
AC 2012-3144: A MULTIDISCIPLINARY GLOBAL HEALTH COURSE WITH AN INTEGRATED INTERNATIONAL FIELD EXPERIENCE

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A Multidisciplinary Global Health Course with an Integrated International Field Experience

Abstract

A new global health course was recently developed and implemented at Western New England University. The course brought together students from a variety of disciplines and academic levels to study issues related to healthcare from a global perspective. The centerpiece of the course was a faculty-led field experience in Guatemala that occurred at the end of the semester. During the field experience, the students visited clinical care facilities where they conducted a needs assessment by interviewing and surveying administrators, healthcare workers, and patients. In order to assess the impact of the new course on student interest and attitudes toward global health, a set of pre- and post-course surveys were developed and administered. The results from the surveys showed increased student-reported knowledge regarding global health issues after completing the course. The students also reported an increased level of interest in pursuing further studies and careers in the area of global health, as well as a desire to become more proficient in a foreign language.

Introduction

The development of solutions to healthcare problems facing the global community is of significant interest to biomedical engineers working in both academia and industry. These solutions often require technologies to be developed within constraints that differ from those found in a typical medical device setting, including strenuous economic restrictions as well as unique cultural considerations.^{1,2} Thus, in order to develop appropriate solutions for global health issues, biomedical engineers must possess a variety of skills that are not typically cultivated in the traditional biomedical engineering (BME) curriculum. For example, BMEs must be introduced to diseases that are prevalent from a global perspective, which are often quite different from conditions that are clinically relevant in the United States.³ Additionally, BMEs must be prepared to develop healthcare solutions in a range of unfamiliar environments, including foreign countries, languages, and cultures.

Recently, a number of engineering programs have developed opportunities for their students that emphasize global perspectives.⁴⁻⁹ In general, these efforts are focused on developing global perspectives in a broad sense, and are not necessarily centered on biomedical topics. Within the biomedical engineering community, there are examples of programs involving extracurricular activities as well as research experiences.^{10,11} The Milwaukee School of Engineering offers a program called Healthcare Without Borders (HWB), which is a service club organized by students. This program is unique in that its activities are designed to exist outside of the curriculum, thus students do not receive course credit for participation. Rather, it is operated as a student life club. Students from a variety of academic backgrounds are encouraged to participate, including from nursing programs as well as all engineering majors. Efforts of the program have

included travel to developing countries, such as El Salvador, to complete assessments of healthcare clinics.¹⁰ The Georgia Institute of Technology recently described their China Undergraduate Research Experience (CURE) program. This program is designed to immerse undergraduate students in an international research experience for a full year, with an aim of enhancing research skills while also offering perspectives on global challenges within biomedical engineering. Secondary goals include impacting student interest in pursuing graduate studies, particularly in programs with international components.¹¹

In order to help meet the needs for globally trained biomedical engineers, a new global health course was recently developed at Western New England University (WNE). The new course, which is titled Global Health & Technology, was designed to provide a multidisciplinary experience at the interface between global health issues and the technologies being developed to solve them. Additionally, the course contained an integrated field experience in Guatemala that was included to provide a practical module to complement the in-class learning. The objectives of the course were to 1) increase student knowledge regarding global health issues, 2) increase student interest in global health as an area for future study or careers, and 3) increase student interest in traveling abroad and learning a foreign language.

Course Background

The new Global Health & Technology course was developed and implemented for the first time in Spring 2011. The course was co-instructed by two faculty members from the College of Engineering, including one biomedical engineer and one electrical engineer (EE). Both instructors had prior experience with global health, including research projects involving medical devices and prior course-based trips to developing countries. Since one of the goals of the course was to create a multidisciplinary learning environment, the course was made available to all undergraduate students on campus through the Integrated Liberal and Professional (ILP) program at WNE. All students at WNE must complete one ILP course as part of the general requirements for graduation, thus the course counts toward the curriculum for BME and other majors.

The student population for the first course offering included 6 biomedical engineering majors and 7 students from the College of Arts & Sciences. This included 1 first-year student, 7 second-year students, and 5 third-year students. Of the 13 students in the course, 3 were male and 10 were female. The course enrollment was limited to 13 students due to travel constraints related to the Guatemala field experience. As a result of the limited size of the course, students were required to go through an application process in order to be accepted into the class. Additionally, each student was required to pay approximately \$2,500 in extra tuition to cover the costs of the Guatemala field experience. This cost included all airfare, transportation, lodging, and food during the trip, and also covered the cost of travel for the two course instructors.

The class was realized as a standard three-credit hour course, with two lecture hours held per week during the semester and the remaining hour completed through the field experience at the end of the semester. The table below shows the list of topics that were covered during the lecture component of the course.

Table 1 – Course Topics

Topic
Introduction to Global Health
Global Health Case Studies
Health Data
Health Economics
Major Disease Conditions
Healthcare Systems & Costs
New Global Health Technologies

The focus of the class involved the relationship between healthcare and technology in a global context, thus the course content included a study of major diseases (e.g., malaria, tuberculosis, and diarrheal disease), types of healthcare systems (e.g., entrepreneurial, socialist, and comprehensive), and socioeconomic considerations (e.g., gross domestic product, health expenditures per capita, and Human Development Index). Additionally, each student conducted an independent literature review of the healthcare status of a foreign country and produced a term paper to communicate the content to the faculty. The students also presented their findings to the class in the form of an oral presentation. For another graded assignment, the students worked in teams to develop technology-based solutions to specific global health issues within economic and material constraints. The resulting design concepts were subsequently described to the class in the form of an in-class presentation. An example of a global health scenario that was assigned to one of the groups can be found in the appendix. In addition to the lecture content on the topic of global health, students were also prepared for the field experience with lectures on the history, current events, and culture of Guatemala. Team-building exercises were also incorporated into the course in order to facilitate the formation of a cohesive group ahead of an intensive field experience.

The course content was delivered exclusively by the course co-instructors. The majority of technical content was delivered by the BME faculty member, whose research expertise involves the development of medical devices for low-resource environments. Specific case studies were included from the BME faculty member's active research projects, as well as from the course textbook, journal articles, and the popular media. The content specific to Guatemala was delivered by the EE faculty member, who had participated in two prior course-based trips to the country involving a business focus. Spanish language training was also provided by this course co-instructor, who had moderate Spanish-language skills. These language training sessions, which were conducted over three hour-long periods during regular class time, included basic

grammar, pronunciation, and conversation. Additionally, students with Spanish language proficiency were encouraged to contribute to these sessions, which led to a dynamic classroom environment.

In order for the course to be approved for offering as an ILP at Western New England University, and satisfy a general graduation requirement for each student, the students were required to demonstrate several competencies common to all ILP courses. Table 2 shows the mapping of the competencies to the assignments and assessment methods. An example of the grading scheme for the health report is shown in the appendix.

Table 2 – Competencies and Assessments

Competency	Assignment	Assessment
Ability to explain or utilize the approach or method of analysis in the perspective	Students will conduct a health assessment of a particular region of the globe via literature review and present their results to the class in the form of an in-class presentation	Rubric for paper Rubric for presentation
Ability to identify key elements of the discipline or perspective area	Student understanding of key issues facing the world regarding healthcare and medical technologies will be assessed through homework assignments and exam questions	Rubric for homework Rubric for exam
Ability to recognize some of the contributions of the discipline or perspective area to contemporary issues, other phenomena relevant to the students' experience or to personal aspirations	Students will write a paper detailing how their particular discipline (engineering, arts and sciences, business, pharmacy, etc.) can contribute to the area of global health, with emphasis on the students' own career aspirations	Rubric for paper
Ability to compare and contrast values and assumptions of a liberal perspective to those from a professional discipline	Interdisciplinary teams will research a healthcare technology application in developing nations, comparing and contrasting the values and assumptions of the technology. Each team will present the results of their research in the form of an in-class presentation.	Rubric for presentation

After completion of exams at the end of the semester, the students and faculty embarked on a 12-day field experience in Guatemala. The timing of the field experience was chosen to not interfere with other coursework and exams, as well as to enable students to return in time for summer internship positions. The field experience was planned and developed by the course instructors in consultation with contacts in Guatemala, including a professor at a local university and the volunteer coordinator at a mission. These contacts, several of whom had worked with WNE in the past on prior course-based trips in the College of Business, provided logistical support such as local transportation and lodging arrangements. Table 3 shows the trip itinerary for the field experience.

Table 3 – Field Experience Itinerary

Day	Agenda
1	Travel to Guatemala, travel to site A
2	Hospital/clinic 1
3	Hospital/clinic 1
4	Hospital/clinic 2
5	Cultural
6	Cultural
7	Travel to site B
8	Hospital/clinic 3
9	Service learning
10	Service learning
11	Cultural
12	Return travel

Throughout the field experience, the students and faculty visited clinical care facilities, such as large regional hospitals and local clinics. These visits were arranged by contacts in Guatemala, and approval was obtained from the facility administrators prior to the visits. During the visits, the students conducted a needs assessment by interviewing and surveying administrators, healthcare workers, and patients at the various facilities. In total, 7 healthcare administrators, 24 healthcare workers, and 74 patients participated. The health assessment was conducted in Spanish in both oral and written formats. The survey instruments, which were approved by the Institutional Review Board (IRB) at WNE, were translated into Spanish prior to the trip by a Spanish language-proficient faculty member from the College of Arts & Sciences at WNE. Additionally, the survey instruments were sent to contacts in Guatemala for their review prior to the trip to ensure that the wording and meaning were clear from the perspective of people living in the country of interest. An example of a survey instrument (prior to translation) for healthcare workers can be found in the appendix. The students were briefed in the ethical conduct of research prior to the trip, and they were required to sign agreements to maintain the confidentiality of the participants and their responses. Additionally, the students were prepared for the health assessment through practice sessions in which they implemented Spanish-language oral interviews of each other under the supervision of the course instructors. The results of the interviews and surveys from the health assessment were tabulated and analyzed by the course instructors after returning from the field experience.

While the health assessment formed the centerpiece of the field experience, a variety of other activities were included. The students attended a lecture given by a Guatemalan professor regarding the state of economic development in the region. Additionally, the students participated in service learning activities at a mission-operated farming cooperative. These activities were designed to reinforce the socioeconomic aspects of global health from the perspective of the Guatemalan scenario, which had been introduced during the lecture component of the course. Several cultural activities were also planned, including visits to a market and a Mayan burial ground.

There were several products required of the students during the field experience. The students maintained daily journals of their experiences as well as an online blog that documented the trip. Additionally, the students were assessed by the faculty members during the field experience regarding teamwork, attitude, and leadership. After returning from the field experience, the students were required to submit a final paper in order to complete the course requirements. The content of the paper included a reflection on the trip and a discussion of how each student's professional skills can contribute to the field of global health.

Results

In order to assess the impact of the new course on student interest and attitudes toward global health, a set of IRB approved pre- and post-course surveys were developed and administered. The pre-course surveys were administered at the beginning of the first lecture, whereas the post-course surveys were completed on the last day of the field experience in Guatemala. In order to maintain confidentiality, each participant was assigned a randomly generated 6-digit number that was used to link their survey results to allow comparison between pre- and post-course responses. All thirteen students in the course completed the pre- and post-course surveys.

The impact of the course on students' knowledge regarding global health issues, interest in pursuing further studies/training in global health, and likelihood in pursuing a career in the area of global health were assessed quantitatively using 5-choice Likert questions (see appendix). A score of zero was assigned to responses indicating not knowledgeable, not interested, and not likely, respectively. Similarly, a score of four was assigned to responses indicating very knowledgeable, very interested, and very likely, respectively. Follow-up questions were also included to ascertain the degree to which the course affected major changes in career choices and interest in traveling abroad. These questions were assessed quantitatively using 4-choice Likert questions (see appendix), where a score of zero was assigned to responses indicating no career involvement and no interest in traveling to a foreign country, respectively. Likewise, a score of three was assigned to responses indicating primary professional area and living in a country for one year or longer, respectively. The Likert questions were analyzed using a one-tailed, paired t-test with a significance level of 0.05 since it was assumed that scores would increase as a result of participation in the course. The results from the analysis are shown in Figures 1 and 2.

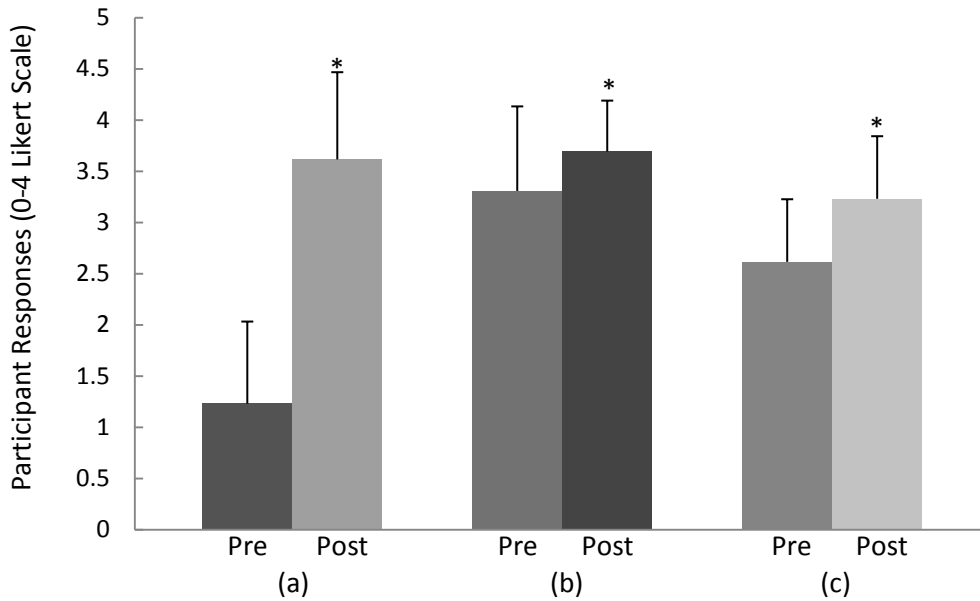


Figure 1. Results from student surveys (Likert scale 0-4): (a) participant level of knowledge regarding global health issues (* $p = 5.22 \times 10^{-8}$), (b) participant level of interest in pursuing further studies/training regarding global health issues (* $p = 0.048$), (c) participant likelihood in pursuing a career in the area of global health (* $p = 0.003$). Results are shown as mean + standard deviation.

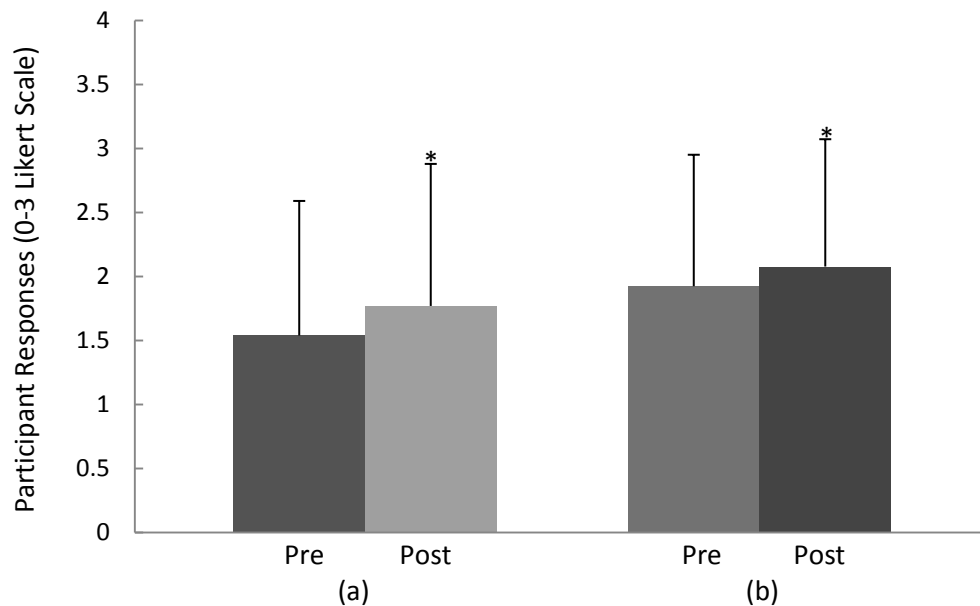


Figure 2. Results from follow-up questions on student surveys (Likert scale 0-3): (a) participant anticipated future professional involvement in global health (* $p = 0.095$), (b) participant realistic level of interest in traveling to or living in a foreign country (* $p = 0.218$). Results are shown as mean + standard deviation.

Qualitative feedback was also used to assess the impact of the course on student interest in traveling abroad and learning a foreign language. The qualitative feedback was obtained through open-ended questions on the student surveys. Students were asked to provide comments on the impact the course had, if any, at the academic, professional, and/or personal level. Student comments included:

In class I learned many things about global health and health problems other countries face, including differences between developed/developing countries... Also made me want to become fluent in Spanish.

This course has allowed me to have a wide range of knowledge in health systems around the world and what some things people are doing to improve them. By going on the trip it brought the knowledge of disease, hardships, citizens, healthcare systems, etc. to reality by seeing it first hand and getting information from the people themselves.

First of all I now am very motivated to learn more Spanish so if I ever visited again I could communicate with the native people more. The trip also really opened my eyes to a whole other culture and it makes me really appreciate what I have back at home.

This trip/course had a large impact on me because I have learned that I would love to live in a country for over a year as a volunteer or for work.

This course really opened my mind to health issues around the world and how lucky we are. I enjoyed this course because it made me realize that I could have an impact by simply spreading what I learned to others.

I've learned a lot! Also I've gained and increased an interest in pursuing a career overseas or perhaps taking my career overseas part time.

This course further increased my drive to learn Spanish and help countries in need in my future.

Discussion

The results from the surveys showed increased student-reported knowledge regarding global health issues after completing the course (mean Likert response increased from 1.2 to 3.6, $p = 5.22 \times 10^{-8}$). The students also reported an increased level of interest in pursuing further studies (mean Likert response increased from 3.3 to 3.7, $p = 0.048$) and careers (mean Likert response increased from 2.6 to 3.2, $p = 0.003$) in the area of global health. It should be noted that the increased interest regarding studies and careers, while statistically significant, do not represent major shifts in student attitudes and potential career choices regarding global health. This result is not unexpected since the students who enrolled in this course are likely to have significant interest in this topic prior to the course beginning, especially considering the financial investment required. The results from the follow-up questions shown in Figure 2 corroborate these results.

At the start of the course, students indicated they had professional interests in global health between advocacy and secondary professional area (mean Likert response = 1.5). Additionally, they were already interested in traveling to multiple foreign countries (mean Likert response = 1.9). These responses were not significantly affected by participation in the course ($p = 0.095$, $p = 0.218$), which could indicate that the course does not result in major shifts in student decisions, especially when the students already have aspirations in these areas. Alternatively, the granularity associated with the 4-choice Likert scale questions could mask the impact of the course. In either case, longitudinal studies with the students are needed to understand the long-term impact on career and travel-based decisions. The student responses to open-ended questions indicate several qualitative outcomes of the course. Multiple students reported a desire to become more proficient in a foreign language. Furthermore, several students mentioned the impact of the field experience on their professional aspirations and global perspectives, including interest in traveling and living abroad.

The course was designed to provide students with opportunities to learn about global health issues from multiple perspectives. During the lecture component, the students were introduced to a variety of global health topics, including major diseases, health economics, and other practical realities of healthcare around the world. The purpose of the Guatemala trip was to provide an experiential learning component to accompany the lecture content of the course. This allowed the students to immerse themselves in a specific global health scenario, which provided a case study while also reinforcing the principles introduced during lecture. Additionally, the course projects and field experience provided opportunities for real-world problem solving in multidisciplinary teams, which is a skill not typically cultivated in the traditional engineering curriculum. Student performance on graded assignments, such as those shown in Table 2, was positive; all 13 students earned an A in the course. This was an unusual occurrence in the teaching experience of both instructors, which is explained in part by the selective nature of the course application process, the small class size, and the high level of student interest in the topic.

The course was made available to any undergraduate student on campus, and was designed to fulfill a general graduation requirement. In the first course offering, students enrolled in the course were predominantly from majors dealing with healthcare: biomedical engineering and pre-pharmacy. In future offerings, a more diverse student population will be targeted, including students from business, basic sciences, communications, etc. Such a diverse student population would be more reflective of the multidisciplinary skill-sets required to address global health issues, and thus could better model the real-world approach to solving such problems. In order to understand how to recruit a diverse pool of students, the students in the first course offering were asked on their pre-course application to describe how they heard about the course. Out of the 13 students in the course, 11 indicated they were personally recruited by a faculty member or student who was familiar with the course. The remaining students heard about the course through advertising on campus, including printed materials and e-mails sent to the entire student

body. As a result of this information, a more targeted recruiting approach will be conducted for the next course offering. This will entail giving presentations to faculty members and students from specific disciplines, thus enhancing the level of personal recruitment.

In addition to providing a learning experience for the particular group of students enrolled in the class, this course provides several other direct and indirect benefits to the faculty and students at our institution. The needs assessment completed during the field experience was used to develop global health projects that are currently being completed by biomedical engineering students in the senior design curriculum. Specifically, one student who went on the Guatemala trip is designing a novel device for training and calibration of ultrasound machines in low-resource environments, which was a need identified as a result of the field experience. It is expected that the results of such projects will be implemented on future trips to Guatemala through subsequent offerings of the Global Health & Technology course. Additionally, students in the next course offering will identify another set of healthcare needs that will be used to generate more design projects, thus engaging the campus community in an ongoing cycle of project development and implementation.

The results obtained from the pre- and post-course surveys represent a short-term measure of the impact of the course on student attitudes and interests regarding global health issues. Follow-up studies are planned to measure the long-term impact of this course on student-centered topics, including whether these attitudes and interests change as a function of time. Additionally, the effect of the course on educational and professional choices of students will also be studied.

Due to the success of the new course, it is expected that subsequent offerings will maintain the integrated format. Additionally, this course may serve as a model for other institutions who wish to bring authentic global learning to their own students at various locations in their undergraduate engineering curriculum. It is suggested that educators who wish to develop similar programs begin the logistical process as early as possible. Development for this course began in March 2010, with the lecture component starting in January 2011 and the field experience undertaken in May 2011. Milestones in the development process included generating course objectives and syllabus, obtaining course approval, establishing contacts for the field experience, conducting logistics for travel, developing course materials, and implementing the lectures and field experience. While these efforts require significant investment on the part of the faculty members developing the course, the impact on the students, the instructors, and the host institution may be substantial.

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Appendix I - Pre/post survey. Note that only the post-survey is shown, as all questions were identical to the pre-survey except for the free response.

Post-Course Survey

Please answer the following questions by filling in the bubble below your selection or, where appropriate, providing a short answer. You are not obligated to answer any or all of the questions, and may stop the survey at any time.

Please rate your current level of knowledge regarding global health issues:

Very knowledgeable				Not knowledgeable	
4	3	2	1	0	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

How confident are you in your ability to develop solutions to global health issues?

Very confident				Not confident	
4	3	2	1	0	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Please rate your current level of interest in pursuing further studies/training (outside of this course) regarding global health issues:

Very interested				Not interested	
4	3	2	1	0	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

How likely are you to pursue a career in the area of global health?

Very likely				Not likely	
4	3	2	1	0	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Based on your current interests, which of the following best describes your future professional involvement in global health:

- Primary professional area – your professional career will involve working to directly solve global health issues
- Secondary professional area – some aspect of your professional career will involve work relating to global health issues
- Advocacy – no aspect of your professional career will involve global health, but you will be involved with advocacy for global health issues
- Do not anticipate any involvement in global health outside of this course

Outside of this course, what is your (realistic) level of interest in traveling to or living in a foreign country?

- I am interested in living (for 1 year or longer) in a foreign country
- I am interested in traveling to multiple foreign countries
- I am interested in traveling to a small number of foreign countries
- I am not interested in traveling to a foreign country

Please comment on the impact this course has had on you, if any, at the academic, professional, and/or personal level.

Please comment on any part of the course that could be improved or changed:

Appendix II - *Handout for in-class Design Activity regarding a global health scenario.*

ILP 296 Global Health & Technology Spring 2011

Design Activity

Instructions:

Work with your teammates to develop a technical solution to the problem scenario described below. Your solution should address:

- How it works
- What it will physically look like
- Training requirements for users
- Cost, materials, etc.

Scenario:

You are designing a diagnostic device to detect malaria in a rural health setting. The device should follow the gold-standard of malaria detection by allowing the parasite to be identified visually in a patient blood sample. Collecting and handling the sample should also be considered. The device must be portable and low cost.

Appendix III - Grading scheme for health report.

ILP 296
Global Health & Technology

Grade report for Health Report Paper

Student Name: _____

- | | |
|--|-------|
| 1. Proper focus & coverage of topic areas [40] | _____ |
| 2. Grammar [10] | _____ |
| 3. Professionalism of writing style [10] | _____ |
| 4. Format/references [5] | _____ |
| Total (65 pts) | _____ |

Comments:

Appendix IV - *Health Assessment survey instrument for healthcare worker prior to translation, including information sheet.*

Guatemala Health Assessment

You are being asked to take part in research to assess the state of healthcare in your community. Our findings may be published so that others can learn what areas of healthcare need to be addressed in Guatemala.

Please complete the survey below. Do not put your name on the survey; this will ensure that your answers remain confidential. You do not have to answer any or all questions, and you may stop taking the survey at any time, for any reason. The survey should take no more than 15 minutes to finish.

Please check one of the boxes below.

I AGREE to participate in the research described.

I DO NOT AGREE to participate in the research described.

If you have questions about the research, please contact the program director at the address below.

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If you have questions or concerns about the conduct of the research, please contact

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Chair, Institutional Review Board
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Health Assessment Instrument 1 – Healthcare Worker

Demographics:

1. What is your age?

18-24

25-34

35-44

45-54

55-64

65+

2. What is your gender?

Male

Female

3. What community do you live in?

4. What is the highest level of education you have completed?

No formal education completed

Elementary school

Middle school

High school

College

Graduate school

Background:

5. What is your level of medical training?

6. How many years have you been practicing medicine?

7. How many years have you worked at this hospital/clinic?

8. What are your areas of medical practice? Check all that apply.

Internal medicine

Family practice

Pediatrics

General surgery

Emergency medicine

____ Other (please provide):

Patient-centered questions:

9. How many patients do you see at the hospital/clinic each day?
10. What is the geographic size of the region served by the hospital/clinic?
11. What are the most commonly treated illnesses in your practice?
12. How do you keep patient records?

Infrastructure/Resources:

13. What medical equipment do you use in your practice?
14. Do you work with other healthcare workers on a daily basis? If so, how many and what type?

Summary

15. Rank the following issues according to their impact on your medical practice, with 1 being the biggest problem.

- ____ Economics
- ____ Physical resources
- ____ Human Resources
- ____ Training
- ____ Time
- ____ Other (please provide):

16. Please describe the problem that you ranked as #1 in question 15.