A.9

Table 3: A summary of the characters we created for our IQP

5.1.2.3. Previously Created Characters

As mentioned earlier, our project was a direct extension of the Humanities Inquiry Seminar. We continued their work by revising their previously-created characters. The initial character roles and assignments were partially developed around diverse disciplines and study themes, and the character role sheets were presented in different formats and had inconsistent information. We revised those character role sheets using our new template and format. By putting the information in the same template, each student has similar character information and it is now clear where there are gaps in character information that need to be developed in the future.

Character Name	**Academic Theme**	**Learning Objective**	**Appendix Location**
Akif	Fog water	Develop awareness of water sustainability, and an understanding of the importance of fog water	B.1
Ibtissam	Argan	Develop an in-depth understanding of the importance of Argan to Berber and Moroccan culture, society, and women	B.2
Ijja	Fog water	Understand the impact that Dar Si Hmad's fog harvesting project has had on local Berber people	B.3
Salma	Berber culture	Engage Berber women in the project	B.4
Akbal Sheetrit	Fluid mechanics	Learn about the physics behind the pumping system	B.5
Menna Demsiri	Berber culture	Better understand Berber women's lives	B.6
Ghita Sheetrit	Berber culture	Understand the effects on the Berber people after fog water installation	B.7
Tasa	Creative writing	Explores the role of an entrepreneur in a Berber setting	B.8
Dija Ri	Communication and technical skills	Explores the role of a community teacher who teaches English	B.9

Figure 4: A summary of the Inquiry Seminar characters we reformatted

5.2. Analysis

5.2.1 Analysis of and Reflection on Processes and Methods

5.2.1.1 Desirable Aspects

We particularly liked the creation of the IQP project. Creating a character demands creativity, empathy and research. By reading articles that support and contradict the issue that we want to address, all of us came to see a bigger picture of the world around us. We realized how some countries, in our case Morocco, lack basic need such as clean running water in homes. We gained a glimpse of the life in the *bled* (countryside) of Morocco through translations of interview conducted in Arabic. Although we were not physically in the *bled*, we experienced it as though we were there because of the generous resources we received through the Executive Director of the NGO, the IQP advisor and previous IQP off-campus projects in Morocco.

5.2.1.2 Goals Accomplished

We created characters that had great depth and through these characters we addressed issues that are crucial in the world and which are crucial to our values and beliefs. We were able to develop assignments that required teamwork and character collaborations. We were particularly pleased to introduce teamwork into the game dynamic and we introduced diverse topics ranging from economics, industrial engineering, female empowerment and ethnobotany.

5.2.1.3 Obstacles

The greatest obstacles we experienced were setting up an ambitious amount of work and communicating with the communities. One of the initial goals of the project was to develop 25-30 distinctive characters. Later on, we found this goal to be unrealistic because we needed to deliberately conduct research on each character and assignment, which resulted in a great amount of time consumed in the character development process.

Additionally, we discovered that there might be some overlaps between characters and assignments. Therefore, we decided to create fewer characters and concentrate instead on developing in-depth characters, backgrounds and assignments. The second obstacle was the communication difficulty that occurred throughout the project. Because most of the characters' assignments and the project content revolved around events and people in the Aït Baâmrane region of southwest Morocco, we had difficulties developing characters because of difficult and slow communication with the communities. Also, since most of the community members could not speak English, so we needed to communicate through the interpreter, which also took a long time due to the difference in time zones and schedule conflicts. However, some of these difficulties were offset by

meetings with the director of Dar Si Hmad, Jamila Bargach, who provided us with helpful information about the fog water project and the communities while she was a visiting professor at WPI in A-Term 2016. Moreover, our advisor delivered our questions and had them answered when she visited the project site in Morocco.

5.2.1.4 Challenges

We found that it was challenging to simultaneously meet three main requirements of the role sheets: to create characters that would be of interest to students, to maintain the integrity of the characters such that they were realistic within our setting, and to meet the needs of the professor as well as the requirements of the IQP. We needed to make sure that the assignments were effectively addressing the curriculum requirements that a professor would desire for his/her teaching. We also wanted to create characters and assignments that would appeal to potential students who participate in this role-playing game, by developing engaging but relevant activities. Finally, keeping these two points in mind, we also had to make sure that we preserved the authenticity of the characters we developed, while still making them appropriate for both the given setting and the learning outcomes we hope can be achieved.

5.2.1.5 Limitations

As we developed the characters' backgrounds and their assignments, we encountered some limitations in which the characters might have not been perfectly developed or applicable to reality. The first limitation was our lack of interactions with the communities, the DSH staff, and the fogwater project.

Unlike the previous work on the fogwater project by WPI students who spent time in the *bled* in Morocco, we developed our project on campus, which limited us to working with the DSH staff. We believed working closely with the organization could lead to more realistic and efficient assignments in which the assignments were applicable and beneficial to the project and the communities. In addition, our lack of interaction with the community members limited our understanding of engagement with the Berber culture. Because we had never been to the Aït Baâmrane region of Morocco, we often found that we didn't possess a deep immersive understanding of the setting with which we were working. If we implicitly knew the setting in a detailed manner based on first-hand experience in the location, the creation of plausible situations within this environment would have come with more ease. This would also affect the way in which we conveyed the background of the characters and assignments, as well as the creation of both authentic characters and assignments. Having an advisor who is continuously working so closely with Dar Si Hmad and has personally been to the Aït Baâmrane region many times proved to be invaluable throughout the course of the project.

Another limitation was having an insufficient period of time for the project to develop more in-depth character roles and assignments. As mentioned earlier, the character development process consumed a great amount of time. If we had invested or extended the project period, we would have developed more characters and been able to widen the variety of perspectives around the issue. Furthermore, we would have had a chance to test our assignments, see the outcomes, and react to them accordingly. An important limitation was that we had little insight into women community members' perspectives due to cultural restrictions that limit them from speaking up. We would have liked to know additional issues caused by water scarcity or the fogwater project that we could then address through the gamification.

5.2.1.6 Needs

As previously mentioned, one of the limitations we encountered during our work was that, because we were working on-campus rather than on-site in Morocco, it was often difficult to contact local Moroccans for interviews. These interviews would have provided us with a richer, more detailed idea of a person's background, so that we could have the option of developing a character based on that person. Going forward, it would be very helpful if there was an easier and quicker mode of communication with participants and community members in Morocco for potential character ideas.

Additionally, one of the primary things we learned from this project is that character and assignment development takes much longer than expected. Since we prioritized quality over quantity, we aimed to develop characters more completely rather than creating a large number of characters with little detail. In the future, we would like to have more time for this process, in order to fully develop the characters richly and with as much detail as possible.

Finally, one of the constraints was the fact that we were completing this project on-campus. It is understandable if this is not possible, but it would ultimately be most helpful if students were able to travel on-site to Morocco for a short period of time to fully comprehend and understand the situation, life in the countryside, and the culture of the Berber people in the Aït Baâmrane region. This would also be a good opportunity for students to meet with members of Dar Si Hmad and personally see the fog nets they have implemented. Students would then have more first-hand experience, and could then develop more authentic characters.

5.2.2 Individual Reflection

5.2.2.1 Suan

I chose this project because I was curious about what a role-playing game was. Prior to this, I had not come across a role-playing game. Approaching the IQP with this mindset, I was prepared and excited to learn and expand my knowledge. The concept certainly caught my attention. As we started working, it was difficult at first to grasp the concept of creating the characters- trying to place myself in the shoes of a 20 year old girl in the bled of Morocco who has been denied education but instead, passes the days with hard labor. In other words, I was failing terribly at empathizing. I realized that empathy was not an easy subject to grasp- you needed practice and much exposure. After much practice, I have come out of this IQP having met my expected goal of learning more and most importantly, becoming a more sensitive empathetic soul.

5.2.2.2 Haru

When I was first introduced to the concept of a role-playing game, I was not totally convinced that the game would have an impact on the way I look at a problem. As an engineering student, I always tackled a problem by applying the scientific knowledge I had learned in class with integrating my own perspectives. However, as I developed the characters and their assignments, I strongly believed that the concept of this IQP could bring awareness of social issues to other engineering students and students in the STEM system when solving problems. This means that STEM students would care more about the people who are affected by an issue, and integrate their personal issues and perspectives.

Throughout the character development process, I enjoyed exploring the different culture of Morocco, getting to know some villagers through their interviews and pictures, listening to their stories from my advisor who met them before, and it was amazing that I became aware of their personal problems from the issue. I believe that students who have a chance to play this role-playing game will enjoy exploring new things and that the game will have a significant impact on the way they address a problem.

5.2.2.3 Shaimae

With this IQP, the processes differed from the perhaps more-common ways of teaching because we were developing a role-playing game and using interactive and interdisciplinary pedagogical methods. I found the process of developing a role-playing game to be extremely interesting and informative. I had previously taken the Inquiry Seminar (see section 3.2.5) at WPI, and I was looking forward to continuing that work with this IQP. Because we needed to create characters which addressed many topics, I discovered that I learned a lot about various concepts, from materials science and beekeeping to ethnobotany and traditional naturopathic medicine . I also enjoyed using my background

knowledge about certain engineering concepts and being able to incorporate that into my work. In addition, due to my prior knowledge about Morocco, I was very pleased with the immersive nature of this project and the collaboration we experienced with people who have actually worked with Dar Si Hmad, including our advisor Leslie Dodson, Jamila Bargach, and the 2016 off-campus IQP team.

Of all these features of game design, I found that the most crucial one for the development of the characters we created was definitely feedback, both from professors and peers. Research is incredibly important, as it allowed me to develop an in-depth and comprehensive understanding of the lives of Berbers in Southwest Morocco. However, it was the continuous feedback I received from these two different sources that had the most impact. Comments made from my group members and from my advisor allowed me to refine my work multiple times, which helped to prune my final product into what it is now. Our advisor's first-hand knowledge of the region and her constructive comments were extremely valuable and enabled me to edit my characters and develop my activities with both credibility and accuracy. This was then very helpful when trying to create realistic and authentic characters and assignments which accurately reflected real-life situations in relation to Dar Si Hmad's work in southwest Morocco.

Chapter 6: Recommendations and Conclusion

6.1. Recommendation

6.1.1 Scheduling

Our IQP went well primarily because of two reasons. The first reason was because of the resources that were provided to us by Professor Dodson and previous project works that resonated around the central idea of our IQP. The second reason was due to the fact that our IQP team acquired one teammate who had prior experience and knowledge of the role-playing game. This compelled us to move forward with larger strides and cover a larger ground. Because this is the first time this IQP has been launched, the scheduling needed constant updates and our team had to go off of estimates for deadlines to cover the goals we set out to achieve. The IQP taking over should set a draft of the timeline of this IQP so that students choosing it will understand the amount of time they are required to commit.

6.1.2 Character Development

Following the completion of our IQP, we have collectively reviewed our accomplishments, as well as the deliverables we have achieved. In retrospect, we had originally planned on creating more characters. We ultimately decided to prioritize quality over quantity, and as a result, we instead developed a handful of characters that had rich, descriptive backgrounds and engaging, relevant assignments for students to perform and learn from. From this experience, we are able to provide some suggestions for character development by future teams.

6.1.2.1 Range of Characters

We believe that it is important to create a wide range of characters, which will span a large demographic. Providing students with characters who possess a variety of qualities, such as age, gender, family, experience, aspirations, and topics, will ensure that as a whole, the class will have an in-depth and extensive knowledge regarding various aspects of their socio-technical environment. Adding these details will also help to give the characters a sense of realism, which will make the learning experience and outcomes that much more realistic and meaningful on a more human level. The development of a wide range of characters in this manner will aid in encompassing more aspects of both the culture and society of the setting, as well as the topics required for the curriculum.

6.1.2.2 Suggestions for Additional Characters

Although we were ultimately unable to create as many characters as we had anticipated, we were constantly brainstorming new ideas throughout the course of the project. As was described in our Methods section, we often began the character creation process through the selection of a topic build and develop our character around. Based on our experience with character creation and development, we believe that these are all viable options for future development of this particular Morocco-based role-playing game.

- Remittances and Migration
- Botanical Surveys
- Fog Science and Fog Droplet Size
- Political Environment
- Current Events
- Islam and Islamic Studies
- Gender Roles
- Climate Change, Desertification, etc.
- Modernity vs. Traditionalism

6.1.2.3 Group Work

We also recommend that students perform work in groups. Although many of the character assignments are presented as individual activities, they can sometimes be complex and/or difficult when tackled alone. Allowing students to collaborate on the activities of one character would be a good opportunity for them to learn how to solve problems while simultaneously collaborating in teamwork.

It may also be a good idea in the future for students to be assigned individual characters, but to also be placed in groups of three or four. In this way, students could individually work on and complete their character assignments, based on the character they were assigned, and then come together in class to discuss their findings. This would allow students to collaborate and learn about the various topics and crucial concepts that are taught with each character.

6.1.3 Rubric and Grading System

We created assignments to help students/characters learn about the issues in a more interactive way. We then decided that because we were also creating a course, we should have a grading system for each of the character's assignments so that the professors and the students can track progress. The grading system is not a fixed system set out for all characters. This is impossible to do because all the different assignments of the different students line up to different grading rubric systems. The rubric or grading

system needs much further improvement, particularly in terms of assigning credit for work that requires much more effort than other assignments.

6.1.4 Culture Day

As we developed the characters and their assignments, one of the first challenges that occurred was having no experience or understanding of the setting which led to some misunderstandings about the communities, and it consumed a great amount of time to do research on several aspects of the setting. Therefore, we felt that it would be helpful for students to learn and become immersed in the setting while completing the given assignments.

In order to provide students immersive understanding of the setting, we encourage the instructor to develop and set up a weekly information session called Culture Day in which a group of three-to-four students is assigned a specific cultural topic. That team would be responsible for deeply diving into and presenting the topic to the class. Some suggested topics include local food, traditional clothes, art, music, house, Berber language, religion, spiritual beliefs, politics, nationalism, gender roles, and history of the setting. To actively engage students into the classroom and presentations, we recommend having a small event after each presentation. For example, the team that is responsible for presenting local food can bring some ingredients and teach other students how to cook a local dish in class. This will definitely create active learning environments in the classroom. These activities can also take place outside of class time.

6.2. Conclusion

Our IQP allowed us to explore and develop an "alternative" pedagogy by integrating a role-playing game with the fogwater project by Dar Si Hmad. We have concluded that the role-playing game is able to engage students in STEM in both engineering and humanitarian aspects of a complex socio-technical issue that involves a variety of disciplines and that is an open-ended problem which invites different approaches and solutions (Boudreau, 2015). Through the game, students are assigned to play different roles in the issues raised in the setting which involve in diverse study fields. In addition, students learn and become immersed into a new culture as they perform the given assignments based on their adopted characters' perspectives. This role-playing game brings awareness of both social and technical issues.

By the end of our IQP, we have added onto the in-class role-playing course by creating a total of nine characters who address the issues that revolve around the fog water project in Morocco. Having successfully created a complete in-class course, we see the opportunity to further take social issues such as the Flint Water crisis and turn it into a course that would not only challenge students, but also educate them on current social issues.

Our team was fortunate enough to collaborate directly with Dar Si Hmad, particularly Professor Leslie Dodson. As our advisor, Professor Dodson was able to provide us with many primary resources, contacts, and information, which helped to make our project possible. By extending the work of past projects, we have built a curriculum that will hopefully be implemented at WPI in the near future. WPI has already ran experimental courses involving

role-playing games, and we hope that our own project will make a great addition to this newly-explored genre of courses.

Our project has the potential for many applications. Although we were unable to develop this role-playing game as much as we would have liked, we believe that our work, particularly the toolkit and role-sheets, has set the stage for another gamification-based course at WPI. With some further development of this course, along with the characters and assignments we have created, we hope that future WPI students will have the opportunity to experience an immersive and engaging classroom experience as they learn more about the social, cultural, and engineering implications of Dar Si Hmad's fog harvesting project. With the immersive nature of role-playing games for a curriculum, gamification possesses great potential for being implemented into the curricula of more schools.

References

A Ground-Breaking Project: Harvesting Water From Fog. (2016) Retrieved from http://darsihmad.org/fog/

Anderton, C. & King, E. (2016). Promoting multicultural literacies through game-based embodiment: a case study of counselor education students and the role-playing game Oblivion. *On The Horizon*, *24*(1), 44-54. http://dx.doi.org/10.1108/oth-09-2015-0061

Boudreau, K. (2015). To see the world anew: learning engineering through a humanistic lens. *Engineering Studies, 7*(2-3), 206–208. doi:10.1080/19378629.2015.1062506.

Boudreau, K., & Dodson, L. (2015). Developing a Teaching Game [Syllabus]. Worcester, MA: Humanities & Arts Department, Worcester Polytechnic Institute.

Carnes, M. (2016). Reacting to the Past. https://reacting.barnard.edu/instructors

Cho, Renee. (2011). The Fog Collectors: Harvesting Water From Thin Air. http://blogs.ei.columbia.edu/2011/03/07/the-fog-collectors-harvesting-water-from-thin-air/

Claypool, A., Daraphet, K., Merino, A., Ruiz, S., Schiavone, I. (2015). A Multimedia Project Based Learning Course: Morocco. Retrieved from https://web.wpi.edu/Pubs/E-project/Available/E-project-121715-111435/unrestricted/MultimediaCourseMorocco.pdf

Costa, A., Kallick, B. (2008). Learning and Leading with Habits of Mind. Retrieved from http://www.ascd.org/publications/books/108008/chapters/Learning-Through-Reflection.aspx

Dar Si Hmad. A groundbreaking Project: Harvesting Fog Water. http://darsihmad.org/fog/ http://www.academia.edu/6725879/Meteorological_Patterns_and_fog_water_in_Morocco_and_the_Canary_Islands

Dar Si Hmad [DarSiHmad]. (2017). [Twitter moment]. Retrieved from https://twitter.com/darsihmad?lang=en

Education Policy and Data Center. (2014). http://www.epdc.org/sites/default/files/documents/EPDC%20NEP_Morocco.pdf

Ervin, S. (2016). Social Business Plan and Publishing Proposal for Global Toolkit. Retrieved from https://web.wpi.edu/Pubs/E-project/Available/E-project-011516-160002/unrestricted/Samantha_Ervin_Final_MQP_Report.pdf

Farnum, R.L., & Moss, A. (2016). Water School by Dar Si Hmad: STEAM Curriculum for ages 6-14. Retrieved from http://darsihmad.org/wp-content/uploads/2016/10/water-school-sc.pdf

Fog Project Pictures – Dar Si Hmad. (n.d.). Retrieved March 21, 2017, from http://darsihmad.org/fog-project-pictures/

FogQuest. FogQuest: Sustainable Water Solution. http://www.fogquest.org/f-a-q/

Global Partnership for Education. (2017). http://www.globalpartnership.org/focus-areas/girls-education

Haas, Christine. (2015). Useful Research for crafting Presentations. http://christinehaasconsulting.com/useful-research/

Hoekstra Y. Arjen, Chapagain K. Ashok, Mesfin M. Mekonmen. (2005). Water Footprint Personal Calculator. http://waterfootprint.org/en/resources/interactive-tools/personal-water-footprint-calculator/personal-calculator-extended/

Jefferson Nathaniel, Ramos Carolina, Praetorius Brian. (2015). A Greywater Recycling System to Support a Fog Harvesting Initiative in Aït Baâmrane, Morocco. Rabat, Morocco Project Center.

Martin David. (2014). Fog Catcher Prototype. https://www.youtube.com/watch?v=F9E_piVrgvk

MIT Mechanical Engineering. (2014). Harvesting Fresh Water From Fog. https://www.youtube.com/watch?v=h8vlzZ25vtg

Morocco World News. (2016). Moroccan Education System: Problems and Solutions. https://www.moroccoworldnews.com/2016/03/181000/moroccan-educational-system-problems-and-solutions/

Nolan, Sarah. Fog Catchers and How to Make Your Own. https://watersustainabilityandfogwater.wordpress.com/fog-catchers-and-how-to-make-your-own/

Pollock, C., & Biles, F. (2016, August). Discovering the Lived Experience of Students Learning in Immersive Simulation. *Clinical Simulation in Nursing, 12*(8), 313-319. http://dx.doi.org/10.1016/ j.ecns.2016.03.002

Randi, M. & de Carvalho, H. (2013). *Learning Through Role-Playing Games: an Approach for Active Learning and Teaching* (p. 2). Rio de Janeiro: Revista Brasileira de Educacao Medica. Retrieved from http://www.scielo.br/pdf/rbem/v37n1/12.pdf

Santarsiero, R., Smallwood, D., McAdams, A., & Schubert, N. (2016, October 11). Developing Promotional Materials for COP22. Retrieved from https://web.wpi.edu/Pubs/E-project/Available/E-project-101216-084927/unrestricted/Fog_Water_Collection.pdf

Schmitz, B., Schuffelen, P., Kreijns, K., Klemke, R., & Specht, M. (2015). Putting yourself in someone else's shoes: The impact of a location-based, collaborative role-playing game on behaviour. *Computers & Education*, *85*, 160-169. http://dx.doi.org/10.1016/j.compedu.2015.02.012

Spires, H. & Lester, J. (2016). Game-based learning: creating a multidisciplinary community of inquiry. On The Horizon, 24(1), 88-93. http://dx.doi.org/10.1108/oth-08-2015-0052

Trautwein, P. (2015). Cloudfisher Mini. Retrieved from https://www.aqualonis.com/download/CloudFisher_mini_en.pdf

Trautwein, P. (2015). Natural Wells in the Sky. Retrieved from http://www.aqualonis.com/download/CloudFisher_Pro_en.pdf

UNEP - International Environmental Technology Centre United Nations Environment Programme. Fog Harvesting. http://www.oas.org/dsd/publications/unit/oea59e/ch12.htm

UNFPA. Empowering Young Women To Lead Change. https://www.unfpa.org/sites/default/files/resource-pdf/empowering-young-women_eng.pdf

UN-Water. (2014). http://www.unwater.org/kwip

Women-Led Fog Harvesting For a Resilient, Sustainable Ecosystem: Morocco (2016) Retrieved from http://unfccc.int/secretariat/momentum_for_change/items/9941.php

WorldBank. http://siteresources.worldbank.org/INTMENA/Resources/App-all-Scarcity.pdf

Appendices

Appendix A: Our Characters

A.1 Amina LeBlanc

Age: 20's
Gender: Female
Residence: Bordeaux, France
Job or Main Task: Select an optimal material for Dar Si Hmad's fog nets

Background

Biography:
You are a recent graduate of the Université de Bordeaux (in southwestern France) named Amina LeBlanc. Your father is a native-born French man, but your mother is a Moroccan immigrant from Casablanca. Therefore, you have vacationed in Morocco many times with your family and are familiar with the country. Although you grew up in France, you wish to connect with your mother's heritage, and so you have accepted a position in Morocco. You have just been hired by Dar Si Hmad as a consultant for your materials science background. You have been tasked with conducting research in order to aid in the selection of the ideal fog net material. Because this is your area of expertise, you are aware of the intricacies and complexities behind choosing a material for this project. Once you perform the appropriate research and have decided on the ideal material for the fog nets, you will collaborate with Peter Trautwein, who will incorporate your selection into his fog net designs.

Affiliations:
You work closely with the staff of Dar Si Hmad in order to learn about their exact needs when it comes to the net material. Peter Trautwein is also your collaborator for designing the fog nets.

Character Possesses:
You have the equivalent of a Bachelor's degree in materials science.

Character Needs:
You will need resources to conduct tests of material choices, and direct access to fog nets and relevant meteorological data.

Character Duties:
You must determine which material is best for Dar Si Hmad to use in their latest design of fog nets.

Objectives

- Develop an understanding for basic materials science concepts.
- Be able to employ learned materials science concepts in relation to a relevant, real-world application.
- Acquire rudimentary knowledge about other fields and utilize various related softwares, such as basic computer science (MATLAB), materials science (CES EduPack), and biomedical engineering (Instron/Bluehill).
- Understand the design process and gain some experience with associated topics: observations, data collection, calculations, material selection, and regulatory issues.
- Appreciate the work performed by Dar Si Hmad to establish the fog net project, through performing basic activites.

Assignments

The following assignments should be performed throughout the term. You should be completing the assignments from the point of view of your character. Some resources are provided for you, but you are expected to perform your own research. If you need additional information, be sure to use ONLY reputable sources; cite all of the sources you use in your work using APA format.

1. The material you ultimately choose must be able to withstand the high wind gusts present in the Anti-Atlas Mountains, such that the fog net should not tear or break. Dar Si Hmad has conducted thorough data collection of wind speed and wind direction at the top of Mt. Boutmezguida, where the fog nets will be installed. (30 points)

a) Your instructor will provide you with this data. Using Excel, find the average wind speed at the top of Mt. Boutmezguida (Hint: there should be a built-in "Average" function at your disposal). This will be the wind speed you will use to approximate what conditions your fog net material must withstand. Please keep in mind that this is merely an estimate of the wind speed that the fog nets will undergo, simply for you to begin modeling some data; in reality, you would have to consider the maximum wind speed present at the top of Mt. Boutmezguida, which is what your net material must withstand. If the data is not available to you, follow the directions below:
   i. Go to "The Weather Channel" website (www.weather.com)
   ii. Type in "Guelmim, Morocco" in the "Search" bar in the upper right corner. This is the major city that is in closest proximity to the villages Dar Si Hmad works with. Please note that this will not be completely accurate, as Mt. Boutmezguida is located further inland than Guelmim; it will simply serve as an approximation in the absence of more accurate data.
   iii. In the middle of the web page, you should see a heading labeled "Right Now." Underneath, there will be a subheading labeled "Wind." Note the wind speed displayed here; this will be the wind speed you will use to approximate what conditions your fog net material must withstand.

iv. Next, type in "Sidi Ifni, Morocco" in the "Search" bar. This is another main city nearby, but is located closer to the coast. Again, this will serve as an approximation in the absence of more accurate data, but is good for comparison. Repeat step iii for Sidi Ifni.

b) Wind speed and wind pressure (force) are directly proportional, as demonstrated by the relationship described in the equation below.

$$F_W = \frac{1}{2} * \rho * v^2 * A$$

Use the equation to calculate the wind pressure associated with your wind speed. The variables are: F_W = wind force (N); ρ = air density (kg/m^3); v = wind velocity (m/s); A = surface area (m^2). The density of air is approximately 1.225 kg/m^3. Assume that your final fog net prototype will be a square sheet with a side length of 1.0 m. . If your wind measurements are in miles per hour, convert them to meters per second. The answer you obtain from this calculation is the force that wind will exert on the fog net.

***(Equation and accompanying information obtained from: http://www.engineeringtoolbox.com/wind-load-d_1775.html)
***(Density of air obtained from: http://www-mdp.eng.cam.ac.uk/web/library/enginfo/aerothermal_dvd_only/aero/atmos/atmos.html)

c) When a load is applied to an object, it exerts a force per unit area; this quantity is called "stress", and is used often to determine specific mechanical properties of materials. Therefore, the stress exerted by the wind on the fog net can be approximated by using the following equation:

$$\sigma_W = \frac{F_W}{A}$$

Calculate the stress that the wind will exert on the fog net. The material you choose must be able to withstand this stress, so that the fog net is strong enough to survive its environment.

2. One important mechanical property of a material is the ultimate tensile strength (UTS). This quantity is the largest stress that a material can withstand before it begins to fail; if a stress of this magnitude is maintained, the material will likely fracture/break. (30 points)
Keeping this in mind:

a) The material you choose must have a desirable UTS, such that it will not fail under the calculated wind pressure. Do you predict that your material will need to have a UTS greater than or less than σ_W? Explain why. (Check in with your instructor for the correct answer before you move on; you will need this information for the next steps).

Figure 15: Preliminary net designs failed because they couldn't withstand wind speeds in the area (Aqualonis, 2015)

b) You will now research potential candidates for the fog net material.
   i. Open up the software called CES EduPack. This can be accessed through Remote Desktop (windows.wpi.edu), or on any computer in Gordon Library.
   ii. When it opens up, you will be prompted to choose one of the many databases. Select "Level 2" to move on.
   iii. On the left hand side of the software is a menu bar, where you can open folders of different categories to find your material. For simplicity, focus on polymers; click "Polymers and elastomers," then "Polymers," then "Thermoplastics." Pay attention specifically to three primary polymer materials: Polyethylene (PE), Polypropylene (PP), and Polystyrene (PS). Which of these three materials has a suitable UTS for the fog nets? Explain your reasoning. A helpful resource for this question is *Fog Water Collection: Developing Promotional Materials for COP22*, included below in the Additional Resources section. This may give you some ideas on which materials to choose.
      - If you have trouble finding these materials, you can search for them by clicking the "Search" icon near the top left.
      - Note – you may need to change the units of these properties for easier comparison. Click the "Settings" icon at the top, next to a picture of a gear. In the next window, select the "Units" tab. Under "Preferred Unit System", select "Metric."

3. Based on your findings, select the material that you believe is the best option for the fog nets. You will be need to obtain a sample of this material in order to test it in an electromechanical machine called an Instron. Before completing the test, measure the length, width, and thickness of your sample, and write it down (this will be needed for the next part of the assignment). The Instron machine on campus is located in Goddard Hall, room 207. Follow the instructions to load your sample in the Instron and run the test. The test program will be provided, as well as any tutorials or help you may need to perform the test. Then, make sure to secure your data file by saving it to a flash drive or equivalent; this is critical for the next part of the assignment. Your data file should be in the form of an Excel spreadsheet, and should include values for time, extension, and force.

4. Engineers utilize many different programs and software to aid in data analysis. You will be working with MATLAB next.

a) Open up the MATLAB software. For WPI students, you may need to log on to Remote Desktop to access the software (windows.wpi.edu).

b) At the top left corner, click on the icon labeled "New Script." Then click "Save" to save the file. When you name the file, make sure that there are no spaces in the name (example: "materials_testing" rather than "materials testing"). In addition, make sure to save this file in the same folder as your Excel data file.

c) You have been given a MATLAB program called "readMyData." This will allow you to input your data file into MATLAB, so that you can work with it. Save this program to the same folder as your Excel data file.

d) Next, copy and paste the MATLAB code below into your new script. This will calculate all of the values you will need to determine the mechanical properties of your material. Some notes about this code:
   i. In line 8 of the code, you will see that filename is set equal to 'Specimen_RawData.csv," in purple. Make sure that your data file is named "Specimen_RawData.csv", so that your data will be successfully imported. This is the raw data file with all of the measured values from your Instron test.
   ii. In line 27, the variable "initial_Length" is established. You will notice that it is equal to "length." Delete this word and enter in the length of your sample, which you measured before the test.
   iii. In line 30, you will notice the line "Strain = d/initial_Length". This is the equation for strain, which dictates that the strain experienced by a material is calculated by dividing the displacement by the initial length of the sample.
   iv. In line 35, the variable "A", which designates cross-sectional area, will be calculated. You will notice that it is calculated by multiplying the width of your sample by its thickness. Delete these words and enter in the appropriate values, respectively, that you measured before your test.
   v. In line 38, you will notice the line "Stress = F/A". This is an application of what you have previously learned in (1c), in which the stress exerted on a material is calculated by dividing the force by the cross-sectional area.

vi. In line 43, you will notice the line "[UTS, position_UTS] = max(Stress)." This is an application of what you have previously learned in (2a), in which the ultimate tensile strength is equal to the maximum value of stress that the sample underwent. The variable UTS will be the value of your ultimate tensile strength.

vii. In line 56, you will notice the line "plot(Strain(position_UTS), UTS, 'or')". This will mark the ultimate tensile strength of your material on the graph. Run the program, and confirm that your curve has small red circle on it; this is the location of the UTS.

viii. In line 62, you will notice the line "linear_Region = find(Strain < value)". This will help you to isolate the linear portion of the curve (the Young's modulus is calculated only in the linear region of a stress-strain curve). Run the program and observe the generated graph. Approximate the x-value that corresponds to the end of the linear region of the curve. Delete the word "value" in the aforementioned line, and replace it with the value you have approximated.

ix. In line 80, you will notice the line "E = slope." This is will find the Young's modulus, which is calculated by dividing the stress by the strain, and is also equal to the slope in the linear region of the stress-strain curve; Young's modulus is an indication of a material's degree of stiffness.

x. Throughout the code, you will notice some lines are in green; these are comments about how the program works, and what each line of code does. This may help you to understand the MATLAB code.

xi. After the code has been run successfully, you will find the results in a sidebar, titled "Workspace." Under the "Name" column, look for the variables "UTS" and "E", then note the corresponding values in the "Value" column. These are your respective values for ultimate tensile strength and Young's modulus, which you will use for later analysis (Problem 5).

The MATLAB script is as follows:

```
%% Materials Testing for Fog Nets

clc; clear all; close all;

%% Import the collected data into MATLAB

% upload the data and assign to a variable name.
fileName = 'Specimen_RawData.csv';

% create a matrix of the data
data = readMyData(fileName);

% define all variables

% Assign the first column of the data sheet to designate the variable "Time".
t = data(:,1);
% Assign the second column of the data sheet to designate the variable
% "Displacement".
d = data(:,2);
% Assign the third column of the data sheet to designate the variable
```

```
% "Force".
F = data(:,3);

%% Calculate the strain

% Establish a variable for the initial length of the sample.
initial_Length = length;

% Calculate the values of strain.
Strain = d/initial_Length;

%% Calculate the stress

% Calculate the cross-sectional area of your sample.
A = width*thickness;

% Calculate the values of stress.
Stress = F/A;

%% Calculate the ultimate tensile strength

% Calculate the ultimate tensile strength
[UTS, position_UTS] = max(Stress);

%% Generate a stress-strain curve

figure
plot(Strain, Stress)
xlabel('Strain (mm/mm)')
ylabel('Stress (MPa)')
title('Stress-Strain Curve')
grid
hold on

% Label the UTS on the graph
plot(Strain(position_UTS), UTS, 'or')

%% Calculate the Young's modulus

% Isolate the linear region of the curve.
% Select the linear region of the stress-strain curve.
linear_Region = find(Strain < value);

% Find the last element of the linear region.
idx = linear_Region(end);

% Find all of the strain values that are in the linear region.
strain_Linear = Strain(1:idx);

% Find all of the stress values that are in the linear region.
stress_Linear = Stress(1:idx);

% Find the slope of the linear region.
```

```
% This slope will be the Young's modulus.
p = polyfit(strain_Linear, stress_Linear, 1);
slope = p(1);
intercept = p(2);

% Find the Young's modulus
E = slope;
```

5. Now it is time to analyze your results. (30 points)

a) The MATLAB code will generate the UTS of your material based on the data you previously collected. Compare your calculated value for UTS with the calculated value for σ_w. Based on this comparison, do you believe your material is a viable option for the fog nets? (i.e. What does it mean if UTS > σ_w or UTS < σ_w?) Explain your reasoning.

b) As was previously mentioned, Young's modulus, E, models the linear relationship between stress and strain. Return to CES EduPack.

i. How does your calculated UTS compare with the documented UTS from CES EduPack?

ii. The MATLAB code also generated Young's modulus. How does your calculated Young's modulus compare with the documented Young's modulus from CES EduPack?

iii. Next, quantify if your UTS and E values are comparable to those from CES EduPack by calculating the percent error, using the following equation:

$$\%\ Error = \left|\frac{Experimental - Theoretical}{Theoretical}\right| * 100$$

Briefly describe your findings; what was your % error for each? Was it large or small? What may have caused it?

***(Equation for percent error obtained from: http://astro.physics.uiowa.edu/ITU/glossary/percent-error-formula/)

6. Another important aspect of material selection is determining what regulations the material must meet for a particular application. Although there may not be a specific regulation geared toward fog nets, it is important to remember that water will accumulate and be collected by the fog nets. This means the material will be in direct contact with the fog, which will eventually become drinking water. Whichever material you chose, it is a polymer, and many plastics have aroused suspicions of adverse health effects on the human body upon frequent exposure. Conduct some research on the material you selected, and determine whether there is any risk associated with its use in fog nets for the collection of running water. Is your material FDA approved for use in conjunction with food? If there are any risks, what are they? Overall, would you strongly recommend your material for use in the fog nets? (10 points)
The following link may be of assistance to you:
http://www.fda.gov/Food/IngredientsPackagingLabeling/PackagingFCS/ucm2006853.htm

Now that you have selected a material, you are ready to consult with Peter Trautwein. You will be bringing your expertise in materials science to the table. As such, make sure you are able to explain to him why you have chosen your material. As a team, you will create a prototype for the fog net.

Figure 16: Most recent versions of the fog nets (Dar Si Hmad)

Additional Resources

Santarsiero, R., Smallwood, D., McAdams, A., & Schubert, N. (2016, October 11). Developing Promotional Materials for COP22. Retrieved from https://web.wpi.edu/Pubs/E-project/Available/E-project-101216-084927/unrestricted/Fog_Water_Collection.pdf

Rubric

The following is a preliminary rubric for the grading of the activities above. Please note that they are subject to change, at the instructor's discretion and based on availability of resources.

Part 1	
Points Awarded	**Degree of Completeness**
30	Successfully obtained wind speed, and calculated force (F) and stress (σ)
20	Successfully obtained wind speed, but only calculated one value (either F or σ missing)
10	Successfully obtained wind speed, but failed to correctly calculate F and σ
0	Failed to complete any of the assignments

Part 2	
Points Awarded	**Degree of Completeness**
30	Successfully used CES EduPack, answered all questions, and explained reasoning
20	Successfully used CES EduPack, answered all questions, but failed to explain reasoning
10	Successfully used CES EduPack, but failed to answer all questions
0	Failed to complete any of the assignments

Part 3
N/A

Part 4
N/A

Part 5	
Points Awarded	**Degree of Completeness**
30	Successfully made comparisons, performed calculations, and answered questions with justifications
20	Completed some questions, with some missing information
10	Completed some questions, with a large amount of missing information
0	Failed to complete any of the assignments

Part 6	
Points Awarded	**Degree of Completeness**
30	Demonstrates understanding of FDA regulation requirements and answered all questions
20	Completed some questions, but with some missing information
10	Completed some questions, with a large amount of missing information
0	Failed to complete any of the assignments

Original character created (March, 2017, IQP) by: Shaimae Elhajjajy

A.2 Mia Wilder

Age: 20’s
Gender: Female
Residence: Toronto, Canada
Job or Main Tasks: Research traditional Moroccan herbal medicine

Background

Biography:
You are a Canadian university student named Mia Wilder currently studying at the Canadian College of Naturopathic Medicine (CCNM) in Toronto, with ambitions to obtain your ND once you graduate. You are participating in a summer program geared towards the exploration of international naturopathic medicine; Morocco was your location of choice. You hold a particular interest in traditional botanical (herbal) medicine of the country; this will be your primary focus. However, other aspects of your project will include historical, cultural, and agricultural studies, which deviate from your area of expertise but are nonetheless relevant. Because Morocco is rapidly modernizing, you realize that the best bet for your project’s success is to focus on rural areas, since people in larger cities will most likely practice Western medicine. Thus, the site for your project is based in Sidi Ifni, and you will be performing your studies in the surrounding regions (specifically, Aït Baâmrane).

Figure 17: People traveling by car through the countryside, which contains countless samples of local plants (Aqualonis, 2015)

Affiliations:
You are friendly with all of the locals in the village.

Character Possesses:
You are well educated and have a vast knowledge of natural medicines and remedies.

Character Needs:
You are in need of knowledge related to traditional medicine, particularly that which is common and significant in Morocco.

Character Duties:
You must perform the appropriate studies and research to fulfill the requirements for your summer research project about Moroccan naturopathic medicine.

Objectives

- Delve into ethnobotany by exploring the significance of traditional Moroccan herbal medicine in the country.
- Understand the medicinal uses of common Moroccan plants.
- Develop an awareness for the role that traditional herbal medicine plays in Moroccan culture.
- Acquire an appreciation for traditional remedies, particularly in the context of rural, Berber Morocco

Assignments

The following assignments should be performed throughout the term. You should be completing the assignments from the point of view of your character. Some resources are provided for you, but you are expected to perform your own research. If you need additional information, be sure to use ONLY reputable sources; cite all of the sources you use in your work using APA format.

You have been tasked with completing an inventory of indigenous plants in Morocco which possess medicinal capabilities. Locally grown plants used in traditional Moroccan and Berber medications are of particular interest to you. Specific targets are those listed below; these are some of the most commonly utilized plants in traditional remedies of Morocco:

- Argan
- Prickly pear
- Aloe
- Olive
- Fig
- Mint
- Wormwood
- Basicl
- Lemon verbena
- Fenugreek
- Cumin
- Henna

- Caraway
- Aniseed
- Saffron
- Thyme

Choose eight of the sixteen plants listed above. Conduct thorough research on each of the plants you've chosen by answering the following questions:

a) Plants and animals are universally identified by their scientific name, which allows people from all over the world to recognize each species despite apparent language barriers. When you present the findings of your study, it is important that you are in accordance with this convention so that others may understand your work. Find the scientific name of each of the plants you chose to research. (10 points)

b) Canada has two official languages: English and French. Because you will be presenting your findings back home, it is also important that each of these plant names are expressed in both languages so it is understood by all audiences. You are provided with the English names here; Find the names of each plant in French. (Hint: www.wordreference.com may be a good place to start) (10 points)

c) You will likely require the help of locals while you conduct your research. To prepare, it will be helpful if you are knowledgeable of the name of each plant in the local Moroccan language, called Darija. What is the vernacular (traditional) Moroccan name of each plant? (10 points)

d) Every plant flourishes at different times throughout the calendar year. You should be able to identify when each plant grows during the year, as well as the time of year at which they are harvested. When is the picking season for each plant? Specify the range of months in which the plants grow, when possible. (10 points)

e) All of the plants listed above grow naturally in Morocco, but they may not necessarily grow in the Anti-Atlas mountain region of Morocco (where Aït Bamraane is located). What climate is necessary to grow each of these plants? Which plants would you predict to find in Aït Bamraane when you go there to conduct your botanical survey? (10 points)

f) As previously mentioned, each plant has various health benefits which are the primary focus of your research as a naturopathic medical student. There are 6 different parts of a plant that can be used: seed, root, stem, leaf, flower, and fruit. Which portion(s) of each plant is used for its medicinal properties? (10 points)

g) Discover the general medicinal properties of each of these plants. Describe the way that each of the plants is used in Morocco. What is it used for? What are its benefits? What illness(es) or condition(s) does it treat? How is it prepared/prescribed (if it is cooked in food, state which kind)? (10 points)

h) If possible, obtain a sample of at least two of your plants; a local grocery store may stock some of the more common herbs in dried form, or perhaps a nearby ethnic foods store. Note any observations you make, including texture, appearance, scent, and taste. (The purpose of this step is for you to better understand and appreciate the plant itself by actually holding it in your hand, rather than just viewing a picture). (10 points)

Figure 18: A sample of Olea europea (Santarsiero et al., 2016)

i) We now connect back to the study of naturopathic medicine. What specific physiological effects does each plant have (i.e. what is happening inside the body when it is ingested)? How does the physiological response contribute to the identified medicinal benefits (i.e. how does the body's response help to heal the body)? (10 points)

j) Chemistry is an important element of health and medicine, and thus should not be overlooked. Choose one of your eight plants and isolate the primary compound that it contains. (For simplicity, you may want to try to select a plant whose primary compound has the simplest molecular structure). Explain at the molecular level how it works in the body, and predict how this compound may be related to the plant's medicinal benefits. Now, creatively build a structure of this chemical (more than just a ball-and-stick model). (10 points)

k) Finally, recall that one of the purposes of traveling abroad for your research is also to understand the ethnobotanical concepts that underlie this particular venture into naturopathic medicine. Investigate the specific intersection between Moroccan culture and traditional Moroccan herbal medicine (i.e. what role does it play?). Describe the importance of traditional herbal medicine in Morocco, making sure to address cultural, religious, and historical aspects. Additionally, address the relationship between traditional and modern medicine practices in Morocco. With the advent of modern technological advances and the younger generations, do you think traditional Moroccan remedies are at risk of extinction? Explain your answer. (10 points)

Additional Resources

The following resources may be useful to you throughout the course of these assignments. Be aware that you are fully expected to conduct your own extensive research; these are just to help you get started. Please note that certain articles from ScienceDirect may not be initially accessible. If you have problems accessing these articles, visit the following website: http://libguides.wpi.edu/databases?_ga=1.214533079.1105521467.1485878284 . Click the link for ScienceDirect under "Frequently Used Databases." Then, in the new web page, copy and paste the title of the article in the first text box; the resulting search should display the article.

- *Ethnobotanical Survey of Medicinal Plants Used by People in Oriental Morocco to Manage Various Ailments*
  http://www.sciencedirect.com/science/article/pii/S0378874114001937
- *Ethnobotanical studies and economic evaluation of medicinal plants in Taounate province (Northern Morocco)*
  http://www.sciencedirect.com/science/article/pii/S0378874103000126
- *Census Ethnobotanical Study of Some Plants Used in Traditional Medicine in the City of Meknes*
  http://file.scirp.org/pdf/AJPS_2014073015123625.pdf
- *Ethnobotanical survey of medicinal plants used for the treatment of diabetes, cardiac and renal diseases in the North centre region of Morocco (Fez–Boulemane)*
  http://www.ethnopharmacologia.org/prelude2016/pdf/biblio-j1-nord2-jouad.pdf
- *Traditional Moroccan Medicine*
  http://www.centerfortraditionalmedicine.org/uploads/2/3/7/5/23750643/a_new_look_at_traditional_medicine_in_morocco_.pdf
- *Phytochemical Study of Prickly Pear*
  http://www.sciencedirect.com/science/article/pii/S1658077X14000563
- *Ethnoeconomical, ethnomedical, and phytochemical study of Argania spinose (L.) Skeels*
  http://www.sciencedirect.com/science/article/pii/S0378874198002281
- *An ethnomedicinal survey of a Tashelhit-speaking community in the High Atlas, Morocco*
  http://www.sciencedirect.com/science/article/pii/S0378874116302719
- *Medicinal Plants Used by Berber and Arab People of Morocco*
  http://www.collectionscanada.gc.ca/obj/s4/f2/dsk4/etd/NQ73218.PDF

Rubric

The following is a preliminary rubric for the grading of the activities above. Please note that they are subject to change, at the instructor's discretion and based on availability of resources.

Part A	
Points Awarded	**Degree of Completeness**
10	Successfully identified the scientific name for all 8 plants
8	Identified the scientific name for 6 out of 8 plants
6	Identified the scientific name for 4 out of 8 plants
3	Identified the scientific name for 2 out of 8 plants
0	Failed to identify the scientific names for any plants

Part B	
Points Awarded	**Degree of Completeness**
10	Successfully identified the French name for all 8 plants
8	Identified the French name for 6 out of 8 plants
6	Identified the French name for 4 out of 8 plants
3	Identified the French name for 2 out of 8 plants
0	Failed to identify the French names for any plants

Part C	
Points Awarded	**Degree of Completeness**
10	Successfully identified the traditional name for all 8 plants
8	Identified the traditional name for 6 out of 8 plants
6	Identified the traditional name for 4 out of 8 plants
3	Identified the traditional name for 2 out of 8 plants
0	Failed to identify the traditional names for any plants

Part D	
Points Awarded	**Degree of Completeness**
10	Successfully identified the picking season for all 8 plants
8	Identified the picking season for 6 out of 8 plants
6	Identified the picking season for 4 out of 8 plants
3	Identified the picking season for 2 out of 8 plants
0	Failed to identify the picking season for any plants

Part E	
Points Awarded	**Degree of Completeness**
10	Successfully identified the climate of plant growth and predicted its location, for all 8 plants
8	Identified the climate of plant growth and predicted its location, for 6 out of 8 plants
6	Identified the climate of plant growth and predicted its location, for 4 out of 8 plants
3	Identified the climate of plant growth and predicted its location, for 2 out of 8 plants
0	Failed to identify the climate of plant growth or predict its location

Part F	
Points Awarded	**Degree of Completeness**
10	Successfully identified the portion of plant used, for all 8 plants
8	Identified the portion of plant used for 6 out of 8 plants
6	Identified the portion of plant used for 4 out of 8 plants
3	Identified the portion of plant used for 2 out of 8 plants
0	Failed to identify the portion of plant used for any plants

Part G	
Points Awarded	**Degree of Completeness**
10	Successfully and thoroughly answered each of the questions asked, for all 8 plants
8	Answered each of the questions for 6 out of 8 plants, or has some missing information
6	Answered each of the questions for 4 out of 8 plants, or has a large amount of missing information
3	Answered each of the questions for 2 out of 8 plants, or has majority of information missing
0	Failed to answer any of the questions, for any of the plants

Part H	
Points Awarded	**Degree of Completeness**
10	Successfully obtained and described 2 plants
5	Only obtained and described 1 plant
0	Failed to obtain or describe any plants

Part I	
Points Awarded	**Degree of Completeness**
10	Successfully and thoroughly answered each of the questions asked, for all 8 plants
8	Answered each of the questions for 6 out of 8 plants, or has some missing information
6	Answered each of the questions for 4 out of 8 plants, or has a large amount of missing information
3	Answered each of the questions for 2 out of 8 plants, or has majority of information missing
0	Failed to answer any of the questions, for any of the plants

Part J	
Points Awarded	**Degree of Completeness**
10	Successfully identified compound and explained its mechanism. Constructed creative and accurate model
8	Successfully identified compound, but some missing information. Constructed creative and accurate model
6	Successfully identified compound, but more missing information. Created model
3	Successfully identified compound, but majority of information missing. Poorly constructed model
0	Failed to identify compound, explain mechanism and/or construct a model

Part K	
Points Awarded	**Degree of Completeness**
10	Successfully and thoroughly answered each of the questions asked. Thoughtfully explained opinion
8	Answered each of the questions asked, or has some missing information. Lacks thoroughness
6	Answered some of the questions asked
3	Answered very few of the questions asked
0	Failed to answer any of the questions asked

Original character created (March, 2017, IQP) by: Shaimae Elhajjajy

A.3 Mohammed Sfoureg

Age: 50's
Gender: Male
Residence: Aït Baâmrane region of southwest Morocco
Job or Main Task: Develop a deep understanding of the art of beekeeping

Background

Biography:
You are a Berber beekeeper in his fifties named Mohammed Sfoureg, who lives in the village of Taloust in the Aït Baâmrane region of southwestern Morocco. You have lived in your village and practiced beekeeping for your entire life; apiculture is your profession, but more importantly, it is your passion. You are very serious about beekeeping, and often go camping with your bees during the season for honey, in areas where flowers are in bloom. Therefore, despite your lack of a formal education, you are the local expert on bees, apiaries, and anything related to beekeeping. As such, you have exceptional knowledge of local plants and fauna, especially of those which attract bees. Because of your years of experience, you are also able to identify almost every single plant that grows in the surrounding area, provide their names, and discuss any of their uses in the nearby communities. You are particularly protective of your bees, as demonstrated in the past, when you built small floatable platforms on which they can perch when collecting pollen so that they may expend less energy. Additionally, Aissa Derham, the president and founder of Dar Si Hmad, is your partner in a small business selling local honey.

Affiliations:
You know everyone in the village, since you have lived here your whole life. Aissa Derham is your business partner and friend.

Character Possesses
You have a vast knowledge of beekeeping, which you are an expert in despite lacking a formal education.

Character Needs
You are in need of the details and scientific aspects of beekeeping, including information you would have received had you experienced a formal education.

Character Duties
You must perform an in-depth study of beekeeping to understand other aspects you did not previously know.

Objectives

- Develop an understanding for the practice of apiculture and the study of beekeeping
- Apply knowledge of apiculture while keeping in mind a specific social context

- Understand the significance of beekeeping and honey in Moroccan and Berber culture
- Comprehend the importance of collaboration with peers working in different fields

Assignments

The following assignments should be performed throughout the term. You should be completing the assignments from the point of view of your character. Some resources are provided for you, but you are expected to perform your own research. If you need additional information, be sure to use ONLY reputable sources; cite all of the sources you use in your work using APA format.

1. BEEHIVES: After many years of loving cultivation, your beehives are flourishing and your bees are happily working. Your goal for the new honey season is to split your beehive. Splitting a beehive is a common practice in apiculture which has multiple purposes. Complete the following activities related to this topic (20 points):

a) Briefly summarize the process of splitting a beehive, in your own words.

b) Describe at least three reasons why beekeepers occasionally split their beehives.

c) Since you are splitting your beehive, you will need to create an entirely new beehive, which will be an addition to your previous collection. Conduct some research about the structure and function of current beehives. Then, build a miniature beehive structure. This can be done with simple materials and supplies (i.e. nothing fancy); the main purpose of this activity is to get you thinking about the inner workings of a beehive and why it is constructed the way it is. Be prepared to present your structure and explain its components and functions

2. BEES AND HONEY: Next, you will learn about the hive community and the honey they produce. (20 points)

a) What kinds of bees are found in the hive? What is the specific function(s) of each type of bee? How do the bees of the hive communicate with each other?

b) Investigate the process by which honey is produced, starting with the mechanism in which bees create the honey and ending with the packaged product on grocery store shelves. This can be presented as a step-by-step procedure, in the form of a numbered list, but must be thorough.

c) What are the similarities and differences between standard honey, pure honey, and raw honey?

d) Honey is only one of the substances that bees produce in the hive. What are the other five products? Give a one-sentence description of each, stating what they are.

e) Take a brief look at the article titled "Beekeeping in Morocco: focus on honey production," which is provided below in Additional Readings. This article is in French, but you will

only focus on the tables and figures. Table 1 contains the three main bee species in Morocco. Research each of these and describe them. Be sure to include some of the other information in the table, by translating them to English (Hint: www.wordreference.com may help).

f) The next portion of your assignment is crucial, to understand the role that honey plays in the lives of Moroccan people. Prepare a five-minute presentation, which you will share with the class, detailing the importance and significance of honey, in both Moroccan and Berber culture. Be sure to especially elaborate the importance of honey in Islam.

3. WATER: Conduct some research about the relationship between bees and water. Then complete the following activities. (20 points)

a) What is the role of water in beekeeping? Describe at least three reasons why water is so important for bees.

b) As you may have uncovered in part (a), it is important that bees have a water source during the honey-making process. There are various factors to consider when providing a water source to the hive. Keeping this in mind, draw a schematic of your beehive and its corresponding water source, making sure to include:
   i. The type of water source
   ii. The distance between your water source and the beehive
   iii. The degree of availability of the water source to the your bees
   iv. The way in which you will keep your bees from drowning

   Provide a justification for each of your decisions.

c) How do you predict your beekeeping duties will be affected by the fog nets installed by Dar Si Hmad?

4. FAUNA: Plants, particularly those which bloom during the appropriate season, are very important to take into consideration. In this part of your assignment, you will delve further into the relationship between plants and beekeeping. (20 points)

a) Honeybees collect nectar from a wide variety of flowering plants. What is the most common type of honey, and which plant does it come from?

b) Explain the effect that flower type has on the taste of the resulting honey. In addition, explain the relationship between the color of honey and its taste. If possible, procure two different varieties of honey, perhaps from your local grocery store. Once you have tasted them, reflect on their taste, color, and origin, then connect your findings with what you previously learned.

c) Next, consult with the student who has the character of Mia Wilder. Mia is studying naturopathic medicine in Toronto and is currently working on a research project focused on local plants growing in the Aït Baâmrane region. Take note of some of the plants that she is studying and have her describe them to you; then, select at least three which have blooming flowers. Investigate the honey which is produced from the nectar of these plants; these are

the honey varieties that you, as an Aït Bamraani, will likely produce through your beekeeping. Summarize your findings.

d) Take a look at the reading "Physiochemical properties of some honeys produced from different plants in Morocco," which is provided below in Additional Readings. This will provide you will some more Moroccan plants which attract bees for the production of honey. Now, between the plants listed here and the ones you learned about from Mia, select three plants which are native to Morocco and which are commonly used in Moroccan honey production. For each, answer the following questions:
   i. What is the water content?
   ii. In what region of Morocco do these plants grow?
   iii. What are their sugar compositions? How do they compare with each other? What does this mean?
   iv. Provide a one-paragraph summary of each honey type produced from these plants, including all the information you gathered above, as well as any properties or characteristics. (Hint: Section 3: Results and Discussion).

5. HEALTH AND SAFETY: There are many health and safety considerations involved with apiculture. Consider the topics below:

a) What are the general health properties of honey? Name and describe at least three.

b) In what specific ways do Moroccans use honey in their everyday lives? In what foods do they use it in? For what maladies do they use it as a remedy?

c) For the three plants you have chosen above, research and describe their specific medicinal properties. You realize that this information will be immensely useful and interesting to Mia; reconvene with her and share your findings.

d) What is the purpose of honey pasteurization? How does this affect honey's medicinal benefits?

e) To familiarize yourself with regulatory practices as established by the FDA, read the information at the following site: http://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/labelingnutrition/ucm389501.htm.

f) Why do some people have severe allergic reactions to bee stings? What is the name of this type of allergic reaction? What is the prescribed treatment, and how does it halt the allergic reaction?

Additional Resources

The following resources may be useful to you throughout the course of these assignments. Be aware that you are fully expected to conduct your own extensive research; these are just to help you get started. Please note that certain articles from ScienceDirect may not be initially accessible. If you have problems accessing these articles, visit the following website:

http://libguides.wpi.edu/databases?_ga=1.214533079.1105521467.1485878284 . Click the link for ScienceDirect under "Frequently Used Databases." Then, in the new web page, copy and paste the title of the article in the first text box; the resulting search should display the article.

- *Beekeeping in Morocco: focus on honey production* (French) http://www.ijias.issr-journals.org/abstract.php?article=IJIAS-16-313-03
- *Physiochemical properties of some honeys produced from different plants in Morocco* http://www.sciencedirect.com/science/article/pii/S1878535211002747
- *Characterisation of Moroccan Spurge (Euphorbia) honeys by their physicochemical characteristics, mineral contents, and colour* http://www.sciencedirect.com/science/article/pii/S1878535215000155
- *Honey: its medicinal property and antibacterial activity* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3609166/
- *Honey: a reservoir for microorganisms and an inhibitory agent for microbes* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2269714/

Rubric

The following is a preliminary rubric for the grading of the activities above. Please note that they are subject to change, at the instructor's discretion and based on availability of resources.

Part 1	
Points Awarded	**Degree of Completeness**
20	Successfully answered all questions, and constructed a beehive creatively and thoughtfully
15	Answered all or part of the questions, but beehive structure lacks components and/or detail
10	Answered some of the questions, and built a beehive with missing components
5	Answered very few of the questions, and built a poorly constructed beehive
0	Failed to answer any questions or construct a beehive

Part 2	
Points Awarded	**Degree of Completeness**
20	Successfully answered all questions and gave a thoughtful, thorough presentation
15	Answered all questions and gave a presentation, albeit lacking detail and thoroughness
10	Answered only some of the questions and gave poor presentation
5	Answered very few of the questions and gave a poor presentation
0	Failed to answer any of the questions or give a presentation

Part 3	
Points Awarded	**Degree of Completeness**
20	Successfully answered all questions and drew a detialed schematic with appropriate justifications
15	Answered all of the questions, but drew a schematic lacking detail and/or justification
10	Answered only some of the questions and drew a schematic lacking detail and/or justification
5	Answered very few of the questions and drew a poor schematic
0	Failed to answer any of the questions or draw a schematic

Part 4	
Points Awarded	**Degree of Completeness**
20	Successfully answered all the questions with thoughtfulness and detail
15	Answered all of the questions, but lacking thought and/or detail
10	Answered only some of the questions and lacks thought and/or detail
5	Answered very few of the questions and lacks thought and/or detail
0	Failed to answer any of the questions

Part 5	
Points Awarded	**Degree of Completeness**
20	Successfully answered all the questions with thoughtfulness and detail
15	Answered all of the questions, but lacking thought and/or detail
10	Answered only some of the questions and lacks thought and/or detail
5	Answered very few of the questions and lacks thought and/or detail
0	Failed to answer any of the questions

Original character created (March, 2017, IQP) by: Shaimae Elhajjajy

A.4 Zaineb Hakimi

Age: 50’s
Gender: Female
Residence: Agni Zekri, Morocco
Job or Main Tasks: Educate the villagers about clean water and sanitation

Background

Biography

You had spent your entire life in Guelmin city where you were provided with water and other sanitation by the government. Since then, you acknowledged that clean water and sanitation are essential to human, especially in health improvements. However, you had been dreaming and chose to enjoy your life after retirement in the Moroccan countryside. This is a huge change in your life. Even though you do not have to fetch water by yourself, the fact that tap water is no longer available makes your life more complicated and uncomfortable. In addition, you know that women spend a great amount of time walking on rocky roads to fetch water from the unprotected well where there is a lot of dust, garbage, and dead animals. As you live in the city, you witness that water scarcity and poor quality water have a negatively impact on health and limit educational opportunities.

You know the fog project can improve the villagers’ lives in many aspects. One day, you heard that some villagers do not acknowledge that the fog project can make a difference in their lives and they do not support the project. Moreover, some villagers do not allow the project to bury the water pipes that will bring the fog under their properties.

Affiliation

You live with you husband in Agni Zekri. You are friends with some of the villagers and always take care of them when they need help.

Character Possesses

You are well educated and acknowledge the importance of clean water to improve health.

Character Needs

- Water for your family
- Good education for your son

Character Duties

- You are the mother of the household who makes sure that water is sufficiently available in your house for the family members.
- You are responsible for filling the water tanks in your house and bringing water buckets into your kitchen.

Objectives

- After hearing about the objections to the fogwater project, you are aware of negative consequents that can shut down the project, and the villagers will live their lives the same way as they do now. Therefore, you want to inspire and educate them about clean water, sanitation, and the project. Also, since you are more familiar with the culture than DSH staff, you are willing to negotiate with the villagers who do not want the water pipes buried under their properties.

Assignments

Assignment 1: Observe community members' lives before the fog project
Notes: Individual, homework assignment

After living in the village for a while, you could see that people live their lives differently from the city people. Your first task is to observe and examine the problems that come along with clean water scarcity and unsanitary activities that people do as their daily routines. Watch the "Tagut" video below to get a better understanding of water scarcity and their routines.
Write 2-3 short paragraphs on your understandings about their lives.

Video: https://vimeo.com/28553227

Assignment 2: Life before and after the fog project
Notes: Individual, homework assignment

Your second task is to dive into the household survey to discern what life was like in the communities before they received fogwater and to surmise how life would be different once they could easily access clean water at their homes. For example, fetching water from the wells takes many hours every day and can be dangerous.
In addition, you must provide diseases caused by non-sanitized water to make your reasoning stronger.

From the point of view of your character, prepare a handmade poster that shows your reasoning about the importance of clean water in the communities in Ait Baamrane.

Organize a meeting and talk about your presentation out of class. Discuss how your character's perspective and experience is the same or different from three other characters. Take note on these similarities and differences. Create a matrix showing three ways in which your character's perspective and experience is the same as three other characters', and three ways it is the same.

Submit the matrix as homework.

Assignment 3: Investigate the reasons and negotiate

Notes: Individual, homework assignment

You heard that the other village opposed having water pipes buried under their land. You believe that you could negotiate and convince them to support the project so that you and the villagers have access to clean, tap water.
To prepare for the negotiation, you must study how to negotiate. Read the article below to help you think rationally about negotiations, and complete the negotiation planning worksheet below

https://www.dropbox.com/sh/q8jl47kketdcnd2/AABIoGDQ7wuwlObyU6tHiUMta?dl=0&preview=Negotiating+Rationally.pdf

Negotiation planning worksheet		
Issue	Without the project	With the project
1.		
2.		
3.		
Options	1. 2. 3.	
BATNA		
Proposals	1. 2. 3.	

Show your presentation to the villagers from both cities and use the negotiation planning worksheet as a guide to successfully negotiate.

Rubric

Assignment 1	
Points Awarded	**Degree of Completeness**
10	The student has a complete understanding of the living conditions
8	The student illustrates some understanding of the living condition
6	The student lacks a basic understanding of the living condition
4	Minimal effort was put in. little to no research was done
0	Fail to do research on the topic

Assignment 2	
Points Awarded	**Degree of Completeness**
10	Significant statistics were collected and the presentation was creative and clear
8	Some statistics were collected and the presentation was clear
6	The student lacks of basic statistics and the presentation was not clear
4	Minimal research was put in. No presentation was done
0	Fail to gather statistics and create a presentation

Assignment 3	
Points Awarded	**Degree of Completeness**
10	Successfully completed the spreadsheet
8	Completed the spreadsheet but lacking detail
6	Completed the spreadsheet with poor justification
4	Minimal effort was put in.
0	Fail to complete the spreadsheet

Original character created (March, 2017, IQP) by: Haruna Okada

A.5 Jamila Bargach

Age: mid-50's
Gender: female
Residence: Casablanca and Agadir
Job or Main Tasks: fogwater project manager

Background

Biography

You and your husband, Aissa, used to live in Casablanca. In 2006, Aissa had to travel to the Ait Baamrane region in rural southwest Morocco to work on setting up the experimental fogwater harvesting nets. At that time, you were asked to work for DSH as well, but you turned down the invitation since you were not interested in the fog project. You decided, instead, to follow your passion, and became a professor at the national school of architecture in Rabat. Unfortunately, a few years into your tenure at the school, they hired a new director who put more emphasis on the sciences and less on the social sciences and arts. You felt uncomfortable working with the new director, and thought that your work and contributions were undervalued. Eventually, you decided to leave the school to join Dar Si Hmad to help develop the organization and build the fogwater project. This was a significant change in your life. Your past experiences had not prepared you to manage a science site or engineering project, and you realize that you need to learn more about the project and the position's responsibilities. Furthermore, you are familiar with the Moroccan culture, and you know that it is hard for women to play a major role in work.

Affiliations

You live with your husband and daughter. You are friends with most of DSH volunteers and researchers, especially Vicky and Peter who are from abroad like you.

Character Possesses

- You know several languages, including Arabic, French and English, but you don't speak Berber.
- You have a teaching skill

Character Needs

- Project Management skills
- Deep understanding of Berber culture
- Respect and trust from your co-workers

Character Duties

- You are the mother of the household who put emphasis on your daughter's education
- You are the manager of the fogwater project who aims to achieve the goals and continue to improve the project

- You make sure that your co-workers do their job

Objectives

- The primary goals of these tasks are to get ready for the manager position and to get insight into rural Berber culture in southwest Morocco.

Assignments

Assignment 1: Research the fogwater project
Notes: Individual, homework assignment

Since you have spent most of your life devoted to practicing and teaching social sciences and humanities, you never had a chance to learn about water nor project management. The first task is to better understand the current situations and the future goals of the project, which are provided in the website below:
http://darsihmad.org/fog/
Prepare a 5-slide PowerPoint presentation on the fogwater project.

Assignment 2: Management Tool and Project Structure
Notes: Individual, homework assignment

As a project manager, you expect to see improvements in processes, results, and the work environment. A management approach called Total Quality Management (TQM) describes 8 principles that you have to be concerned with while managing the project.
Determine and summarize the 8 principles of your project from your perspectives as the project manager.

Resource: TQM
http://asq.org/learn-about-quality/total-quality-management/overview/overview.html

Assignment 3: Create a tree diagram
Notes: Individual, homework assignment

Create your individual tree diagram with each branch describing one principle. Present the first version of your tree diagram to a mixture of DSH staff, community members, local authorities, etc. Discuss the tree diagram with them and get input from you co-workers and other stakeholders on how it can be improved.

Revise the tree to reflect this new input. Write a few paragraphs on what you learned from sharing the tree with the group. How has the tree changed?

This assignment allows you to deep dive into every branch of the project, and to acknowledge the villagers who are interested in helping the project.

Resource: Tree Diagram
http://www.slideteam.net/business_powerpoint_diagrams/
relation/relation-tree.htm

Assignment 4: Understanding Ait Baamrane Berbers
Notes: Individual, homework assignment

Familiarize yourself with the Ait Baamrane Berber culture. Since you have never lived in rural Morocco, you realize you need to better understand the Ait Baamrane region. To help you become familiar with the culture and society, you are required to read the history of Ait Baamrane Berbers and also develop your understandings of other culture aspects, such as family values, beliefs and superstitions, and communication.

Fill out the following table to compare these culture aspects of Ait Baamrane Berbers with the culture where you live. Present the table to the community members, DSH staff, and local authorities.

Resources: History if Ifni
http://www.ifniville.com/sidi-ifni/ifni-more-history.php?id=H515311255892040
Resource: Berbers from southwest Morocco
https://en.wikipedia.org/wiki/Berbers

Topic	Your hometown	Ait Baamrane
Traditional houses		
Religious Background		
Political History of Ifni		
Social Organization		
Fashion-clothes		
Family Values		
Beliefs and Superstitions		

Rubric

Assignment 1	
Points Awarded	**Degree of Completeness**
10	Successfully identified the current situations and future goals
8	Identified the current situations and future goals with some missing details
6	Identified the current situations and future goals, but had a large amount of missing information
4	Minimal effort was put in. Poorly identified the current situations and future goals
0	Failed to identify the current situations and future goals

Assignment 2	
Points Awarded	**Degree of Completeness**
10	Successfully identified the 8 principles with thoughtfulness and detail
8	Identified the 8 principles, but lacking thought and/or detail
6	Identified the principles, but had a large amount of missing information
4	Identified the principles for less than 5 out of 8
0	Failed to identify the 8 principles

Assignment 3	
Points Awarded	**Degree of Completeness**
10	Successfully created a diagram and acknowledged the villagers
8	Created a diagram and acknowledged the villagers with some missing details
6	Created a diagram and acknowledged the villagers, but had a large amount of missing information
4	Minimal effort was put in. Created a poor diagram and acknowledged the villagers
0	Failed to create a tree diagram

Assignment 4	
Points Awarded	**Degree of Completeness**
10	Successfully filled out the spreadsheet with thoughtfulness and detail
8	Filled out all of the aspects, but lacking thought and/or detail
6	Filled out only some of the aspects and lacks thought and/or detail
4	Filled out very few of the aspects and lacks thought and/or detail
0	Failed to fill out the spreadsheet

Original character created (March, 2017, IQP) by: Haruna Okada

A.6 Peter Trautwein

Age: 40's
Gender: male
Residence: Munich, Germany
Job or Main Tasks: Industrial Designer

Background

Biography

You are an industrial designer from Munich, Germany who specializes in designing commuter trains, buses and other transportation vehicles. As a passionate designer and "global citizen," you have been involved in several water projects in under-developed countries, where water scarcity and low quality water negatively affect people's lives. In addition, you have joined the WasserStiftung research foundation that supports water projects around the world. Through your work with the foundation, you understand and have confronted the problems related to the lack of water accessibility, and are determined to help develop solutions that can provide a better life for people. Through the WasserStiftung foundation, you visited Morocco and saw the initial nets that were getting torn due to the high-speed winds. You decided to put your industrial design talent towards coming up with a new solution to the problem in which the new fog-collecting nets were capable of withstanding high-speed winds and catching a sufficient amount of water. Your work with Dar Si Hmad has been greatly appreciated by the villagers and your co-workers. With the first nets carefully and thoughtfully designed, the nets have been providing the villagers a sufficient amount of water. This has made several significant differences to the villages, including health improvements and a decrease in exposure to dangers caused by fetching water from the wells. However, you realized that there are some villages nearby that do not have potable water. Therefore, you and Dar Si Hmad is working on the new-generation of high-efficiency nets which are capable of doubling fog water harvested over the same net surface.

Character Possesses

- You are well educated and specialize in designing commuter trains, buses and other transportation vehicles
- You are full of experiences about water issues around the world

Character Needs

- Potable water for other villages
- Collaboration from the meteorologist (Vicky) and the material scientist (Amina LeBlanc)

Character Duties

- You are the industrial designer of the fogwater project who is responsible for searching for the best net material and designing the frame for the nets.

Objectives

- You are located in the rural Ait Baamrane region in southwest Morocco, where people still have to haul water from wells. The project manager asks you to design frames for the new-generation nets and determine the best net material to use.

Assignments

Assignment 1: Gather information about the topography and meteorology on Mt. Boutmezguida, the mountain where the Dar Si Hmad nets are located.
Notes: a team of 2 students, homework assignment

Your first task is to explore the lay of the land on the mountain where the new, experimental nets will be installed. Gather the information about the location and the weather conditions (meteorology) around the area, including temperature, air pressure, direction of the wind, and density of the fog from the meteorologist of the project (Vicky). The following figure provides the experimental data done by Dar Si Hmad and the WasserStiftung research foundation.

Write up a 2-3 paragraph about the location information and plot a graph of month versus amount of fog water

MONTH	Fog days	Wind direction WNW 300° l/1m²	Wind direction NNW 340° l/1m²
January	8	2.3	3.4
February	14	5.3	9.1
March	7	3.0	3.7
April	19	12.5	20.3
May	11	6.3	9.9
June	18	10.7	17.2
July	0	0.0	0.0
August	6	2.6	3.7
September	8	2.9	6.1
October	7	1.9	3.0
November	7	3.2	4.3
December	7	2.5	4.2
Average	112	4.4	7.1

Figure 19: Average amount of fog days per month and amount of fog water according to wind direction (Aqualonis, 2015)

Assignment 2: Find net materials that will possibly meet the requirements
Notes: a team of at least 2 students, homework assignment

After collecting a significant amount of location information, your next task is to outline some design requirements of the fog nets based on the location information found in assignment 1. The requirements may involve the amount of water needed in the village, the limited size of the nets, and the capability of the nets. For example, what is the maximum wind speed that the fog nets need to be able to withstand. Then, you are required do further research on your own to find net materials that will possibly meet the requirements, and that will be efficient physically and economically. This means the chosen net has to be able to collect a great amount of fog water continuously for a long period of time, and to cost at a reasonable price. Make the lists of the design requirements and tabulate the net materials you find along with their advantages/disadvantages, costs, and lifetimes.

Design requirements	• • • • •

Parameter	Material#1	Material#2	Material#3	Material#4	Material#5
pH value					
Conductivity (20℃)					
Unique Characteristics of the materials					
Lifetime					
Cost/square meter					

The following figure provides five suggested net materials that you might consider

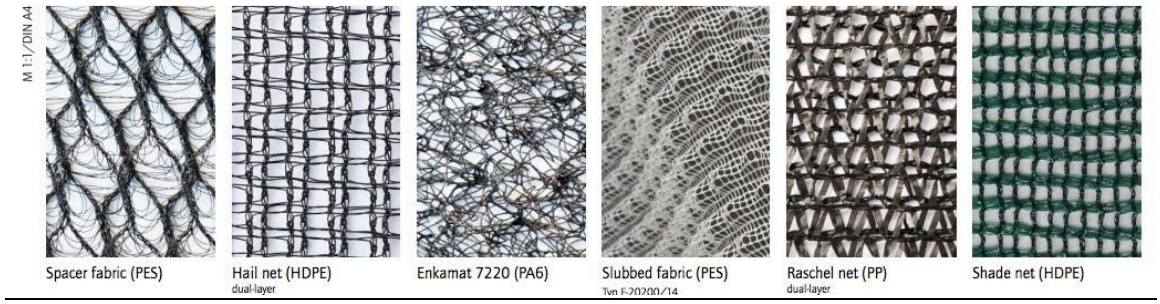


Figure 20: six different mesh types studied for the next-generation nets (Aqualonis, 2015)

Assignment 3: Design the net samples and the frames
Notes: a team of 2 students, homework assignment

Once the net materials are studied, your next task is to determine which net material is best. To do this, you need to create small net models that are made of each material. You also need to design a frame of the fog nets that will help the nets to withstand the wind.

The following picture is an example of how the nets and frames are designed and set up.

Figure 21: Six modules of the next-generation nets with differet types of mesh (Aqualonis,2015)

Assignment 4: Experiment with harvesting water from the nets you designed. Collect data from each net (amount of water caught)
Notes: a team of at least 2 students, homework assignment

Once the net models are completely designed, you are now ready to find out which net material collects the greatest amount of water. To do this, you need to collaborate with (Amina LeBlanc), who can help you design a hands on experiment in which you do not need to set up the samples at the real location; instead, you will mimic the manners of the fogs by using spray bottles.

Assignment 5: Compare the data. This comparison will be presented at a scientific conference Notes: a team of 2 students, homework assignment

The experimental results are significant factors that indicate the quality of each net. However, you do not determine which net material to use based solely on the quality; you also need to take the other factors, such as cost and lifetime, into your consideration. At the meeting, briefly show the work process and state the final result. Articulate your points of view and your feelings, while giving the reasons for choosing the design.

Rubric

Task 1	
Points Awarded	**Degree of Completeness**
10	The student gathered a significant amount of information
8	The student gathered some information
6	The student lacked basic information
4	Minimal effort was put in. little to no research was done
0	No research was done on the topic

Task 2	
Points Awarded	**Degree of Completeness**
10	Design requirements were made and the student found net materials with information
8	The requirements and net materials were determined, but with lacking some information
6	The student lacked basic information
4	Minimal effort was put in. little to no research was done
0	No research was done on the topic

Task 3	
Points Awarded	**Degree of Completeness**
10	Successfully designed the net samples and frames
8	Designed the net samples and frames but with some missing detail
6	Designed the net samples and frames but with lacking detail
4	Minimal effort was put in. Poorly constructed designs
0	Fail to complete the designs

Task 4	
Points Awarded	**Degree of Completeness**
10	Successfully did the experiment with great results
8	The experiment was done, but some missing results
6	The experiment was done, but more missing results
4	Minimal effort was put. Majority of results missing
0	Failed to do the experiment

Task 5	
Points Awarded	**Degree of Completeness**
10	Successfully determined the net material with clear explanation
8	Determined the net material with some explanation
6	Determined the net material with weak reasons
4	Poorly determined the net material
0	Fail to determine the net material

Original character created (March, 2017, IQP) by: Haruna Okada

A.7 Dave Canmori

Age: 30’s
Gender: male
Residence: San Francisco, California
Job or Main Tasks: Social Entrepreneur

Background

Biography
You are a start-up entrepreneur interested in investing and planting firm business units in areas of sustainable business. It is no surprise that you are a strong advocate to help fight against global warming which further takes your passion into green energy business. At a conference, you meet a friend who tells you about the fog water project in Morocco and you are instantly driven to implement these fog nets in as many areas as the climate would allow. You gain an interest in social entrepreneurship, which you take it upon yourself to study. Your dream country to have these fog water nets implemented is Ethiopia particularly the region of Addis Ababa.

Character Possesses

- You are well educated with an undergraduate degree in sustainable business and business management and a MBA from Yale University.
- You are very passionate about the environment and you envision to impact the world through the sustainable business which you have initiated.

Character Needs

- You need information about the fog water project. You must collaborate with Peter Trautwein and Jamila Bargach to gain more knowledge about the fog water project.
- Although you are a social entrepreneur, you need to improve public speaking and get more comfortable with it.

Character Duties

- You are the self-starter of your own sustainable business. This sustainable business is the implementation of the fog nets in Ethiopia in the region of Addis Ababa.

Objectives

- Discover what social entrepreneurship is and the strategic planning that would go into setting up a “business plan” of a social enterprise.

- Develop effective communication skills in the form of presentations and giving elevator pitches. Communication skill is an essential asset to polish where its usefulness is never questioned and is ever in demand.
- Gain an insight to the financial aspect of the fog water nets implementations

Assignments

Assignment 1: Building 2 Prototype Fog Nets
Notes: 1 student, homework assignment

In order to make the implementation of the fog nets successful, you would need to convince potential investors how efficient and reliable the fog nets are. You will build two different types of fog nets. It is critical to use contrasting materials to build the two meshes. You will need to keep in mind that because these nets will be prototypes, they will range smaller in size than the actual fog nets. You must decide upon the appropriate size and buy your materials accordingly. Your costs for the products should be neatly organized and recorded in an Excel spreadsheet (the format that is expected is shown below in the Hints section].

[Hints]

- Hint on information that should be included [and not limited to] in Excel Spreadsheet:

Type of Material Used	Locaation where material is bought	Where the material shall be used	Cost per (ft/ squared meters etc.)	Total lenth of material bought	Total cost

- Hint on selection of material: The material that would be suitable is one that is cheap enough so that it is affordable for large scale production and must capture fog efficiently.

- Hint on the estimate total cost: Remember that your goal is to convince your investors that these fog water nets are efficient and low cost so the materials you buy should reflect on the efficiency and low-cost side of it.

Resource: http://www.fogquest.org/f-a-q/

https://watersustainabilityandfogwater.wordpress.com/fog-catchers-and-how-to-make-your-own/

"Harvesting Fresh Water from Fog"-https://www.youtube.com/watch?v=h8vlzZ25vtg (YouTube video)

"Fogcatcher Prototype"-https://www.youtube.com/watch?v=F9E_piVrgvk (YouTube video)

Assignment 2: Compare & Contrast Chart
Notes: 1 student, homework assignment

a) After you have constructed the two meshes, you will record which mesh works better at capturing water. You will need to research on how much water a good fog net can collect.

You will write a detailed “Compare and Contrast” between the two meshes. The primary points you should cover are [but not limited to] :

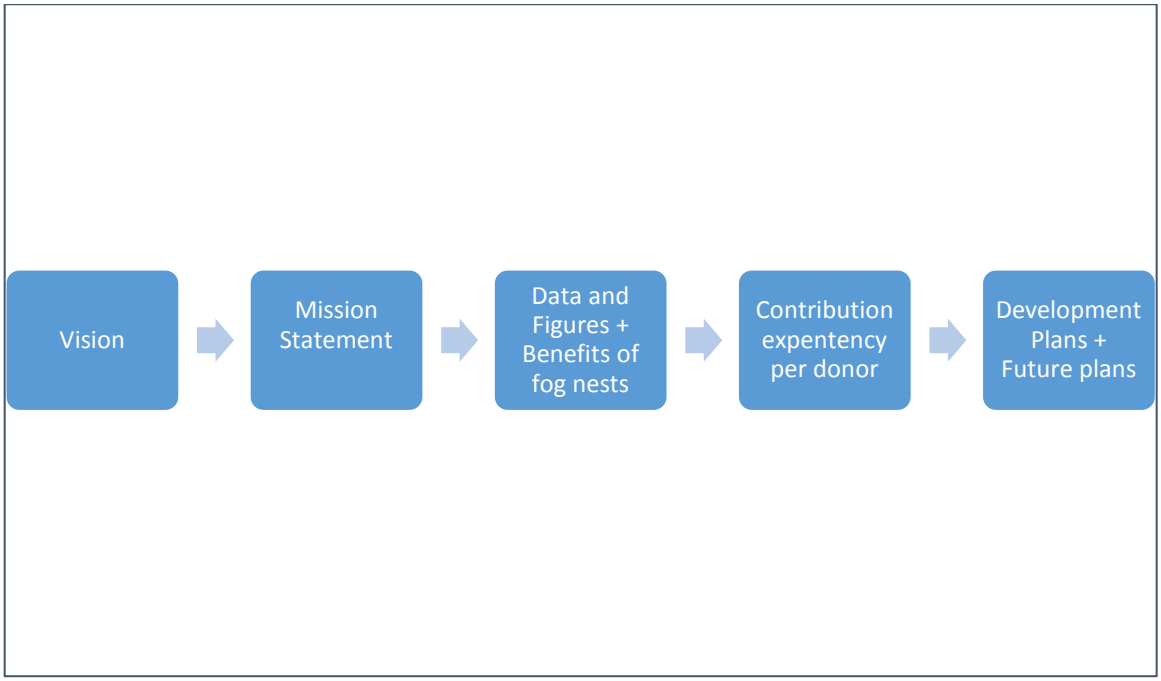
-costs of construction (measurements inclusive)

-duration of construction (which mesh took longer….why did it take longer…)

-amount of water collected at different locations of both meshes (e.g. on a slope vs. levelled ground).

Assignment 3: Develop communication skills
Notes: 1 student, homework assignment

You are scheduled to give a presentation to a group of potential investors to present your Kickstarter campaign for a fog net project in Africa. Your presentation must be thoughtfully laid out with all essential ideas very accessible to read and understand. Your presentation slides should contain the following points, but is not limited to, in the flow chart presented below:



- The vision is the collective summary of the answers to the following questions: What is your big vision? What problems are you solving and for whom? Where do you want to be in the future? What are your guiding principles?
- The mission statement is the inspirational statement to the purpose of your project.
- The data and figures represent the number of countries that have these nets implemented. List the countries that haves these nets implemented. List the amount of water the different sizes of meshes provide (from the meshes you have built in Assignment 1 and the general

sizes offered in the market right now). The benefits of the fog nets should be strongly supported to communicate how useful, sustainable and efficient the fog nets are.

- Based on your cost calculations, you should estimate how much contribution each investor can be expected to make. The investors can contribute at the beginning of the fog nets but you will also want investors willing to donate for the maintenance of the fog nets they have been implemented.

Assignment 4: Creative Thinking: Designing New Nets
Notes: 1 student, homework assignment

- The fog water nets are set to become more innovative, with new designs of meshes. These future plans should be highlighted with estimate costs of new materials and how the total price of building new fog nets could vary from that of the old design fog nets (the prices of the old fog nets should include the nets you built in Assignment 1 as well as general fog nets offered in the market as of now). [This assignment requires you to engage in creative thought processes. What are the ways you see that can be done differently and more efficiently?]

Presentation slides should be designed for the audience to read clearly the information on the slides.

Resource: Creating effective presentation slides: http://christinehaasconsulting.com/useful-research/

Presentation slide template: Download the "Presentation Starter Template" which can be found on the same website.

Rubric

Task 1	
Points Awarded	**Degree of Completeness**
10	Constructed a considerable extensive material Excel table reflecting research
10	Fog net prototypes achieve the points that are required
5	Pattern of the meshes in the fog net

Task 2	
Points Awarded	**Degree of Completeness**
25	Complete list of compare and contrast criteria

Task 3	
Points Awarded	**Degree of Completeness**
10	Delivery of presentation (pitch, voice, smooth transitions)
30	Presentation slides (content, design)
10	Creativity of fog net meshes

Task 4	
Points Awarded	**Degree of Completeness**
25	Innovative creative design of meshes

Original character created (March, 2017, IQP) by: Niang Thang

A.8 Vicky Marzol

Age: 30’s
Gender: female
Residence: Canary Islands
Job or Main Tasks: Meteorologist

Background

Biography

You were born in the Canary Islands but you have always had close ties with Sidi Ifni and the people in Ait Baamrane. You spent a few years in Sidi Ifni when you were a little girl when your father was part of the Spanish military that colonized this part of Morocco. At a young age, you have been exposed to the frequent droughts in the countryside. You hear of other girls your age who had to miss school because they had to haul water. These stories strike a deep chord within you and become decisive factors in your choice to become a meteorologist. Your childhood inspiration to address the drought crisis in Ifni remains with you and as you advance through college, you study meteorology. You are fascinated with geography and want to help the citizens of Sidi Ifni and Ait Baamrane with the drought crisis. Your primary focus and emphasis becomes research on fog-climate and weather patterns in the Canary Islands and the region including Sidi Ifni and the effects of fog on flora and fauna and human communities. Your advanced research focuses on the meteorological conditions necessary to harvest fog as a source of water.

Character Possesses

- A solid understanding of the basic concepts of meteorology

Character Needs

- You need information update on the weather pattern about the fog water project. You must keep in touch with the Dar Si Hmad team preferably Jamila.

Character Duties

- You are responsible for the research that goes on about weather patterns in the Canary Islands and its neighboring regions.

Objectives

- Gain an understanding of the concepts of fog harvesting.
- Differentiate and distinguish between Sidi Ifni, the Ait Baamrane region and the Canary Islands (such as the success rate of fog nets in both countries, the factors underlying the criteria for the location of fog nets).

- Comprehend the innovative solution to a global problem that will help you address a real-life crisis and challenge you to create a solution for those problems

Assignments

Assignment 1: Understanding water scarcity & Your water footprint
Notes: 1 student, homework assignment

Resolving the drought crisis must take place one step at a time. Therefore, follow the steps listed below before you arrive at a solution to fix the problem of water scarcity. Look at the following indices to see what Morocco water access looks likes from a regional perspective:

1. Where does the Middle East and North Africa (MENA) stand relative to other regions of the world?

World Bank Food and Agriculture Organization's Making the Most of Scarcity (http://siteresources.worldbank.org/INTMENA/Resources/App-all-Scarcity.pdf)

2. United Nations Key Water Indicator Portal (http://www.unwater.org/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 (http://growingblue.com/the-growing-blue-tool/)

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:
http://waterfootprint.org/en/resources/interactive-tools/personal-water-footprint-calculator/personal-calculator-extended/

Assignment 2: History of Dar Si Hmad Fog Harvesting
Notes: 1 student, homework assignment

Dar Si Hmad is a non-profit organization that pioneered the world's largest fog water harvesting project. Provide a brief history of Dar Si Hmad, stating clearly the history, objectives, and succesess of this non-profit organization. [The brief report must be between 300-500 words].

Resources: http://darsihmad.org/fog/

Assignment 3: Properties of Fog
Notes: 1 student, homework assignment

Elaborate on what fog is and the physical properties of fog that make fog-harvesting a possible water source. [The report should be a max. of 500 words with 3 minimum fog properties that make fog harvesting a success].

Resources: http://www.oas.org/dsd/publications/unit/oea59e/ch12.htm - (First paragraph)

http://blogs.ei.columbia.edu/2011/03/07/the-fog-collectors-harvesting-water-from-thin-air/

Assignment 4: Factors that contribute to success
Notes: 1 student, homework assignment

The fog research has been conducted in Ait Baamrane, Sidi Ifni and the Canary Islands. List effective factors that make fog net implementations such a success in these locations.

Resources:
http://www.academia.edu/6725879/Meteorological_Patterns_and_fog_water_in_Morocco_and_the_Canary_Islands

http://www.oas.org/dsd/publications/unit/oea59e/ch12.htm

Assignment 5: Assessing Data: The Elephant Parable
Notes: 1 student, homework assignment

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 300-word essays, each assessing a different point of view. 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? (300 words)

a. You work from the Canary Islands with the Dar Si Hmad team in Morocco. This team is primarily run by Jamila Bargach and Aissa Derhem. Write a short report answering these questions:
    1. What normal or unusual activity(s) do they see concerning the weather pattern and the water they are getting from the fog nets?
    2. What recordings are they keeping track of?
    3. What light do they shed on the water issue in Morocco?
    4. What can they tell you about water use and access in this region?

5. How does this data compare to, or connect with the data from the other indices you have studied?
6. How accurate are these data?
7. In what particular ways are the data useful? (300 words)[Team up with Jamila]

b. Write about the view from the household surveys. Reference several different households 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? (400 words)

c. 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.

d. 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. (800-1000 words).

Rubric:

Task 1	
Points Awarded	**Degree of Completeness**
35	Complete answers to the questions listed from 1-4
Task 2	
Points Awarded	**Degree of Completeness**
10	Successfully answered all the questions
Task 3	
Points Awarded	**Degree of Completeness**
10	Successfully answered all the questions
Task 4	
Points Awarded	**Degree of Completeness**
10	Successfully answered all the questions
Task 5	
Points Awarded	**Degree of Completeness**
35	Successfully answered all the questions

Original character created (March, 2017, IQP) by: Niang Thang

A.9 Rkia Rahmend

Age: 30's
Gender: female
Residence: Sid Ifni
Job or Main Tasks: Housewife

Background

Biography
You are the mother of two children: an eight year old boy (Hisham) and a thirteen year old daughter (Aisha). Although you married young (at the age of 16), you remain fairly independent, trying to make a small income of your own. You have a mind of your own and if you sincerely believe in an idea or a cause, you will not be afraid to voice it even if it means having to go against your family or your husband. You believe that education should be prioritized more than marriage for young women, a thought that is often not encouraged. You are not entirely sure why you were brought up with that notion and this feature is what makes your character exceptionally unique.

Character Possesses

- You believe that your children, especially your daughter should be educated rather than married off young.
- You are impressed by strong, independent women like Jamila and Leslie and imagine your daughter to grow up to be like one.

Character Needs

- Learn to read and write in Arabic because you are illiterate

Character Duties

- As a mother of two young children, you are responsible for the housework
- You also collect argan nuts to sell it in the market to earn more money

Objectives

- To educate your children
- To ensure that females are strong individuals

Assignments

Assignment 1: Exploration of the education system in Morocco
Notes: 1 student, homework assignment

As you believe education plays a major role for you, you want to learn more about the education system in Morocco. You are to explore the education system in Morocco and write a 250-500 essay on the Moroccan education system. Detailed information on the education system is expected. In your report, you should consider the following questions but should not limit your report to only answering these questions.

Hints:

1. How strongly are children encouraged to pursue further education? Do students tend to leave the country to further their education?
2. How strongly are students, particularly girls, encouraged to pursue a STEM-related career?
3. What common problems are evident in Moroccan schools? e.g. Is bullying a major issue in these schools?

Resource:
https://www.moroccoworldnews.com/2016/03/181000/moroccan-educational-system-problems-and-solutions/
http://www.epdc.org/sites/default/files/documents/EPDC%20NEP_Morocco.pdf

Assignment 2: Creativity Station: Problems in Rural Schools
Notes: 1 student, term assignment

You have been hired as the school social worker in a rural public school. Your assignment is to keep a record book of at least ten problems rural children in Morocco are facing. Come up with creative solutions to the problems that you have raised.

Resources: Consult information on rural schools in Morocco and in other developing countries. Keep track of your sources. Submit them with your record book at the end of the term.
https://www.moroccoworldnews.com/2013/05/92534/moroccan-education-problems-and-solutions/
http://www.universityworldnews.com/article.php?story=20090515144011160

Assignment 3: Girls in School
Notes: 1 student+ 5 students, term assignment

In order to empower young women in the *bled* to go to school, you first have to convince their mothers and grandmothers. Read up on the role gender plays in the education sector of Morocco. Is there any gender discrimination concerning education? Why is this? Write a 500-word report on the findings from your reading.

You talk to other stronger women figure and express to them your ideas of female empowerment. You then receive a brochure (the link to the brochure is shown in the link) :
https://www.unfpa.org/sites/default/files/resource-pdf/empowering-young-women_eng.pdf

You must come up with activities or sessions where you find a group of women to do activities and work together to encourage independence, leadership and confidence. The small group should be made up of 4-6 women. In one of these talk sessions, be sure to invite Jamila. The session will be

10-20 minutes long. The activity sessions will vary from week to week. Since the school term covers 7 weeks, you will discuss 7 different topics. The selection of topics have been provided as helpful hints but you are not required to stick to these topics. You will be the moderator for these talk sessions. Come up with 5 good questions that address your topic for each week.

Resources:
http://www.unicri.it/topics/trafficking_exploitation/archive/women/nigeria_2/women_empowerment/
https://www.google.com/webhp?sourceid=chrome-instant&rlz=1C1CAFA_enUS604US604&ion=1&espv=2&ie=UTF-8#q=female+empowerment+activities
http://www.globalpartnership.org/education
http://www.globalpartnership.org/focus-areas/girls-education

Assignment 4: Learning Arabic
Notes: 1 student, term assignment

Because Rkia is illiterate, she would like to teach herself Arabic now that she has the resources. Each week, you are to teach yourself five Arabic alphabets together with one phrase. By the end of the seven weeks, you will have learnt the entire Arabic alphabet and 7 phrases. You will be taking a basic written and speaking test where you will tested with your alphabets and the 7 Arabic phrases. The 7 phrases should be picked out from the sections “Greetings” and “Social Etiquettes” from the website provided below.

Resource: https://pollylingu.al/ar/en/courses/1

https://pollylingu.al/ar/en/alphabet

Rubric:

Task 1	
Points Awarded	**Degree of Completeness**
25	Successfully answered all the questions

Task 2	
Points Awarded	**Degree of Completeness**
10	Successfully answered all the questions

Task 3	
Points Awarded	**Degree of Completeness**
10	Successfully ran the talk sessions asking insightful questions

Task 4	
Points Awarded	**Degree of Completeness**
5	Successfully recited the seven phrases and wrote out all alphabets

Original character created (March, 2017, IQP) by: Niang Thang

Appendix B: Inquiry Seminar Characters

B.1 Akif Sheetrit

Age: 17
Gender: Male
Residence: Timtda
Job or Main Task: Develop an awareness of water sustainability and an understanding of the importance of fog water

Background

Biography

You are a young man, 17 years old, who is currently finishing his high school education. You are the eldest child of 2 children and the only son. You live at home in Timtda and go to school every day; this commitment prevents you from helping your mother collect water for your family during the week. You are very family-orientated and want to be able to help your family in whatever way you can. You are a man who is very grateful for the fog water as it allows your mother to have more 'free' time, and allows you to go to school in the nearby town of Mesti, knowing that there is enough water for your family. You hope the fog water allows your younger sister to now be able to go to school consistently, as there is no need for her to fetch water anymore.

Affiliations

You are very close to his mother and father. You go to school and when you are home you help your mother fetch water. You have friends at school, and you are a dedicated learner and are sometimes made fun of because of your studious ways.

Character Possesses:

- You are a man and so you can talk to other men
- You are well educated compared to many of the people in your town
    - Mathematics skills
    - Berber language skills
    - Arabic writing and reading skills

Character Needs:

- Transportation to and from school
- English lessons
- Water for your family

Character Duties:

- The man of the household while your father is away
- Middle man between your mother and any men she might need to talk to
- Keep your sister safe and out of trouble
- Fetch water if you are not in school

Relationships with the big ideas

  - The big idea is the function of fog water and its effect on the community – your relationship to this is that when the water is available at home you are able to go to school knowing that your mother does not have to go out and fetch water every day. This is not a modern perspective which involves an increase in woman's rights, you just want to insure her safety.
- Relationships with other people
  - While your father is away, you try to ensure that your sister learns and follows what is expected of women in the Berber community

Objectives

Objectives for the student:

- Awareness of water sustainability (Assign. 1)
- Develop empathy (Assign. 1)
- Identify factors that produce certain outcomes (Assign. 2)
- Develop written argument skills (Assign. 2)
- Relating STEM to real life scenarios (Assign. 3)
- Deduction skills (Assign. 3)

Objectives for the character:

- To increase your education by finishing High School and going to college. You would also like to be able to speak English fluently. Learn to read and write in English and possibly go on to tertiary education
- Help your sister be able to pursue education and stay in school long enough to learn how to read and write. Ensure that your sister does not grow up illiterate
- Retrieve water during the weekends
- Help your family keep track of the amount of money that they have, especially the money that your father sends back as remittances

Assignments

Assignment 1: Calculating Water Travel Time & Distances Before Fog Water

Using the National Geographic link provided, please calculate your own water footprint based on your water consumption, food consumption, purchasing history, as well as travel tendencies. There are many ways that people use water or cause water consumption, it does not always have to be

through the physical use of water. For the purpose of this activity we will only be looking into your personal consumption at home. In rural Morocco people often need to walk several miles to fetch water, and are limited by the size of the water containers and the maximum carrying weight of the donkeys. For the purpose of this activity the closest well in the winter time is 0.5 miles away and in the summer time it is 3 miles away. During the summer closer wells dry up and so residents have to walk further to fetch water. In this activity you are only able to carry back 3 gallons at a time. How many trips would you have to make to maintain your normal water consumption? How long will it take you to collect your total number of gallons consumed per day?

(http://environment.nationalgeographic.com/environment/freshwater/change-the-course/water-footprint-calculator/)

Assignment 2: Topography and Meteorology

There are many types of fog but not all of them are able to produce fog water. What topographical or meteorological factors allow for the use of fog nets in the mountains of Morocco? Chose one that you think is the most important and compose a well-structured (500 word minimum) argument supporting your choice. Students will be asked to present their finding and why they chose their specific aspects in class.

- This can also be a group activity. Each group needs to choose a specific requirement for fog water success and will do research on their topic. Then each group can be given the chance to argue and defend why their typographical/meteorological aspect is the most important when looking at how fog nets work in Morocco.

Assignment 3: Fixing a Leaky Pipe: Sealants

A pipe leading from the fog nets to the house is fully exposed and starts to leak and needs to be fixed. You have Durcuppan epoxy, EP-400 Epoxy Sticks and Perma-Wrap. Research these three sealants and determine which one is best suited for fixing the leak. If the leak was from an indoor pipe and was less accessible would this make a difference in which sealant is best suited? Which sealant would not achieve the desirable result for both scenarios?

Ideas to Develop: Water Marbles and Strategy Game:

- Strategy advice
    - The game that you are playing is not played to have one player win. The main objective is to work together with your family and community to make it through the week without spending all of the family's money or water marbles.
- Special tokens
    - Water marbles: can be used as currency if needed, but it is mainly used to emphasize the role that water plays in the community

- Remittances: The game is only 1 week long, and so the family has a set amount of money for that week. Things may happen that causes the family to have to spend money, and a set amount of money will have to be spent at certain intervals for items such as food.

Additional Resources

- History and evolution of Berber culture - [The Berbers (Aharoni &Melman, 2012)]
  - This article is very insightful in terms of culture and religion
- A Bled Hitchhiker interview transcript
  - Gives insight into the character and the travel involved in trying to get to school
- Watch the following video to see Houssein (a 19 year old man), his passion for learning and gratefulness for water being available in his home (https://video.wpi.edu/Watch/Houssein_IdAchour)

Rubric

Assignment 1	
Points Awarded	**Degree of Completeness**
10	Student calculates their own water footprint using the link provided
10	Student was able to determine how many trips they would have to make
10	Student is able to make a plausible assumption of time it would take to collect the water

Assignment 2	
Points Awarded	**Effort and Quality of Work**
5	Student was able to talk about their stance in class and defend their point of view
5	Argument is well made and the stance is defended well
5	Citations are from reputable sources
5	Minimum of 500 word argument was submitted
5	Student identified a specific topographical aspect related to fog water collection

Assignment 3	
Points Awarded	**Key Identifiers Needed**
20	Student is able to determine that because the pipe is fully accessible the best option would be the Perma-Wrap as it is able to cover the full circumference and stop large leaks that may occur in larger outside pipes.
15	Student is able to determine that because the pipe is small and not fully accessible the best option would be the EP-400 Epoxy Stick as it is malleable and able to plug small leaks that are hard to reach.
10	Student is able to identify that Durcuppan epoxy is not well suited for the purpose of patching up water pipes as it water soluble.

B.2 Ibtissam

Age: 12
Gender: Female
Residence: Aït Baâmrane region of southwest Morocco
Job or Main Task: Develop an in-depth understanding of the importance of Argan to Berber and Moroccan culture, society, and women

Background

Biography:
You are a young 12-year old Berber girl named Ibtissam who lives in the Aït Baâmrane region of Southwest Morocco. You perform activities based on your life situations preceding and following the installation of fog nets by the local foundation Dar Si Hmad.

Before fog harvesting: Your father works as a mechanic in Agadir. He has long hours and can only come home on weekends, but even then he comes only occasionally because the trip is long and tiring; Agadir is 3 to 4 hours away from where the family lives in Aït Baâmrane, or even longer if he takes a bus to Ifni. He sends weekly remittances home, which is how the family survives. Your mother's day is filled with the task acquiring water. Not wanting her oldest child to take the trip for fear of her safety, she, not you, walks to the well with her donkey and two large, battered, plastic jugs several times each day to bring in the household's daily supply of water. You usually lives with her grandmother, mother and two younger siblings (7-year old sister and 4-year old brother), there are no adult males in the household, so you, as the oldest child, must take on the majority of housework. This even includes the chores usually taken up by the men of the household if they are present, like taking out the goats to pasture for grazing. You cook, clean, do other daily chores, and views it as your responsibility to watch over and protect your younger siblings. Your increased workload at home makes it difficult for you to keep up with school work, and so after finishing primary school last year you were forced to remain at home to fulfill your domestic duties.

After fog harvesting: Your father comes home permanently from Agadir and lives in the *bled* instead of the city. Since he has experience working with his hands, he has been made the site manager for the area's fog nets. You are often asked by women of the village to act as messenger between them and your father whenever they have technical problems with their pipes. Additionally, because there are no older boys in your family, you is able to acquire some plumbing skills from your father and therefore helps ladies throughout the village by teaching them basic pipe management and training them with simple tools. Because your mother no longer has to make trips to the well for water, she has joined an Argan co-op that has just been opened up within walking distance from their village. When she has time, you work there as well. Most importantly, and to your great excitement, your mother has suggested she continue her education by going back to secondary school, with the help of Argan money. You dreams to speak French and even

English, as well as Arabic so you can read the Qu'ran for yourself and for your illiterate grandmother and mother. The other foreign languages would be helpful for you in the long run, since you aspires to go to university. Your favorite subject is math, which you want to use to help organize the treasury of the co-ops by teaching the female workers basic arithmetic skills, so that they are run properly and fairly. You also want to help run and develop new Argan cooperatives as a strong, female entrepreneur, to help your own family and other women, and to do well in life so you can make your life, your siblings' lives, and one day, your own family's life better. Your main goal is to pursue environmental studies, so you can initiate a project for the conservation of Argan trees; Aït Bamraane is your home and you want to preserve your culture and heritage. You further hopes to go to university for these disciplines so you can develop methods (maybe a campaign advocating the preservation and conservation of the Argan tree) to achieve these goals. Your proficiency in multiple languages, your advanced math skills, and your specialization in environmental studies will all contribute to her aspirations.

Affiliations:
You live with your mother, father, grandmother, and two younger siblings. You are friendly with all the women in the village, since you help them when they have issues with their wells.

Character Possesses:
You have a strong drive to work hard and are motivated to make an impact on the world. You have a primary education.

Character Needs:
You are in need of higher education (secondary school and college).

Character Duties:
You must finish college to gain a better education, help the women learn how to manage their co-ops, and become an expert on the issue of Argan preservation and conservation.

Objectives

- Demonstrate the dynamics of the lifestyle of Berber women and girls, through a first-person account, and how it is affected by and benefits from the Argan tree.
- Describe the changes in Berber life as a result of both Argan oil production and fogwater harvesting projects, as well as their relationship with each other.
- Understand the choices and sacrifices involved in decision-making for young Berbers, especially girls.
- Quantitatively discover the direct connection your life can have with the Berbers' by investigating the relationship between your own life, Argan oil, and Argan trees, through the calculation of an "Argan footprint."
- Through performing a commodity chain analysis, develop a deeper understanding (and empathy) of the importance of the Argan tree in the life of Berber women and girls, and the role it plays in their lives.

- Raise awareness through a convincing persuasive essay, consisting of a description of the current threats on the Argan tree (large-scale commercialization, harvesting practices, etc.), the detrimental effects that it has on the Berbers and their way of life, and a proposal of possible solutions to this problem.

Assignments

Your assignment is composed of 6 different parts, each connecting back to the central topic of the Argan tree and Argan oil. You are performing them from the point of view of your assigned character. Please complete each assignment in the order in which they are written; you are following Ibtissam's life in chronological order, based on her life situations and the decisions she must make along the way (as if you were living out her life).

1. Ibtissam's whole life has changed for the better after the fogwater projects were introduced. She is ecstatic, as is her mother, who buys her a notebook as a small gift in celebration. Thus, she is able to keep a journal in which she writes her day-to-day experiences and her feelings. Based on the background story of your assigned character, write a journal entry, from her perspective, on how her life has changed since the introduction of fogwater. Consider all aspects of her life and integrate your detailed research on day-to-day life in Berber households, which may include things like: weather (see Weather Source for the nearby town of Guelmin), national, Muslim, and Berber holidays, Berber weddings or funerals, etc. Make sure to directly connect this to how the Argan tree can now play a direct role in her life. (10 points)

2. Ibtissam and her family must make a decision regarding her education. Despite her mother's suggestion and willingness to pay for her school and supplies, her father is unsure of whether or not he should allow her to continue with school. Create an extensive table consisting of the pros and cons of a young Berber girl continuing her education at the secondary school level, paying special attention to her social, familial, and cultural circumstances, to help her (and her father) make the decision of whether she will pursue an education or a life solely in the household. Then write a persuasive argument in which you speak from Ibtissam's point of view, trying to convince your father to allow you to continue with your decision (with the assumption that he wants you to do the opposite). Include the pros and cons list as reasons for your decision. (15 points)

3. Whatever your decision above, assume Ibtissam is now attending secondary school. She has decided to pursue higher education to learn basic math skills. One of her curiosities is finding out how much Argan oil the average Western consumer uses, which she completes for a school project. Think about what is involved in calculating a water footprint (without the use of software). Now extend this idea to the context of Southwestern Morocco by calculating your "Argan footprint." Assume you are working from the point of view of your character, who is now able to perform these calculation as a direct result of her education, has access to the numbers and statistics involved in the calculations, and will present her project to her class. (20 points)

    a. Assume it takes the average Western consumer 1 month to use 13 oz. OGX Renewing Moroccan Argan Oil Shampoo and 13 oz. Renewing Moroccan Argan Oil

Conditioner, and that each time you wash your hair, the equivalent of 1 tsp (~5 mL) of argan oil is used (as a rough estimate). Using math skills, and the numerical information from all your sources, calculate how much Argan oil is used by a consumer per year.

b. Now perform calculations to find out how long it takes Berber women to manually produce that oil. Also calculate how much it would cost if buy pure Argan oil in the quantity calculated in part (a).
c. Reflect on your findings. Include comments on the workdays of Berber women, their pay (how much, is it enough, etc.), and if you think this arrangement is ideal for both parties (consumers vs. workers). If you think this arrangement works, explain why. If you do not, explain why not and suggest ways in which the situation can be improved.

4. Ibtissam has now finished secondary school and is working on a paper in university pertaining to her environmental studies class. Extend the previous train of thought: based on your "Argan footprint," how does this situation directly affect the argan forest in Morocco? (20 points)

    a. Using the same resources as in the previous assignment, calculate some (approximate) figures to give an idea of how much oil each tree could produce, how much the forest could produce in a year, etc. Include data from before and after the 1999 boom to get a better idea of the large-scale decrease of Argan trees and compare the data sets.
    b. Based on your results, do you think that Argan oil consumption should be lowered? Further discuss your results. What other factors, besides increased global consumption, are threatening the Argan forest? Write your findings from the same perspective as above, as if part of a debate on whether Argan consumption should be mediated or not. (Do not worry about possible solutions; that will be another assignment).

5. Ibtissam has graduated from university and got her first job as a weekly columnist in an environmental magazine. Investigate the intricate connection between climate change, drought, desertification, and the actual Argan tree. Why do you think the Argan tree is indigenous to Morocco? How has each of these factors contributed to the crisis regarding the Argan tree and the reduction of Argan yield? Write a short research paper (2-3 pages), as if for publication in the magazine, on your findings. (15 points)

6. Ibtissam has moved on and is now working on her dream project: the project/campaign for Argan conservation. Write a persuasive essay/speech about what you think should be done with the argan tree, to be presented at the Moroccan Department of Agriculture, based on what you have learned about its threatened sustainability. You are trying to convince them of your opinion and also to receive funding for your project. Additionally, suggest possible solutions and explain how they will work toward conservation (examples: have Moroccan government mediate *and* enforce harvesting limits, ensure that a percentage of money made from selling Argan oil is returned to the producers, etc). You may use some of these examples but you must elaborate on them and come up with some suggestions of your

own. Make sure to consider all factors (cultural, local, global, etc.) and support your opinion with credible and legitimate resources. (20 points)

Additional Resources

- *Moroccan Households in the World Economy* by David Carpenter
- *A Foggy Desert: Equitable Information Flow For a Fogwater System in Southwest Morocco* by Leslie Dodson
- *Does Resource Commercialization Induce Local Conservation? A Cautionary Tale from Southwest Morocco* by Travis Lybbert
- *Rural Poor Communities and High Value Crops in Morocco* by Daria Kaboli and Zhen Liu
- *Hey, my Berber friend, draw me a rural forest!* by Didier Genin and Romain Simenel
- *An Ethnobotanical Study of Medicinal Plants of the Agadir Ida Ou Tanane Province (Southwest Morocco)* by H. Ouhaddou
- *The Use of Participatory Methodologies to Increase Women Farmers' Access to Productive Resourses* by Patricia Biermayr-Jenzano
- *Global Commodity Chains: Genealogy and Review* by Jennifer Bair
- *Argan Oil* by Zoubida Charrouf and Dom Guillaume
- *Helping Moroccan Women Preserve the Argan Tree at the Gateway to the Sahara* by Zoubaida Charrouf and Serge Dubé
- *Household and Local Forest Impacts of Morocco's Argan Oil Bonanza* by Travis Lybbert
- Videos (Youtube):
    a. "How Argan Oil is Made in Morocco"
    b. "Seed of Life (Morocco)"

Rubric

The following is a preliminary rubric for the grading of the activities above. Please note that they are subject to change, at the instructor's discretion and based on availability of resources.

Part 1	
Points Awarded	**Degree of Completeness**
10	Writes a clear, thought-provoking journal entry that demonstrates vast understanding of the situation, and adeptly integrates all relevant research
8	Writes a good quality journal entry that demonstrates moderate understanding of the situation, with some relevant research
6	Writes a journal entry which demonstrates little understanding and lacks supporting relevant research
4	Writes a poor journal entry, which demonstrates very little understanding of the situation and does not contain any relevant research
0	Fails to write a journal entry, completed no work

Part 2	
Points Awarded	**Degree of Completeness**
15	Develops a table with at least 5 pros and cons each, and writes a thorough, convincing persuasive essay with supporting details
12	Develops a table with at least 5 pros and cons each, and writes a persuasive essay
9	Develops a table with less than 5 pros and cons each, and writes a persuasive essay
6	Develops a table with less than 5 pros and cons each, and writes a poor persuasive essay
0	Fails to create a table for pros and cons and/or write a persuasive essay

Part 3	
Points Awarded	**Degree of Completeness**
20	Successfully performs all calculations regarding the Argan oil footprint, and thoughtfully reflects on their findings
15	Performs Argan oil footprint calculations with some errors, and/or adequately writes a reflection on their findings
10	Argan oil footprint calculations are incomplete, and/or reflection on their findings lacks enough detail
5	Argan oil footprint calculations are incomplete, and/or writes a poor reflection on their findings
0	Fails to caculate the Argan oil footprint, and/or write a reflection

Part 4	
Points Awarded	**Degree of Completeness**
20	Successfully performs relevant calculations, thoughtfully answers all questions, and develops a convincing debate argument
15	Performs all relevent calculations with some errors, minimally answers all questions, and/or adequately writes a debate argument
10	Relevant calculations are incomplete, not all questions are answered, and/or debate argument lacks supporting details
5	Same as above, but overall demonstrates poor quality and understanding
0	Fails to perform any or all of the assignments

Part 5	
Points Awarded	**Degree of Completeness**
15	Successfully and professionally writes a research paper fit for publication, with thoughtfulness and abundant detail
12	Writes a presentable research paper which demonstrates some thoughtfulness and moderate detail
9	Writes a presentable research paper, but which lacks thoughtfulness and sufficient detail
6	Writes a research paper of overall poor quality
0	Fails to write a research paper

Part 6	
Points Awarded	**Degree of Completeness**
20	Successfully develops a convincing persuasive argument which includes abundant supporting evidence and suggests viable possible solutions
15	Writes a convincing persuasive argument, with adequate supporting evidence and some possible solutions
10	Writes a persuasive argument, but which lacks sufficient supporting evidence and/or possible solutions suggestions
5	Writes a persuasive argument of overall poor quality
0	Fails to write a persuasive argument

Original character created (A term, 2015, Developing a Teaching Game) by: Shaimae Elhajjajy

B.3 Ijja

Age: ~ 60's (elderly)
Gender: Female
Residence: Alma (village in southwest Morocco)
Job or Main Task: Understand the huge impact that Dar Si Hmad's fog harvesting project has had on local Berber people

Background

Biography:

You are an elderly widowed woman who lives with her son and his family (wife and 16 year old daughter) in the small village called Alma in southwest Morocco. Your husband died 5 years ago from pneumonia because he couldn't get proper treatment. You now live quiet happily with your son and his family. Your son works in a city nearby and he is the only source of income for the family. Since the income isn't too much and there are five members in the family, everyone lives on a strained budget, and your son can't afford to send his daughter to school. You really wish for her to get an education. You're job around the house is to delegate your daughter-in-law and take care of household chores the best you can. You are illiterate because when you were younger, girls helped out at home by getting water from the wells, and helping your mother around the house. They did not go to school to get an education. Your parents were also not financially stable enough to give you an education but because of that you made sure your son got an education and you really want your granddaughter to go to school too.

Character's Needs:

The Fog Nets have just been installed. You are so grateful for them because now your daughter-in-law and granddaughter don't have to travel for miles every day to fetch water; it comes straight to your house. Your biggest need, now that your family has a supply of water, is to find another source of income for your family so you can send your granddaughter to school because you really want her to get a proper education.

Responsibilities:

- Duties
    - Cooking, cleaning up the house, making sure your granddaughter or daughter-in-law fetch water from the well, and making sure your son is well taken care of when he is at home. Because of your age, you are not able to travel for miles to fetch water so your daughter-in-law takes care of that and you take on chores at home.
- Power/Relationships
    - Your relationship with your family is very good. You like spending time with your granddaughter and telling her stories about your childhood and how much times

have changed. Your son is the head of the family as he is the one who is bringing in the money but after him, you have the most power when it comes to making decisions and everyone in your family respects you immensely and your opinions are valued. Depending on the situation, you might actually have the most power because your son respects you and never disobeys your wishes.

Objectives

Objectives for the student:

- The learning outcome of the first activity is to make sure you understand the importance of the fog water nets and how they affect the people in the Berber community. In order to do the other activities, it is important for you to really understand your characters' lives.
- The learning outcome of the second activity is try to maximize your family's income now that you have free running water in your house and save time on travelling for mile to fetch the water. For this activity it is important to do some research about the Argan Cooperative in Morocco.
- The learning outcome of the third activity is to think about the daily lives of your character and come up with ideas as to how they can use money to better their standard of living.

Objectives for the character:

- To understand the importance of fog water nets and how it affects your daily life.
- To figure out a way to utilize the time you save now that no one has to get fetch water from the wells in a way so that you can increase your family's income.
- To learn some basic financial tips so that you can manage your family's money better and send your granddaughter to school to get an education.

Assignments

1. Write a series of blog posts (one every day for a week) as your character. Talk about what your daily life was before the fog water nets, and how the fog water nets have changed your, as well as your family's, routine. Talk about what aspects of your life the fog water nets have affected the most and think about if there are any downsides to that. In order to get a better understanding of the people in your community and how the fog water nets have affected other, read the Dar Si Hmad Interview Transcripts, the Water Surveys, and Leslie's dissertation provided to you (all of which are listed below under Additional Resources). Get an understanding of the community through these transcripts and incorporate those in your blog posts. (40 points)

2. Brainstorm three ideas about how you can utilize the time your family saves now that they don't have to fetch water. For example, you or your daughter-in-law could get involved with a co-op in your village. Do not simply list your ideas; provide reasoning behind the ideas and explain why you think it would help increase the family's income. Do some

research about the Argan Oil Cooperatives in Moroccan villages and use those sources when you present your ideas. (30 points)

3. Now that your family has more time, thanks to the fog water nets, and more money, thanks to the ideas your just came up with, you need to figure out a way to teach your family basic financial strategies to be smart about the money you have, so you can send your granddaughter to school. There is a woman in your village that is very well educated. Her husband works at a bank in France and sends money back to her. She is a mathematics teacher at the school in your village. You are going to ask her to teach you how to be smart about your money. Create a spreadsheet or budget form of all your expenses so that you can show her. This activity requires you to really get into your character and think about all the things her family might spend money on. What other things can they invest in with this extra money to make their daily lives more comfortable? Write no more than one page about these expenses and what other things they should invest in (for example they can buy farmland, or cattle). Be sure to explain your reasoning. (40 points)

Additional Resources

- Dodson, L. (2014). *A Foggy Desert: Equitable Information Flow for a Fogwater System in Southwest Morocco* (Doctoral dissertation). Retrieved from Worcester Polytechnic Institute**.**
- Dar Si Hmad Interview Transcripts
- Dar Si Hmad Water Surveys

Rubric

Assignment 1	
Points Awarded	**Degree of Completeness**
40	Successfully and thoughtfully writes 7 blog posts that address all topics listed, each demonstrating understanding, thoroughness, and sufficient research
30	Successfully and thoughtfully writes 7 blog posts that address only some of the topics listed, with a moderate degree of understanding, thoroughness, and research
20	Writes less than 7 blog posts, and/or lacks demonstration of detail, understanding, and research
10	Writes less than 7 blog posts, and/or demonstrates an overall poor quality of work
0	Fails to write any blog posts

Assignment 2	
Points Awarded	**Degree of Completeness**
30	Successfully brainstorms three ideas with a thorough explanation and reasoning, and thoughtful integration of research
20	Brainstorms three ideas, which lack explanation, reasoning, and/or supporting evidence from research
10	Brainstorms less than three ideas and/or demonstrates an overall poor quality of work
0	Fails to complete any activities

Assignment 3	
Points Awarded	**Degree of Completeness**
40	Successfully creates a thorough spreadsheet that demonstrates understanding of the subject, and writes a thoughtful reflection
30	Successfully creates a spreadsheet but may have some missing elements; Writes a moderate reflection
20	Creates a spreadsheet with many missing elements; Writes an adequate reflection
10	Demonstrates an overall poor quality of work, and/or is missing one of the two activities (spreadsheet or reflection)
0	Fails to complete any activities

Original character created (A term, 2015, Developing a Teaching Game) by: Meghana Prakash

B.4 Salma

Age: Female
Gender: 21 years old
Residence: Timtda, Morocco
Job or Main Tasks: Dar Si Hmad's representative

Background

Biography

You are a young woman living with your family in Timtda in the Moroccan bled. Currently, you are the main water provider of your family, however you were able to go to school until you were ten. One day, after drinking contaminated well water you became sick with typhoid and were bed-ridden for a month. Consequently, your parents had to begin paying for water from the nearby villagers which meant that they could no longer afford to put your younger sister through school. You no longer trust any of the wells in the surrounding villages and wish there was a way for the village to have a cleaner and more reliable water source. Currently, an organization called Dar Si Hmad is considering a project with fog nets near Boutmezguida, however the village is doubtful and Dar Si Hmad workers need help evaluating and implementing the idea. You see the fog nets as an opportunity to improve the health of the village and for women to reduce their water carrying work-load, however many of the village women will have to change their ways to make the system work.

Affiliation

Your best friend's name is Tasa.

Character Possesses

You own a mobile phone which you use to communicate with your parents, your friends, and Dar Si Hmad. You can speak and read some English as you went to school until you were ten. You possess a basic numeracy. You are familiar with Berber language and culture.

Character Needs

You need to make money to pay back your parents, but you are unsure of how to get it. You don't feel comfortable cooking or taking care of children as you were just sick with typhoid. You need to convince the women that their role as water providers can be changed, however you do not possess much influence and cannot speak directly with many young men in the village as an older woman without a husband.

Character Duties

You have volunteered to work with Dar Si Hmad to raise awareness and educate the women in the village about the fog nets. You must hold a workshop to teach the women about fixing basic problems with the fixtures. You will be providing Dar Si Hmad with an evaluation of the fog nets and you must keep in communication with Dar Si Hmad via text while convincing villagers of the need for the fog nets. You will continue to be responsible for the water collection for your family or you must find a way to make extra money.

Objectives

- Convince the women to become the new caretakers of the fog net water system. You will be successful if one woman texts Dar Si Hmad about a problem with their taps or pipes.
- Pay your parents back for the water they had to buy in order to put your sister back in school. You will be successful if you collect 50 Dirhams.

Assignments

Assignment 1: Mobile-Phone: Surveying Community Members

Notes: individual, homework assignment

As Dar Si Hmad moves into the planning phase for the fog nets, they need you to analyze the efficacy, the need, and the current opinion on the fog nets. You will be tasked to interview and inform your fellow villagers about the fog nets and then convince the women to become the caretakers of the new system.

The student will be provided with a cheap cell phone. The teacher will play the Dar Si Hmad representative and text questions about the fog harvesting evaluation to the character. The character will then survey the relevant characters of their water use and perform the relevant calculations and use limited texts to provide the answers. If you are successful you might be rewarded with phone credits (which can be sold).

Assignment 2: Evaluating the amount of fog water harvested

- Perform an evaluation on how much fog can be harvested from Boutmezguida and whether or not it would be a viable water source for the entire village for annual use. You will then calculate the volume of fog necessary to sustain the village's water demands for a year using current data and sources. Your goal is to determine the efficacy of the fog nets and convince Dar Si Hmad that the site will work.
- Learning objectives include: Predict weather trends from historical data, extrapolate personal water use and calculate communal water use, understand the process of fog formation, understand the principles of mass transfer behind fog harvesting, determine the yield of water from a specific volume of fog, make accurate simplifying assumptions, and calculate the volume of fog necessary to sustain the village for a year.
- This activity will encourage students to examine the numbers and scientific principles behind water scarcity and the availability of untapped surrounding resources. The students will have to determine if a water source is viable for large-scale and long-term use and justify the implementation of a fog harvesting project.
- References: The Dar Si Hmad Fog Net Proposal: http://homepage.agrl.ethz.ch/~eugsterw/publications/fog/06-Marzol-097-119.pdf
- FogQuest Manual

Assignment 3: Impact interviews

Notes: individual, homework assignment

The Dar Si Hmad representative has decided to come see the impact the fog nets has had on life in Timtda. However, they are unfamiliar with Berber culture and language. Help them understand the impact by helping them interview some of the local residents.

- You will read and listen to interviews from the Dar Si Hmad achieve to understand the impact of a readily available water source on those who live in water scarce areas. Then you will create your own set of interview questions and then interview various other residents of the village about the impact of the fog nets on their lives.
- Learning objectives include: practice and perform public speaking, understand the stories of those living in water scarcity, recognize the impact of water on people living in water scarce areas, write a piece from an alternate perspective, and identify the difference between Berber language and Arabic.
- This activity will contribute to the group project on water scarcity as it will allow students to connect with the villagers living in water scarcity and students will be able to comprehend the meaning of living in water scarcity.

Assignment 4: Water Caretaker Lesson Plan

Notes: individual, homework assignment

- You will create a lesson plan for the village women on how to care for the new water system. Pull from any resources available to you in the village or by Dar Si Hmad. Your objective is to convince the women to become the caretakers of the system otherwise the fog nets will not be around for much longer!
- Learning objectives include: creating and implementing learning objectives, determining the cultural implications of new technology, and interacting with practicing presentation and public speaking.
- This activity will contribute to main objective of the character as they will have to communicate with the women how to take care of the fixtures. Additionally, the character will have to retrieve information from various resources by interacting with multiple other characters.

Additional Resources

- Dar Si Hmad, interviews
- Dar Si Hmad Website: http://www.darsihmad.org/fog-harvesting/
- Transcripts of the Dar Si Hmad Water and Sanitation Survey
- Hidden, Fog Water Dissertation, pg 45 Integrated Water Resource Management

Rubric

Assignment1	
Points Awarded	**Degree of Completeness**
10	Successfully answered all the questions without exceeding the limit of texting
8	Successfully answered all the questions with a small amount of exceeded texts
6	Answered some of the questions
4	Answered a few questions
0	Failed to answer any question

Assignment 2	
Points Awarded	**Degree of Completeness**
10	Successfully evaluated the amount of fog water harvested and answered all the questions with detail
8	Evaluated the amount of fog water harvested and answered all the questions without detail
6	Evaluated the amount of fog water harvested and answered some of the questions without detail
4	Answered a few questions
0	Failed to answer any question

Assignment 3	
Points Awarded	**Degree of Completeness**
10	Successfully created interview questions with thoughtfulness and detail and had them answered
8	Created some interview questions, lacking thought and/or detail, but had them answered
6	Created only a few interview questions and lacks thought and/or detail, and had a few of them answered
4	Created a very few interview questions and did not have them answered
0	Failed to create an interview question

Assignment 4	
Points Awarded	**Degree of Completeness**
10	Successfully created a lesson plan and gave a thoughtful, thorough presentation
8	Created a lesson plan and gave a presentation, albeit lacking detail and thoroughness
6	Created an inefficient lesson plan and gave poor presentation
4	Created an inefficient lesson without giving a presentation
0	Failed to create a lesson plan

Original character created (A term, 2015, Humanitarian Engineering: Past and Present) by: Olson

B.5 Akbal Sheetrit

Gender: male
Residence: Paris, France
Jobs or Main Tasks:

Background

Biography

You are the father figure of a four-person household. You and your wife have a 17-year-old son and a seven-year-old daughter. You want nothing more than for both of your children to finish their education. While you are proud of the small three-room house you maintain for yourself and your family, you want your children to reach another level of fulfillment so their education is a priority to you. You have always thought that if you were able to finish your education you would be able to find better work than what you are currently doing. You want your children to be able to read and write, and know basic mathematics. More importantly you want them to have choices about what they want to do with their life. You don't necessarily want them to leave home, but if they feel there are better opportunities in the city, or in another country, you will support them.

Several months ago, you made the difficult decision to travel to Paris, France to find work. You are currently working cleaning dishes at a restaurant. You live in a small apartment above the restaurant with many other immigrant workers, many of whom do not speak a common language with you. You know enough French from school and growing up to get you through the day, and because French is the only common language amongst you and the people around you, it is constantly improving. You are usually able to find food leftover at the restaurant so your expenses are limited to the rent for your living quarters. From this job, you are able to send back a consistent amount of money each month, but a new resident in your apartment, Birsa, is claiming that he knows of better work at dairy farms outside the city, but his wife is sick and he needs to stay in the city to get care for her. At the start of the game, you will have to decide if you are going to take the chance and see what this Dairy farm work is all about, or if you should stay with your consistently paying job. Keep in mind your strong desire to send your kids to school and the amount of money you will be sending back to your family. Will this be enough?

When you hear about the fog water system that Dar Si Hmad may be implementing in your village, you don't quite believe it. Water has always been such a struggle for yourself and your family that having water piped into your home seems impossible. As the system is being installed, you decide its time you make a visit back home to see your family and this magical water source.

Affiliations

- Your family:

    - Wife: Ghita
    - Son: Akif
    - Daughter: Yasmine
- Roommate: Birsa

Character Duties

- Provide for your family.
- Help with the fog water installation
- Help maintain the new water system in your village

Objectives

- Provide for your family as successfully as possible.
- Send your children through the education system

Assignments

This activity has been divided into four lessons – read the game instructions for specifics. Your personal activities are included below as well as in the game instruction.

Assignment 1: Investigating and observing the fogwater project
Notes: individual, homework assignment

The family hears about the fog water system and doesn't quite believe it exists. Their lives revolve so much around water that water being piped into their homes seems impossible, despite having electricity and cable available in many of these villages. Two tasks for this assignment:

1. As Akbal: Investigate this rumor and teach your family about its viability, and a general overview of how it would work, from the nets to your home. Provide an example of where it has already been successfully done. (Write a short summary of this)
2. As Student: Water plays an important role in the Berber communities. Research how the Berber's view water and how this differs from other cultures. In addition to the Berber's water relationship, explore another culture who has an interesting view on water and develop a compare / contrast table, or Venn diagram to illustrate the similarities and differences. Some potential cultures are Christianity, Native Americans, Hinduism and other cultures or religions.

Assignment 2: Prototype of the fog net
Notes: individual, homework assignment

During this lesson you will be building a prototype fog net with your family. See the game instructions for specifics.

Assignment 3: Learning about physics behind the pumping system
Notes: individual, homework assignment

You are back home and have decided to help Dar Si Hmad install the fog water system. You are assigned to the plumbing team, the ultimate goal of which is to get the water from high on the mountains where the fog water nets are, to the homes of your village. The objective of this activity is for you to learn about how water pressure varies with height. During the design of a plumbing system, it is important to place the water source at a location high enough that there is adequate pressure to get the water to its destination, but not so much pressure that it will burst pipes or cause leaks.

1. To visualize the effect of height on pressure, take a milk carton (or similar container) and cut three holes vertically on the side. Make sure they are spaced out significantly. Cover the holes with a single piece of tape and fill the container with water. Once the container is full, remove the tape and observe the difference in flow of each hole. Provide an explanation for this result.
2. The fog water nets collect water and it is then piped to a permanent well, or storage area, where it is stored until it is needed. Given that a typical faucet pressure is 400,000 Pa and the density of water is 1000 kg/m^3, determine a reasonable height for this well. Use the approximation that:

   $P = \rho g h$

Where:

P = Pressure (Pa)
ρ = Density (kg/m^3)
g = 9.81 = acceleration due to gravity
(m/s^2) h = height (m)

Assignment 4: Determining the water consumption
Notes: individual, homework assignment

Now that the nets have been installed, people have been trained to maintain the system. You are recruited by the water manager due to your help setting up the system.

Currently there is about 2.5 square meters of fog net per person. Given that table of daily fog water production below, and an average consumption of 15 liters per person per day, determine if this is enough to support the village for an entire year. Assume the nets are installed in April and there is infinite water storage available.

Bonus: What is the minimum area per person of fog ne

Table 1: Average Daily Fog Water Production in Boutzmeguida by month

	Water Producced (Liters/ m^2/day)
April	20.3
May	9.9
June	17.2
July	0
August	3.7
September	6.1
October	3
November	4.3
December	4.2
January	3.4
February	9.1
March	3.7

Hint: Pretend there is a population of 1 and develop an excel spreadsheet that tracks the amount of water available. A potential way to do this would look like the table shown below:

	Water Produced (Liters/ m^2/day)	Monthly Production (Liters/ m^2	Monthly Production (Liters)	Monthly Demand (Liters)	Volume in tank (Liters)
April	20.3				
May	9.9				
June	17.2				
July	0				
August	3.7				
September	6.1				
October	3				
November	4.3				
December	4.2				
January	3.4				
February	9.1				
March	3.7				
Square meters per person:					

Additional Resources

Why do migrants remit? Testing hypotheses for the case of Morocco, Jamal Bouoiyour and Amal Miftah (Pages 1-6)

Solyman Bobri Interview

Rubric

Assignment 1	
Points Awarded	**Degree of Completeness**
10	Successfully answered all questions with a thoughtful, thorough paragraph
8	Answered all questions, but lacking detail and thoroughness
6	Answered only some of the questions with a large amount of missing information
4	Answered very few of the questions
0	Failed to answer any of the questions

Assignment 2	
Points Awarded	**Degree of Completeness**
10	Successfully built a prototype fog net with thoughtfulness and detail
8	Built a prototype for net, but lacking in detail
6	Built a prototype fog net with poor design
4	Minimal effort was put. Poor prototype was built
0	Failed to build a prototype

Assignment 3	
Points Awarded	**Degree of Completeness**
10	Successfully determined the height of the well with clear, right thinking
8	Determined the height of the well with unclear thinking
6	Failed to get the right answer but followed the given instructions
4	Failed to get the right answer and did not follow the given instructions
0	Failed to determine the height. No effort was put

Assignment 4	
Points Awarded	**Degree of Completeness**
10	Successfully filled out the table with the bonus question answered
8	Successfully filled out the table
6	Filled out the table with more than 4 missing answers
4	Filled out the table with more than 8 missing answers
0	Failed to fill out the table

Original character created (A term, 2016, Humanitarian Engineering: Past and Present) by: Varney

B.6 Menna Demsiri

Age: 30's
Gender: Female
Job or Main Tasks: Understanding of Berber women's lives

Background

Biography

You are a mother of two children: a 10 year-old boy, and an 8 year old girl. Your husband works on a farm in Spain as a migrant worker, so he is not home the majority of the time. He tries to visit once a month. He counts on you to complete household chores and care for your children while he works. He is ecstatic that you have water piped to your home now because the walk to and from the well could be dangerous for you and life in general is less stressful without water to think about. He hesitantly approves of you pursuing a new opportunity, such as an education or paid labor, so long as it does not interfere with your chores and duties.

Before life changed with the fog water, you spent your days walking to and from the well multiple times per day. Since the fog water project was completed, you now have running water in your home and no longer spend hours fetching water. You're daily chores include sending your children off to school, cooking, cleaning, washing laundry, gathering materials for fuel, watering and feeding the livestock, and harvesting crops, among other things.

You feel *baraka*, a blessing in this new fog water piped directly into your home. Now you do not have to worry about rationing water or yelling at your children for wasting it. After the pipe system is installed, you have spare time during the day since you do not have to spend hours gathering water. Since the fog water has been piped to your home, you have struggled with how to spend your free time. You have been spending it doing your regular chores more frequently, but have found it is unnecessary, so you would like to fill that time doing something more fulfilling. You are interested in earning money of your own. You want to do something that will give you the opportunity to socialize with others besides your husband and children, because you used to see your neighbors when you left the house to collect water, but now that you do not have that job, you do not leave the house as much or have as many opportunities to be social.

Affiliations
You live with your children a boy, 10, and a girl, 8 in the bled. Your husband, who works in Germany, usually comes to visit you and his children once a month.

Character Possesses

- No education- you are illiterate.
- You have water in your home.
- You know how to pick the Argan nuts and produce Argan oil.
- You have home maintenance skills and child care skills.
- You are very eager to learn new skills and are not afraid of hard work.

- You are physically strong from harvesting crops and from when you had to fetch water.
- You would be willing to trade off days watching children with another mother who works for pay so you could have childcare available while you are away.

Character Needs

- Money for children's education.
- Someone to care for your children if your working hours do not allow you to be home when they are not in school.
- Transportation to paying job if it is outside the village.

Objectives

The goal of this assignment is to get a better understanding of Berber women's lives, and also to explore the difficulty of learning new things.

Assignments

Assignment 1: Understanding Berber women's lives

Notes: individual, homework assignment

To get to know your character and understand what life is like for Berber women, write journal entries as your character for one week. Through five journal entries, try to answer the following questions: What is her schedule like every day? How has the introduction of the water pipes in her home affected her life? Positive/Negatives of water pipes in the home? What is her family like? What is her relationship with her husband like? How does he feel he should spend her newly acquired free time? How does she want to spend her free time? Is she interested in learning and doing new things with her spare time? What opportunities is she interested in pursuing (education, Argan coops, etc.)? Pros/Cons of her choices? How will it affect her family? Interact with other players during the week and include these exchanges in your entries. For reference and inspiration, read the character background, the Dar Si Hmad Water Use Surveys, and A Foggy Desert (Dodson's Dissertation).

Assignment 2: Learning to use a mobile phone
Notes: group of 2, homework assignment, in-class presentation

Your husband will let you get a mobile phone so you can communicate via text while he is away if you learn to read and write. Find another player whose character is literate and willing to devote 3 hours per week to teach you these skills. Remember, you are not allowed to interact with an unrelated man, but you can with a child of either sex or another woman in the village. How can you convince them to help you? What do you have to offer in return for their services? Write one page (maximum) that you will present to the other character in front of the class.

Assignment 3:
Notes: individual, homework assignment, in-class presentation

You have been given the opportunity to be paid a wage to make jewelry that will be sold in the market in Guelmim. Your character needs to learn how to make the jewelry. Research Berber jewelry and create a 2-3 minute presentation on Berber jewelry- it's history, it's cultural significance, how it's made, what it's made of, etc.- to be presented to the class. Bonus points given if you attempt to make your own jewelry!

Additional Resources

- Sadiqi & Ennaji, eds., Women in the Middle East & North Africa: Agents of Change (2011)
- David Carpenter, Moroccan Households in the World Economy
- A Foggy Desert (Dodson, 2014)

Rubric

Assignment 1	
Points Awarded	**Degree of Completeness**
10	Successfully and thoroughly answered each of the questions asked. Thoughtfully explained opinion
8	Answered each of the questions asked, or has some missing information. Lacks thoroughness
6	Answered some of the questions asked
4	Answered very few of the questions asked
0	Failed to answer any of the questions asked

Assignment 2	
Points Awarded	**Degree of Completeness**
10	Successfully and thoroughly answered each of the questions asked. Thoughtfully explained opinion
8	Answered each of the questions asked, or has some missing information. Lacks thoroughness
6	Answered some of the questions asked
4	Answered very few of the questions asked
0	Failed to answer any of the questions asked

Assignment 3	
Points Awarded	**Degree of Completeness**
10	Successfully answered all questions and gave a thoughtful, thorough presentation
8	Answered all questions and gave a presentation, albeit lacking detail and thoroughness
6	Answered only some of the questions and gave poor presentation
4	Answered very few of the questions and gave a poor presentation
0	Failed to answer any of the questions or give a presentation

Original character created (A term, 2016, Humanitarian Engineering: Past and Present) by: Gina Rios

B.7 Ghita Sheetrit

Age: 40
Gender: Female
Job or Main Tasks: Mother of two children

Background

Biography
You are a 40 year-old mother of a Berber family living in a three room adobe brick house in the village of Timtda in Morocco. Your husband works in Paris, France as a waiter for most months of the year to send remittances back to your family. You have a cellphone to speak with your husband, but the minutes are expensive so you only want to use it in emergency situations or when he calls you. Texting would be cheaper except you are unable to communicate in that way. You have two children; a 17 year old son and a seven year old daughter. It is your job as the mother of the family, to walk to the nearest well to get water for your family. You want your children to stay in school so you would rather do this work yourself. Your family owns a donkey, but it still takes you 2 hours to get to the well and back while riding on the donkey. You do all this while it is usually 100-degrees Fahrenheit. Sometimes the amount of water that you are able to bring back to your house is not sufficient, so then you must make the trip 2 to 3 times total in one day.

Your role is very important to the family as well as relating to the water project because the fog water installation directly relates to your everyday life. Removing your trips to the well leaves a lot of free time for you as well as provides more water for your family. You have very minimal education, you went to school for 3 years in primary school and then you had to stop because you had to help your mother with the chores around the house. You are mostly illiterate, you know a few letters from the Arabic alphabet but from your years of not practicing you are unable to read or write. You also do not know your numbers. You want your children to grow up with a better life and more opportunities than the ones you had, so you strongly push them to get an education. You are intrigued by the fog water installation, and think it is a vast improvement for your village. After the water installation occurs you also want to receive more of an education yourself, you want to be able to read and write in English because it is the language used on your cellphone. You know and speak with the other women in the village of Timtda. You are also affiliated with the teacher because your daughter goes to her school that is a mile down the road.

Character Possesses

- You want your children to stay in school so you would rather do this work yourself.
- Your family owes a donkey which makes your trips to fetch water easier but it still takes time

Character Needs

- You would like to be literate and somewhat educated along with your children.

Character Duties

- Your duties are to keep the household clean, doing things such as cleaning dishes and rugs etc., feed your children and your donkey, and take care of your family in general, doing things such as purchasing medicine for a sick child and/or donkey.

Objectives

- Learning to read and write in English
- Using critical thinking to make difficult decisions when it comes to their water use
- Identifying these decisions as decisions that the Berber people must face every day.
- Recognizing that the fog water systems will have a major impact on the daily lives of the Berber people and predicting some of these changes.
- Research and Identify the texting symbols that these Berber women must use to communicate with the water managers.

Assignments

Assignment 1: Roll of the Dice: Rationing Water

After the dice have been rolled, and the certain amount of water has been collected. The mother character role will do an activity where they must create and fill out a spreadsheet to distribute the amount of water that the family has in that particular day. The spreadsheet will cover their basic needs as well as extras. An example spreadsheet is included, it is called "Mother's water use activity 1 table" the students may refer to this one, but they must come up with more categories of activities that would require water for this family.

Assignment 2: How Fog Changes Life

The mother character role will research the fog water projects and write a short essay about the possible changes in the family's lives that the fog water installation would bring.

Assignment 3: Testing Codes: Creating a Symbol Chart

The mother character role will research the communication between the women and the men fixing the fog water pipes. They will learn all about the texting codes, and will then create a chart clearly showing the symbols and their meanings in relation to the communications between the women and the men fixing the pipes. A picture of some of the symbols and their meanings is included that they may use to start.

Additional Resources

RESPONSIBILITIES:

Duties: Your duties are to keep the household clean, doing things such as cleaning dishes and rugs etc., feed your children and your donkey, and take care of your family in general, doing things such as purchasing medicine for a sick child and/or donkey.
Powers: You are the head of the household when your husband is away. You are in charge of making all the decisions when it comes to the use of water and money. However when he comes back, you must consult him for all decisions. If there is a decision that you must make while your husband is away, yet you are hesitant to make it yourself you may call him on the cellphone.
Assignments: Your assignments are to daily get water for your family until the fog water installation is completed, and decide how to use that water around the house, whether it means using it for cleaning, drinking, or watering a garden. You must roll dice each day until the fog water installation occurs to obtain the amount of water you are able to get.

RELATIONSHIPS:
With the Big Ideas: You would like to be literate and somewhat educated along with your children.
With Other People: You have a 7-year old daughter named Yasmine, a 17 year old son named Akif and a husband named Akbal.

STRATEGY ADVICE:
Your general goal is to keep your daughter in . However, certain things might occur in which you might have to use one of your children to fetch more water, in that case that child would not be attending school that day. The cost of sending your daughter to school is the same as the transportation cost to get your son to his school. So when finances are tight you might have to choose which child will go to school, just keep in mind your general goal.

SELECTED SOURCES:
A Foggy Desert: Equitable Information Flow for a Fogwater System in Southwest Morocco by Leslie Lynn Dodson
Moroccan Households in the World Economy by David Carpenter
Dar Si Hmad water use surveys
SPECIAL TOKENS: Blue marbles are used to represent amounts of water, monopoly money is used to represent their money in dirhams and the dice are used to represent the chance occurrences that may occur in their everyday lives.

ROLE-SPECIFIC READINGS:
The interview transcripts of:
Hakimi Zaineb from Agni Zikri
A Bled Water Walk interview transcript
Zahra & Mbarka from Id Soussan
L'Mouden from Timtda
Aisha house tour interview transcript
Aisha's mother, Rkia from Agni Hiya
Satour Kadija, widow of Id Soussan
Zaina's water walk interview transcript

Rubric:

Assignment 1	
Points Awarded	**Degree of Completeness**
0	Student does not complete or hand in the finished spreadsheet
3	The spreadsheet is completed but not entirely realistic
5	The spreadsheet is completed well, relating to their realistic lives, showing the student had shown effort

Assignment 2	
Points Awarded	**Degree of Completeness**
0	Student does not complete or hand in the finished spreadsheet
3	The spreadsheet is completed but not entirely realistic
5	The spreadsheet is completed well, relating to their realistic lives, showing the student had shown effort

Assignment 3	
Points Awarded	**Degree of Completeness**
0	Student does not complete or hand in the finished spreadsheet
3	The spreadsheet is completed but not entirely realistic
5	The spreadsheet is completed well, relating to their realistic lives, showing the student had shown effort

B.8 Tasa

Age: 18 years old
Gender: Female
Job or Main Tasks: Take care of your younger siblings and help around the house

Background

Biography

You are playing the role of a young woman who dropped out of school to help her father and disabled mother raise her three younger siblings as well as care for her sick grandparents. Your father went to school and is now a skilled engineer working for Dar Si Hmad. Your father must work full time as the water manager because your mother is not able to. She previously would collect well water every day for her own family as well as for your grandparents. After her injury, she could no longer collect water so you would instead. Since the fog water nets have been put in place, you still need to help your father and mother raise your younger siblings but are able to return to school a few days a week, part-time. You enjoy studying both mathematics and chemistry as well as learning more about the Islamic ways of life. However, you face cultural limitations in your aspirations because as a woman, you are expected to remain in the household and raise a family rather than get a full time job and make money to support a family. Your parents are very set in their ways and uphold the pillars of Islam and you are concerned you may not be able to change their minds about going to school and eventually moving to Europe.

Character Possesses

- You own a mobile phone that you use to communicate with your female friends in the village, your father, mother, and the local teacher from school. You speak some English but are not yet proficient in the language.

Character Needs

- You need money to first start a cooperative in the village. One of your friends is willing to help you and can get you the money but needs you to pay her back as soon as you can. You think your friend Salma may be able to help you as well but you are anxious about sharing your plan with her because you don't know how she will react. Your grandmother used to run a cooperative in the village with her own friends when she was younger but doesn't talk about it when your parents are around. There is no one else in the village who has the same knowledge about the cooperative as your grandmother does.

Character Duties

- Your parents have put you in charge of helping to raise your siblings. Your mother sometimes asks you to watch over the household water supply so your siblings aren't

using too much water. Even though your family now has a steady water supply, your grandparents do not want to overuse the water.

Objectives

- Understand the cultural differences of Berber peoples in relation to the United States
- Analyze readings and extract cultural limitations young women face in Berber culture in comparison to both Moroccan and American cultures
- Creative writing to interpret personal reflections and reactions to the cultural differences observed in these assigned readings.
- Interpret visual data in the computer game and identify important environmental sources near the village
- Prepare a short presentation giving clear and concise information that other students may find relevant.
- Rank water sources in terms of quality based on visual data, such as color, and infer potential contaminants based on the type of source it is.

Assignments

Assignment 1: Role Exploration: Journaling

Create a journal about what you think this teenage girl is going through and what challenges she may face daily before the fog water nets were implemented as you read your role-specific sources.

Assignment 2: Role Exploration: Mapping the pipes and villages

Explore the home, village, and surrounding village area of the character using a computer game, marking where additional sources of water can be found along with where the fogwater nets are located for your village. Include any important pieces of information such as where the pipes are laid, how far the water needs to travel, and the quality of water from the additional sources you find. Create a map of your findings and present your map to the rest of the villagers (other students in the class).

Additional Resources

Strategy Advice: You need to convince your parents that it is a good idea for you to get a job and produce argan oil rather than staying home and learning how to raise children. You should start by enlisting your friends and trying to discuss it with your grandmother. If your grandmother agrees with you and believes an argan cooperative is a good idea for younger village women, you have a strong feeling your father may agree to let you do it.

Sources/Role-specific Readings: The listed readings below have been chosen to help you understand your character more. These should be read over the first few weeks of the term, at the beginning of the course.

- Interviews collected by the IQP team https://my.wpi.edu/bbcswebdav/pid-532695-dt-content-rid-2713981_1/courses/HU3900-A15-A10/WPI-NOT%20FOR%20PUBLICATION-EDC-2015-WatSan%282%29.pdf
- Posted reading about Berber culture and history (Crawford/Aharoni & Melman)
- 2004 Moroccan Family Code http://www.hrea.org/programs/gender-equality-and-womens-empowerment/moudawana/
- "A New Feminism? Gender Dynamics in Morocco's February 20th Movement" (Salime) https://my.wpi.edu/bbcswebdav/pid-484513-dt-content-rid-2555488_1/courses/HU3900-A15-A10/A_new_feminism__Gender_dynamic.pdf

"Morocco and its Women's Rights Struggle: A Failure to Live Up to its Progressive Image" (Elliot) https://my.wpi.edu/bbcswebdav/pid-484512-dt-content-rid-2555493_1/courses/HU3900-A15-A10/Elliott%2C%20Morocco%20%26%20Its%20Women's%20Rights%20Struggle.pdf

Rubric:

Assignment 1	
Points Awarded	**Degree of Completeness**
0	Student does not complete journal entries
5	Student does not provide insightful thoughts and provides dry journal entries
10	Student provides insightful thoughts and the entries reflect the student's thoughts and ideas.
Assignment 2	
Points Awarded	**Degree of Completeness**
0	Student does not hand in the map
5	Student does not fulfill detailed information in the map
30	Student includes detailed information about the questions asked in a clear, organized map

B.9 Dija Ri

Age: 15 years old
Gender: Female
Job or Main Tasks: Community Teacher

Background

Biography
You are Dija Ri, the eldest daughter of the local school teacher. For years, your father has taught you the English he had learned from his time abroad. He stores his teaching books at home, so that you can teach your brother. Unfortunately, he recently got sick from drinking unclean water and has gone to Guelmin to get treatment. Your mother is with him, so you need to take care of your younger brother at home. Hofesh is 4, and he follows you everywhere.

While Father and Mother are away, a flood destroyed your new pipe system and the nearby well. You cannot get water from the faucet. Most of your funds have gone towards the expensive medical treatment. You cannot hire a plumber. You thought about going to wells that are farther away, but the roads are too dangerous for you to bring your brother along. Your mother is depending on you to take care of Hofesh. You can cook and clean fairly well, but you can do neither without water.

You have decided to become a community teacher. You intend to teach English to local women in exchange for clean water. Several women told you they would be interested in using their spare time to learn. They can get clean water in their home so they have more time and incentive for education.

Character Possesses

- You have English reading and writing skills.
- You have a passion to teach.
- You have basic English course materials.
- You can do household chores including cooking and cleaning.
- You can talk to both genders.

Character Needs

- You need clean water for your younger brother and yourself.
- You need your pipes to be fixed.

Character Duties

- You take care of your little brother, Hofesh.

Objectives

- Present your perspective in a short time with relevant supporting details.
- Practice writing concise explanations that are both descriptive and easy to understand.
- Assess a situation in another person's perspective. Consider possible counter arguments.
- Clearly communicate a problem or need. Communicate what you have to offer. A useful skill in interviews is being able to convince the employer of a need and then explain how you can satisfy that need (according to the Career Development Center).
- Learn to anticipate the questions your audience may ask and respond to counter arguments.
- Develop an understanding of the role Berber women play in the rural community. Become familiar with their daily activities as well as community affairs (communal disputes, obstacles).
- Approach and communicate with new people.
- Understand the group dynamics in a work environment where individuals rely on the contributions of others to complete a task.
- Practice persuasion and negotiation with people of different interests. Experience the uncertainty of how negotiations may turn out.
- Understand the value of resources through the scarcity of water.
- Follow technical instructions.
- Gather experimental data from a selected population of students.
- Write simple functions in Excel to analyze data (Summation, Averages). Extract meaning from numerical values.
- Understand the Berber community's values. Vocabulary chosen for each lesson would reflect the important aspects.
- Surveying the class to find the correct target audience.
- Understand the challenges of teaching and explaining concepts.
- Understand how they perform under pressure.
- Understand the challenges a language barrier can cause. Practice different modes communication including body language, pictures or vivid imagery to overcome communication barriers.

Assignments

Assignment 1: Convince the neighbors: Elevator Pitch

Develop a 5 minute elevator pitch (tree stump pitch) that will persuade your neighbors of the following:

> a. Your need for water. Why do you need their help? You need water for you and your brother. The recent flood destroyed the nearby well and the pipes that supply water into your house. Because medical treatment is so expensive, there is not enough money for a plumber.

b. The importance of education. Education can lead to better economic prospects including tourism and foreign research. Knowledge of English would also make it easier to use more functions on mobile phones, since they have English operating systems. Keep in mind that some of your neighbors still have access to clean water and may have free time. Others may want you to teach them and their children.

c. Your credibility as a teacher. You are more educated than most in the village since your father has been teaching you for years. You also have access to academic resources.

How will you respond to counter arguments? Prepare 2 to 3 sentence responses for each scenario:

a. Your neighbor may suggest going farther away to wells that evaded the flood. However, the roads are in bad condition.

b. Neighbors (ages 15-50) may be more willing to accept your request. However, you may be the same age or younger than the neighbors you are asking.

c. Some of your neighbors are already learning English by watching TV. Why is teaching in person better?

d. Older neighbors (ages 51-80) may believe it is too late for them to learn. They believe they are too ignorant to learn English.

e. The household dynamics may discourage education in favor of labor. For example, a husband may discourage his wife from learning English if he believes she needs to focus on the household.

f. Your neighbor does not see how English can be useful.

Assignment 2: Water Logbook

Part 1. Persuade other characters to participate in your English lessons and give you water. Deliver your elevator pitch to your classmates' characters. Receive a "YES" or a "NO."

a. If they respond "NO," proceed to ask another neighbor.

b. If they respond "YES," have them roll 2 dice (6 sided). The total is the liters of water you gained. Now it is your turn. Roll 1 die, that number is the total liters of water you and your brother consumed in one day. For each "YES" neighbor, record the number of liters gained and the number of liters consumed. For the purpose of this exercise, consumption is synonymous to drinking. 10 is the recommended minimum of "YES" in order to have a sufficient amount of varying data. If you cannot reach 10 and you have approached most of your classmates, assume "YES" and follow the directions for the dice roll.

Part 2. Develop a water logbook in excel using the results from Part 1. Analyze the results.

Recommended:

You will be creating a table with embedded equations that do the calculations for you. To ensure you created the correct equations, please replicate the table below before entering in your own data.

# of YES / # of Days	Liters Gained (2 Dice)	Total Liters Gained Before Consumption	Liters Consumed Daily (1 Dice)	Total Liters Left After Consumption	Liters Consumed Daily by Each Person
Start	4				
1	2	6	6	0	3
2	5	5	6	-1	3
3	2	1	2	-1	1
4	11	10	6	4	3

Figure 1. Sample Data

Procedure for creating the table

a. Column A: # of YES / # of Days

i. # of YES correlates to the number of neighbors willing to participate and the number of days passed. (The sequence should start with 1.)

ii. Write Start in the first row under the column headings. This will be the number of liters you start with.

b. Column B: Liters Gained (2 Dice)

i. Start with a number of liters equivalent to the number of people that responded YES.

Ex. If 4 people responded YES, you start with 4 liters.

ii. Record number of liters gained from each neighbor.

c. Column C: Liters Consumed Daily (1 Dice)

i. Record number of liters consumed.

d. Column D: Total Liters Gained Before Consumption

i. For Day 1, write a function to add the number of liters you started with to the number of liters gained in Day 1. (Refer to Figure 2)

ii. For Day 2, write a function to add the number of liters gained in Day 2 to the total liters left after consumption in Day 1. (Refer to Figure 3)

ii. For Day 3 and after, write a function to add the number of liters gained that day to the total liters left after consumption in the previous day. (For Day 3, use the total liters left after consumption of Day 2). (Refer to Figure 4)

WARNING: If negative, you were forced to drink water that may not be clean. You risk water borne illness.

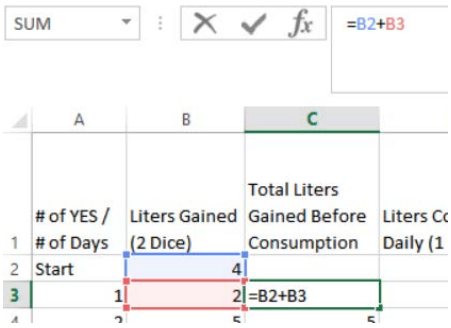


Figure 2. Day 1 Total Liters Gained Before Consumption

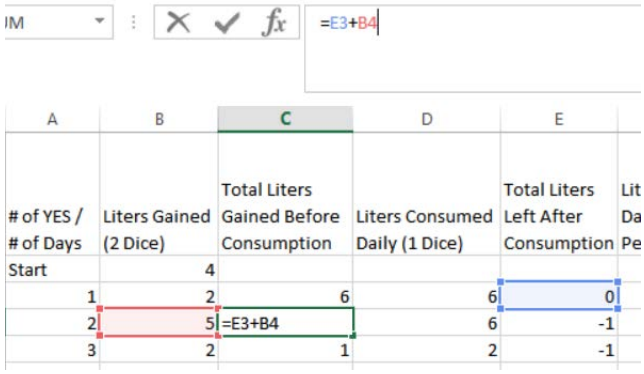


Figure 3. Day 2 Total Liters Gained Before Consumption

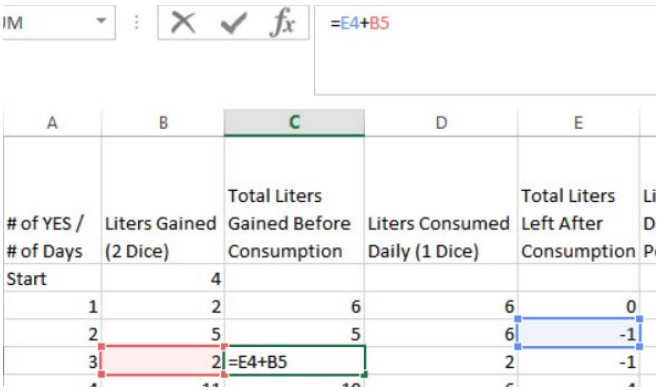


Figure 4. Day 3 Total Liters Gained Before Consumption

e. Column E: Total Liters Left After Consumption

i. Write a function to subtract the total liters gained before consumption by the liters consumed daily (Figure 5).

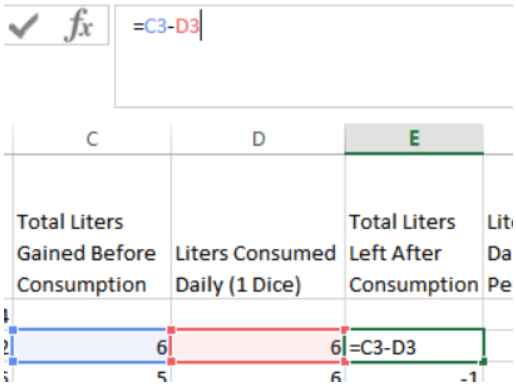


Figure 5. Total Liters Left After Consumption

f. Column F: Liters Consumed Daily by Each Person
   i. Write a function to divide the liters consumed daily by 2.
   ii. This represents the liters that each you and your brother drinks a day.

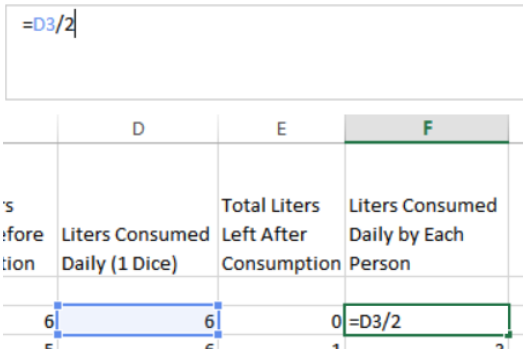


Figure 5. Total Liters Left After Consumption

Answer the following questions:
For the purpose of this exercise, consumption is synonymous to drinking. Find out the average number of liters Males and Females drink daily. What is the average number of liters you and your brother drinks daily? Is it enough? How many times did you have to drink unclean water? What illnesses could you get from drinking dirty water?

Additional Resources

Affiliation / Relationship (Village, school, family, etc.)

Father, a sick local schoolteacher
Mother, household wife
Dija Ri, eldest daughter, attends school, friendly to classmates
Hofesh, 4 year-old brother, does not attend school

The family is loved by the neighbors because the family has always been very generous especially in times of need. You may talk to characters of both genders.

Responsibilities and Needs

I need to take care of my younger brother, who follows me everywhere.
I need clean water for my younger brother and myself.
I need our pipes to be fixed.

Resources and Powers

I have English reading and writing skills.
I have a passion to teach.
I have basic English course materials.
I can do household chores including cooking and cleaning.
I can talk to both genders.

Rubric:

Assignment 1	
Points Awarded	**Degree of Completeness**
50	Successfully answered all the questions

Assignment 2	
Points Awarded	**Degree of Completeness**
50	Successfully answered all the questions

Original character created (October, 2015, Humanities Inquiry Seminar) by: Iok Wong

Appendix C: Answer Keys

C.1 Amina LeBlanc - Preliminary Answer Key

Author

Shaimae Elhajjajy

Assignments

The following assignments should be performed throughout the term. You should be completing the assignments from the point of view of your character. Some resources are provided for you, but you are expected to perform your own research. If you need additional information, be sure to use ONLY reputable sources; cite all of the sources you use in your work using APA format.

1. The material you ultimately choose must be able to withstand the high wind gusts present in the Anti-Atlas Mountains, such that the fog net should not tear or break. Dar Si Hmad has conducted thorough data collection of wind speed and wind direction at the top of Mt. Boutmezguida, where the fog nets will be installed. (30 points)

d) Your instructor will provide you with this data. Using Excel, find the average wind speed at the top of Mt. Boutmezguida (Hint: there should be a built-in "Average" function at your disposal). This will be the wind speed you will use to approximate what conditions your fog net material must withstand. Please keep in mind that this is merely an estimate of the wind speed that the fog nets will undergo, simply for you to begin modeling some data; in reality, you would have to consider the maximum wind speed present at the top of Mt. Boutmezguida, which is what your net material must withstand. If the data is not available to you, follow the directions below:

i. Go to "The Weather Channel" website (www.weather.com)

ii. Type in "Guelmim, Morocco" in the "Search" bar in the upper right corner. This is the major city that is in closest proximity to the villages Dar Si Hmad works with. Please note that this will not be completely accurate, as Mt. Boutmezguida is located further inland than Guelmim; it will simply serve as an approximation in the absence of more accurate data.

iii. In the middle of the web page, you should see a heading labeled "Right Now." Underneath, there will be a subheading labeled "Wind." Note the wind speed displayed here; this will be the wind speed you will use to approximate what conditions your fog net material must withstand.

Sample wind speed: 11 mph (4.91744 m/s)

iv. Next, type in "Sidi Ifni, Morocco" in the "Search" bar. This is another main city nearby, but is located closer to the coast. Again, this will serve as an approximation in the absence of more accurate data, but is good for comparison. Repeat step iii for Sidi Ifni.

Sample wind speed: 8 mph (3.57632 m/s)

e) Wind speed and wind pressure (force) are directly proportional, as demonstrated by the relationship described in the equation below.

$$F_W = \frac{1}{2} * \rho * v^2 * A$$

Use the equation to calculate the wind pressure associated with your wind speed.

The variables are: F_W = wind force (N); ρ = air density (kg/m^3); v = wind velocity (m/s); A = surface area (m^2). The density of air is approximately 1.225 kg/m^3. Assume that your final fog net prototype will be a square sheet with a side length of 1.0 m. If your wind measurements are in miles per hour, convert them to meters per second. The answer you obtain from this calculation is the force that wind will exert on the fog net.

***(Equation and accompanying information obtained from: http://www.engineeringtoolbox.com/wind-load-d_1775.html)
***(Density of air obtained from: http://www-mdp.eng.cam.ac.uk/web/library/enginfo/aerothermal_dvd_only/aero/atmos/atmos.html)

Guelmin:

$$F_W = \frac{1}{2} * \left(1.225 \frac{\text{kg}}{\text{m3}}\right) * \left(4.91744 \frac{\text{m}}{\text{s}}\right)^2 * (1.0\ m2) = 14.81\ N$$

Sidi Ifni:

$$F_W = \frac{1}{2} * \left(1.225 \frac{\text{kg}}{\text{m3}}\right) * \left(3.57632 \frac{\text{m}}{\text{s}}\right)^2 * (1.0\ m2) = 7.834\ N$$

f) When a load is applied to an object, it exerts a force per unit area; this quantity is called "stress", and is used often to determine specific mechanical properties of materials. Therefore, the stress exerted by the wind on the fog net can be approximated by using the following equation:

$$\sigma_W = \frac{F_W}{A}$$

Calculate the stress that the wind will exert on the fog net. The material you choose must be able to withstand this stress, so that the fog net is strong enough to survive its environment.

Guelmin:

$$\sigma_W = \frac{14.81\ N}{1.0\ m2} = 14.81\ Pa$$

Sidi Ifni:

$$\sigma_W = \frac{7.834\ N}{1.0\ m2} = 7.834\ Pa$$

2. One important mechanical property of a material is the ultimate tensile strength (UTS). This quantity is the largest stress that a material can withstand before it begins to fail; if a stress of this magnitude is maintained, the material will likely fracture/break. (30 points)
Keeping this in mind:

c) The material you choose must have a desirable UTS, such that it will not fail under the calculated wind pressure. Do you predict that your material will need to have a UTS greater than or less than σ_W? Explain why. (Check in with your instructor for the correct answer before you move on; you will need this information for the next steps).

The material must have a UTS greater than σ_W, because then it will be strong enough to withstand the force of the wind.

d) You will now research potential candidates for the fog net material.
   iv. Open up the software called CES EduPack. This can be accessed through Remote Desktop (windows.wpi.edu), or on any computer in Gordon Library.
   v. When it opens up, you will be prompted to choose one of the many databases. Select "Level 2" to move on.
   vi. On the left hand side of the software is a menu bar, where you can open folders of different categories to find your material. For simplicity, focus on polymers; click "Polymers and elastomers," then "Polymers," then "Thermoplastics." Pay attention specifically to three primary polymer materials: Polyethylene (PE), Polypropylene (PP), and Polystyrene (PS). Which of these three materials has a suitable UTS for the fog nets? Explain your reasoning. A helpful resource for this question is *Fog Water Collection: Developing Promotional Materials for COP22,* included below in the Additional Resources section. This may give you some ideas on which materials to choose.
      - If you have trouble finding these materials, you can search for them by clicking the "Search" icon near the top left.
      - Note – you may need to change the units of these properties for easier comparison. Click the "Settings" icon at the top, next to a picture of a gear. In the next window, select the "Units" tab. Under "Preferred Unit System", select "Metric."

Polyethylene: UTS = 20.7 – 44.8 MPa
Polypropylene: UTS = 27.6 – 41.4 MPa
Polystyrene: UTS = 35.9 – 56.5 MPa

3. Based on your findings, select the material that you believe is the best option for the fog nets. You will be need to obtain a sample of this material in order to test it in an electromechanical machine called an Instron. Before completing the test, measure the length, width, and thickness of your sample, and write it down (this will be needed for the next part of the assignment). The Instron machine on campus is located in Goddard Hall, room 207. Follow the instructions to load your sample in the Instron and run the test. The test program will be provided, as well as any tutorials or help you may need to perform the test. Then, make sure to secure your data file by saving it to a flash drive or equivalent; this is critical for the next part of the assignment. Your data file should be in the form of an Excel spreadsheet, and should include values for time, extension, and force.

4. Engineers utilize many different programs and software to aid in data analysis. You will be working with MATLAB next.

e) Open up the MATLAB software. For WPI students, you may need to log on to Remote Desktop to access the software (windows.wpi.edu).

f) At the top left corner, click on the icon labeled "New Script." Then click "Save" to save the file. When you name the file, make sure that there are no spaces in the name (example: "materials_testing" rather than "materials testing"). In addition, make sure to save this file in the same folder as your Excel data file.

g) You have been given a MATLAB program called "readMyData." This will allow you to input your data file into MATLAB, so that you can work with it. Save this program to the same folder as your Excel data file.

h) Next, copy and paste the MATLAB code below into your new script. This will calculate all of the values you will need to determine the mechanical properties of your material. Some notes about this code:

   i. In line 8 of the code, you will see that filename is set equal to 'Specimen_RawData.csv," in purple. Make sure that your data file is named "Specimen_RawData.csv", so that your data will be successfully imported. This is the raw data file with all of the measured values from your Instron test.
   ii. In line 27, the variable "initial_Length" is established. You will notice that it is equal to "length." Delete this word and enter in the length of your sample, which you measured before the test.
   iii. In line 30, you will notice the line "Strain = d/initial_Length". This is the equation for strain, which dictates that the strain experienced by a material is calculated by dividing the displacement by the initial length of the sample.
   iv. In line 35, the variable "A", which designates cross-sectional area, will be calculated. You will notice that it is calculated by multiplying the width of your sample by its thickness. Delete these words and enter in the appropriate values, respectively, that you measured before your test.
   v. In line 38, you will notice the line "Stress = F/A". This is an application of what you have previously learned in (1c), in which the stress exerted on a material is calculated by dividing the force by the cross-sectional area.

vi. In line 43, you will notice the line "[UTS, position_UTS] = max(Stress)." This is an application of what you have previously learned in (2a), in which the ultimate tensile strength is equal to the maximum value of stress that the sample underwent. The variable UTS will be the value of your ultimate tensile strength.

vii. In line 56, you will notice the line "plot(Strain(position_UTS), UTS, 'or')". This will mark the ultimate tensile strength of your material on the graph. Run the program, and confirm that your curve has small red circle on it; this is the location of the UTS.

viii. In line 62, you will notice the line "linear_Region = find(Strain < value)". This will help you to isolate the linear portion of the curve (the Young's modulus is calculated only in the linear region of a stress-strain curve). Run the program and observe the generated graph. Approximate the x-value that corresponds to the end of the linear region of the curve. Delete the word "value" in the aforementioned line, and replace it with the value you have approximated.

ix. In line 80, you will notice the line "E = slope." This is will find the Young's modulus, which is calculated by dividing the stress by the strain, and is also equal to the slope in the linear region of the stress-strain curve; Young's modulus is an indication of a material's degree of stiffness.

x. Throughout the code, you will notice some lines are in green; these are comments about how the program works, and what each line of code does. This may help you to understand the MATLAB code.

xi. After the code has been run successfully, you will find the results in a sidebar, titled "Workspace." Under the "Name" column, look for the variables "UTS" and "E", then note the corresponding values in the "Value" column. These are your respective values for ultimate tensile strength and Young's modulus, which you will use for later analysis (Problem 5).

The MATLAB script is as follows:

```
%% Materials Testing for Fog Nets

clc; clear all; close all;

%% Import the collected data into MATLAB

% upload the data and assign to a variable name.
fileName = 'Specimen_RawData.csv';

% create a matrix of the data
data = readMyData(fileName);

% define all variables

% Assign the first column of the data sheet to designate the variable "Time".
t = data(:,1);
% Assign the second column of the data sheet to designate the variable
% "Displacement".
d = data(:,2);
% Assign the third column of the data sheet to designate the variable
```

```
% "Force".
F = data(:,3);

%% Calculate the strain

% Establish a variable for the initial length of the sample.
initial_Length = length;

% Calculate the values of strain.
Strain = d/initial_Length;

%% Calculate the stress

% Calculate the cross-sectional area of your sample.
A = width*thickness;

% Calculate the values of stress.
Stress = F/A;

%% Calculate the ultimate tensile strength

% Calculate the ultimate tensile strength
[UTS, position_UTS] = max(Stress);

%% Generate a stress-strain curve

figure
plot(Strain, Stress)
xlabel('Strain (mm/mm)')
ylabel('Stress (MPa)')
title('Stress-Strain Curve')
grid
hold on

% Label the UTS on the graph
plot(Strain(position_UTS), UTS, 'or')

%% Calculate the Young's modulus

% Isolate the linear region of the curve.
% Select the linear region of the stress-strain curve.
linear_Region = find(Strain < value);

% Find the last element of the linear region.
idx = linear_Region(end);

% Find all of the strain values that are in the linear region.
strain_Linear = Strain(1:idx);

% Find all of the stress values that are in the linear region.
stress_Linear = Stress(1:idx);

% Find the slope of the linear region.
```

```
% This slope will be the Young's modulus.
p = polyfit(strain_Linear, stress_Linear, 1);
slope = p(1);
intercept = p(2);

% Find the Young's modulus
E = slope;
```

5. Now it is time to analyze your results. (30 points)

c) The MATLAB code will generate the UTS of your material based on the data you previously collected. Compare your calculated value for UTS with the calculated value for σ_w. Based on this comparison, do you believe your material is a viable option for the fog nets? (i.e. What does it mean if UTS > σ_w or UTS < σ_w?) Explain your reasoning.

d) As was previously mentioned, Young's modulus, E, models the linear relationship between stress and strain. Return to CES EduPack.

i. How does your calculated UTS compare with the documented UTS from CES EduPack?

ii. The MATLAB code also generated Young's modulus. How does your calculated Young's modulus compare with the documented Young's modulus from CES EduPack?

iii. Next, quantify if your UTS and E values are comparable to those from CES EduPack by calculating the percent error, using the following equation:

$$\%\ Error = \left|\frac{Experimental - Theoretical}{Theoretical}\right| * 100$$

Briefly describe your findings; what was your % error for each? Was it large or small? What may have caused it?

***(Equation for percent error obtained from: http://astro.physics.uiowa.edu/ITU/glossary/percent-error-formula/)

Example calculation:

$$\%\ Error = \left|\frac{15 - 14.82}{14.82}\right| * 100 = 1.35\ \%$$

6. Another important aspect of material selection is determining what regulations the material must meet for a particular application. Although there may not be a specific regulation geared toward fog nets, it is important to remember that water will accumulate and be collected by the fog nets. This means the material will be in direct contact with the fog, which will eventually become drinking water. Whichever material you chose, it is a polymer, and many plastics have aroused suspicions of adverse health effects on the human body upon frequent exposure. Conduct some research on the material you selected, and determine whether there is any risk associated with its use in fog nets for the collection of running water. Is your material FDA

approved for use in conjunction with food? If there are any risks, what are they? Overall, would you strongly recommend your material for use in the fog nets? (10 points)
The following link may be of assistance to you:
http://www.fda.gov/Food/IngredientsPackagingLabeling/PackagingFCS/ucm2006853.htm

Students must mention the risks of carcinogenicity. There is much debate about whether or not these plastics have a potential for causing cancer, so students should elaborate. They should also describe the current regulations related to these materials, especially in regards to food. Whether or not they recommend their material, they must give a valid explanation supporting their argument.

Now that you have selected a material, you are ready to consult with Peter Trautwein. You will be bringing your expertise in materials science to the table. As such, make sure you are able to explain to him why you have chosen your material. As a team, you will create a prototype for the fog net.

C.2 Mia Wilder – Preliminary Answer Key

Author

Shaimae Elhajjajy

Assignments

The following assignments should be performed throughout the term. You should be completing the assignments from the point of view of your character. Some resources are provided for you, but you are expected to perform your own research. If you need additional information, be sure to use ONLY reputable sources; cite all of the sources you use in your work using APA format.

You have been tasked with completing an inventory of indigenous plants in Morocco which possess medicinal capabilities. Locally grown plants used in traditional Moroccan and Berber medications are of particular interest to you. Specific targets are those listed below; these are some of the most commonly utilized plants in traditional remedies of Morocco:

- Argan
- Prickly pear
- Aloe
- Olive
- Fig
- Mint
- Wormwood
- Basil
- Lemon verbena
- Fenugreek
- Cumin
- Henna
- Caraway
- Aniseed
- Saffron
- Thyme

Choose eight of the sixteen plants listed above. Conduct thorough research on each of the plants you've chosen by answering the following questions:

l) Plants and animals are universally identified by their scientific name, which allows people from all over the world to recognize each species despite apparent language barriers. When you present the findings of your study, it is important that you are in accordance with this convention so that others may understand your work. Find the scientific name of each of the plants you chose to research. (10 points)

Common Name	**Scientific Name**
Argan	*Argania spinosia*[2]
Prickly Pear (Barbary fig)	*Opuntia ficus-indica*[3]
Aloe	*Aloe socotrina*[4]; *Aloe vera*[5]
Olive	*Olea europaea*[1]

Fig	*Ficus carica*[3]
Mint	*Mentha rotundifolia, mentha viridus*[3]
Wormwood	*Artemisia absinthium*[3]
Basil	*Ocimum basilicum*[3]
Lemon verbena	*Aloysia triphylla*[6]
Fenugreek	*Trigonella foenum-graecum*[3]
Cumin	*Cyminum Cuminum*[4]
Henna	*Lawsonia inermis*[4]
Caraway	*Carum carvi*[3]
Aniseed	*Pimpinella anisum*[3]
Saffron	*Crocus sativus*[4]
Thyme	*Thymus vulgaris*[1]

m) Canada has two official languages: English and French. Because you will be presenting your findings back home, it is important that each of these plant names are expressed in both languages so it is understood by all audiences. In addition, a large percentage of the Moroccan population speaks French as a second language, so this will be particularly helpful when presenting this information to Moroccans as well. You are provided with the English names here; Find the names of each plant in French. (Hint: www.wordreference.com may be a good place to start) (10 points)

English Name	**French Name**
Argan	Arganier[8]
Prickly Pear	Figue du Barbarie[8]
Aloe	Aloès[8]
Olive	Olive[8]
Fig	Figue[8]
Mint	Menthe[8]
Wormwood	Absinthe vraie[7]
Basil	Basilic[8]
Lemon verbena	Verveine citronnelle[8]
Fenugreek	Fenugrec[8]
Cumin	Cumin[8]
Henna	Henné[8]
Caraway	Carvi[8]
Aniseed	Anis[8]
Saffron	Safran[8]
Thyme	Thym[8]

n) You will likely require the help of locals while you conduct your research. To prepare, it will be helpful if you are knowledgeable of the name of each plant in the local Moroccan

language, called Darija. What is the vernacular (traditional) Moroccan name of each plant? (10 points)

English Name	**Moroccan Name**
Argan	Argan (Darija)[2]
Prickly Pear	Hindiya (Darija)[3]
Aloe	Siber (Darija)[5]
Olive	Azmmour (Berber)[1]; El-zeytoun (Darija)[4]
Fig	El-bakur[3]; El-karmouss
Mint	Na-na (Darija)[3]
Wormwood	Sheba (Darija)[3]
Basil	El-hbak (Darija)[3]
Lemon verbena	Louiza
Fenugreek	El-halfa (Darija)[3]
Cumin	Kamoon[4]
Henna	Henna[4]
Caraway	El-quarwiya (Darija)[3]
Aniseed	Habbat hlawa (Darija)[3]
Saffron	Zefran
Thyme	Azoukemni (Berber)[1]; Zeitra (Darija)[5]

o) Every plant flourishes at different times throughout the calendar year. You should be able to identify when each plant grows during the year, as well as the time of year at which they are harvested. When is the picking season for each plant? Specify the range of months in which the plants grow, when possible. (10 points)

p) All of the plants listed above grow naturally in Morocco, but they may not necessarily grow in the Anti-Atlas mountain region of Morocco (where Aït Bamraane is located). What climate is necessary to grow each of these plants? Which plants would you predict to find in Aït Bamraane when you go there to conduct your botanical survey? (10 points)

q) As previously mentioned, each plant has various health benefits which are the primary focus of your research as a naturopathic medical student. There are 6 different parts of a plant that can be used: seed, root, stem, leaf, flower, and fruit. Which portion(s) of each plant is used for its medicinal properties? (10 points)

Plant Name	**Portion of Plant Used**
Argan	Fruit[2]
Prickly Pear	Flower[3]
Aloe	Cortex, leaf[4]
Olive	Flower, leaf, seed[4]
Fig	Fruit[3]
Mint	Leaf, stem[3]

Wormwood	Leaf[3]
Basil	Seed[3]
Lemon verbena	Leaf[6]
Fenugreek	Seed[3]
Cumin	Seed, leaf, flower[4]
Henna	Leaf, whole plant, cortex[4]
Caraway	Seed[3]
Aniseed	Seed[3]
Saffron	Flower[4]
Thyme	Leaf, flower, whole plant[4]

r) Discover the general medicinal properties of each of these plants. Describe the way that each of the plants is used in Morocco. What is it used for? What are its benefits? What illness(es) or condition(s) does it treat? How is it prepared/prescribed (if it is cooked in food, state which kind)? (10 points)

Plant Name	**Preparation**	**Administration**	**Medicinal Use(s)**
Argan	Oil[2]	Oral, external application[2]	Dermatology, cosmetics[2]
Prickly Pear	Powder[3]	Oral[3]	Stomach pains[3]
Aloe	Decoction, oil[4]	External application[4]	Dermatology (burns, skin issues, etc.), cancer[4]; Diabetes[5]
Olive	Oil, decoction, infusion[4]; often cooked in food or dipped with bread	External application, oral[4]	Dermatology, respiratory, diabetes[4]
Fig	Raw[3]	Oral[3]	Digestive system[3]
Mint	Decoction, infusion (tea)[3]	Oral[3]	Cold, digestive system, headache, tiredness[3]
Wormwood	Infusion (often in tea)[3]	Oral[3]	Stomach pains, heart[3]
Basil	Decoction[3]	Oral[3]	Anti-hemorrhoid, heart diseases[3]
Lemon verbena	Infusion (often in tea or milk)[6]	Oral[6]	Digestive system, aromatic, antispasmodic, colds, fevers[6]
Fenugreek	Maceration[3]; often cooked in food	Oral[3]	Diabetes, scurvy, digestive system[3]
Cumin	Powder, decoction, infusion[4]; often cooked in food	Oral[4]	Digestive system, respiratory system, nervous system[4];

			Diabetes, hypertension[5]
Henna	Powder, decoction, maceration[4]	External applications, oral, inhalation[4]	Dermatology, digestive system, head problems[4]
Caraway	Decoction[3]	Oral[3]	Digestive system, kidneys, diabetes[3]
Aniseed	Decoction[3]	Oral[3]	Kidney, digestive system, diabetes[3]
Saffron	Powder, infusion, maceration[4]	Oral, external application, inhalation[4]	Microbial infection, respiratory system, head problems[4]
Thyme	Decoction, infusion[4]	Oral[4]	Digestive system, respiratory system, allergies[4]; Hypertension[5]

*Note: this is a preliminary list of medicinal uses for each of the plants. Please be aware that there are many other medicinal uses depending on the region of Morocco; students should be graded accordingly (different answers than those listed here should be awarded full credit if they have cited their work from a reputable resource).

s) If possible, obtain a sample of at least two of your plants; a local grocery store may stock some of the more common herbs in dried form, or perhaps a nearby ethnic foods store. Note any observations you make, including texture, appearance, scent, and taste. (The purpose of this step is for you to better understand and appreciate the plant itself by actually holding it in your hand, rather than just viewing a picture). (10 points)

t) We now connect back to the study of naturopathic medicine. What specific physiological effects does each plant have (i.e. what is happening inside the body when it is ingested)? How does the physiological response contribute to the identified medicinal benefits (i.e. how does the body's response help to heal the body)? (10 points)

u) Chemistry is an important element of health and medicine, and thus should not be overlooked. Choose one of your eight plants and isolate the primary compound that it contains. (For simplicity, you may want to try to select a plant whose primary compound has the simplest molecular structure). Explain at the molecular level how it works in the body, and predict how this compound may be related to the plant's medicinal benefits. Now, creatively build a structure of this chemical (more than just a ball-and-stick model). (10 points)

v) Finally, recall that one of the purposes of traveling abroad for your research is also to understand the ethnobotanical concepts that underlie this particular venture into naturopathic medicine. Investigate the specific intersection between Moroccan culture

and traditional Moroccan herbal medicine (i.e. what role does it play?). Describe the importance of traditional herbal medicine in Morocco, making sure to address cultural, religious, and historical aspects. Additionally, address the relationship between traditional and modern medicine practices in Morocco. With the advent of modern technological advances and the younger generations, do you think traditional Moroccan remedies are at risk of extinction? Explain your answer. (10 points)

References

[1] Santarsiero, R., Smallwood, D., McAdams, A., & Schubert, N. (2016, October 11). Developing Promotional Materials for COP22. Retrieved from https://web.wpi.edu/Pubs/E-project/Available/E-project-101216-084927/unrestricted/Fog_Water_Collection.pdf

[2] Charrouf, Z., & Guillaume, D. (1999). Ethnoeconomical, ethnomedical, and phytochemical study of *Argania spinosa* (L.) Skeels. *Journal of Ethnoparmacology, 67*: 7-14. doi: 10.1016/S0378-8741(98)00228-1

[3] El-Hilaly, J., Hmammouchi, M., & Lyoussi, B. (2003). Ethnobotanical studies and economic evaluation of medicinal plants in Taounate province (Northern Morocco). *Journal of Ethnopharmachology, 86*: 149-158. doi: 10.1016/S0378-8741(03)00012-6

[4] Fakchich, J., & Elachouri, M. (2014). Ethnobotanical survey of medicinal plants used by people in Oriental Morocco to manage various ailments. *Journal of Ethnopharmacology, 154*: 76-87. doi:10.1016/j.jep.2014.03.016

[5] Tahraoui, A., El-Hilaly, J., Israili, Z.H., & Lyoussi, B. (2007). Ethnopharmacological survey of plants used in the traditional treatment of hypertension and diabetes in south-eastern Morocco (Errachidia province). *Journal of Ethnoparmacology, 110*: 105-117. doi: 10.1016/j.jep.2006.09.011

[6] Carnat, A., Carnat, A.P., Fraisse, D., & Lamaison, J.L. (1999). The aromatic and polyphenolic composition of lemon verbena tea. *Fitoterapia, 70*: 44-49. doi: 10.1016/S0367-326X(98)00016-1

[7] Moussaoui, F., Alaoui, T., & Aoudry, S. (2014). Census Ethnobotanical Study of Some Plants Used in Traditional Medicine in the City of Meknes. *American Journal of Plant Sciences, 5*: 2480-2496. doi: 10.4236/ajps.2014.515263

[8] www.wordreference.com

Mohammed Sfoureg – Preliminary Answer Key

Author

Shaimae Elhajjajy

Assignments

The following assignments should be performed throughout the term. You should be completing the assignments from the point of view of your character. Some resources are provided for you, but you are expected to perform your own research. If you need additional information, be sure to use ONLY reputable sources; cite all of the sources you use in your work using APA format.

1. BEEHIVES: After many years of loving cultivation, your beehives are flourishing and your bees are happily working. Your goal for the new honey season is to split your beehive. Splitting a beehive is a common practice in apiculture which has multiple purposes. Complete the following activities related to this topic (20 points):

d) Briefly summarize the process of splitting a beehive, in your own words.

- http://www.dummies.com/home-garden/hobby-farming/beekeeping/how-to-create-a-second-bee-colony-from-your-existing-beehive/
- http://kiwimana.co.nz/how-to-split-a-beehive/
- http://www.honeybeesonline.com/making-spring-splits/
- http://www.bushfarms.com/beessplits.htm

e) Describe at least three reasons why beekeepers occasionally split their beehives.

1. To increase the number of hives
2. To requeen
3. To get more or less production
4. To raise queens
5. To prevent swarms

http://www.bushfarms.com/beessplits.htm

f) Since you are splitting your beehive, you will need to create an entirely new beehive, which will be an addition to your previous collection. Conduct some research about the structure and function of current beehives. Then, build a miniature beehive structure. This can be done with simple materials and supplies (i.e. nothing fancy); the main purpose of this activity is to get you thinking about the inner workings of a beehive and

why it is constructed the way it is. Be prepared to present your structure and explain its components and functions.

- http://www.ontariobee.com/sites/ontariobee.com/files/document/construction.pdf
- http://www.michiganbees.org/wp-content/uploads/2012/01/Hive-Bodies_20110323.pdf
- http://www.beverlybees.com/parts-beehive-beginner-beekeeper/
- https://www.researchgate.net/figure/51839721_fig1_Fig-1-Schematic-of-the-Langstroth-Beehive-with-one-brood-chamber-and-one-honey-super

2. BEES AND HONEY: Next, you will learn about the hive community and the honey they produce. (20 points)

g) What kinds of bees are found in the hive? What is the specific function(s) of each type of bee? How do the bees of the hive communicate with each other?

- https://agdev.anr.udel.edu/maarec/honey-bee-biology/the-colony-and-its-organization/
- http://www.fao.org/docrep/t0104e/T0104E05.htm
- http://www.aces.uiuc.edu/vista/html_pubs/BEEKEEP/CHAPT1/chap1.html
- http://www.pbs.org/wgbh/nova/bees/hivecomm.html
- http://www.dummies.com/home-garden/hobby-farming/beekeeping/how-honey-bees-communicate/
- http://www.hiveandhoneyapiary.com/TheWaggleDanceTalk.html

h) Investigate the process by which honey is produced, starting with the mechanism in which bees create the honey and ending with the packaged product on grocery store shelves. This can be presented as a step-by-step procedure, in the form of a numbered list, but must be thorough.

- http://honeybee.org.au/education/wonderful-world-of-honey/how-bees-make-honey/
- https://www.honey.com/honey-at-home/learn-about-honey/how-honey-is-made/
- http://fordshoneyfarm.com/honeymade.html
- http://www.beemaid.com/how-is-honey-made
- http://www.livescience.com/37611-what-is-honey-honeybees.html

i) What are the similarities and differences between standard honey, pure honey, and raw honey?

- http://organics.org/differences-between-honey-and-raw-organic-honey/
- https://www.honey.com/faq
- http://empoweredsustenance.com/raw-honey-definition/
- http://www.livestrong.com/article/270565-difference-between-organic-natural-honey/
- http://www.benefits-of-honey.com/natural-honey.html
- http://healthywithhoney.com/what-is-the-difference-between-pure-honey-and-raw-honey/
- http://permaculturenews.org/2014/02/08/shocking-differences-raw-honey-processed-golden-honey-found-grocery-retailers/

j) Honey is only one of the substances that bees produce in the hive. What are the other five products? Give a one-sentence description of each, stating what they are.

- Honey
- Nectar
  - http://www.beeculture.com/a-closer-look-nectar-collection-processing/
  - http://www.scholastic.com/browse/lessonplan.jsp?id=794
- Beeswax
  - http://beesource.com/resources/elements-of-beekeeping/all-about-beeswax/
  - http://www.honeybeecentre.com/learn-about-beeswax-candles#.WMAjumTyuRs
- Pollen
  - https://draxe.com/bee-pollen/
  - http://www.foodmatters.com/article/10-amazing-health-benefits-of-bee-pollen
- Bee bread
  - http://nordicfoodlab.org/blog/2015/9/4/bee-bread
  - http://healthywithhoney.com/beebread/
  - http://kylevialli.com/bee-bread-the-truth-about-bee-pollen/
- Propolis
  - http://www.greenmedinfo.com/blog/7-health-benefits-bee-propolis
  - http://www.healthline.com/health/propolis-an-ancient-healer#Overview1
  - https://draxe.com/bee-propolis/

k) Take a brief look at the article titled "Beekeeping in Morocco: focus on honey production," which is provided below in Additional Readings. This article is in French, but you will only focus on the tables and figures. Table 1 contains the three main bee species in Morocco. Research each of these and describe them. Be sure to include some of the other information in the table, by translating them to English (Hint: www.wordreference.com may help).

- Apis mellifera intermissa
- Apis mellifera major
- Apis mellifera sahariensis

http://www.ijias.issr-journals.org/abstract.php?article=IJIAS-16-313-03

l) The next portion of your assignment is crucial, to understand the role that honey plays in the lives of Moroccan people. Prepare a five-minute presentation, which you will share with the class, detailing the importance and significance of honey, in both Moroccan and Berber culture. Be sure to especially elaborate the importance of honey in Islam.

- http://www.islamreligion.com/articles/10321/liquid-gold-benefits-of-honey/
- http://www.4islam.com/honey.shtml
- http://www.islamicbulletin.org/newsletters/issue_13/honey.aspx
- http://iqrafoundation.com/2011/08/the-benefits-of-honey/

Students should mainly talk about the importance of honey in Islam, as well as the fact that it is specifically mentioned in the Qu'ran. They should then connect this back to why it is important in Moroccan culture.

3. WATER: Conduct some research about the relationship between bees and water. Then complete the following activities. (20 points)

d) What is the role of water in beekeeping? Describe at least three reasons why water is so important for bees.

- http://outdoorplace.org/beekeeping/citybees.htm
- https://www.uky.edu/Ag/Entomology/ythfacts/4h/beekeep/basbeop.htm
- http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=11349

e) As you may have uncovered in part (a), it is important that bees have a water source during the honey-making process. There are various factors to consider when providing a water source to the hive. Keeping this in mind, draw a schematic of your beehive and its corresponding water source, making sure to include:

i. The type of water source
ii. The distance between your water source and the beehive
iii. The degree of availability of the water source to the your bees
iv. The way in which you will keep your bees from drowning

Provide a justification for each of your decisions.

- http://outdoorplace.org/beekeeping/citybees.htm
- https://www.uky.edu/Ag/Entomology/ythfacts/4h/beekeep/basbeop.htm
- http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=11349

f) How do you predict your beekeeping duties will be affected by the fog nets installed by Dar Si Hmad?

Students should make the connection that the fog harvesting project implemented by Dar Si Hmad provides the villagers with greater water accessibility. The beekeepers will then have more water to spare for their bees, and the bees will then have a more reliable water source.

4. FAUNA: Plants, particularly those which bloom during the appropriate season, are very important to take into consideration. In this part of your assignment, you will delve further into the relationship between plants and beekeeping. (20 points)

e) Honeybees collect nectar from a wide variety of flowering plants. What is the most common type of honey, and which plant does it come from?

- http://www.livestrong.com/article/272053-clover-honey-nutritional-facts/
- http://www.honeytraveler.com/single-flower-honey/clover-honey/

f) Explain the effect that flower type has on the taste of the resulting honey. In addition, explain the relationship between the color of honey and its taste. Give three examples of different varieties of honey, and how the taste will differ between the different types. If possible, procure two different varieties of honey, perhaps from your local grocery store.

Once you have tasted them, reflect on their taste, color, and origin, then connect your findings with what you previously learned.

- https://www.honey.com/honey-at-home/learn-about-honey/honey-varietals/
- https://www.honey.com/newsroom/press-kits/honey-color-and-flavor
- http://www.benefits-of-honey.com/honey-varieties.html

g) Next, consult with the student who has the character of Mia Wilder. Mia is studying naturopathic medicine in Toronto and is currently working on a research project focused on local plants growing in the Aït Baâmrane region. Take note of some of the plants that she is studying and have her describe them to you; then, select one which has blooming flowers. Investigate the honey which is produced from the nectar of this plant; this is the honey variety that you, as an Aït Baâmrani, will likely produce through your beekeeping. Summarize your findings.

- Thyme honey
  - http://www.honeytraveler.com/single-flower-honey/thyme-honey/
  - http://healthywithhoney.com/thyme-honey/

h) Take a look at the reading "Physiochemical properties of some honeys produced from different plants in Morocco," which is provided below in Additional Readings. This will provide you will some more Moroccan plants which attract bees for the production of honey. Now, between the plants listed here and the one you learned about from Mia, select three plants which are native to Morocco and which are commonly used in Moroccan honey production. For each, answer the following questions:
   i. What is the water content?
   ii. In what region of Morocco do these plants grow?
   iii. What are their sugar compositions? How do they compare with each other? What does this mean?
   iv. Provide a one-paragraph summary of each honey type produced from these plants, including all the information you gathered above, as well as any properties or characteristics. (Hint: Section 3: Results and Discussion).

- http://www.sciencedirect.com/science/article/pii/S1878535211002747

Students should look at Tables 3 and 4 in the article for information regarding questions i, ii, and iii. For question iv, they should read Section 3: Results and Discussion.

5. HEALTH AND SAFETY: There are many health and safety considerations involved with apiculture. Consider the topics below:

g) What are the general health properties of honey? Name and describe at least three.

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3609166/
- http://www.webmd.com/diet/features/medicinal-uses-of-honey#1
- https://draxe.com/the-many-health-benefits-of-raw-honey/
- http://www.mindbodygreen.com/0-8743/6-delicious-health-benefits-of-honey.html
- http://www.care2.com/greenliving/10-health-benefits-of-honey.html

h) In what specific ways do Moroccans use honey in their everyday lives? In what foods do they use it in? For what maladies do they use it as a remedy?

- Food: msemen, baghrir, batbout, chebakia, thé (Moroccan mint tea)
- http://www.morocco.com/blog/tantalizing-tastes-of-the-honey-festival

*Note: it may be challenging for students to find resources for this question. Instructors are encouraged to help students start this question by giving them the name of these foods, and then having them research what those foods are.

i) For the three plants you have chosen above, research and describe their specific medicinal properties. You realize that this information will be immensely useful and interesting to Mia; reconvene with her and share your findings.

*Note: This will depend on what plants the students chose in their previous question. Please grade accordingly. Students must have cited all of their work to receive full credit and for their answers to be valid.

j) What is the purpose of honey pasteurization? How does this affect honey's medicinal benefits?

- http://www.beemaid.com/honey-pasteurization
- http://www.honey.com/images/downloads/shelflife.pdf
- http://www.westernsagehoney.com/faqs.html
- http://naturalrevolution.org/shocking-differences-raw-honey-processed-golden-honey/
- http://www.blueridgehoneycompany.com/faq.htm#6

k) To familiarize yourself with regulatory practices as established by the FDA, read the information at the following site: http://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/labelingnutrition/ucm389501.htm.

l) Why do some people have severe allergic reactions to bee stings? What is the name of this type of allergic reaction? What is the prescribed treatment, and how does it halt the allergic reaction?

- http://www.mayoclinic.org/diseases-conditions/bee-stings/symptoms-causes/dxc-20251623
- https://www.epipen.com/what-is-anaphylaxis/what-causes-anaphylaxis/bee-sting-allergy
- https://www.aaaai.org/conditions-and-treatments/library/allergy-library/stinging-insect-allergy
- http://acaai.org/allergies/types/insect-sting-allergies
- https://www.epipen.com/en/about-epipen
- https://www.epipen.com/en/about-epipen/what-is-epinephrine
- https://www.epipen.com/en/what-is-anaphylaxis

Students should mention that some people are allergic to bee stings, and explain why. They should state that the severe allergic reaction is called anaphylaxis, and that the prescribed treatment is the EpiPen. They should then describe that it is an epinephrine auto-injector, and explain why the dose of epinephrine is able to stop the allergic reaction.