

# Future of Higher Education

a Study on Community-Based Project-Based Learning at WPI

An Interactive Qualifying Project  
Submitted to the Faculty of  
Worcester Polytechnic Institute

## Authors:

Anqi Shen

Cynthia Teng

## Advised By:

Curtis A. Abel

Katherine C. Chen

Arthur C. Heinricher

## **Abstract**

Higher education in engineering in the future will produce engineers that not only solve problems but also prevent more problems resulting from these solutions. To accomplish this, *world-readiness* and *self-actualization* of the engineering students should be stressed.

Community-Based project-based Learning (CBL) is proposed to achieve these two elements, and the feasibility of increasing CBL at WPI is discussed in this project. Students, faculty, and community members were involved in this exploration of creating the future of higher education at WPI.

# Executive Summary

This project explores the future of higher education, specifically at Worcester Polytechnic Institution (WPI). By looking into the predictions made by scientists and futurologists for 2050, we concluded that STEM education, and engineering education in particular, should develop both social awareness and personal development. To produce competent engineers for the future, two elements of higher education in engineering should be further stressed: *world-readiness* and *self-actualization*. After comparing several current curricula, we hypothesize that Community-Based project-based Learning (CBL) curriculum can better prepare engineering students. In CBL, students work on problems that community members bring, with not only technical knowledge and necessary skill sets like communication but also motivation, connections with community groups, and mindfulness to give back to society. The CBL curriculum involves students, faculty, and community members as the main stakeholders of the study.

WPI currently practices a Project-Based Learning (PBL) curriculum, within which some programs already involve community-engagement to various degrees. One unique feature of the WPI curriculum is the Interactive Qualifying Project (IQP), a nine-credit team project usually completed in the student's third year. In 2017-18, more than 70% of students complete this project at one of WPI's off-campus project centers and the project they complete is sponsored by a local business, government, or community organization (WPI, 2019d). Many students, faculty have experience with CBL, and some local and global communities have partnered with WPI on projects. However, in the 135 credit hours required for graduation, only 21 credits are entirely project work. The IQP accounts for 9 of these credits and so if this project is the only community-based experience, then less than 7% of a students academic work could be called

community based. It may be possible, and valuable, to connect more academic work, including courses, with community partners.

To explore the three stakeholders' opinions on their past experience with community projects and the feasibility of further integrating CBL within the current WPI curriculum, we designed focus groups or interviews for each of the stakeholder groups. Within the scope of this project, we conducted focus groups for the students and interviews for faculty; the community member focus groups will be conducted in the fall of 2019. From the data collected from student focus groups, we concluded that students thought that CBL helped them contextualize knowledge learned in classes and prompted them to apply it to real-world problems. Not only did CBL contribute to students' academic and professional development, but it also aided the self-actualization process. Faculty agreed with these benefits of CBL in their interviews.

To improve the current community-based projects, as well as further integrating CBL, we asked both the students and faculty to describe some of the major challenges they encountered when working with communities on projects. The frequently mentioned challenges were:

- Students were frustrated by the conflicting requests from the advisors and community members, which made them more hesitant to work on community-based projects.
- Seven-week terms were too short for students to learn and reflect from CBL.
- Faculty experienced difficulties balancing between ensuring the achievement of student learning outcomes and the community sponsors' needs during CBL.
- Certain learning contents might not fit into CBL or the fundamental "technical" content would not be thoroughly taught by CBL.

- The current grading criteria could sometimes fail to evaluate the efforts of the students' during CBL.

When prompted to solve these problems and promote CBL at WPI, the two stakeholders produced these recommendations:

- Faculty should communicate the learning outcomes and the expectations with their students before the beginning of the projects.
- Community-based projects could become more outcome-driven so that students could achieve all the learning outcomes without feeling rushed. This may be achieved through modifying the credit and grading conventions to better represent skills obtained in projects.
- WPI should build an online platform where communities could post their problems and propose projects.
- WPI should encourage faculty and community members to discuss and document some key elements regarding the project before involving students.

These suggestions, if implemented, could improve CBL experiences for students, faculty, and community members, and eventually, increase CBL on WPI campus.

Beyond the focus groups, interviews, and the report, we also proposed an annual workshop program that will invite the main stakeholders of higher education to discuss the future of WPI. This workshop program was developed to expand the conversation at WPI about how higher education could better prepare for the future. The results from the workshop are to engage the stakeholders in discussions about higher education and to collect data from these discussions to aid the decision-making process for the future of WPI. The first workshop was held during

WPI's Winter Session in January 2019 and focused on CBL. Participants of the workshop thought the program was very engaging, and they would like to attend similar workshops in this program. The data collected from this work agreed with the findings from the focus groups and interviews, which supported that the workshops could be useful for gathering information, with the added benefit of being less time consuming comparatively. The workshops also offer a more participatory way of engaging the stakeholders to co-design the future of higher education. Therefore, we recommend WPI continue to run this workshop program annually. Finally, we hope that future researchers will continue to study and modify WPI's approach to CBL and keep WPI constantly thinking of the changes in higher education and society.

# Table of Contents

Abstract .....	i
Executive Summary .....	ii
Table of Contents .....	vi
List of Figures .....	xi
List of Tables .....	xii
Introduction.....	1
1. Background.....	5
1.1 Future of Higher Education in 2050: the Needs, the Forces, and the Challenges ....	5
1.1.1 Development in 2050.....	5
1.1.3 Current Engineering Culture and the Challenges .....	8
1.1.4 Changes in Engineering Competency .....	10
1.2 Existing Educational Models .....	13
1.2.1 Portfolios for Learning.....	13
1.2.2 Project-Based Learning and The WPI Plan .....	18
1.2.3 Service Learning .....	21
1.3 Stakeholders .....	28
2. Methodology.....	29
2.1 Overview.....	29

2.2 Focus Groups .....	30
2.2.1 Advantages and Disadvantages.....	31
2.2.2 Progressive method.....	32
2.2.3 Institution Reviewing Board (IRB).....	33
2.2.4 Student Focus Group.....	34
2.2.5 Faculty Focus Group.....	35
2.2.6 Community Member Focus Group .....	37
2.3 Annual Workshop Program .....	38
2.3.1 Purpose of the Annual Workshop .....	38
2.3.2 Other Future of Higher Education Workshops .....	39
2.3.3 Goat Tank Challenge .....	40
2.3.4 Developing the First workshop.....	40
2.3.5 Constraints of the Program .....	44
3. Results and Analysis .....	45
3.1 Student Focus Groups .....	45
3.1.1 Overview .....	45
3.1.2 World-Readiness and Self-Actualization.....	46
3.1.3 Connection with the Communities.....	52
3.1.4 Mentorship.....	54
3.1.5 Challenges of CBL.....	57



3.2 Faculty Interviews.....	59
3.2.1 Overview .....	59
3.2.2 Student Development.....	60
3.2.3 Challenges with Expectations .....	63
3.2.4 Expansion of CBL at WPI and Challenges.....	64
3.3 Winter Session Workshop.....	68
3.3.1 Overview .....	68
3.3.2 Findings from Goat Tank.....	68
3.3.3 Findings from Workshop .....	70
4. Discussion and Recommendations .....	72
4.1 Summary of key findings.....	72
4.1.1 The Benefits of CBL.....	72
4.1.2 Challenges for Further Integrating CBL .....	73
4.2 Recommendations for WPI.....	74
4.2.1 Internal Changes .....	74
4.2.2 External Connections .....	77
4.2.3 Annual Workshop Program on Future of WPI .....	79
4.3 Suggestions for Future Research .....	80
4.3.1 Community Members Focus Group.....	80
4.3.2 Conducting Annual Program .....	80

4.3.3 Grading Criteria .....	80
4.4 Project Conclusion .....	81
5. Citations .....	82
Appendices.....	89
Appendix A – Student Focus Group Consent Form .....	89
Appendix B - Student Focus Group Screener Questions.....	90
Appendix C – Students Focus Group Handout.....	91
Appendix D – Student Focus Group Questionnaire .....	92
Appendix E – Faculty Focus Group Questionnaire .....	93
Appendix F – Community Member Focus Group Questionnaire.....	94
Appendix G -Trivia.....	95
Appendix H – Role Play Characters .....	96
Appendix I - Winter Session Survey .....	100
Appendix J – Student Focus Group Demographics.....	101
Appendix K – Student Focus Group Notes.....	102
Student Focus Group 1.....	102
Student Focus Group 2.....	103
Appendix L – Faculty Interview Notes.....	107
Faculty Interview 1 .....	107
Faculty Interview 2 .....	108

Faculty Interview 3 ..... 109

Faculty Interview 4 ..... 111

Appendix M – Workshop Photos..... 114

Appendix N – Workshop Posters..... 116

## List of Figures

Figure 1 Workshop Photo 1 .....	114
Figure 2 Workshop Photo 2 .....	114
Figure 3 Workshop Photo 3 .....	115
Figure 4 Workshop Photo 4 .....	115
Figure 5 Workshop Poster 1 .....	116
Figure 6 Workshop Poster 2 .....	117

## List of Tables

Table 1 Stakeholders' Current Needs and Future Needs.....	28
Table 2 Student Focus Group 1 .....	101
Table 3 Student Focus Group 2 .....	101

# Introduction

The future is uncertain; however, we are confident that in 2050 engineering will continue to have a significant role in society. Challenges of the future, such as global warming and overpopulation, require future engineers to work together and be effective, creative, and considerate of both the technological and social impact of their work. To be prepared for future challenges, institutions of higher education should prepare students, engineers-in-training, with a modern community-based approach. This way, students will develop a better understanding of social contexts, and social awareness in of the problems they solve for clients and communities.

The current world population is about 7.7 billion people and it is estimated that by the year of 2050, the world's population will reach 9.7 billion people (United Nations, 2015). A drastic increase in population for groups in less developed areas will lead to the lack of proper natural resources: a study by the World Wildlife Fund (WWF) warns that "increased demand combined with climate change will leave two-thirds of the planet living in water-stressed regions by 2050" (Krchneck & Sara, 2017). The United Nations and many other organizations, including groups of engineers from remote and local sites, have been fighting against water shortage and unsanitary water in rural areas for many decades. Yet one of the major challenges they face is not about finance as many may assume but about the maintenance of the water systems. According to a report from The International Institute for Environment and Development, over 50,000 water supply points are not functioning across rural Africa because they are not maintained or repaired when broken (Skinner, 2009). The report's author, Jamie Skinner, suggested that the new systems were usually built without consulting or training the local people for repairing and maintaining the technology.

Such examples where the "solved" problem either keeps growing or turns into many other issues is fairly common. This usually results from the lack of considering social impacts, such as

cultural differences and economic barriers. As more challenges await in the future, engineers should be able to take on the responsibility of solving not only the technical issues but also considering social justice in order to actually create sustainable value for society. The system of higher education, therefore, should improve the curriculum to prepare students with the new skills and mindsets towards a more well-rounded global citizen. Higher education, especially in engineering, faces the challenge of producing students who are experts in their field who are also able to solve real problems in the real world. In Scott Harley's book *The Fuzzy and The Techie* from 2017, Harley describes a polarized culture of the humanities students, the fuzzies, and the engineering students, the techies, at Stanford University to describe a broader problem in society (Harley, 2017). Harley argues that research in the humanities are no less significant than the research in science and engineering (Harley, 2017). He lists people who majored in the humanities who were identifying social needs, gathering resources, finding cheap and accessible technical help, and building successful businesses. Harley argued that the fuzzies are more successful because a higher education in the humanities gave them the mindset to create value. The arguments in *The Fuzzy and The Techie* challenge higher education in engineering to make the engineer of the future more competitive and help them create more value for the world.

Over the past 50 years, WPI has aimed to prepare its students through its pioneering Project-Based Learning (PBL) strategies (Landry & Cruikshank, 2015), where students learn not only about science and engineering but also develop skills such as communication and teamwork, through projects. While PBL already prompts students to work in teams on various projects that they are interested in and to apply classroom knowledge to practical applications, the social and global perspectives should be further emphasized. Current projects, even though various scopes of focus exist, more students tend to focus on developing professional and technical skills. We believe that there could be more emphasis on utilizing the projects to add value to communities. We propose that

WPI students engage in more world-relevant experiences to become better global citizens where the team structure and advising include community members in a significant way. Therefore, community-based project-based learning (CBL), as an integral of the current project-based learning curriculum, would stress the humanitarian aspects of the projects to improve the quality of people's lives.

We aim to make WPI a campus that is constantly engaged in rethinking the purpose of higher education and adapting the learning programs to changes and challenges that the world brings.

Given the setting, the goal of our project is to assess the benefits and challenges that the primary stakeholders (student, faculty, and community member) currently experience with CBL, and make recommendations for improvements so that there will be more CBL at WPI. We can meet this goal by addressing each of the following objectives:

1. Conduct focus groups with student, faculty, and community member to gather their opinion towards the current state of CBL at WPI.
2. Develop a workshop at WPI to brainstorm what future of higher education should be like.
3. Deliver recommendations to the school's CBL experiences for three main stakeholders.

We hope this research will be a step toward improving students' learning experience increase graduates' competency and prepare them better for future challenges. We think that CBL will help students develop and practice their skill sets, and further help their self-development as they learn and solve the problem. We hope that our recommendations on CBL will help students, as well as faculty and community members, to have better experiences learning, teaching, and empowering each other, and thus, produce more competent engineers in the future.





# **1. Background**

## **1.1 Future of Higher Education in 2050: the Needs, the Forces, and the Challenges**

This chapter discusses the possible changes of context and the challenge for higher education, particularly in the engineering field, in the year 2050, and how this may affect different groups of stakeholders. It will also address the gap between the expectations for engineers and the goals of current higher education for the future.

### **1.1.1 Development in 2050**

In order to predict the future of higher education in engineering, one must look into the future of the world. Engineers have been changing the world by turning conceptual knowledge to practical tool that solve human problems. From wireless radio to autonomous cars, the newest gadgets not only bring excitement but also shape how people live. In other words, the development of technology facilitates and powers change in society, the economy, and the environment. Higher education can be the incubator for the future engineers who can and will make changes for the better.

The trends of technological development have always been a hot topic among the futurologists. These experts make scientific predictions based on historical data and often have decent accuracies. They believe that technologies will be even more integrated into humans' daily lives, changing the society in 2050. Ian Pearson, a futurist with an 85% accuracy record, believes that technology will develop new types of clothes that could give people superhuman skills in the next 10 years and that people could start using robots to do work around their house and provide companionship starting in 2030 (Muoio, 2016). His hypotheses are mostly based on many industrial companies' plans. For example, Toyota had already announced its plans to build robots geared

towards assisting people around the house. The technology trends in the future, according to Pearson, will be human-centered and advanced technologies will become more available to the public and eventually blend into people's lives. Meanwhile, anthropologist Amber Case has a similar view but is more worried about the potential damage to human society. She explains the relationship of human beings and technology in her Ted Talk, where she refers to most people as "cyborgs" because they rely on "external brains" (cell phones and computers) to communicate and remember (Case, 2010). She expresses the concern that people are no longer interested in nor have the time to invest in self-reflection because of the distractions of an instantaneous button-clicking culture. Teenagers, especially, could fail to connect with the external world. And therefore, it is likely that human interactions and connections will eventually migrate to the Internet created by people. Both opinions are valid and well-supported, and the engineers will have to decide what the next gadget will be to not only satisfy the consumers but also be responsible for the society the gadgets create. Higher education institutions will need to discuss the ethics and impacts of technology in addition to basic science and engineering skills.

In the future, technology may create opportunities for socio-economic changes. Many foresee the future of the education system to be more accessible and directed to train future professionals who would contribute to social development and the "common good." In the Khan Academy presentation of *Year 2060: Education Predictions*, Salman Khan predicts that there would be fundamental changes in the traditional education system: the disappearance of classroom structure, replacement of seat-time based credentials, new roles for teachers as mentors, and higher global literacy rate (Khan, 2011). These predictions include and further expand to social changes. The needs for physical labor would be replaced by machines development, and the needs for human mental labor would start to be replaced by artificial intelligence, referring to those will be in charge of the "frontier," pushing art, innovation,

and creativity. And a higher global literacy rate could potentially bring economic and social growth to society, for example, people who did not have access to higher education will have the opportunity to explore their potentials in the future and make a change to the unprivileged groups he or she comes from, which would form a positive feedback loop that continuously eliminates the economic and education level gap. The need and search for talents to help sort out economic and environmental challenges in the future might also lead to a twist of culture on the immigration side. Economist Ian Goldin, in his Ted Talk entitled *Navigating our Global Future*, describes the changing of dynamics that will develop and argues that “the xenophobic concerns of today, of migration, will be turned on their head” (Goldin, 2009). Therefore, the higher education system in the future of 2050, at a macro level, will be expected to develop a bridge between the accelerated growing technology and human cultures, economies, and societies.

Technology and engineers have tried to fix the environmental issues caused by earlier technological developments. One of the most concerning environmental issues is energy the shortage. However, the futurologists are making optimistic predictions: people won't need to use fossil fuels to power things on the ground anymore in 2050. The ability to draw solar energy from areas with more access to the sun, like the Sahara Desert will increase people’s reliance on solar power over time, and eventually, solar energy will be able to power the many countries. In addition to solar energy, other sources of energy such as nuclear fusion will replace current technologies. In 2016, a team of scientists from China's Institute of Plasma Physics announced that their own nuclear fusion machine has produced hydrogen plasma at 49.999 million degrees Celsius and held onto it for an impressive 102 seconds (Kilbride & Xiao, 2018). Although the energy crisis may be solved soon, there are still other problems such as pollution and climate change. Some futurologists claim that with such a high pace of technology development, it is very likely that before environmental issues become a threat to

human species, technology will provide sustainable solutions that eliminate the tension between humans and nature. That being said, not only do higher education institutions need to produce graduates who can solve these problems, but they will also should train engineers that will not cause more environmental problems. Some claim that system engineering should be emphasized to balance the relationship between man and nature to build a sustainable living environment.

Technological advancements impact social, economic, and environmental changes, as well as the goals of higher education in STEM fields. Since higher education acts as an engine for technological developments by feeding the future with creative minds, the institutions should listen to the needs of the future in order to better prepare the students. Currently, interdisciplinary problem solvers are needed to deal with social issues; for a better future, the engineers should foresee the potential humanitarian problems and make holistic decision about the products they create. WPI is unusual in its approach to interdisciplinary work and has been quite successful in developing interdisciplinary programs such as Robotics Engineering started in 2007.

### **1.1.3 Current Engineering Culture and the Challenges**

Engineering has been a profession since the fourteenth-century, while in the earliest days, the description for the profession was “a constructor of military engines” or “one who designs and constructs military works for attack or defense” (OED, 1989). The emphasis of engineering professions today, however, is placed on serving society with technology development in many fields. According to ABET (formerly the Accreditation Board for Engineering and Technology), engineering is the profession “in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind” (ABET, 2019). With this shift in the definition of engineering, the public view of engineering as well as the value the profession is creating

has been changed significantly over the years. Yet compared with the rapid development of technology and social environments, the rate of change in the engineering curriculum is slow and still reactive, and from the gap, challenges start to emerge.

One of the major challenges that engineers face today is convergent thinking and its limitation. This refers to how engineers tend to jump into the core of the problem and explore a technical solution in depth, while professionals from other fields tend to stretch the problem to different, adjacent aspects. Alice Pawley, assistant professor of engineering education at Purdue University, used data from the National Science Foundation and interviews with working engineering to establish that most engineers work in private for-profit organizations and on industrial, commercial, and military problems (Pawley, 2007). While most engineers are embedded in military or corporate organizations and work on large-scale systems, a culture within engineering has been developed where engineers rarely question authority and follow the hierarchical military and corporate organizations. The culture was then naturally integrated into the learning curriculum for engineers to meet the need of graduates' employment. Donna Riley, Head of the School of Engineering Education at Purdue University stated in her book *Engineering and Social Justice* that "engineering students learn to think analytically only in certain ways appropriate to technical analysis," and she followed up with an example that when engineering students are given a problem, their training routine guides them to start solving the problem immediately instead of thinking critically of why the problem was given in the first place (Riley, 2008). The reason behind this, as Riley argues, was that the students are too busy learning the techniques of problem-solving. As the focus is always to seek the optimal technical solution, the larger context of the problem as well as the broader impacts of the solution will usually be ignored. Thus, the importance of learning critical approaches from the humanities and social sciences for engineering students has been stressed in many pieces of research. Eddie Conlon even argues in her commentary

on *Social Responsibility in French Engineering Education: A Historical and Sociological Analysis* that “engineering needs to look beyond the corporate world and engage with the wider community in defining appropriate goals and content for engineering education which would focus on meeting the needs of society,” in order to develop technologies which meet these needs and promote human flourishing (Conlon, 2013).

### **1.1.4 Changes in Engineering Competency**

Over the last century, the engineering curriculum of higher education focused on training future engineers with technical expertise and knowledge to increase their employability. And over the past years, we could see the content of employability shifts its focus toward some new skills. The current research showed that potential employers wanted to hire applicants with strong interpersonal skills; according to Marcel M. Robles’ report *Executive Perceptions of the Top 10 Soft Skills Needed in Today’s Workplace* in 2012, these non-technical skills were so important that “they are ranked as the most important for potential job hires in many occupations and industries” (Robles, 2012). The so-called “soft skills,” also known as non-cognitive skills, could be defined as character traits and behaviors with which people interact with others or lived their lives accordingly. One key feature for soft skills, identified by Robles, was that “unlike hard skills, soft skills are interpersonal and broadly applicable,” and the value of such determines business success, as many employers believed. And to react to the increased need for an understanding of the social impacts of engineering, there have been attempts to change the engineering curriculum: in 2000, ABET changed their criteria for accrediting engineering programs to require the development of non-technical capacities, such as the “ability to function on multidisciplinary teams” and “ability to communicate effectively” as part of students learning outcomes (ABET, 2018). WPI was one of the first universities reviewed under the new ABET criteria. The extent to the ABET criteria are addressed varies from program to program, and

more innovative learning models will be explored in the following chapter. However, as E. Conlon emphasized in *The New Engineer: Between Employability and Social Responsibility*, “a focus on employability skills alone will not give engineers the capacities required to reflect critically on the structure of work and the manner in which the rewards of productive activity are distributed” (Conlon, 2008). The focus on employability, in many engineering learning curricula limits engineers’ capability within their workplaces and ignores the wider social context.

Both the changes in the definition of engineering competency and the changing of the engineering curriculum suggests that the society and its future is dependent on the profession, and it requires future engineers with more social responsibility. They will solve problems that address more than technology, but higher education will be expected to produce engineers with professional skills, soft skills, and more importantly, engineers who are able to think independently, critically and care about the society.

#### **1.1.4.1 Self-actualization**

Self-actualization is a concept that was first introduced by the psychologist Kurt Goldstein for the ability to realize one's full potential. The concept was then further developed by Abraham Maslow in his description of a hierarchy of needs: the final level, *self-actualization*, is achieved when all basic and mental needs are essentially fulfilled and the "actualization" of full personal potential takes place (Maslow, 1954). In our definition, which is applied to the engineering learning experience, self-actualization occurs when certain criteria are all meet:

- the individual is able to fully understand his or her own talents, core strengths, and development areas;
- the individual has discovered his or her passion and a lifelong goal;
- the individual feels motivated and willing to work toward the goal;



- the individual feels connected to the outside community and feels comfortable communicating with that community.

Deep feelings of empathy and positive affiliation with human beings are important in our definition of self-actualization. According to Maslow, individuals who are self-actualized have a greater capacity to identify with others and form stronger relationships (Maslow A., 1943). As a consequence, many researchers find that self-actualization allows more-effective communication as individuals have greater depth to their understanding of their shortcomings, and as mentioned above, communication skills are a key expected outcome of the engineering curriculum (Franzenburg, 2009). In addition to communication skill, many other expectations of future engineers are included in the self-actualization concept. Michaela Neto, in her article *Educational motivation meets Maslow: Self-actualization as contextual driver*, state that the ultimate objective of education is to reach a state in which “acts of kindness and goodwill are undertaken in everyday life to benefit human society” (Neto, 2015). She believes that education can be considered a route by which individuals achieve esteem needs through finding a purpose in society, and individuals who engage in a suitable learning curriculum would be more likely to reach self-actualization and become more capable and willing to give back to the society. In other words, the pursuit of self-actualization could allow engineering students to focus more on their surroundings during the search for purpose. Once they feel more connected with society, it could be easier to understand the needs, and natural for them to take on the responsibility to empower and develop society.

The concept of self-actualization has never been officially adapted to the engineering curriculum of higher educational institutions, but it could potentially become one of the criteria for future engineers.

## **1.2 Existing Educational Models**

To develop a curriculum for WPI that can help students achieve self-actualization, we explored current pedagogies that focus on student development. Three existing education models, *portfolios for learning*, *project-based learning (PBL)*, and *service learning* are practiced by many higher education institutions. Among these three, portfolio for learning establishes the foundation for evaluating engineering competency through portfolios, rather focusing on exams and grades, and allows the students to explore the subjects that they are interested in. This method offers opportunities to personalize higher education for individuals to discover their core strength and areas for development. PBL targets complex problem-solving skills that require students to both develop and apply knowledge in context, which enhances the learning experience with the added benefits of developing other professional skills, such as communication and teamwork skills. The element of community engagement in service learning connects students with outside community partners. Through solving problems for communities, engineering students will be prompted to consider the humanitarian and ethical aspects of a technical challenge. By analyzing these three current models, we hope to shed some light on the development of a new curriculum that focuses on community-based project-based learning.

### **1.2.1 Portfolios for Learning**

Portfolio for learning at the higher education level requires students to collect evidence that they have developed various skill sets that contribute to their career goals in a professional portfolio. These portfolios could include work that demonstrates the student's competencies in key areas. When used for educational assessment, portfolios usually require an additional measure of personal reflection on the personal impact of the work completed. This method of demonstrating achievements is widely accepted in some areas of the professional world and could be adopted as the core curriculum of

higher education. According to the 2007 article, *Portfolios for Learning, Assessment, and Professional Development in Higher Education*, by Klenowski, Askew, and Carnell, portfolios for learning should “identify a focus relating to professional practice, collect evidence of competencies and skills, reflect on professional and personal learning, incorporate a relevant literature review, and identify issues for professional practice” (Klenowski, Askew, & Carnell, 2006). Most importantly, the case studies conducted by Klenowski, Askew, and Carnell found that learning portfolios must be actively driven by the students rather than being enforced by the instructors. Connecting the dots between different sets of knowledge, the students would reflect on their learning progress by creating these portfolios, and the reflection process was considered the key to better learning.

#### **1.2.1.1 Responsibility of Learning**

The learning portfolio approach to higher education underscores students’ participation in active learning, which would require the students to take responsibility for their own portfolio. In other words, the students would personalize their education by collecting skill sets that could help them reach their personal career goals. Giving the students the power of being in charge of their own learning has been proved effective. In *Learner-Centered Teaching* by Maryellen Weimer, the first two principles of effective student engagement were: “teachers let students do more learning tasks” and “teachers do less telling so that the students can do more discovering” (Weimer, 2013). These two principles emphasize that in order to lead students toward active learning, the teachers should allow them more power to learn by themselves. In a classroom, the teachers might offer all the information they believed to best help the students understand the subject, yet the effectiveness of the class would be measured not by how much material the teacher taught, but by how well the students learned. When teachers adopted the learner-centered teaching, they “balanced the power” (Weimer, 2013) between

the teachers and the students, where the students would no longer be learning for the teacher, but learning for themselves.

The pedagogy of learner-centered teaching could be extended beyond the classroom to higher education curriculums. For example, the degree requirement could be more competency based rather than credit hour based, where students would prove that they were proficient in a list of skills with a portfolio of courses and projects. With basic knowledge and learning skills from K-12, college students should be able to explore and discover the skills which they needed to learn. Klenowski, Askew, and Carnell studied the learner-centered teaching in learning portfolios and summarized:

“Learning portfolios are driven by learner agency, so effective learners take responsibility for their own learning. Through the learning portfolio, participants monitor and review the effectiveness of approaches and strategies for their own goals and for the context.... the learning portfolio is drawn on as a way of promoting learning in coursework evaluation. The learner draws on their record to demonstrate understanding, shifts in learning and meta-learning processes. The learning portfolio helps participants understand their learning and assists the planning, monitoring, and reflections on learning” (Klenowski et al., 2006).

Not only would the learning portfolio guide the students to take responsibility for their learning but also encourage students to discover a personal purpose for their studies. To develop the portfolio, the student must identify a goal and research the paths to achieve their goal. During this journey, students might further discover themselves and become self-actualized along the way.

### **1.2.1.2 Online Education**

This idea of portfolio learning was used in traditional classrooms in higher education, but was quickly adopted by new media. With the rise of online education programs like Khan Academy and Coursera, more people, despite their different ages, could sign up for classes with a simple internet connection. By searching for courses and videos online, the students were already actively engaged in the learning process. The online students often take the classes because of curiosity or career advancement plans, which gave them purpose to add more skills to their portfolios. As a result, the

online classes translate to specific competencies that showcase the students' achievements. According to a survey done by the Learning House in 2013 on 1500 students who completed at least one online class, among which 44% were able to acquire more desirable positions, 45% had increased in salary, and 36% received promotions (Learninghouse, 2013). To enhance the connection between skills learned through online courses and career development, Coursera, one of the most well-known online education platforms, allowed students to directly share class certificates on their personal LinkedIn profile (Coursera, 2019). Employers and headhunters could directly access these certificates when they shopped for human resources.

The high acceptance of portfolios in the professional world facilitated the popularity of learning portfolios among students. Salman Khan, founder of Khan Academy, explained in his Youtube video *Year 2060: Education Prediction* why he believed that the future of education, not limited to higher education, might produce portfolios rather than GPAs (Khan, 2011). Skills could not be measured by the traditional grading scale. For example, a doctor could only be capable or not capable to operate on patients, instead of being barely capable for getting a C in the corresponding course work. Thus, the portfolio should be valued over the GPAs because it could honestly reflect the work one would do. In Khan's vision, the education system would no longer be linear, meaning that students would be grouped by skills and interests rather than age groups. This idea was supported by Sir Ken Robinson in his TED talk about changing the paradigm of education, where the production line-like school system amplified conformity, killing the creativity, or more specifically, "divergent thinking" in the young generation (Robinson, 2009). They both agreed that having more personalized education would benefit the students individually and collectively. The learning portfolio allowed students to identify the subjects they are interested in, and online education made education resources more accessible to those who were seeking them.

### 1.2.1.3 Reliability of Portfolios

Since portfolios could demonstrate a person's competencies through past experience and relevant comments, which were mainly objective data, the reliability of a portfolio might need to be ensured by certain standards. Unlike GPAs or standardized testing scores, two portfolios could be difficult to compare side by side. However, in order for schools to adopt such a structure, the teachers would have to make sure that each student would be evaluated fairly and consistently (e.g., against a rubric). The UK Staff and Educational Development Association, a professional association encouraging innovation in higher education, made standards to the portfolio assessment. While the teachers were still required to offer evidence and commentary, they were also asked to provide two additional elements when they propose a course involving learning portfolios:

“The first of these elements is a statement of the outcomes that a course participant must achieve in order to be accredited. These outcomes are relatively open accounts of what a teacher does—they include planning courses and classes, teaching and assessing student work. The second element is an account of the principles and values that must be shown to underpin the work of a teacher. These include an understanding of how students learn, commitments to student learning and to scholarship, and a concern for equality of opportunity” (Baume et al., 2010).

To test the consistency of this assessment method, Baume and Yorke performed a case study, where they invited 75 judges to evaluate 53 portfolios and compared the difference between the grades would give. Through the experiment, Baume and Yorke found that two judges for each portfolio were sufficient to determine the overall quality; a third judge may be needed in case of severe disagreement between the initial judges. Because inviting the third judge could lower the efficiency of the assessment, Baume and York recommend detailing specific expectations and providing thorough judges' trainings. Thus, it would be feasible for schools to assess student portfolios in a fair manner when expectation was clearly communicated, and the assessors were adequately trained.

#### **1.2.1.4 Synthesis of Portfolio for Learning**

The core of portfolio for learning was to allow the learners themselves to find subjects that would interest them or contribute to their career goals. This purpose-driven pedagogy would encourage students to learn for their own sake, as well as help them develop lifelong learning habits. Many higher education institutions already implement this method by offering electives, concentrations, career development centers, and e-portfolio resources. The acceptance of portfolios in the professional world also re-enforced the adaptation of portfolios in college. However, one might argue that the learners need guidance and mentorship while creating the portfolio so that their visions and plans align with reality. Meanwhile, there must be core values and skill sets, such as critical thinking, required by schools to set up the foundations of the learners' higher education. Providing guidance and identifying these necessities for the future are higher education's responsibilities to prepare the students for the future.

### **1.2.2 Project-Based Learning and The WPI Plan**

#### **1.2.2.1 Project-Based Learning (PBL)**

Project-Based Learning (PBL) is an innovative, student-centered teaching approach where the content is taught through projects. Projects would usually involve complex and challenging tasks that the students solve within teams. The instructor acts as the facilitator and assists students. This pedagogy solved the controversial debate of whether “knowing” or “doing” should be the priority of education by integrating both: students learned knowledge and elements of the curriculum but also apply the knowledge to solve authentic problems and produce results that matter. In one British study, over the course of three years where one group of students were taught in traditional curriculum and the other through PBL, the result showed that three times as many PBL students achieved the highest

possible grade on the national exam than the students in the traditional classroom (Bell, 2010). This supports that elements in PBL lead to better learning progress in traditional contents.

PBL also promotes social learning as students practice the skills of communicating, cooperating, and problem-solving through the process, which the traditional learning curriculum lacked. For example, the student-driven projects benefit from allowing more independence in students' different learning styles and their decision-making skills, for they would determine the approach for the problem and plan in a timely manner. Students learn and become more responsible through PBL; for most of the times, they must use their work time effectively and stay focused on-task in order to succeed, and the goal in PBL is usually more defined and relevant so that students are more motivated. In conclusion, it has been demonstrated that PBL impact students' skill set development, as well as academic competencies.

In the science field, the K-12 education system had already started to adopt PBL; their experience may shed some light on how higher education could further extend PBL in universities. "The Center for Learning Technologies in Urban Schools (LeTUS) is one example of a PBL approach rooted in the design principles of project-based science" (Condliffe, 2017). LeTUS researchers found a positive relationship between the implementation of LeTUS curricular units and student academic achievement, and they found that the students who participated in the LeTUS units significantly outperformed non-participants on the state standardized tests. The success of PBL in the K-12 program has lead to attempts of integrating PBL into higher education.

#### **1.2.2.2 The WPI Plan and its outcomes**

The WPI Plan was first initiated under the consideration of future demands for engineers based on the traditional curriculum, as well as predictions for the future by a small group of faculty members in 1969. They redefined the goal of higher education and designed a new curriculum, The WPI Plan,



as an approach to meet the new goal. They believed that future engineers should not only be experts of the fundamentals of their disciplines but also be "technical humanists," which refers to engineers who are aware of and will be able to take into account the societal effects and impacts, as well as technical impacts of problems. To achieve such goal, the plan proposed innovations in the admissions system, grading system, advising system, and course format and requirements. The new system required students to complete The Major Qualifying Project (MQP), The Interactive Qualifying Project (IQP), Humanist Sufficiency, and The Competency Examination for their degree (Gorgan, 1975).

The Plan emphasized Project-Based Learning (PBL) and the accomplishment of these projects. In *The WPI Plan: Promise and Reality*, Karen Cohen concludes that "the project approach to learning was selected as a major vehicle for achieving the Plan's goal," and indeed the MQP and IQP had initiated the PBL curriculum on WPI campus, where students learn through applying the knowledge they learned in classes to real-world situations to solve problems (Cohen, 1977b). The school believed in the value of these projects and PBL, as well as active learning, professional practices of knowledge, and more interactions with their professors. According to the WPI administrative page, the WPI plan "fundamentally changes the students, building leaders who possess passion, proficiency, and a certainty that their life's work can change the world" (WPI, 2019c). A follow-up study of the Plan and its effects on student body further demonstrate and prove the outcomes. In *Impact of the WPI Plan*, which was a report of a three year longitudinal study at WPI from 1972 to 1975, Karen Cohen and her colleagues found that students who had experiences the Plan were seen competent on-the-job situations and 93% were rated as "hireable" by potential employers as a result of questionnaire (Cohen, 1977a). Students were considered "hirable" due to their ability to have better interactions with their future employers and have a better understanding of the problems posed by the sponsors, which were skill sets developed and exercised during their PBL experiences. In a more recent study

conducted by WPI in 2012, more than 2,500 WPI alumni across a span of 38 years confirmed that “there are lifelong professional and personal benefits of experiential, hands-on learning through project work” (WPI, 2019b). In conclusion, the PBL proposed by the WPI Plan has proven over time to be beneficial for the students’ technical knowledge competency, professional skills development, and preparation for their future careers as engineers currently.

### **1.2.2.3 Synthesis of PBL**

The value of PBL can be concluded as allowing students to learn through their own inquiry on problems that exists in the real world. The student-driven learning curriculum has been proven to be beneficial for a thorough understanding of the learning contexts, as well as the development of certain skills of the students, such as communication, teamwork, and independent thinking. Such an innovative approach to teaching had been adopted by many K-12 programs and some college campuses including WPI from studies that focus on the outcomes of these PBL adaptations demonstrated that students and faculty could receive better learning/teaching experiences with PBL.

### **1.2.3 Service Learning**

Service learning refers to the combination of traditional content learning and community engagement; some may also call it community-based learning. Service learning curriculums not only required the same level of academic competencies as traditional programs but also the ability to apply knowledge in complex real-world situations. According to Gustavus Adolphus College, which started its service learning program in 2011, “[community-based learning] promotes students’ academic learning and civic development while simultaneously addressing real-world problems, community needs, and interests. It is characterized by its emphasis on reciprocity and collaboration with community stakeholders” (GAC, 2019d). A community-based learning course includes working with outside communities and providing realistic solutions based on content learned in class.

### **1.2.3.1 Existing Service Learning Programs**

There have been higher education institutions that have adopted service learning courses and extracurricular programs. In the previously mentioned Gustavus Adolphus College in Minnesota, over 1200 students (approximately 50% of the overall student population) participated in its community-based learning program last year (GAC, 2019c). This private liberal arts college offered 42 service learning courses in the academic year of 2018-2019, including children welfare policies, Latin American culture, and perspectives on the news (GAC, 2019a). In each of the courses, the professors must design community and civic engagement, integration of community engagement and academic coursework, as well as at least two student learning outcomes relating to community engagement (GAC, 2019d). The school provide faculty support through its Center of Community-Based Service and Learning and offers mini-grants of \$1000 to eligible courses (GAC, 2019b). The courses mainly partnered with local communities in St. Peter, Minnesota, and the school provided daily shuttle services to these locations. Through eight years of service-learning programs, Gustavus Adolphus College enforced the importance of student's civic development and social responsibility, as well as the ability to contextualize knowledge in order to realistically solve problems.

Another liberal arts college, Swarthmore College in Pennsylvania, started its service-learning program in 2015 by offering the Engaged Scholarship to those who contribute to both the academic community and also social issues. The Lang Center for Social and Civic Responsibility connected campus, communities, and the curriculum with the Engaged Scholarship, which support faculty, students, and community members to work with each other (Swarthmore College, 2019). The Engaged Scholarship provided financial, human, and social resources to those students wanting to start a service-learning program. For faculty, the Lang Center offers curriculum development grants, publication support, and interdisciplinary project groups. The school acts as the middleman to bring

communities in need and researchers together to work on social issues. Since 2017, Swarthmore College has offered 87 service learning courses in various humanitarian fields (Swarthmore College, 2018).

Service learning is practiced at private engineering colleges as well. Purdue University's EPICS program connects students with local and global communities to work on various projects. Founded in the fall of 1995, the EPICS program focused on "real designs for real people" (Purdue University, 2019a). In the spring of 2019, there were 43 ongoing programs in both humanitarian and engineering fields, ranging from working with the school's disability center to communities in India, and from assistive technology to smart cities (Purdue University, 2019b). These project teams addressed social and humanitarian issues and engineered technical solutions that aid people in need. For example, the EPICS VETS team developed a series of workout equipment to help the physical therapy of veterans who lost limbs on the line of duty (Purdue University, 2019c). They worked with Jared Bullock, a disabled veteran who works as a bodybuilder for child amputees and designed a deadlift machine and a rowing machine. The Purdue Journal of Service Learning quoted the Research Making Change Research Corporation in explaining the influence of community-based learning in higher education:

"Service-learning is a high-impact practice that increases student engagement, critical thinking, and retention. It enhances students' overall academic experience with the foundations to advance further civic engagement and/or employment sustainability" (Purdue University, 2019d).

Currently, Purdue offers over 150 courses involving community-based learning in engineering, science, and humanities departments. The Purdue Journal of Service Learning has published 5 volumes of findings and experiences about community-engagement written by students since 2014.

Purdue has been proud of their social impact through service learning; although service learning still remains a voluntary-based program, it has been highly recommended and praised.

### **3.2.3.2 Benefits of Community Engagement**

Community Engagement through service learning not only aided student learning, but also brought benefits to other stakeholders of higher education. In the Purdue University’s Service Learning Fact-Sheet (Purdue University, 2019e) for promoting community-based projects, the benefits of service learning included “[improvements in] self-esteem, empowerment, critical thinking, civic responsibility, leadership, communication, [and] team building.” These elements concluded Purdue University’s experience with service learning and the EPICS program in the past 14 years. The other two programs mentioned above also agreed that community engagement had a positive effect on students’ learning. By connecting with communities and industries through projects, students grow their professional networks and have more career opportunities. Moreover, other stakeholders such as faculty, schools, and communities are also rewarded in various ways in the process of service learning. Joe Bandy, the assistant director of the center of education at Vanderbilt University listed these benefits:

- “Faculty Benefits of Community Engagement
  - Satisfaction with the quality of student learning
  - New avenues for research and publication via new relationships between faculty and community
  - Providing networking opportunities with engaged faculty in other disciplines or institutions
  - A stronger commitment to one’s research
- College and University Benefits of Community Engagement

- Improved institutional commitment to the curriculum
- Improved student retention
- Enhanced community relations
- Community Benefits of Community Engagement
  - Satisfaction with student participation
  - Valuable human resources needed to achieve community goals
  - New energy, enthusiasm, and perspectives applied to community work
  - Enhanced community-university relations” (Bandy, 2019).

These benefits bring the stakeholders together to start constructing the framework of service learning at a higher education institution.

### **1.2.3.3 Integrate Service Learning**

Service Learning has proven to be beneficial by existing programs and research; however, how to integrate this concept with the colleges’ current curriculum was easier said than done. What role should service learning play and whether it could replace traditional classrooms would be a case by case discussion. In the effort of establishing protocols and standards for moving toward community-based learning, University of Illinois’ Center of Innovation in Teaching and Learning designed 3 basic models:

1. **“Service-learning course:** Students relate community-based service experience to course objectives using structured reflection and learning activities in a regular academic course.
2. **University-community partnership:** These partnerships are ongoing relationships between the university (department or faculty) and community partners in which students are involved in service.

3. **Internship, practicum, or field experience:** Students are placed in selected service sites where they work individually. They apply their knowledge and skills to complete their hours of service” (University of Illinois, 2019).

These three models were meant to help higher education institutions set up community-based learning foundations to the degree which the schools saw fit for their overall learning outcome goals. Schools may start by experimenting with extracurricular programs to test out the feasibility of further incorporating service learning. For those schools that already have voluntary community-engagements, they might organize more course works involving service elements or even enforce service learning as a degree requirement. Bandy suggested six ways to integrate service learning with existing courses:

1. “One-time group service projects”: all the students in the course would participate in an organized community-service event.
2. “Optional within a course”: the faculty would offer a community-based project as an alternative to a portion of normal course work.
3. “Required within a course”: the faculty would require a community-based project as a graded element and explain its necessity in the syllabus.
4. “Action research projects”: students would research within the community and may be under an ongoing research project of a faculty.
5. “Disciplinary capstone projects”: the school would require service learning as a qualifying element in the degree program. Upper-class students would demonstrate their accumulated knowledge in the form of a community-based project.

6. “Multiple course projects”: course and service-learning projects would be designed to go hand-in-hand, so that they allow students to learn and apply knowledge simultaneously (Bandy, 2019).

These six suggestions included 6 different levels of service learning involvement in coursework and degree programs. Professors and schools may have different needs for community involvement depending on goals and learning outcomes.

#### **1.2.3.4 Synthesis of Service Learning**

Although service learning could benefit students, faculty, and community members, not to mention some colleges already practicing it, how WPI might adopt it in the current curriculum and program still required more exploration. First of all, among the existing programs, all of them introduced service learning mainly as an extracurricular element. Some courses might include community engagement in the syllabus but completing a certain number of community-based projects or courses was not required by the degree program. WPI also had community-engaging elements such as the GPS, majority of the IQPs, some of the MQPs, and a few normal courses. However, like the other colleges, service learning was not listed as one of the learning outcomes of the undergraduate program. Secondly, although protocols and models have been developed to facilitate the implementation of service learning, there is little literature on how to balance the rigid course content and unpredictable communities’ needs. Professors would be more malleable to add service learning to their curriculum when they can better control the outcomes of it. Thirdly, the existing programs did not mention how they maintain the relationships with their communities or connect with new communities. In order to attract community partners, a mutual expectation should be set between the stakeholders to ensure a sustainable relationship. Even though the projects would be a learning experience for the students from the school’s perspective, what the communities expects to get from it



might be different, which could lead to later conflict or tension. We further examine these three issues with stakeholders at WPI to develop a proposal for the Future of WPI.

### 1.3 Stakeholders

After researching on the needs, forces, and challenges of engineering higher education in 2050 and the existing solutions and curriculums, we generated a table of current needs and future needs for the stakeholder groups of higher education. These stakeholder groups were identified and categorized in the literature review, and the bullet points in each of the sections were concluded from information above. Our methodology to further explore the feasibility of CBL at WPI was developed based on these stakeholders and their needs.

*Table 1 Stakeholders' Current Needs and Future Needs*

Stakeholder	Current Needs	Future Needs
Students	<ul style="list-style-type: none"> <li>• Students want an effective, fun learning experience.</li> <li>• Students wish to be employed after graduation.</li> <li>• Students wish to be supported mentally and academically by mentors on the college campus.</li> </ul>	<ul style="list-style-type: none"> <li>• Employment after graduation will remain as one of the students' needs in the future.</li> <li>• Students will become more motivated and wish to learn what they want to learn.</li> <li>• Through higher education, they will learn more about themselves and the world to achieve long term happiness.</li> </ul>
Faculty	<ul style="list-style-type: none"> <li>• Faculty want to continue doing research while teaching.</li> <li>• In general, faculty want to stay at the school and get paid for their hard work. Some of them may want to secure their employment at the school by applying for tenure.</li> <li>• Many faculty care about their reputation among students, and</li> </ul>	<ul style="list-style-type: none"> <li>• Faculty, in the future, will still want to continue doing research while teaching.</li> <li>• They will want to keep their jobs.</li> <li>• Faculty in the future will be more willing to help students inside and outside of the classroom.</li> </ul>

	their student evaluations are reviewed by the department.	
School	<ul style="list-style-type: none"> <li>• The institutions want to see higher admission and retention rate to make it more competitive.</li> <li>• The institutions need more funding and grants for infrastructure and learning programs.</li> <li>• To establish a good reputation, the institutions want to produce the most desired students by employers.</li> </ul>	<ul style="list-style-type: none"> <li>• Higher education institutions will want to stay competitive against other schools.</li> <li>• They still want to produce the most desired students by employers.</li> <li>• In the future, the institutions might want to keep their students living on campus, to compete with online schools.</li> </ul>
Community Members	<ul style="list-style-type: none"> <li>• They want to have enough cash-flow and funding to be sustainable.</li> <li>• They need human resource, preferably people that are passionate about the same mission.</li> <li>• Many non-profit organizations' goal currently is to promote social justice.</li> </ul>	<ul style="list-style-type: none"> <li>• They may still need fundings to solve their problems.</li> <li>• They need young people to continue working on these social issues.</li> <li>• Many non-profit organizations' goal will continue to service to the pursuit of social justice.</li> <li>• They will need more awareness of social justice from other social institutions.</li> </ul>
Employers	<ul style="list-style-type: none"> <li>• Employers want competent employees in their corporations.</li> <li>• To stand out among other competitors in the fields, employers want to build a good reputation and develop more innovations.</li> </ul>	<ul style="list-style-type: none"> <li>• The employers still want to hire competent, innovative employees</li> <li>• As companies, they will want good reputation and be more competitiveness in the fields.</li> </ul>

## 2. Methodology

### 2.1 Overview

The goal of our project was to explore approaches to higher education that contributed to the development of students' skill sets and mindsets, and thus, experiments were designed to collect

opinions from stakeholders. Particularly, we assessed the current curriculum of WPI PBL and explored the feasibility and possibility of achieving PBL with the involvement of communities' members working more on projects with students and faculty in the future. In this chapter, we will describe the different methodologies we developed to gather and analyze inputs from the key stakeholders: student, faculty, and community members.

## **2.2 Focus Groups**

We decided to use the technique of focus groups to conduct qualitative data about insights and information from a couple of stakeholder groups of higher education. By definition, the method of focus group “typically [would bring] together eight to ten qualified people for a face-to-face discussion for a particular topic” and was utilized most when certain feedback is needed for some new concepts from groups who were directly affected (Edmunds, 2000). There are various approaches to conduct a focus group, including tele-focus group, internet focus group, video focus group, or mini-focus group, and the applications of the variations for each stakeholder group will be explained more later in this chapter. We chose this method for our project research because it allowed us to capture perceptions, comments, and feelings towards our research topic from groups of people who would potentially influence or be influenced by changes in higher education. The word community-based PBL was a fairly new concept to most people on campus, even though many students and faculty already unknowingly experienced it before. Focus groups would not only introduce the concept of community-based PBL to the stakeholders, but it would also help us obtain a more in-depth understanding of their perspectives and opinions on the topic through direct group discussions or telephone interviews.

Throughout the process, we were fortunate to receive help from Paula M. Quinn, who works in WPI PBL Center as an associate director. She met with us several times during the design process of

focus group questionnaires, and she consulted us by giving suggestions, and offering help on how to conduct focus groups.

### **2.2.1 Advantages and Disadvantages**

After we established that focus groups were the appropriate research method for our project, it was necessary to evaluate the advantages and disadvantages of this research method. This allowed us to better tailor this commonly-adopted method for our research. The most prominent advantage and one of the main reasons why we picked the focus group method was that this type of research could be conducted in a shorter period of time. Compared to other research methods, such as interviews, for the method of focus groups allows us to collect information from multiple participants at ones. Given less than a month, we had to gather thoughts and questions on the topic of the project-based-learning environment at WPI, specifically community engagement through those projects, from the three main stakeholders: students, faculty, and community members. Additionally, the size of each stakeholder group would be too big to conduct thorough research within less than a month. The focus group research method allowed us to conduct interviews and discussions with small groups of representatives from each stakeholder group. Since we kept the group sizes relatively small, we were able to record, probe, and analyze participants' comments easily. Furthermore, with the small budget for our study, the focus group method was the best choice since it would not cost as much as a wide-range survey would.

However, recruiting representatives for focus groups could be challenging. Not only must we identify and reach out to our research target either on campus or in the community near WPI, but we also had to convince them to share their personal thoughts. Despite incentives, candidates still might not be willing to take an hour or two for the focus groups. It would become even harder when it came to contacting community members, since no community member (i.e., non-WPI faculty or staff) were

involved in our project advising, nor were we given any contact information of them. As a compromise, we planned to reach out to them through several IQP and GPS advisors. In addition, participants' responses would likely to be influenced by others' talking in a group setting. Participants may respond differently regarding their own attitudes toward the questions. Also, they might be daunted to share their opinions with a group of total strangers. To overcome these challenge, we designed an icebreaker activity prior to the group discussion to allow attendees to get more comfortable among the company of others and to get them into their thinking mode.

### **2.2.2 Progressive method**

We decided to use the progressive approach to conduct the focus groups. There are generally two ways to conduct a series of focus groups: static and progressive. The static method would ask all the focus groups the same set of questions, whereas the progressive method would adjust the set of questions based on the results from previous focus groups. With the static method, the researchers would take advantage of the small size of the focus groups to collect more qualitative data on a certain set of questions. It would provide thorough results on a limited number of topics from a variety of candidates. Researchers could also compare the data from different focus groups to study the reactions of certain demographics. While the static method may be appropriate for rigorous educational studies, the progressive method would be more appropriate for our research. Since we planned to conduct three different focus groups based on the three main stakeholders, each focus group should have its own set of prompts that were relevant to their perspectives. For example, the students could give their unrestricted suggestions based on their current experiences at WPI, but the community members might have other concerns regarding the logistics of the projects. As students ourselves, we would like to gather more opinions on PBL from other students to help us design better questionnaires for faculty and community members

In addition, the focus group with faculty, who worked closely with outside communities, could shed some lights on what questions would be appropriate for the last focus group with community members. The progressive approach would allow us to compare the data vertically rather than horizontally, which further extends the conversation revolving around the future of higher education at WPI. In the end, we would combine the results from these focus groups to design lists of questions for the annual workshop program, using the progressive method.

### **2.2.3 Institution Reviewing Board (IRB)**

The Institutional Review Board (IRB) is an administrative body established to protect the rights and welfare of human research subjects recruited to participate in research activities conducted under the auspices of the institution with which it is affiliated (Oregon State University, 2019). The IRB is charged with the responsibility of reviewing, prior to its initiation, all research involving human participants. The IRB at WPI promotes and supports efforts to conduct innovative research at WPI while also helping researchers understand and comply with the ethical guidelines and regulatory requirements for research involving human subjects (WPI, 2019a). The IRB approval for any applicable research should and must be obtained before any human studies begin.

For our research, prior to the recruiting process for the first focus group, we went through the IRB application process for the permission to conduct focus groups on WPI campus. During the process, we analyzed the potential human risk for the subjects of the groups and were educated of the importance of respect and subjects' consent, during the research. We created the form of consent, attached in appendix A, where the subjects would grant us the consent to analyze the information they provided during the focus groups. In the end, we received the approval for our IRB application and started the next step of recruiting the focus group participants for our research.

## 2.2.4 Student Focus Group

The objective for student focus group was to understand how community based PBL can help students feel “world-ready,” which refers to the skills that were needed to achieve a sense of readiness when students graduate. It would include but not limited to communication, team work, presenting, developing empathy, decision-making, problem-solving, and many other skill sets that the participants or the society would value; the number of required skills could vary for different participants from different backgrounds or different professional fields. Through research about the benefits of PBL and service learning, we hypothesized that community engagement based PBL(CBL) can fulfill the needs of learning and acquiring the skills to help students become “world ready.” Thus, we feel it should be emphasized on the WPI campus. We would like to hear from the students about their self-development through CBL.

The focus group was designed to be approximately two hours long and moderated by one of the members on the research team. The focus group session was collected by an audio recorder, and every participant would be informed and asked to sign a form of consent before the beginning of the focus group. In order to attract more students to participate in the session, we offered pizza and had a gift-card raffle at the end of the focus group session. In order to obtain a diverse group of students with various levels of experiences with WPI’s current PBL curriculum, screener questions were distributed to potential participants to filter for qualified contacts, see Appendix B for screener questions. Those questions explored students’ year of graduation, major, and whether they had experienced PBL, including IQP, MQP, GPS, and extracurricular projects. We chose the participants who had done at least one of the listed projects. In the screener questions, we also asked students to generally rate their project experiences on a scale of 1 to 5 to obtain a general, quantitative idea of their level of satisfaction with PBL. The incentives and screener questions were sent out to clubs and organization

on campus in the form of a survey. As a result, we received many interests from the student body: 34 students filled out the survey and 32 selected “yes” when asked if they were interested in participating our focus group. Two groups of 5 to 8 students were selected, with the senior class members evenly distributed in the two groups since they would have had more project experiences on campus and might need more time to share their stories; the rest of the participants were assigned to each group randomly.

At the beginning of each student focus group, we handed out a note card to each participant, where we defined the concepts of “world-readiness” and “self-actualization” in the context of higher education in Appendix C. By doing so, we hoped that participants would understand the concepts that we were interested in, yet not feel limited by the definitions and be able to draw the concepts to their own lives and study experiences. Student focus group first started with a quick introduction and presentation of the research team and topic. Before starting the discussion, ground rules were stressed to the whole group, including being respectful and mindful during the discussions, keeping the confidential information “in the room,” and freedom to ask questions at any time. These ground rules would help maintain a healthy and safe environment for discussions about personal experiences. The focus group discussion started after the moderator checked with every participant and made sure that they had no confusions about the handout context or the ground rules. Student focus group questions are attached in Appendix D.

### **2.2.5 Faculty Focus Group**

The objective for the faculty interviews was to explore WPI faculty thoughts on the impacts of community-based Project-Based Learning on students’ development, particularly self-actualization, as well as the feasibility of further integrating community-engagement with the current curriculum We hoped to understand how project advisors balanced between ensuring the achievement of student



learning outcomes, and needs of community sponsors. In addition, we also identified the challenges on WPI campus of establishing more community-based PBL for students and involving community members as crucial stakeholders, and to explore potential solutions with the faculty for these challenges. The full list of question is attached in Appendix E. For the purpose of obtaining data, this focus group targeted faculty who were more experienced with the WPI curriculum and PBL concepts, which meant they were most likely highly involved with the IQP, MQP, and GPS programs, as well as integrated community-based PBL in their courses contents.

The faculty interviews were designed to be approximately one to two hours and moderated by one of the people on the research team. The focus group session was collected by an audio recorder, and every participant would be informed and asked to sign a form of consent before the beginning of the focus group. The recruitment process was done via emails. Considering of the limited availability of faculty, we asked them to recommend three other potential participants for the focus group if they were not available for it. In the end, we were able to get in contact with four interested faculty members who would be available for the focus group. However, due to time conflict, we had to schedule one focus group for each individual faculty member at different times, which turned the focus group into interviews. The questionnaires we designed for the focus group remained the same, and the conversations were limited to only between the moderator and the participant rather than a group discussion, yet we were able to collect more information from each participant in this way.

At each focus group session, we started by introducing ourselves and the general concept of our researching topic. Unlike the previous focus group, we chose to read our definition of “world-readiness” and “self-actualization” to faculty participants. The moderator started the conversation after making sure that the participant had no confusion over the definitions. Due to the time limitation, we

developed only four questions for this focus group and prioritized them according to the importance of our researching topic.

### **2.2.6 Community Member Focus Group**

The community member focus group was designed to survey the WPI community partners about their involvement, relationship, value, and expectation in their past CBL program experience, see Appendix F. We would like to know what projects they have done with WPI and why they chose WPI as their partner in these projects. From their answers, we could explore WPI's value propositions in the market of community partners, so that more connections could be established in the future. We hoped to understand the roles that community partners play in the project both on the professional and personal levels. We are interested in how community members perceive their involvement in the projects, particularly their relationships with the students. In addition, we would like to solve some problems brought up by the student and faculty interviews. These problems mainly consisted of misalignment of expectations among students, faculty, and community partners, which resulted difficulties in establishing new CBL programs. To approach these problems, we are interested in what the community partners value in these projects and what they expect as the outcomes of these projects. With these information, we could synthesize a report that the project advisors could use to better integrate CBL with learning outcomes.

The objectives and questions were developed, but the focus groups will be conducted by our teammate in A term of 2019 in September. Like the student focus groups and faculty interviews, the community members will be recruited via email invitation through faculty connections. While we hope to get generalized opinions from the community members, we understand that the ones that agree to meet us may already have more involvement and care more about the students than the average community member in the projects. They will be asked to sign the consent form; these conversations

will be recorded in audio. The community members will not be given the definitions for world-readiness and self-actualization because these definitions are irrelevant to the questions.

## **2.3 Annual Workshop Program**

We designed workshop to be held on January 8th during Winter Session about the future of WPI. This workshop invited people from all of the stakeholder groups to discuss what WPI could do to better prepare for the future. The result of this workshop would be reported to the small decision-making group of faculty members so that people's voice could be heard. Meanwhile, we hope to raise awareness among the stakeholders of higher education about the challenges and needs of the future. For this workshop, we engaged attendees with topics involving the role of community-based project-based learning. Since the workshop took a lot less time, funding, and effort to run than the focus groups, we compared the data from the workshop and the focus groups to decide if this workshop could replace focus groups as the mean to gather qualitative data. In the future, we might make it annual program to revise the recommendations for the future of WPI.

### **2.3.1 Purpose of the Annual Workshop**

This workshop would be one of the deliverables of this IQP as a legacy program. We were concerned that the research in this report might become obsolete long before 2050, judging by the current rate of technological, social, political, environmental, and economic changes. Therefore, we would like to develop a sustainable and efficient way of carrying out the conversation about the future of WPI. Each year, the main stakeholders, namely the students, the faculty, and community members, would be invited to attend the workshop to have conversations and express their thoughts on the future of higher education. A synthesis of the data collected at the program would help correct the predictions with new information, thus generating a more accurate plan for the future. By doing so each year, we hope to keep WPI proactive about the changes in the world, rather than reactive.

The second purpose of the program was to test out data sampling on people’s opinions about the future of WPI. We compare the data gathered from the focus groups to the results from the workshop program. The comparison could suggest the repeatability and accuracy of the workshop results since focus groups would be considered a standard way of collecting qualitative data. If the workshop results would agree with focus group results, we would recommend conducting the workshop instead of the focus group because the workshop would take much less preparation comparatively. If not, we might consider further develop the content of the workshop or go back to conducting focus groups.

### **2.3.2 Other Future of Higher Education Workshops**

There have been many “future of higher education” workshops held by colleges and universities because it has been an important and intriguing topic. On the Inside Higher Ed website’s higher education event calendar, there were 47 conferences scheduled for the year of 2019 (excluding January) as for January 27th, 2019 (Inside Higher Ed, 2019). Many of these events would be hosted by universities, such as Texas A&M, University of South Florida, and Olin College; others were designed by platforms and organizations, such as EdX, Association to Advance Collegiate Schools of Business, and University Professional & Continuing Education Association. All of the conferences focused on reforming higher education to better suit the future.

One event that we attended was the Remaking Education hosted by Olin College and Emerson College on November 2nd, 2018 in Boston (Olin College, 2018). This event invited educators, business leaders, and other influencers to participate in 3 workshops that explore principles of education. The three workshops, Dissent, Deepen, and Design, were made to prompt people to think outside of the current education system to come up with new ideas. The Dissent workshop was especially inspiring. Attendees were randomly grouped into discussion teams of 4-5 people. There was

a moderator at each team to keep time and oversee the discussion. The moderator asked the attendees to identify the current problems, imagine what the future would be like without the problem, and find ways to achieve the goal. The results of this workshop were recorded in the form of posters filled out by each of the discussion teams. This later inspired us to create activities for this year's program.

### **2.3.3 Goat Tank Challenge**

In order to design the workshop, gain more funding, and promote the program, we entered the WPI Goat Tank Challenge. The Goat Tank Challenge, similar to the Shark Tank TV show, promoted entrepreneurial projects on WPI campus. Our product for this challenge was the workshop program, and we would like to sell it to the school so that the school would host it annually. Although we would not be paid for this program, funding would be needed to cover costs for venue, food, and other administrative tasks. We expected to clarify the need, approach, benefit, competition, and the final ask for the Future of WPI workshop program, as well as how to persuade the school to host this program. The structure of Goat Tank Challenges allowed us to pitch our workshop program idea weekly in front of different judge boards, which were composed of WPI alumni, faculty, staff, and community members. The groups were all considered stakeholders for our projects. In the pitch, we introduced the workshop program as well as the background concept of community-based PBL, therefore, we received feedbacks and recommendations from the judges' perspectives on our project. This process contributed to not only develop the workshop, but also collect more insights from stakeholders, especially groups that we were not able to cover during the focus group.

### **2.3.4 Developing the First workshop**

The first annual workshop, *Back to the Future of Higher Education*, was held on January 8th, 2019, at the WPI third annual Winter Session event. We were able to reserve a one-and-a-half-hour time slot at the Winter Session. Hosted by the WPI Launch Pad club and the school, Winter Session

had the tradition of inviting interesting programs and courses to campus during winter break. We chose Winter Session to host our first workshop was because the platform already attracted people from the main stakeholders so that there was less pressure to promote the program. Moreover, the school provided the venue, food, and other supports, thus it was less costly for us. The topic for this year's program was community-based project-based learning, and we designed a series of activities to collect data. Each section of the program would be further discussed in detail in the following subsections.

#### **2.3.4.1 Trivia**

People would first be divided into small groups of 3-5 randomly as they come in. As an icebreaker for the event, a short trivia contest would be used to bring the group members together as they competed. They would have to work with strangers in the group and make decisions together in a short amount of time. These trivia questions, see Appendix G, would assess people's knowledge about the history of WPI in the past 50 years, mainly in innovative areas, such as the WPI plan, global project centers, and the GPS program. The questions were developed for the intention of making people understand what has changed in 50 years, and helping them imagine what could happen in the future. The competition would be recorded in points obtained by each group. Depending on their rank in the trivia contest, each team would later have the opportunity to pick the sub-topic in the order of their ranking. By recording the points, we would like to enthuse the audience and better engage them.

#### **2.3.4.2 Posters**

After the attendees have familiarized themselves with their group mates and the topic of higher education, we would introduce the main topic of this workshop: 'In the year 2050, community-based projects will replace/change \_\_\_\_\_.' The groups may fill in the blank space with the following subtopics: 'nothing', 'project-based learning', 'traditional classroom', 'faculty', and 'four-year

residential college'. An initial poll would be conducted for all individuals, where it would ask which of the 5 subtopics they believed in the most at the moment. The data collected in the poll would be used as the baseline to compare to what we learned from the focus groups about people's opinion on community-based project-based learning. As mentioned before, the group with the highest score in the trivia would be able to pick the subtopic first, then the later groups would have to pick from the rest of the subtopics. We would provide each group with markers and blank posters with the main topic on the top. Two follow up questions would also be presented on the poster: 'what would it be like? (to what extent)', and 'how to get there?'. Each team would have 25 minutes to develop their poster and arguments. The hosts would keep time and moderate the conversations in the room.

Inspired by the Dissent workshop at the Remaking Education Conference, we designed a similar activity with poster development. This activity would allow individuals from different stakeholders to work together and share their experiences involving community-based projects. To complete the poster, they would have to come with evidence to support their arguments. For the groups who did not receive their desired subtopic, they would need to step out of their comfort zone and think outside of the box about what could happen in the future. Depending on the number of attendees, the three hosts might not be able to participate in each of the group discussions; the posters would act as a visual aid as well as a physical report for later synthesis and presentation. Through this activity, we would learn their initial reaction, as well as the brainstormed ideas for each subtopic, coming from all the stakeholders.

#### **2.3.4.3 Discussion & Roleplay**

Each group would have 1 minute to explain the subtopic they chose and the answers to the two questions. After each poster had been acknowledged, the individuals would receive a character tag with background stories on the back. These characters were typical personas from each of the

stakeholder groups, see Appendix H. Half of the group members would first stay with the poster to answer questions, while the other half would go to other groups to ask questions. The attendees would be encouraged to play their given roles when they asked questions about the other posters. The hosts would distribute notepads so that the questions they asked or any comments they made would be attached to the poster. The first set of role players would have 15 minutes, then they would switch with their group mates who stayed and answered questions; the second set would also have 15 minutes.

This roleplay activity was designed to consider the future of higher education from another stakeholder's perspective and critically think about each of the subtopics, as well as the main topic of community-based project-based learning. They would challenge each other's ideas about community-based projects; the role-play would add another level to the critical thinking, also would make the activity more fun. The notepads would let us keep track of the questions asked about each poster and provide us with physical evidence. In case we had more attendees from one stakeholder group than another, we could use this roleplay activity to bring more diverse points of views about the main topic.

#### **2.3.4.4 Feedback**

In order to improve the program and make it sustainable at WPI, we would gather feedback from the attendees. For this session, a survey was designed to assess the successfulness of the activities, see Appendix I. The attendees would be asked to rate each of the activities on the scale of 1-5; from this, we would learn which activities were more engaging and fun. We would also inquire about how well the program matched their expectation prior to coming to the event, and whether or not they would like to attend it again. Through these two sets of data, we might adjust our marketing strategies. Meanwhile, we could present these data to WPI to prove that this program is valuable and meaningful and should be made regular.



### 2.3.5 Constraints of the Program

The program was meant to collect ideas and opinions about the future of WPI from all three main stakeholders as mentioned in the focus group section; however, it would be difficult to have a group where the three stakeholders were evenly distributed. For example, since the program would be a school-run event, more students and faculty may come to the event, leaving the community member group under represented. In this case, the final report would not reflect the perspectives of the community members as well as those of the students and faculty. Another constraint of this program was that the sample set might not represent the opinions of all the people within the group. Unlike the focus groups, where we might attract people with food and gift cards, the program would not offer physical rewards. Therefore, the ones who would attend a 1.5-2 hr workshop on the future of higher education might already be very active members of the stakeholders or at least feel strongly about the subject. This would lead to exaggerated data compare to a random poll from a stakeholder group.

## **3. Results and Analysis**

### **3.1 Student Focus Groups**

#### **3.1.1 Overview**

Two student focus groups were conducted during the research, and eight students in total participated in the focus groups, with four in each group. The groups were relatively small due to time conflicts of the students. Within the first focus group, there were four female students: 2 seniors, one junior, and one sophomore; the second group contained 3 senior male students and 1 junior female student. For more detailed demographics and project participation, see Appendix I. All of these students were selected to participate in the focus groups because they had experience with community projects, whether as part of a course, degree requirement, or extracurricular activities. All of them were also involved in traditional higher education forms such as lectures, exams, and non-community-based projects.

Since the sample size of these focus groups was small, the results from the participants were cross referenced with WPI Alumni Survey Findings from 2012 and 2014 on the long-term impact of a project-based curriculum (Heinricher, Quinn, Vaz, & Rissmiller, 2013), with sample size of 2532, and long-term impacts of off-campus project work on student learning and development (Vaz & Quinn, 2015), with sample size of 1780. The surveys were sent to alumni graduated from 1974 through 2011, who were under the WPI Plan, where they completed IQP and MQP. Because the specific projects of the alumni in these surveys were not reported, but the results were separated by off-campus and on-campus project experience, we can assume that the off-campus group represented alumni with CBL experience (referred to as the off-campus group later), and the alumni with only on-campus project experience (referred to as the on-campus group later) were not involved in community-based projects.

These surveys studied the long-term impact of project work on three main categories: professional, world view, and personal. Each of the main categories were then further divided into detailed areas of impacts. The participants rate their experience in each of the areas of impact on the scale of 5 degrees from 'not at all' to 'very much'. The data was then synthesized to produce a percentage that represent the average impact of project work on a certain area of impact for the group.

All participants in the focus groups have consented to let us record and use the information in the focus group. To protect the students' privacy, no real names or project details would be mentioned that would reveal the participants' identities. In the future section, they would be referred to with their code names as listed in Appendix I. Each of the focus groups was 90 minutes long instead of 120 minutes as proposed in methodology, and all prepared questions were thoroughly discussed.

### **3.1.2 World-Readiness and Self-Actualization**

The definition of 'World-readiness' and 'Self-Actualization' were given to the students at the beginning of the focus group session, see Appendix C for the definitions. After understanding the meaning of these two phrases in the context of higher education, the students reflected that the projects helped them become more world ready; on the topic of self-actualization, the first group discussed more about their self-development through working on projects, but the second group emphasized the practical skills they learned rather than self-actualization. In the 2012 survey, out of 24 areas of professional impact, 18 of them had the off-campus group report significantly (over 2%) more positive results, 5 of them with less-significantly (1-2%) more positive results, and only 1 group where the on-campus group reported one more percent than the off-campus group (Heinricher et al., 2013). Especially, the off-campus group rated 86% for project work helped them function effectively in the real world, and the on-campus group rated the same area 78% (Heinricher et al., 2013). In the 2014 survey, all 8 areas of professional impact reported the off-campus groups had at least 8% more

positive feedback (Vaz & Quinn, 2015). In all 15 areas of impact on world views and personal developments, which reflected self-actualization, both off-campus groups in the two surveys had more positive feedback than the on-campus groups. Data from the student focus groups support the results from both surveys.

The students associated world-readiness with learning skills that would help them in the professional world. Some high-frequency skills and qualities mentioned in both student focus groups were:

- Teamwork skills
- Communication skills
- Adaptation to new environments
- Problem-solving skills for open-ended cases
- Research and interview skills

Since most of the projects at WPI were completed by teams, students learned teamwork skills through PBL. Teamwork skills included working with others, negotiating, decision-making, communicating, along with other aspects. Having teamwork skills would mean that students could manage complex interactions with other people to achieve a goal. These skills would prepare students better for the future because engineers often work in teams in professional settings, where they would cooperate, use the collective skills, and solve a problem. B mentioned that she developed teamwork skills during her off-campus IQP since the team was sent abroad to an unfamiliar community, and they had to finish their project in 7 weeks. Stressful but exciting, the IQP forced B to quickly understand the team dynamics in order to direct the right people to the right tasks. D also mentioned a similar situation with her RBE 1001 project, where teammates had different expectations, capabilities, and

work styles. It was crucial for her team to cooperate and communicate well to complete the final project for the course. They both felt that working with teams in projects made them feel more comfortable about working with others in the future. In the 2012 Survey, the off-campus group rated their project experience help them function effectively on a team at 90%, where the on-campus group gave 83% (Heinricher et al., 2013). The conversation from the focus groups supported the data from the survey that project experiences enhance students' teamwork skills, and community projects may be more effective comparatively.

The communication skill was emphasized by many other participants. This set of skills would include but are not limited to communication within the teams, with advisors, and with the clients or target community members. The students were able to clearly express their ideas and listen to the needs and requests of the others as they strengthened these communication skills. C pointed out that she was explaining technical problems and solutions with the community members during her off-campus IQP. The non-technical community members had a hard time understanding what the IQP team wanted to do and could offer very little help. The IQP team then realized the situation and translated the technical terms to ways that the community members could understand. As a result, the team received more help and support from the local community. In the second group, F also underscored the importance of communication in his extracurricular project, where he developed skills to accurately communicate with the young kids in the program and effectively teach them. H mentioned that in her off-campus IQP, she successfully communicated with her sponsor about the expectations and goals regarding their project, which made it go smoother. Finding effective ways to relay the ideas accurately was important because the students would need to communicate with others daily, whether face-to-face or via emails. Through the projects, they understood that not only do they have to actively initiate the communication, but also listen to the feedback to ensure that both sides

were on the same page. Similar conclusions were drawn from the surveys. In the 2012 survey, over 75% alumni thought that their project work at WPI helped with their communication skills in managing dynamics, writing, presenting, and visually communicating (Heinricher et al., 2013). The off-campus group rated experience consistently higher in these four areas than the on-campus group. The 2014 survey arrived at very similar conclusion in the same four areas but with lower average rating for the impact on communication skills (Vaz & Quinn, 2015). From both the qualitative data from current students and quantitative data from alumni, one can see that PBL is effective at improving communication skills, but projects with communities further amplifies the impact.

For many of the off-campus IQPs, students travel abroad and experience culture shock; they learned to understand and embrace the local culture by adapting to the environments. Both A and B said that they had to deal with culture shock on their IQP. They went abroad to different countries in Asia to work on site. B also had language barriers where the WPI team and the local community members had to communicate via a translating app. A and B thought that their experience abroad would help them “better adapt to future work or living environments” because they learned how to embrace different cultures. Similarly, G worked in an office setting for his IQP, where he started to prepare for working in an office in the future. The alumni agreed that their project experience at WPI helped them become more successful in business or industry, 80% in the off-campus group in 2012 and 76% in the on-campus group (Heinricher et al., 2013).

Because many projects were open-ended, students developed skills to solve problems that don't just have one solution. These types of problems would require students to identify the core elements and essential needs themselves and then provide solutions. C was especially drawn to these aspects. According to her, these problems were interesting and challenging, where she felt “more engaged”. The creative thinking element of these projects was difficult to learn from the traditional

classes. Unlike the problem sets and textbook exercises, the complex and unique open-ended questions would inspire students to dig deeper and use interdisciplinary knowledge, and these problems would also be more similar to real-life problems that they would be expected to solve after they graduate. In the 2012 survey, these open-ended problem-solving skills were divided into 3 areas of impacts: “solve problems”, “mastery of fundamental concepts and methods in the major”, and “make connections across disciplines” (Heinricher et al., 2013). Both “solve problem” and “mastery of fundamental concepts and methods in the major” received relatively even ratings from both groups, but the off-campus group rated “make connections across disciplines” 8% higher than the on-campus group (Heinricher et al., 2013). Both the results from the focus groups and the survey suggest that CBL helped improving problem-solving skills, especially when interdisciplinary elements were involved.

Many projects also required students to research the communities or clients, which developed their research skills. Using these research skills, students would be able to effectively find and extract the information they need. G thought that the projects he worked on were “research-intensive” and taught him how to learn from outside of textbooks. The first focus group also discussed that by researching and exploring, they gained a better understanding of the problems and were able to apply their knowledge. The self-taught skills motivated them to keep learning even after they graduate from college. The second focus group also brought up that projects that involved interviews were educational. They learned a different type of research skills, conducting research about humans through the interviews. This would further help them with communicating and extracting information from more complex situations. When asked to rate the impact of project work on “integrat[ing] information from multiple sources”, the off-campus gave 90%, which was 3% more than the on-campus group (Heinricher et al., 2013), which was supported by the student focus group results.

Beyond skills that would prepare the students for the future, students discovered more about themselves and some even became more self-actualized through these projects. Within the first focus groups, the students agreed that working on a project that had practical meaning made them feel “useful and helpful.” When working with communities, they especially feel depended upon. C said that she was motivated by the expectations of the community and was able to do a better job. B agreed with C: working with communities helped her visualize the concepts learned in class, and it was exciting to work in the field that she was passionate about. A agreed with them that after she got closer to the community, she was driven by the expectation of the community members she cared about rather than grades to deliver a better project. When they finally finished the project, she felt more rewarded that the community members were satisfied with the outcome than getting an A in the grade book. We would consider these students self-actualized because they were internally motivated to do what they believe to be the right things, in which case is to help the community partners. Alumni reported that they had “feelings of being able to make a difference” and “feelings that own ideas are valuable” through project work, which was similar to the cases the students described; the off-campus group rated 72% and 82% in these two areas of impact where the on-campus groups only rated 62% and 76% (Heinricher et al., 2013). The 2014 survey had similar results as well. The differences in the results of the two groups suggest that the community element in CBL contributes more to self-actualization.

Some students might also become self-actualized by realizing their strength and weaknesses. Particularly, when they worked in teams, they distributed the work according to their expertise and areas they wished to improve in each task and made an effort to overcome the weaknesses by learning from their teammates. In these projects, they were able to try different roles and positions to discover more about their strengths and development areas, or sometimes reevaluate their major and career plan



choices. D faced challenges in her robotics class project where each of the teammates was specialized in certain aspects of robotics but not the others. When they worked together, they talked about their strength and weaknesses, divided up the work, and was able to complete the project on time. During this process, they taught and learned from each other, as well as explored more about themselves. The second focus group mentioned that they were able to figure out their likes and dislikes in terms of areas of study. Through her IQP, H confirmed her love for her major and found some fields that she would not want to work for a living. On the same note, the second focus group wished that they could have had more connection to real-world in the projects, and they believed that it would help them develop a better sense of their future directions. While surveys did not explicitly ask about personal development, the off-campus groups rated “develop a stronger personal character” and all the areas of impacts in the world views category higher than the on-campus group, which agreed with the students’ opinions in the focus group (Heinricher et al., 2013; Vaz & Quinn, 2015).

### **3.1.3 Connection with the Communities**

As the students discussed about world-readiness and self-actualization, the projects had a big impact on them, especially those with community engagement elements. All of them experienced working with communities in their projects, whether during IQP, MQP, or extracurricular programs; most believed that they learned a lot more from these projects. They connected with the communities through research, emails, interviews, face-to-face meetings, living with the communities for 7 weeks, and sometimes even through translation apps. Alumni who participated in off-campus projects rated “feelings of being connected to a non-WPI community” 59%, which was much higher than the 39% from the on-campus group (Heinricher et al., 2013). In the later survey, the results were 32% and 17% (Vaz & Quinn, 2015), which was lower but consistent with the proportion between the two groups. C mentioned that the community she worked with during IQP started from being a client of the project to

becoming part of a group of people she truly cared about. Others in the focus group agreed by saying that they also developed empathy for the external communities. D pointed out that through research and surveys, she found out more about the problems within the community. Even though it was an extracurricular project, she was passionate about it and dedicated a lot of her time and energy to solving these problems. H connected with her IQP sponsor as well as other workers onsite. By listening to their needs, she was able to design a better fitting system for the project. G also said that he found out more about their target community through research and was inspired to design systems that cater to their needs. Through these project experiences, H and G appreciate the cooperation of the communities. The sense of connection with outside communities motivated students to achieve better project outcomes.

When asked where working with communities would rank in their line of priorities, if they could choose what every project they want, most of the students agreed that community engagement ranked high. The second group, who had more mishaps while working with communities, said that they would like to work with communities if the goals were clearly defined. When their grades were directly correlated with the completeness of the projects, they would like enough time to work on developing the final product than spending too long on figuring out the needs. Through the past project experiences, some of them found out that their strengths lie within the technical fields. When given the choice, they would rather work toward a list of set outcomes and solve the problem than identifying the problem and explaining to the communities. While they see the importance of the humanitarian side, personally, they would rather work with the technical aspects of problem-solving. These students would like to create value for those in need, but they were concerned that they were not be able to satisfy all the needs and develop a technically sound product at the same time within the time limit of the project. The first group ranked working with the communities higher than the second group. They

enjoyed helping communities with their needs; if it meant that sometimes they had to spend more time explaining, that would be ok too because they would be expected to do so in the future when they would be on their jobs. Overcoming these challenges with the team gave them a sense of achievement once they did it. By satisfying the needs of the communities, the students felt rewarded and were happy to help them even more. Moreover, in the alumni surveys, the participants were asked to rate “desire to maintain involvement with a non-WPI community” after project work, the off-campus groups gave 49% and 23% in the two studies, whereas the on-campus groups produced 32% and 13% (Heinricher et al., 2013; Vaz & Quinn, 2015). The quantitative data showed that more people with CBL experience were self-motivated to work with communities, which will be needed in the future as discussed in Background.

Both focus groups suggested that CBL will be popular among the students, but some restrictions may apply. For example, the expectations and rubrics will need to be clearly communicated. The student would like to choose the level of involvement when it comes to direct communication with the outside community members. They also expressed concern for the credit given in these projects. The grading of a project should depend on the progress of the team rather than the final results, in case unpredictable events happen through no fault of the students that hinder the outcome. The students need to know that they will be graded fairly in order to develop empathy and help the community partners. Revise learning outcomes such that they reflect the changes in the project progress and the team’s effort would help students feel more comfortable choosing community-based projects.

### **3.1.4 Mentorship**

When discussing self-development, we were also interested in whether the students found a mentor through the PBL. This mentor would be someone who aided the students’ self-actualization

process, helped with the projects, or connected with the students on a personal level. The students reflected on their past PBL experience and discussed their stories with mentors. Interestingly, the mentors were not limited to faculty advisors, some students identified community members and fellow students as their mentors as well.

Faculty advisors assigned by WPI were the most popular choice of mentors. They have expertise in education and are assigned to the students to offer guidance. A was able to connect with her IQP advisor during the 7 weeks when they were abroad. Her advisor led her team to successfully complete their project and gave her advice on internships and career plans. Similarly, F said that his mentor was also his advisor. The mentor was very strict about the work they did in the project and pushed them to become better engineers. His mentor inspired him to pursue his passion. As a role model, the mentor showed him what his dream career could be like and provided guidance. He and his mentor became friends through the project, and she will write him a recommendation letter for a graduate school application. Both students think that the mentors believed that they could accomplish great things, which gave them the confidence and strength to work harder to live up to their expectations. The faculty members supported the students on a personal level: they cared about them, spent time with them, and talked to them. While it may be unrealistic to require faculty to be mentors to all of their students, the ones that do will deeply impact the students to be their best selves.

Some students considered faculty as their mentor because the faculty members were so passionate about what they do that it inspired the students to love their major. One of D's professor was an example of these inspirational mentors. He had so much energy and passion in his lectures that it engaged D more in the subject. G in the second focus group also had a similar experience. His project advisor was a retired professional engineer who worked in the industry for over 30 years, and yet he still loved electrical engineering. G would like to be as passionate about his work in 30 years as

well. He was initially surprised that his advisor was so excited about a group of college seniors' MQP after being in the industry for so long, but then he was touched by how much the professor cared about their interests that he determined to not let him down. The spirit and passion exerted by these faculty members motivated students to look for their life-long goals to become self-actualized.

Other students found their mentors in peers. Although their peers might not offer as much expertise as the faculty, they are closer to the students in age and sometimes experienced the same struggles. D considered the student leader in her extracurricular project her mentor because he was very passionate about the club, his major, and helping the younger members in the club. As a current student, he had insights about campus life, and he would talk to D like a big brother when she was frustrated. D valued their friendship and looked up to him. Their friendship also motivated her to work harder in the extracurricular project. Her mentor inspired her to start working on her ideas and turn those ideas into projects and products. Other students identified community members as their mentors. A said that she developed friendship with a peer in the community she worked with during her IQP. The mentor was very curious about the project and A's interest in the field and asked her many questions. These questions led A to reflect and evaluate her decisions and helped her learn more about herself. A year after A finished her project, she and her mentor still talked via texts and support each other.

These stories about mentorship shed some light on a kind of support system the school can offer that can help the students along the journey of self-actualization. Some faculty members build strong bonds with the students in projects and get to know them better. Some other faculty members inspire students with their passion and self-actualization. Students and community partners also help students through human interactions and personal conversation. People from another culture and

background often bring new perspectives to how one looks at him or herself. These examples suggest that self-actualization can be better achieved in the presence of mentorship.

### **3.1.5 Challenges of CBL**

Students discussed the challenges they faced in their past CBL projects in the focus groups. In order to offer a better experience and further integrate CBL with the current WPI curriculum, these problems will need to be addressed and solved. One recurring problem mentioned during the student focus groups was that the students' expectations misaligned with those of the others on their projects. Due to the misalignment, there were conflicts with task assignment and time management.

One student had a problematic relationship with the community that her MQP served. In A's MQP project, she and her team were asked to design a medical device using thermodynamic and biomedical principles to demonstrate the knowledge she obtained through the four years at WPI. As the MQP team researched the requirements and existing practices, they found out that the most efficient, economical, and effective way to perform the same tasks was to use a hot water bath. When they reported their findings to the sponsor, he agreed with them that there could be no better way to do this but still insisted that they design an intricate high-tech device for the same task. His response to the reason behind such request was that "otherwise [the MQP team] would not have a project." Feeling defeated and ridiculed, A and her team had to keep working on designing the device that would never be put to use by the community. The MQP team clearly had different expectations from the community sponsor.

Another case was that the project advisors' expectations for the students were different from the community's needs. There was a certain set of learning outcomes of each of the projects that the advisors need to follow to assess the completeness of the project; however, sometimes the

communities have different opinions on what is valuable for them. For example, H was involved in a technical project where they were asked to develop a better device for a National Park. The advisor wanted the project team to do more research and try out different approaches to the problem. Meanwhile, the project team soon found out that the easiest solution to the problem was to simply move the device to a different location rather than improving the original design of the device. However, with the limited time, if they were to provide the community with the best solution, they would have failed to satisfy the learning outcomes set by the advisor.

C's IQP team ran into problems caused by different needs identified by the faculty advisor and the community partner. Toward the end of the project, the students want to keep working on the software they have been developing for the community, but their faculty advisor thought that writing the report would help them learn more from their IQP experience. The students believed that they were doing something meaningful and creating value for many people in the community; whereas, writing a paper that only a few people would read was not the best use of their limited time. When the advisor asked them to focus more on the research and reflection rather than improving the software, the students did not see the appeal of that. In the end, they completed the paper and devoted some extra hours to work on the software. C was glad that her team continued to improve the software because she believed that it was the right thing to do, and she thought that she was more self-actualized because of it. While she understood from the beginning of the IQP that she was responsible for a final report, she did not value the writing aspect of the project as much as her advisor, and she believed that it was not useful for the community she cared about either. This may be solved by extending the project deadline or modifying the deliverables according to the specific case.

A similar problem happened to E, where his team thought that their advisors' views on technology outside of their major field were outdated, which resulted in unrealistic expectations for the

project. The faculty advisors believed that the project was still current and in demand, yet the students found out through research that there have already been more economical solutions through mass production. While the project they proposed could potentially be interesting, it would be too expensive and time-consuming, nor did it contribute to the targeted clients' main need. When the students decided to reach out to the targeted clients for surveys and interview, the request was denied by the faculty advisors, leading to the lack of community input when solving a problem for the community. The IQP team was also frustrated because sometimes the advisors would have requests in conflict between themselves. They wish that they could have talked to actual people involved to bring their perspectives into the project , and that the advisors could make more practical changes to the project.

In conclusion, the students feel that if the expectations of the community sponsor and the faculty advisor were clearly communicated and agreed upon, it would make CBL go smoother. Some students may consider dealing with challenges like these help them become more world ready and self-actualized, but others think that some of these struggles were unnecessary and hindered their overall learning experience. While the students could not provide solutions on how to balance the line between the positive and negative conflicts, we turned to the faculty interviews for the professors and advisors' perspectives on these challenges brought up by the students.

## **3.2 Faculty Interviews**

### **3.2.1 Overview**

As mentioned in the methodology section, the faculty interview turned out to be the form of one participant at each interview section due to unavoidable time conflict limitation. Four faculty participated and there were three females and one male. The notes from the interviews are shown in



Appendix L. From the interview, we developed the following findings concerning the impact of CLB on the WPI campus from the perspective of the faculty:

1. CBL could help students with their academic achievement and self-development.
2. Faculty experience difficulties balancing between ensuring the achievement of student learning outcomes and the need of community sponsors during CBL.
3. Faculty generally support having more CBL on campus, yet there are challenges, including the difficulties of finding community connections, grading on multi-discipline projects, modifying the curriculum to better fit the learning objectives, and time constraints.

### **3.2.2 Student Development**

The faculty group, during the interview discussion, acknowledged the value of community engagement in helping students with their academic achievement and their self-development. First, we found that through direct interaction with community members as stakeholders of the project, the faculty observed that their students become more motivated in the problem-solving process, as well as completing the work assigned to them by the faculty. All the participants agreed that they thought students were more motivated with CBL than with regular learning curriculum or regular projects because they could feel the importance the work through its direct impacts on community members. One participant provided with the example of the class ID 2050, Social Science Research for the IQP, which was a course that was required for students to take before their off-campus IQP, actually did not ask the instructors to grade their students after, yet he still observed that students worked hard on researching and developing potential solutions. He believed the reason was that the students were told or suggested that “If you do this well, you will help somebody,” and the power of helping community

members inspired the students to do well versus getting a good grade. Some participants even thought that the value of helping others could be more powerful than the simple grades for students sometimes.

We also learned that many faculties were pleased to see their students broadening their horizons and improving their communication, negotiating, and other non-cognitive skills during CBL. Participants mentioned CBL contributed to the level of social awareness for their students, and help them develop empathy and compassion by directly working with community members. Most participants who worked as advisors for off-campus IQP stressed the change they noticed from their students' mindset during CBL. For example, one pointed out that her students did not realize certain community groups' struggles until they started researching and interviewing the sponsors, and she believed that it was important for them to know that there were different groups of people out there having different needs. Such awareness also contributed to students' self-reflection process, as one participant mentioned, her students were able to understand their own privileges throughout the process and further motivated them to use their advantages to help other people who didn't have such privileges. The new level of awareness students received about themselves, as well as the world, from CBL could lead to their self-actualization development, since they learned about their own identities and privileges by interacting with more diverse groups than he or she would normally be exposed to within their comfort zones. Therefore, CBL not only helped students learn but also "showed students that the world is a much bigger place."

The process of connecting and communicating with community members, however, was viewed as a non-technical, yet fundamental challenge by some of our faculty participants. Many of them mentioned that students experienced cultural shock during CBL. Some argued that a certain amount of discomfort from cultural differences should be expected and is beneficial to prepare their students to develop empathy and to become better engineers to serve society in the future. One

participant gave an example from a lecture provided by a social entrepreneur: students were asked to identify the problem of a toothless lady in the picture. After many guesses of poverty or lack of medical treatment, it was revealed to be no problem at all because being toothless was considered as a symbol of wisdom in the lady's culture. And from the example, she drew the conclusion that "not all differences are problems that need to be fixed." The community members, who lived in and accustomed to the environments and settings, were usually not able to identify the problem or see the severity of which as much as the students, who usually grow up in a more developed environment. She suggested that students should play the roles to "provide avenues that they (community members) were not otherwise to see" instead of just solving the problem itself. Such procedure required, from the students, a full understanding of the cultural backgrounds of the community groups, and then shared goals to work towards by all the stakeholders together. The faculty participants believed that the change of certain issues would not be accomplished without the change of the community's mindset, and as students become future professionals, they needed also to understand the rule of change in order to bring fundamental changes to the society. One participant provided a contrasting idea that empathy would not be taught through CBL nor did it matter to the problem-solving process. One of his main arguments was that the obstacles of communication, such as language barriers, existed even among one community group itself, so it would nearly impossible to ask students to overcome the issue within a limited time. His own experiences had proven that students could reach the expectations of community groups as well as advisors' without being emotionally devoted to the community. Thus, we conclude that faculty consider the cultural barrier and communication challenge proposed by CBL mostly beneficial for the students' overall learning and development of skills.

### **3.2.3 Challenges with Expectations**

We found that faculty, especially project advisors, experienced difficulties balancing between ensuring the achievement of student learning outcomes and the need of community sponsors with CBL. As mentioned above, community sponsors tended to propose a different perspective or need than the faculty or students would expect, so it became a struggle for faculty to retain the project structure that the school requires and help students achieve the learning objectives of these projects while satisfying the need of community members.

All participants confirmed that they had experienced challenges and resistance of not meeting the required learning outcomes with CBL due to various reasons: sometimes the project sponsor from communities would unintentionally deviate the project teams from the learning objectives to meet another goal, or the students would feel motivated to further investigate in the project problem instead of writing the report as they were asked. During interviews, all of the participants believed in the importance and necessity of achieving these learning objectives, including writing a final report and conducting a certain amount of research, as well as the value that they would benefit their students in the long run. One participant particularly believed that making sure the projects would meet the objectives was the “core of (project) advisors’ job,” and as responsibility of being a project advisor, she would let the learning objectives for the projects come first. There were many solutions and potential solutions being mentioned and explored during the interviews. One of the main solutions to such a dilemma, according to most participants, was to communicate and negotiate with students and community members so that they would also understand the importance of learning objectives. They emphasized more on communication with students, while some were more flexible with their expectations than others. One participant said she would be willing to have discussions with her GPS students over the forms of final deliverables by the end of the course/project, as long as the

deliverables could effectively show what the students had learned. Another participant said that when contradiction happened, he would negotiate with students but still allow them to make the decision regarding their own project: as he said “if it doesn’t work, I got to tell my students ‘I told u,’” because he believed that students might push back to direct rejections and sometimes it could be more effective to have them learn from the actual outcomes. We also heard strong opinions against changing the expectations from our participants: one faculty held the value that “students have to stay within the (school’s) structure as they agreed to when they enrolled to WPI,” and thus, the school’s learning objectives for projects should always be met by the students as one of their responsibilities as WPI students. Even though many different approaches to stress the common objectives and expectations for CBL were explored, we found that there was not an official, effective, and general applied solution for the dilemma.

In conclusion, we discovered that the main challenge for faculty instructors in CBL was that their students were not meeting the learning objectives of the projects as determined by WPI. Though many methods were applied, depending on the instructors’ personal perspectives on the objectives there was not a perfect solution yet.

### **3.2.4 Expansion of CBL at WPI and Challenges**

For the interview, we asked participants to provide their opinions on whether they agree with the statement that there should be more CBL on the campus, and we found that all of the faculty participants agreed that CBL should be expanded for certain learning subjects, while some subjects should still be taught in traditional curriculum for achieving certain learning outcomes. They believed that CBL could help the students obtain the knowledge and skill sets more effectively, and also help the school with changing demographics. One participant agreed with the idea of expanding more CBL because she thought it better prepared her students with the skill sets that their future employers need,

for example teamwork skill. She stated that one of the key values that employers request from graduates was the ability to work and cooperate in a team and “WPI students need to learn how to work in a team.” Another participant thought that the value of CBL also included training the students with the ability to apply the learned subjects to the real world in a multidisciplinary way. She provided us the examples of the GPS program at WPI where students are asked to solve problems focused on themes of global importance; and in most cases, the problem could not be thoroughly understood without knowledge from multiple technical and liberal arts fields.

Faculty participants also expressed some concerns over the expansion of CBL. Some main challenges of such were then explored in the interview, based on what teaching obstacles faculty members had heard of or experienced themselves with CBL. We were able to identify some main challenges from the faculty’s perspective:

**1. Certain learning contents might not fit into CBL, or the fundamental knowledge would not be thoroughly taught by CBL.**

Half of the participants, from the instructors’ perspective, told us that it would be challenging for faculty to design the projects to fit the criteria, considering certain topics in the course might not be fully covered in the projects. They were worried that if all the subjects were introduced through community-based projects, faculty would have limited control over the focus of course or course materials, and thus, fundamental contents in professional fields might not be stressed enough. Some participants also suggested that certain subjects should be taught in the traditional curriculum, and in ways it could receive the best learning outcomes from students, especially when community sponsors tended to focus on the results rather than the process of problem solving. Courses like calculus required students to acquire the ability to solve equations themselves, yet in CBL where no

examination are given, faculty worried that students would directly use the available tools to generate the result for them instead of spending time exercising their skill.

**2. The current grading criteria can sometimes fail to evaluate the efforts of the students' during CBL.**

Another current challenge and major concern over the expansion of CBL was the inflexibility of the current grading system. Some participants suggested that the current requirements of final deliverables: a paper and a presentation (sometimes optional) limited students' creativity and failed to show the complete result of CBL. For example, for the final evaluation of the projects, skills like communicating with sponsors or community members did not play an important role in determining the students' grade at all. Another participant also pointed out that since faculty would only provide them with the problem statement and let students choose the approach to solutions in CBL, students had more control over the projects, which increased the variety of projects as well the difficulty of grading. A possible dilemma could be comparing and evaluating two projects under the same topic: one project had a well-thought idea yet was poorly carried out, while the other was lacking innovation in the idea but had research and paper neatly done. In conclusion, faculty participants expressed their wish to see more detailed instructions for grading CBL on not only the academic achievement but also skill sets acquisition.

**3. Faculty would most likely be in charge of finding the connections of community groups and they faced difficulties of doing so due to time and resources constraints.**

Based on the hypothesis that there would be more CBL on campus, faculty participants predicted that the responsibility of finding community partners would most likely fall on faculty members, as students have limited resources and network to reach out themselves. There were two major challenges in faculty finding the community partners: time commitment and resource

limitations. Most faculty have other commitment besides teaching, such as research or committee work, and thus, adding the task of connecting with community members would add to the original time commitments of faculty. In addition to preparing course materials, advising students and evaluating their work, faculty might not have the time for building connections with communities for CBL. Speaking from their own experiences as project instructors, many participants remarked on the difficulties of finding community partners due to limited resources and platforms. Despite one participant mentioning multiple community engagement educational initiatives that she had noticed, there were not any specific platforms dedicated to helping match faculty and community partners. Participants expressed their hope to see programs that gather all the interested stakeholders, as they believed easier access to connecting communities could potentially help and motivate faculty to include and generate more CBL on the campus.

#### **4. Seven-week terms were too short for students to learn and reflect from CBL.**

We found that if to expand more CBL to more disciplines, another major challenge would be the time constraints of accomplishing all the learning outcomes: WPI has four terms every academic year (also optional summer term E1 and E2) and there are usually seven weeks in each term, faculty worried that seven-week was too short for the students to learn and reflect through CBL. One participant who had experienced advising off-campus IQP commented that “seven weeks is not long enough for a through cultural understanding.” He suggested that the development of empathy or self-actualization required time and real experiences, and it would take a certain amount of interactions, mostly communication, between students and the community members before students were able to develop compassion. Particularity for projects that happened in international sites where people speak different languages and have different cultural practices, students would need time to overcome the cultural shock before they felt comfortable to learn and contribute to the community’s development -



and seven weeks was far not enough for the whole process. Another participant also agreed that it would be “more realistic” to also expand the time of CBL for students so that their development of skill sets would not be rushed, and also have the time to practice afterward. Faculty predicted that a longer time for CBL would ensure a better learning outcomes for the students, including learning academic contents, practicing skill sets, and reflecting on self-development.

From the faculty interview, we learned that faculty members generally appreciate the values of CBL and agreed with the hypothesis that WPI should include more CBL, if some of the major challenges could be resolved.

### **3.3 Winter Session Workshop**

#### **3.3.1 Overview**

Through Winter Session, we gathered information from multiple stakeholders (community members, WPI faculty, staff, and students) of their thoughts towards the ideas of futures of CBL, as well as the proposal of an annual workshop that explores the future of higher education for WPI campus. We identified some challenges of sustaining an annual workshop. We also found, through the participants of the workshop, that the campus generally believed CBL would become the new focus of PBL in the future.

#### **3.3.2 Findings from Goat Tank**

As mentioned in the Methodology section, we entered the Goat Tank Challenge with our workshop idea and were able to receive feedback and recommendations on the annual workshop from the judges, who identified as WPI alumni, faculty, staff, and community members and were considered as stakeholders for our workshop. In addition to the opinions we gathered from the judges, we also received \$200 funding for building and developing this year’s workshop.

One key finding from the Goat Tank Challenge was that our method of collecting data through the annual workshop needed certain preparation and mentorship, in order to avoid issues such as topics overlapping. Our proposal was, as mentioned in the methodology section, to utilize the workshop as an approach to developing a sustainable and efficient way of carrying out the conversation about the future of WPI, which could inform future directions of WPI, and thus, generate a more accurate plan for the future. The judges proposed some potential challenges as well as possible solutions. One of the main challenges that was brought up was that students who continue the projects and develop future workshops might end up with duplicate topics due to lack of communication, once the previous generations have graduated. There were also concerns resulting from the same communication issue, that the quality of the workshops might not be well-maintained. We brainstormed with the judges as well as the audience, and learned that we could maintain the structure and quality of the workshops by having the same group of mentors, who would assist groups of students to research and develop the workshop every year. We also were recommended that we could develop a “train to the trainer” for the following generation of the students who would work on the future of higher education projects, which would include ground rules, fundamental principles of team and work quality, and list of previous topics.

Through the Goat Tank Challenge, we further clarified the need, approach, benefit, and competitions of the workshop program, which was integrated into the development for this year’s workshop. In the future, the judges from Goat Tank offered to coach us on how to approach the school and the decision-making group to better present our findings from the workshop and make the changes happen.

### 3.3.3 Findings from Workshop

During Winter Session in January 8th, 2019, we conducted the *Back to the Future of Higher Education* workshop. Some snapshots from the workshop can be found in Appendix L. Through the workshop, we found out that most participants believed that CBL could potentially replace PBL in the future. Participants thought by having more CBL projects on campus, the structure of higher education on WPI, in the year of 2050, would have less influence from traditional classes and more flexibility for diverse learning styles and focus on individual students' portfolios. We also explored the challenges of having more CBL on campus.

For the workshop, we had six participants in total, and they were composed of three students and three staff. During the poster section, participants were first asked to fill the blank in the sentence of "In the year 2050, community-based projects will replace/change \_\_\_\_\_" with five options: "nothing", "project-based learning", "traditional classroom", "faculty", and "four-year residential college." An initial poll was conducted with all participants, and we gathered the information (each participant could only vote once): two participants voted for "project-based learning," and two participants voted for "traditional classroom," while the subtopics of "nothing" and "four-year residential college" each got one vote. The participants were then divided into groups of two to each pick a subtopic for the group and develop a poster with one of the subtopics. From the posters in the Appendix N(a) and (b), we see that both groups mentioned that CBL would become a stronger focus of PBL: one group believed that in 2050, CBL will replace/change PBL, while the other thought many of the traditional classes will be changed or replaced, and PBL in the future will have a stronger focus on community engagement. During discussion sections, both groups explained their posters and predicted that the traditional class curriculum would be changed by CBL in different ways. One group mentioned that the higher education system of engineering schools should adopt the portfolio learning

model (as mentioned in the background section) that many online schools were already using. Another group mentioned that CBL would allow more flexibility in the education system, such as new grading criteria and fewer time constraints so that students could learn whenever they want in the most effective ways for themselves.

In terms of possible barriers in the way of achieving more CBL, participants defined two main challenges: lack of platforms and awareness. Participants explained that they thought there was limited platforms for project instructors to contact interested community groups, which resulted in fewer CBL. This statement aligned with our finding from faculty interviews. Another barrier that was mentioned during the discussion was the lack of awareness, specifically awareness of the students to develop their own portfolios, as well as to empower the community groups in need. Participants believed that some students were having a difficult time in stepping out of their comfort zone to experience new learning curriculum, or to interact with groups who had very different cultural backgrounds. Thus, their reluctance to experience CBL, such as off-campus IQP or GPS, would contribute to being a challenge of expanding CBL on campus, since they would be a direct stakeholder.

Overall, we found that the campus generally appreciated the value of CBL and hoped to see more community-based projects, despite the challenges that needed to be resolved to achieve the expansion of CBL on WPI.

## **4. Discussion and Recommendations**

### **4.1 Summary of key findings**

#### **4.1.1 The Benefits of CBL**

Through the focus groups with WPI students and faculty, as well as the Winter Session workshop, we found that CBL was popular among the stakeholders. All participants agreed that CBL benefited students in various ways beyond the traditional classes. Two main areas of development were further explored through reflections: world-readiness and self-actualization. World-readiness focused on the skills that made the student more prepared for professional careers. Self-actualization emphasizes personal development, attitude, and motivation.

##### **4.1.1.1 World-Readiness**

The students thought that CBL helped them contextualize knowledge learned in class and prompted them to apply it to real-world problems. Along the way, they also developed other professional skills, such as teamwork, communication, and research. When they interacted with outside communities, they learned to understand cultural differences and gained new perspectives. The faculty advisors reported that they observed improvements in communication, negotiation, and other non-academic skills. All participants believed that these skills obtained through CBL will make the students more prepared for working in a professional environment and more desirable in the job market. They welcome more CBL because the students' past experience with community-engaged projects helped them become more world-ready.

##### **4.1.2.1 Self-Actualization**

Not only did CBL contribute to students' academic and professional development, but it also aided the self-actualization process. While helping the community members, the students felt that they

were dependent upon and truly cared about the well-being of the community. They thought that the project was meaningful, and the outcomes were more than their grades. The students also believed that they learned about their strengths and weaknesses when they worked with teams on the projects; therefore, they had a clearer understanding of themselves and their future paths. Some of them experienced cultural shocks and reevaluated their own lives and choices. In the student focus groups, we also noted that through discussion and reflection, more students realized their self-actualization. By sharing their experiences, they become more aware of their progress toward self-actualization. The faculty supported the idea that CBL helped with students' self-actualization. They noticed that the students were more motivated to do work when community interactions were involved. The advisors also commented on culture shock. Some of them thought that it was beneficial to students' personal development because it pushed students to consider their situation from new perspectives.

#### **4.1.2 Challenges for Further Integrating CBL**

We identified some current challenges that students and faculty faced in their community-engaged projects. These data were gathered from both the focus groups and the workshop. By identifying these challenges, we hoped to provide recommendation for WPI to further integrate CBL within courses and projects in the current curriculum. A list of challenges that we found through student and faculty focus group include the following:

- Some communities had no clear need or did not have any needs when they proposed projects.
- Students were frustrated by conflicting requests from the advisors and community members, which made them more hesitant to work on community-based projects.
- Seven-week terms were too short for students to learn and reflect from CBL.
- Faculty experienced difficulties balancing between ensuring the achievement of student learning outcomes and the community sponsors' needs during CBL.

- Certain learning content might not fit into CBL, or fundamental technical contents would not be thoroughly taught by CBL.
- The current grading criteria could sometimes fail to evaluate the achievement of the student during CBL.
- Faculty would be responsible for developing relationships with community groups and they faced difficulties of doing so due to time and resources constraints. For IQPs, this work is now done by project center directors.

## **4.2 Recommendations for WPI**

### **4.2.1 Internal Changes**

In order to increase CBL, we identified recommendations to help with the communication between students and faculty and overcome some of the main challenges that some community-based projects face.

#### **4.2.1.1 Learning Outcomes and Expectations**

From the focus groups, we concluded that one of the common challenges that students and faculty faced during community-based projects was the difficulty of meeting the required learning outcomes. This is already a challenge for IQPs but would be more of a challenge when a course has a clear set of academic content to cover in a standard course. We recommend that faculty should communicate the learning outcomes and the expectations with their students before the beginning of the projects so that they could assist students better in achieving their personal goals as well as the general learning outcomes. It could ensure that students would understand the need and importance of each one of the learning outcomes, and thus, accomplish the task more willingly during the projects. On the other hand, if students have other goals that they would like to achieve during CBL, he or she

should also communicate with faculty, in order to allow faculty members to better assist students with their learning experience as well as playing the role as mentors.

#### **4.2.1.2 Time Constraints**

Another challenge that was brought up for the current community-based projects was that seven-week terms did not leave enough time for students to accomplish all the learning outcomes without feeling rushed. For classes that hoped to integrate CBL, we suggested that students should be able to receive credits for not only completing the class but also for finishing a community-based project that included the real-life application of the content. The project could take longer than one term, and the faculty would communicate with the students the expectations and requirements for the outcomes of the project to make sure it fairly proved that the students had fully understood the content through CBL.

We also recommend that for off-campus IQP specifically, instead of having a time requirement of when the project would be finished, the projects could be outcome-driven. The team would set up the goals as well as the timeline themselves before the projects began, and the projects could last from one term to a full semester, as long as all the learning outcomes and goals were met as expected. In this way, students and faculty would no longer feel rushed through the process, and thus, less anxiety for meeting the deadline. It also ensured a comprehensive problem-solving process that would produce well-designed solutions.

#### **4.2.1.3 Courses That May Incorporate CBL**

To encourage more professors to incorporate CBL in their courses, we generated a list of potential courses that are traditionally taught with lectures or in-class projects:

- Higher level classes for juniors and seniors: These classes tend to have less students in each class than lower level foundations classes, which could make project work more feasible. The



students have learned a lot in their major fields and are applying for internships or full-time jobs soon, so they need more CBL experience. Some may be doing IQP or MQP just before or after the course, which makes CBL good practice for enhancing and improving professional and technical skills. Some courses in this category that already have CBL are CS 3733 Software Engineering and ECE 2799 Electrical and Computer Engineering Design.

- Series of classes with sequential topics: Some faculty members mentioned in their interviews that 7-weeks maybe too short for community projects. In this case, many sequential classes in specific major requirements may help students to understand content more holistically through a community project. For example, the mechanical engineering major's degree requirements include experience in mechanical systems and thermal systems, each part currently has 3 required lecture-based courses that sometimes have mini-projects at the end of the individual courses. The professors for these courses may cooperate with each other and develop a project for the series of course, where the students can use the knowledge from all three courses and develop a system for a community. This will give the students 21 weeks to contextualize the academic content in their major.
- Interdisciplinary topics: Some introductory interdisciplinary courses on the undergraduate level could also have more CBL. Students from all levels may sign up for these courses as their electives if they are interested in some fields in these courses. Especially for those who may want to double major, these courses may help them explore options and better use their skills at work. Some students may also find topics they want to further explore for MQP or graduate level work. Faculty members from different departments may partner up and design a 14-week program. One example is the Great Problem Seminars program where humanities or social science or business professors work within science or engineering professors.

- Lab intensive courses: WPI has many lab intensive courses that may benefit from community engagement. As a biology professor mentioned in the interviews, there are many CBL opportunities for biology labs that can either become an MQP or continue in the course with different students, where students can develop lab skills that they will use after they graduate.
- First-year experience: many first-year college students are unsure about where they would like to major. Current courses help students make these decisions include FY1800: Discovering Majors and Careers, and ID200X: Mapping your Mission. Since CBL helps with world-readiness and self-actualization, we recommend the students have a CBL experience in their first year.

## **4.2.2 External Connections**

By examining the challenges discussed in the faculty interviews and the workshop, we identified two recommendations that would improve the relationship and connection between WPI (specifically the faculty advisors, and communities). To help faculty reach out to more communities in need, a project platform could be established to connect project teams with the needs of the communities. To resolve the conflicting requests from the faculty and the community, we propose an agreement template for them to go over before they begin to work on a project that involves students. These two recommendations will hopefully attract more communities to work with WPI project teams and help the projects run smoother and achieve better outcomes.

### **4.2.2.1 Project platforms**

Through discussions with faculty, we found that many of them would like to be involved in community engagement and offer CBL experiences to their students. However, they found it difficult to reach out to communities and the process took a lot of time. Some faculty thought that the students were responsible for bringing communities to the project. In our research about service learning at

other higher education institutions, some of the projects were legacy programs with local communities, and others were approached by the communities. During conversations with faculty, one recommendation mentioned was to build an online platform where communities could post their problems and propose projects. Faculty can then connect with those communities through the platform and set up projects for the students. There are already similar platforms for some fields, but these resources should be further extended to more majors or interdisciplinary areas.

All three stakeholders could benefit from this an online platform for community projects. The students may browse the posted problems, find the projects they are interested in, and be motivated to help other communities. The platform will reduce the amount of time and effort required from faculty to find community-based projects. For those faculty members wanting to implement CBL but do not know how to reach out to communities, the platform will connect them with the communities. Similarly, the communities will have an easier time finding faculty advisors and student project teams to solve their problems. The platform will require less personal connections and effort to get help from the school. Meanwhile, it might attract more organizations that care about student development and be willing to provide training. Some drawbacks of this platform could be that it is difficult to maintain, and it may cause problems and complaints when some communities' requests are left unfulfilled for a long time.

#### **4.2.2.2 Agreements Between Faculty and Community Partner**

Since the majority of the students and faculty experienced misalignment of expectations between faculty advisors and community sponsors, we think it is necessary for the two parties to discuss and document some key elements regarding the project before involving students. The goal of this agreement is to communicate the expectations for the student project team and the resource allocations. Generally, faculty advisors expect the students to meet the learning outcomes of the course

or project, and they will spend a certain amount of time helping the students each week. We hope to find out more about what the community partners can provide and want to receive through the community focus groups that will be conducted next semester. This consent should reduce unnecessary friction and conflict between the advisor and the sponsor. By clarifying the expectations, the students may focus more on solving problems and creating value. One might argue that some misalignment of expectations is beneficial to the students because the students can learn communication skills from it. From an example in the student focus group, one student thought that she was more self-actualized because of the conflict. However, for most students, these conflicts gave them a bad experience and drove them away from CBL. While disagreements and conflicts may still be present in the projects, a written agreement before the project will help control the situation and create a better experience for all stakeholders.

#### **4.2.3 Annual Workshop Program on Future of WPI**

We highly recommend that WPI host a workshop program on the Future of WPI annually and invite all stakeholders to attend. The workshop will engage these stakeholders to imagine how WPI will meet the challenges facing the future for higher education. All of the attendees of this year's workshop on CBL said that they would be interested in participating. They found the topic of the workshop interesting and the activities very engaging. Every year, a different dimension of the future could be considered, which could help WPI become for proactive in a changing world. This year's workshop was held during Winter Session. It was a good starting point because the Winter Session program helped us attract more attendees, but in the future the workshops could be held at more times during the year to attract more participation. More analysis and recommendation can be found in Appendix O.

## **4.3 Suggestions for Future Research**

### **4.3.1 Community Members Focus Group**

For our project, we were able to conduct students and faculty focus groups to determine the current impact of CBL on the main stakeholders. However, we were not able to proceed with community member focus group as we hoped due to time constraints. Community member's opinion towards CBL will help identify more values that community-based projects create from another perspective, as well as current challenges, that will help future researchers generate more recommendations that increase the popularity and impacts of CBL on WPI campus.

### **4.3.2 Conducting an Annual Program**

Though our project was rooted in CBL and its impacts, we believe that the future of higher education will change in other directions. In order to keep the school constantly engaged in thinking of the concept of higher education and its changes, we highly recommend that the school continues the annual workshop where all stakeholders discuss the future directions for higher education. The topic each year could be generated by students through literature reviews and research, such as focus groups. Students should be in charge of designing and facilitating the workshop, and afterwards, they will analyze the data collected during the workshop from participants. In this way, we hope that continuous exploration on the future of higher education will not only keep the school updated with competitiveness and general quality of graduates, but also keep the public thinking of the purpose of higher education and recognize the importance of it.

### **4.3.3 Grading Criteria**

We recommend future research that focuses on possible changes for the evaluation and grading criteria of WPI for community-based projects. This project's recommendations addressed the

challenges that meeting learning outcomes but not the challenge of current grading criteria fails to fully evaluate students' learning experiences of both knowledge and skill sets. Due to the time constraints, we were not able to research other engineering institutions' current method of evaluating student development of skill sets.

## **4.4 Project Conclusion**

In the future, engineers need to not only have the technical and professional skills to solve technical problems, but also the ability to understand the social and human aspects of the issues. Community-based project learning (CBL) in higher education would introduce engineers in training to work with outside communities in order to help them learn to work with and for different cultures and communities. At WPI, students and faculty members believe that CBL helps with self-actualization and better prepares them for the real world. While most of the students and faculty members wanted more CBL at WPI, they identified challenges in further integrating CBL within the current curriculum. We recommend a series of changes both within WPI and with the community partners to improve the CBL experience and attract more community-based projects. To continue the conversation about the future higher education at WPI, we propose an annual workshop program that involves students, faculty, and community members to bring their own perspectives. During this portion of the project, we focused on the students' and faculty members' opinions on CBL, and a future IQP will extend the study to include community members.

## 5. Citations

ABET. (2018). Criteria for Accrediting Engineering Programs, 2018-2019.

ABET. (2019). Accreditation.

Bandy, J. (2019). What is Service Learning or Community Engagement? Retrieved February 22, 2019, from <https://cft.vanderbilt.edu/guides-sub-pages/teaching-through-community-engagement/>

Baume, D., Yorke, M., Driessen, E., Van Der Vleuten, C., Schuwirth, L., Van Tartwijk, J., ...

Friedman Ben David M, Davis M H, Harden R M, Howie P W, K. J. and P. M. J. (2010). Studies in Higher Education The Reliability of Assessment by Portfolio on a Course to Develop and Accredited Teachers in Higher Education The Reliability of Assessment by Portfolio on a Course to Develop and Accredited Teachers in Higher Education. *Medical Education*, 44(2), 37–41.

<https://doi.org/10.1111/j.1365-2929.2004.02059.x>

Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 83(2). Retrieved from <https://www.tandfonline.com/doi/abs/10.1080/00098650903505415>

Case, A. (2010). We are all cyborgs now. TED Woman. Retrieved from [https://www.ted.com/talks/amber\\_case\\_we\\_are\\_all\\_cyborgs\\_now/transcript?referrer=playlist-what\\_does\\_the\\_future\\_look\\_like#t-258279](https://www.ted.com/talks/amber_case_we_are_all_cyborgs_now/transcript?referrer=playlist-what_does_the_future_look_like#t-258279)

Cohen, K. (1977a). *Impact of WPI Plan*. Worcester: Worcester Polytechnic Institute.

Cohen, K. (1977b). The WPI Plan: Promise and Reality. *The Journal of General Education*, 29(2), 105–112. Retrieved from [https://www.jstor.org/stable/pdf/27796627.pdf?seq=1#page\\_scan\\_tab\\_contents](https://www.jstor.org/stable/pdf/27796627.pdf?seq=1#page_scan_tab_contents)

- Condliffe, B. (2017). Project-Based Learning: A Literature Review. Working Paper.
- Conlon, E. (2008). The new engineer: between employability and social responsibility. *The European Journal of Engineering Education*, 33(2), 151–159. Retrieved from <https://www.tandfonline.com/doi/abs/10.1080/03043790801996371>
- Conlon, E. (2013). Broadening Engineering Education: Bringing the Community In. *Science and Engineering Ethics*, 19(4), 1589–1594. Retrieved from <https://philpapers.org/rec/CONBEE>
- Coursera. (2019). Share your Course Certificate. Retrieved from <https://learner.coursera.help/hc/en-us/articles/208280246-Share-your-Course-Certificate>
- Edmunds, H. (2000). *The Focus Group Research Handbook*. McGraw Hill Professional. Retrieved from [https://books.google.com/books/about/The\\_Focus\\_Group\\_Research\\_Handbook.html?id=vGa5szorHEAC](https://books.google.com/books/about/The_Focus_Group_Research_Handbook.html?id=vGa5szorHEAC)
- Franzenburg, G. (2009). Educational intervention: Theory and practice. *Problems of Education in the 21st Century*, 13(1), 37–43.
- GAC. (2019a). CBL Course Highlights: Community-Based Learning Across the Curriculum. Retrieved February 22, 2019, from [https://gustavus.edu/communityservice/course\\_highlights.php](https://gustavus.edu/communityservice/course_highlights.php)
- GAC. (2019b). Community-Based Learning Mini-Grants Applications are accepted on a rolling basis pending availability of funds. Retrieved February 22, 2019, from <https://gustavus.edu/communityservice/cblgrants.php>
- GAC. (2019c). Service Programs: Community-Based Service and Learning. Retrieved February 22, 2019, from <https://gustavus.edu/communityservice/serviceprograms/>



- GAC. (2019d). What is Community-Based Learning? Bridging Theory and Practice. Retrieved February 22, 2019, from <https://gustavus.edu/communityservice/faculty.php>
- Goldin, I. (2009). Navigating our global future. TED Global. Retrieved from [https://www.ted.com/talks/ian\\_goldin\\_navigating\\_our\\_global\\_future/up-next?language=en](https://www.ted.com/talks/ian_goldin_navigating_our_global_future/up-next?language=en)
- Gorgan, W. (1975). *Restructuring Undergraduate Education at Worcester Polytechnic Institute: A Report To The Twenty-eighth Meeting of the Advisory Committee for Science Education National Science Foundation*. Worcester.
- Harley, S. (2017). *The Fuzzy and The Techie*. (H. M. Harcourt, Ed.) (First Edit).
- Heinricher, A. C., Quinn, P., Vaz, R. F., & Rissmiller, K. J. (2013). Long-term Impacts of Project-Based Learning in Science and Engineering. *2013 Asee Annual Conference*.
- Inside Higher Ed. (2019). Higher Ed Events. Retrieved from [https://www.insidehighered.com/events\\_people](https://www.insidehighered.com/events_people)
- Khan, S. (2011). Year 2060: Education Predictions. Khan Academy. Retrieved from <https://www.khanacademy.org/talks-and-interviews/conversations-with-sal/v/year-2060-education-predictions>
- Kilbride, J., & Xiao, B. (2018, November 15). China’s “artificial sun” reaches 100 million degrees Celsius marking milestone for nuclear fusion. *ABC*. Retrieved from <https://www.abc.net.au/news/2018-11-15/china-attempts-to-create-an-artificial-sun/10495536>
- Klenowski, V., Askew, S., & Carnell, E. (2006). Portfolios for learning, assessment and professional development in higher education. *Assessment and Evaluation in Higher Education*, *31*(3), 267–286. <https://doi.org/10.1080/02602930500352816>

- Krchnack, K., & Sara, J. (2017). Water For All: Securing Global Freshwater Resources for People and a Living Planet. *World Wildlife Magazine*. Retrieved from <https://www.worldwildlife.org/magazine/issues/fall-2017/articles/water-for-all>
- Landry, J., & Cruikshank, J. (2015). *True to Plan*. Worcester Polytechnic Institute.
- Learninghouse. (2013). Online College Students: Demands and Preferences.
- Maslow A. (1943). A theory of human motivation. *Psychological Review*, 50, 370–396.
- Maslow, A. (1954). *Motivation and Personality*. (2nd ed.).
- Muoio, D. (2016). 17 ways technology will change our lives by 2050. Retrieved February 22, 2019, from <https://www.businessinsider.com/ian-pearson-predictions-about-the-world-in-2050-2016-7>
- Neto, M. (2015). Educational motivation meets Maslow: Self-actualisation as contextual driver. *Journal of Student Engagement: Education Matters. University of Wollongong Australia*, 5(1).
- OED. (1989). “Engineer, n.” The Oxford English Dictionary, 2nd edn. OED Online. Retrieved February 22, 2019, from <https://en.oxforddictionaries.com/definition/engineer>
- Olin College. (2018). Remaking education, 2018.
- Oregon State University. (2019). What is the Institutional Review Board (IRB)? Retrieved from <https://research.oregonstate.edu/irb/frequently-asked-questions/what-institutional-review-board-irb>
- Pawley, A. (2007). Where do you draw the line? A study of academic engineers negotiating the boundaries of engineering. *Doctoral Dissertation, Industrial Engineering, University of Wisconsin-Madison*.

- Purdue University. (2019a). EPICS. Retrieved February 22, 2019, from <https://engineering.purdue.edu/EPICS>
- Purdue University. (2019b). EPICS Teams. Retrieved February 22, 2019, from <https://engineering.purdue.edu/EPICS/teams>
- Purdue University. (2019c). EPICS VETS. Retrieved February 22, 2019, from <https://epics.ecn.purdue.edu/vets/>
- Purdue University. (2019d). Purdue Journal of Service Learning and International Engagement. Retrieved February 22, 2019, from <https://docs.lib.purdue.edu/pjsl/about.html>
- Purdue University. (2019e). Service-Learning Fact Sheet. Retrieved February 22, 2019, from [https://extension.purdue.edu/4h/Documents/Volunteer IN 4-H Toolkit/Service-learning Fact Sheet.pdf](https://extension.purdue.edu/4h/Documents/Volunteer%20IN%204-H%20Toolkit/Service-learning%20Fact%20Sheet.pdf)
- Riley, D. (2008). Engineering and Social Justice. *Synthesis Lectures on Engineers, Technology, and Society*, 3(1), 1–152. Retrieved from <https://www.morganclaypool.com/doi/abs/10.2200/S00117ED1V01Y200805ETS007>
- Robinson, K. (2009). Changing education paradigms. TED. Retrieved from [https://www.ted.com/talks/ken\\_robinson\\_changing\\_education\\_paradigms/details](https://www.ted.com/talks/ken_robinson_changing_education_paradigms/details)
- Robles, M. (2012). Executive Perceptions of the Top 10 Soft Skills Needed in Today's Workplace. *Sage Journals*. Retrieved from <https://journals.sagepub.com/doi/pdf/10.1177/1080569912460400>
- Skinner, J. (2009). Where Every Drop Counts: Tackling Rural Africa's Water Crisis. *International Institute for Environment and Development, March*(March), 4. Retrieved from [www.iied.org/pubs/display.php?o=17077IIED%5Cnhttp://pubs.iied.org/pdfs/17055IIED.pdf](http://pubs.iied.org/pdfs/17055IIED.pdf)

- Swarthmore College. (2018). Engaged Scholarship and Community-Based Learning Courses. Retrieved February 22, 2019, from [https://docs.google.com/document/d/1M-X1zKsaXsfBBdYN6YaRoICrIKwrXzM-bfW\\_vVeGgLA/edit](https://docs.google.com/document/d/1M-X1zKsaXsfBBdYN6YaRoICrIKwrXzM-bfW_vVeGgLA/edit)
- Swarthmore College. (2019). Lang Center for Civic & Social Responsibility. Retrieved February 22, 2019, from <https://www.swarthmore.edu/lang-center/about-lang-center>
- United Nations. (2015). World population projected to reach 9.7 billion by 2050. Retrieved from <http://www.un.org/en/development/desa/news/population/2015-report.html>
- University of Illinois. (2019). Community-Based Learning: Service Learning. Retrieved February 22, 2019, from <https://citl.illinois.edu/citl-101/teaching-learning/resources/teaching-strategies/community-based-learning-service-learning>
- Vaz, R. (2012). *Long-Term Impacts of a Project-Based Curriculum : WPI Alumni Survey Findings*.
- Vaz, R., & Quinn, P. (2015). Long term impacts of off-campus project work on student learning and development. *Proceedings - Frontiers in Education Conference, FIE, 2015–Febru(February)*, 1–5. <https://doi.org/10.1109/FIE.2014.7044128>
- Weimer, M. (2013). *Learner-centered teaching five key changes to practice* (2nd ed.). San Francisco: Jossey-Bass.
- WPI. (2019a). Institutional Review Board. Retrieved from <https://www.wpi.edu/research/resources/compliance/institutional-review-board>
- WPI. (2019b). Lifelong Project Impact. <https://doi.org/2019-02-22>
- WPI. (2019c). Project Based Learning.
- WPI. (2019d). WPI Project Center Directory. Retrieved from <https://www.wpi.edu/project-based->

[learning/global-project-program/project-centers](#)

# Appendices

## Appendix A – Student Focus Group Consent Form

IQP: Future of Higher Education Student Focus Group Informed Consent

Principal Investigator: Anqi Shen, Claire Long, Cynthia Teng

### Purpose

This study investigates the students’ opinions on community-engaging Project-Based Learning(PBL) at WPI. As part of this study, you will be asked to participate in an interview and answer structured and open-ended questions. This study will take approximately 60 minutes.

### Participants’ Rights

I understand that my responses will be kept in the strictest of confidence and will be available only to the researcher. No one will be able to identify me when the results are reported and my name will not appear anywhere in the written report. I also understand that I may skip any questions or tasks that I do not wish to answer or complete. I understand that the consent form will be kept separate from the data records to ensure confidentiality. I may choose not to participate or withdraw at any time during the study without penalty. I agree to have my verbal responses tape-recorded and transcribed for further analysis with the understanding that my responses will not be linked to me personally in any way. After the transcription is completed, the tape recordings will be destroyed.

I understand that upon completion, I will be given full explanation of the study. If I am uncomfortable with any part of this study, I may notify the moderator and leave the room at any time.

I understand that I am participating in a study of my own free will.

### Consent to Participate

I understand my rights as a research participant as outlined above. I acknowledge that my participation is fully voluntary.

Print Name: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

## **Appendix B - Student Focus Group Screener Questions**

1. What major and year
2. Email
3. Do you have any PBL(Project-Based-Learning) experience on WPI campus
  - a. GPS
  - b. IQP
  - c. MQP
  - d. others
4. How much did you learn from your project experiences compared with lectures
  - a. from 1-5, 1 being not much more, 5 being very much more
5. How much would you rate your project experiences in general
  - a. from 1-5, 1 being not much, 5 being very much
6. How would you rate your mentorship experience
  - a. from 1-5, 1 being not much, 5 being very much

## **Appendix C – Students Focus Group Handout**

### **Self-actualization:**

- Through your own experiences, you understand your own talents, core strengths, and development areas; you also find your passion and a lifelong goal. You feel motivated and willing to work toward the goal.

### **Have you ever experienced when you...**

- Feel tired but willing to work because you are motivated to help solve an important issue rather than for any physical reward
- Feel satisfied and happy with your work even if no one else knows what you are doing
- Feel a sense of content after finishing certain work

### **World-ready**

Here are some the skill you need to have to be world ready:

- Communicating skills with certain groups of people who will be likely to be affected or affecting the solution of the problem/research
- Researching skills, including literature review, conducting interviews or focus group when necessary
- Teamwork skills
- Compassion and care
- Connection with the surroundings, such as people, culture, and environment



## Appendix D – Student Focus Group Questionnaire

1. To what extent did your projects work help you feel world ready to work with other communities?
2. How did you connect/interact with the communities your project served? **“can you tell me more about that?”**
3. If you could choose any project you want to work on, where would working with a community fit in the line of priorities?
4. While you were working on projects, how would you describe the alignment of your personal goals and the goals that others (community) in the project had?
5. What types of skills and experiences do you think you learned from projects that you wouldn't learn from a traditional classroom that contribute to World-readiness?
  - a. Are there skills you think you should have learned but did not get to learn?
6. **Show of hands** for people experienced interaction with **a person who helps you become self-actualized** It could be a community member, advisors, sponsors, peers etc., **give examples/“can you tell me more about that?”**
  - a. How did the advisors help you connect with the community?
  - b. How did the community sponsors help you fulfill the project successfully?

## **Appendix E – Faculty Focus Group Questionnaire**

1. Would you please briefly tell us about your past community-based project experience here at WPI, this includes IQP, MQP, GPS, and course-based projects.
  - a. If not, why? And would you be willing to instruct these projects?
2. How do you think these community-based projects contribute to students’ self-actualization as we defined before,
  - a. Compassion & empathy development
  - b. Contribute to “world readiness”
3. While you were working on projects, how do you balance the needs of student learning outcomes and needs of the community stakeholders?
4. We think there should be more community-based PBL on campus, what do you think of that?

# Appendix F – Community Member Focus Group Questionnaire

## Objectives:

1. Understand community members' involvement in CBL
2. Explore the value community members expect to receive and received through CBL
3. Learn about how community members perceive their role in CBL, especially their relationship with students
4. Understand the expectations of the community members and how it has changed after working with WPI.
5. Find out any challenges they face

## Questions:

1. What WPI projects have you been involved in?
2. Why did you choose to partner with WPI to work on the project(s)?
3. How would you describe the outcomes of the project(s)? And why?
4. What role did you play in these projects?
5. How much time do you usually spend with the students per week?
6. What's the purpose of spending time with students?
  - a. Details
7. How does that work with the availability you have, does it meet with your expectation?
8. How did you set up these projects with WPI? What were the challenges in running into?
9. What were your personal and your organization's expectations for the projects? To what extent were they met? How did they change along the way?
10. What were the costs and benefits of working on these projects?
  - . Personal/organizational scales

## Appendix G -Trivia

1. What year was the WPI Plan established? 1969
2. What were the four degree-requirements in the original WPI plan? MQP, IQP, HUA, competency exam
3. When was the Competency exam taken out of the curriculum (general time frame)? The Mid-1980s
4. 50 years ago, what was the female student percentage in the class of 1969? 0%
5. WPI became co-ed in 1968, how many women enrolled in the fall of 1968? 2
6. Where was WPI's first off-campus project center? Washington D.C., USA
7. When was the GPS program first started? 2006
8. Name 3 learning outcomes in the undergraduate program. Read, Write, Math

## Appendix H – Role Play Characters

### I. 4 Freshman

1. A first-gen college student: Both of your parents did not get to go to college, and today, even though they both have decent jobs, they keep emphasizing the importance of going to college for you. They helped you a lot with your college application process and now that you are here in WPI, you feel the burden of doing well so you won't let them down.
2. An international student from Jamaica: You are an international student from Jamaica, and this is the first time you are in the United States. Everything is overwhelming, especially the school workload makes you sick, and you start to feel more and more homesick. You start to wonder if coming to the U.S. for higher education is a good idea.
3. Domestic American student: You are glad that WPI offers you some scholarship. But you are not sure what major you are doing, so you signed up a class called “Discover your major”, and GPS since it fulfills both a humanity credit and one science credit.
4. A student who has other interest than technology: You are a freshman who decided to enroll in WPI because it was on the top of your college options list. You always have wanted to be a surgeon. After a term, you found out that WPI does not pre-med programs that you need for your future career. And you feel a bit left-behind comparing with your friends who are already practicing on real patients now.

### II. 4 Senior ready to graduate/ alumni

5. Domestic senior: You are an ECE senior, and you are so glad that you finally finished all the requirements because you have come a long way. Fortunately enough, you got a full-time job offer from Bose, and you are ready to get out of WPI and to launch your exciting career as an engineer.

6. Graduate school students: You went to another school for the undergraduate program and came to WPI for graduate school. The campus is quite different from your previous university and you, living off campus, are having a hard time fitting in.
7. Senior Transfer student: You came to WPI because of its good reputation STEM field, which will help you more likely to get a job after graduation. You are still at the stage of exploring campus resources, knowing people, and relatively new to this PBL concept. So you are a little bit concerned about MQP.
8. Senior that will do the 5-year BS/MS program: You are not rush in finding jobs after undergraduate, and also thinking that a master degree will put you in a more competitive spot in the market, so you applied for WPI BS/MS program, without worrying taking the GRE. You are quite familiar with the concept of PBL.

### III. 4 Parents of WPI students

9. Parents who did not go to college because they didn't have money or time, but wish they had: You put all the hopes and expectations on your kid that is attending WPI because you believe that a college degree is the only way to get him/her a job. You have invested a lot on your child's education, hoping that you will get a good return one day.
10. Parents that own a family business, fairly well-off: You send your kids to college because that has been a trend of doing so. Also, college is a good place to build up your kid's social network, which would be beneficial for your family business. But whether or not your kid gets a good grade, does not really matter because you believe your kid will inherit the business after graduation.

11. Parents who are alumni: You went to WPI and graduated with an engineering degree as well as fun memories and solid friendships. You enjoyed your college so much that you would like to have your children to also have the blessing.
12. Homeschool parents: You home-schooled(caged) your kid till he/she is 18, and all of a sudden, your house seems too empty. You tried to call him/her every day and even consider renting a place near campus to take care of your kid. You have no trust in the current higher educational system

#### IV. 4 Sponsor/ community members

13. Alumni graduated a long time ago: You graduated in the year of 1980, joined a start-up company at that time and ended up very successful. You are a millionaire now and you keep donating to the school annually so much that one of the Foisie's tech suites is named after you.
14. Alumni graduated recently: You graduated in the year of 2013, after a gap year of backpacking in Europe, you just started job-searching. You still try to donate to WPI every Founders' day for the sake of the wonderful four years' experiences you had on campus, and you want to see the campus to do better.
15. Worcester locals: You were born and grew up in Worcester. You live close to WPI so you have witnessed the development of WPI campus over the past several years.
16. Off-campus IQP sponsor: You are a project manager in a tech company in Switzerland, and your company has connected with WPI to send students for their off-campus IQP program, specifically assist your team on their project. You are not sure how to work with college students and do not know what to expect from this collaboration.

#### V. 4 Professor/advisor

17. An HUA professor who teaches GPS: You have background humanities or arts, and you are interested in the social impact and ethics of engineering projects. You have been teaching GPS course on campus with other colleagues with technical backgrounds. You liked your career because you think it brings awareness to young engineers.
18. A tenure-track professor who went to WPI: You love WPI so much that you never want to leave. You have ideas about how WPI could be better ever since you were a freshman, and you want to make these changes by becoming a tenured professor. At the same time, you are starting a family here and have babies to support.
19. A professor in practice who retired from the industry: You retired from your position as the lead engineer or project manager from a big company, but you think that there are more things you can do for the engineering community. Thus, you started to teach at the local engineering college.
20. A research professor who teaches in some grad level classes: You are passionate about your research, but everything else seems sort of unimportant. You are Sheldon Cooper, but a better professor, hopefully.





## Appendix J – Student Focus Group Demographics

*Table 2 Student Focus Group 1*

Student (Gender)	Class	Major	GPS	IQP	MQP	In class	Extracurricular
A (F)	2019	BIO	No	Off-campus	Yes		
B (F)	2019	BME	No	Off-campus	Yes	Biology class	
C (F)	2020	BME	No	Off-campus	No		
D (F)	2021	RBE	No	No	No	RBE 1001	Entrepreneurship club

*Table 3 Student Focus Group 2*

Student (Gender)	Class	Major	GPS	IQP	MQP	In class	Extracurricular
E (M)	2019	RBE	No	On-campus	Yes		
F (M)	2019	CS/ RBE	No	Off-campus	No		Youth organization
G (M)	2019	ECE	No	Off-campus	Yes	ECE 2799	
H (F)	2020	ECE	No	Off-campus	No		

## Appendix K – Student Focus Group Notes

### Student Focus Group 1

1. To what extent did your projects work help you feel world ready to work with other communities?
  - Off-campus IQP: Understanding the team dynamics of working in a team; Culture shock: overcoming language barrier; forming friendships;
  - RBE class: team dynamics; scheduling/ time management;
  - Communication with co-workers & different groups of people working with
2. How did you connect/interact with the communities your project served?
  - Translation apps,
  - Explain professional, technical concepts in simple language
3. If you could choose any project you want to work on, where would working with a community fit in the line of priorities?
  - Make more meaningful project: interested, motivated, hard work > a positive cycle;
  - To have passion, in order to become motivated
  - Concerns over liability: decrease the risk of “tried to help but screw up” by doing the projects with school
4. What types of skills and experiences do you think you learned from projects that you wouldn't learn from a traditional classroom that contribute to World-readiness or **self-actualization**?
  - a. Are there skills you think you should have learned but did not get to learn?
    - Figure out the solutions yourselves, no rigor requirements, “no wrong answer”
    - Interesting
    - Feeling a sense of responsibility when being “dependent” by the community, more motivated, driven to “do a better job”
    - Understand the needs of people to make something “actually useful”
    - Concepts make more sense when you can visualize them, especially within fields that you are interested in/ passionate about
    - Creative thinking skills are missing when in the traditional lectures
    - Self-actualization:
      - Understand your strengths & development areas & if you are passionate about your major/what you do or not
        - Understand themselves better
      - Comfortable to fail with teammates around
        - “Not totally in charge”
      - Adapt to working under pressure, getting patient with people, team roles assignments
      - Multidimensional tryouts in different fields
5. While you were working on projects, how would you describe the alignment of your personal goals and the goals that others (community) in the project had?

- IQP advisor contradicted with sponsors: overcoming the challenge as a team to cater both sides as much as possible
- “Well then you won’t have a project”
  - The expectation of actually helping with the community & achieve real accomplishments are not meet/contradicts with academic requirements
- Accustomed to cater to upper-level leaders’ need when doing a project
  - Push them to balance the two worlds & make correct decisions
- Generation gap
  - Become more mindful

**6. Show of hands** for people experienced interaction with a person who helps you become self-actualized It could be a community member, advisors, sponsors, peers and etc., give examples

- a. How did the advisors help you connect with the community?
  - b. How did the community sponsors help you fulfill the project successfully?
- Members from the community, upperclassmen from club, advisor, teammates who push you
  - Solid friendships, driven to achieve better self

## Student Focus Group 2

### 1. To what extent did your projects work help you feel world ready to work with other communities?

Confused about community-based learning, could be club and academic

Not enough communication skill, just one person team, more research

Through community service, boy scout, more teamwork, and communication, less research

*Skills that can be applied after college?*

Learning from young kids,

National park service, different goals, a middle ground between volunteer/staff and visitors

The survey, communication skills. Teammates double check, self-assign

On campus, 3D print, working with various people

*Unexpected situations?*

- Hard to work with people that you don't get to interview as much

NPO, working in office, communication, professional, get alone even outside of work, which helps teamwork.

Research-intensive.

On-site family home interview

### 2. How did you connect/interact with the communities your project served? “can you tell me more about that?”

Had lists of requirements from park staff, prioritize visitors needs

*How to communicate?*

- Email, not very social overall, quite technological aspects, people not knowing the project work\_
- A lot explanations to people who don't understand

Working with stubborn people

Advisor doesn't know 3D printing

Summer RBE research. Animation work, need to teach the artistic side of things, and conference to explain everything to people don't know anything

- Understand audience the weakness/strength

*HOW to know tasks for projects beforehand?*

- Look up last year's responses, and improve based on that
- Go to factory/manufacturer, then look at incentives, identifies problem  
*Surprising stuff?*  
Aus. gov push fossil fuel over solar power
- Know the background beforehand, and compare similar situation stats
- Improve current design

### **3. If you could choose any project you want to work on, where would working with a community fit in the line of priorities?**

Scale?

Low - logical thinking, data says everything applies to how community thinks, **qualitative**

*Hard to satisfy everyone?*

- Just to avoid trigger emotions

As soon as it is fulfilling some people's needs at some extent, necessity drives innovation

Rather work on technical side, and let some people take care of humanitarian

When people don't understand their own problem, have to spend time explaining the problem

- Similar experience, b/c age gap
- Advisors over complicate project, not the optimal solution

Community members do not know what they want

Inflexible community member

*Want help, but can't b/c of that ??*

- Possible, haven't come across

### **4. While you were working on projects, how would you describe the alignment of your personal goals and the goals that others (community) in the project had?**

Advisor shaped personal goal, and similar goal within the team

Everyone has a similar goal, but advisor doesn't acknowledge, so have to do what advisor wants you to do.

Advisor inflexible

Advisor not knowing anything helps the team follow their own path

*Doing the project just for the sake of academic success?*

- Vague instruction
- Unnecessary steps suggested by the profs, not feasible
- Detach from real-world issue
  
- Profs don't accept your solution
  
- Create something that already exists

*Value of these projects?*

Solving problems is the first thing, doesn't matter if the solution is new or something existing

- The classroom setting is learning, through IQP learn teamwork, although not the best solution

*Need tradition training all?*

- Some extent, but only 10% would be used in jobs
  
- Dropping people at work setting would be the best training

*Then what the value of college?*

- Learn to learn, problem-solving skills
- College makes you repeat
- Let you the chance to explore, trying different things
  
- Only tailored to research type study
- Four years not necessary

**5. What types of skills and experiences do you think you learned from projects that you wouldn't learn from a traditional classroom that contribute to World-readiness?**

- Through trying different things, know what you like
  
- Through projects- interpersonal skills
- Project through research skills too

**a. Are there skills you think you should have learned but did not get to learn?**

- Marketing the projects, wish to learn to present
- Ready for different questions, know your stuff

- Projects only run to school, but we would need real world experts to validate
- Lose connect with the real world
- Should shadow real world experts
- 
- Good MQP sponsors from company, supportive to own direction

**6. Show of hands for people experienced interaction with a person who helps you become self-actualized It could be a community member, advisors, sponsors, peers and etc., give examples/ “can you tell me more about that?”**

$\frac{3}{4}$

How to write a paper, help you figure personal path/ passion

Inspiring, been in the industry for 30+ years

Good connection with advisors, personal interaction affects you

*The moment you think this is a helpful person?*

- Recommendation letter
- Advisor open to our project ideas, caring enough, so that keeps us motivated
- Before college.

*Still, keep in touch?*

- a. How did the advisors help you connect with the community?**
- b. How did the community sponsors help you fulfill the project successfully?**

## Appendix L – Faculty Interview Notes

### Faculty Interview 1

1. **Would you please briefly tell us about your past community-based project experience here at WPI, this includes IQP, MQP, GPS, and course-based projects.**

- “Limited”
- GPS
  - not in partnership with community members
  -
- IQP
  - Biochem research
  - Student reached out to CDC (career development center)
- Ask students to ask somebody, each to two people
  - Communication

2. **How do you think these community-based projects contribute to students’ self-actualization as we defined before,**

- Work seems immediately important
  - More than a grade
  - Very motivating and even inspiring for most students
    - Very powerful
- GPS contribute to compassion & empathy development
  - Access to cultural diversity, broaden **awareness**
    - Realized their own privileges & use their advantages to help other people who don’t have so
    - Let the community identify the problem, let students provide avenues that they were not able to see instead of just solving the problem
    - “Not all differences are problems that need to be fixed”
      - Toothless represents wisdom
  - “Show students that the world is a much bigger place”

3. **While you were working on projects, how do you balance the needs of student learning outcomes and needs of the community stakeholders?**

- For GPS & IQP: What should project deliverables be
- A constant dilemma & there isn’t a perfect solution
- Concepts “better remember”
  - Why do students want to know/ learn biochemistry
  - More impactful in the long-term
    - Trans-discipline mindset
  - “Way more valuable” learned in GPS than a regular course like Chem1010

4. **We think there should be more community-based PBL on campus, what do you think of that?**

- Challenges:



- Find community
  - asks connections with outside communities from faculties - contradict busy time commitment
  - Hard for students to build the connections
- The risk of lacking fundamental contexts for some subjects
- Evaluate teamwork & design syllabus
  - More time-consuming for faculty
- Grading criteria
- WPI students need to learn how to work in a team
  - The key value for employers
- Self-actualization
  - Study of Alumni: students with off-campus IQP are happier
    - ASAE

## Faculty Interview 2

### 1. Would you please briefly tell us about your past community-based project experience here at WPI, this includes IQP, MQP, GPS, and course-based projects.

- IQPs
  - nonprofit organization sponsor
  - Community reaction towards biology ethics
- IGEM
  - Engagement of students from other campuses

### 2. How do you think these community-based projects contribute to students' self-actualization as we defined before,

- Student development empathy for certain unprivileged community
  - Awareness of different people have different needs
  - Sensitive towards these needs
- More motivating, more appealing than regular projects
  - Opportunity to integrate technical skills & practical outcomes
- Students are being proactive, were able to reach to different community groups on their own
- Borden horizon & gain exposure, understanding the perspectives of different groups, which helps them to refine their very own opinion

### 3. While you were working on projects, how do you balance the needs of student learning outcomes and needs of the community stakeholders?

- "Core of advisors' job"
- Fundraiser idea from sponsors: deviate from the learning objectives from IQP
- "Learning objective for the projects comes first"/ primarily
  - Negotiation & communication to let the stakeholders know
- Final paper: "contributing to knowledge"
  - Share your result to the academic audience/ the public
  - Learning to do/ develop the skills of analyzing quantitative/qualitative data -- crucial for students

- Being able to communicate the result of the project
- “Students have to be within the structure as they agreed to when they enroll to WPI” but in the future, without the limitation of structure/ boundaries, they can pursue their passion
- structure/ boundary
  - The common expectation of IQP has to be met first
  - Attempt to go beyond the expectation without meeting the requirements of basics

**4. We think there should be more community-based PBL on campus, what do you think of that?**

- Not all projects are going to have community engagement
  - IQP expectation would have to be changed
- Room for more courses to do that
  - SENCER network
    - How could a classroom find a more practical problem?
  - IGEM
    - research experience, to think about the ethics, to engage with communities
- Grading criteria for GPS
  - How well is the project thought out
  - Even without the impact, a team with well-written paper and well-thought ideas will have a good grade
  - Credit:
    - The best solution exists so far
    - Fair application of the subject to “dig out the knowledge themselves” in a trans-discipline way
- Challenge of the time commitment of faculty
  - Databases and other resources are available (Gands initiatives)
  - Unit all the interested groups could use a more convenient approach

**Faculty Interview 3**

**1. Would you please briefly tell us about your past community-based project experience here at WPI, this includes IQP, MQP, GPS, and course-based projects.**

- IQP groups on & off campus
  - Off-campus, lives on school dorms
  - Interact with students on technology
  - Use smartphones for academic means
- What community knows, what they want, and what they do
  - Actualize community’s potentials
  - Connect the community with/ help them to figure out what they need

**2. How do you think these community-based projects contribute to students’ self-actualization as we defined before,**

- To make students “feel useful to the world” - self-affirmation

- “Don’t have to care for the particular groups/ people”
  - “Empathy is not necessary for the process of helping the community”
  - “You can’t teach empathy”
- Wood sticks instead of electricity for cooking
  - “I don’t think a group of students would have developed cultural empathy with that community groups”
  - Language barrier -> cultural shock even within a country itself
- Are students more motivated when working for communities
  - Students are used to “do well”
  - “If you do this well, you will help somebody”, no grades for ID2050
  - Students don’t wanna be embarrassed/ look stupid
  - 80% of off-campus: **students bonding with each other**
    - Out of comfort zone experiences
    - Sense of achievement

**3. While you were working on projects, how do you balance the needs of student learning outcomes and needs of the community stakeholders?**

- Case by case
- “Use community’s help to train students” - change of perspectives
  - More awareness
- Provocative prompt
  - For the community, to let people think about different approaches
  - “What do they mean by that?” - and that’s the success
- Contradiction with students’ needs & course objectives
  - **Negotiate** with the students
  - “If it doesn’t work, I got to tell you ‘I told u’”
  - Saying “no” requires very clear reasons behind from advisors
    - As much growth from “Nos” as “Yeses”
- Structure requirement
  - IQP learning outcomes -- guide
  - “Case by case” what is most needed by the team
  - To help students see the value of the helpful skills

**4. We think there should be more community-based PBL on campus, what do you think of that?**

- 7 weeks is not long enough for a throughout cultural understanding
  - Too much class work, and way less practice
  - Empathy & compassion takes real experiences
- What skill sets are obtained by students through CBPBL
- Faculty are researchers, not engineers
- The need for academic non-practical courses
  - “How much you need those in 20 years?”
- Show students the tools/relevant pieces that will be available
  - Only one project cannot cover all tools in the toolbox
    - Hard to design the project to fit the criteria
- Early exposure of PBL in high school

## Faculty Interview 4

### 1. Would you please briefly tell us about your past community-based project experience here at WPI, this includes IQP, MQP, GPS, and course-based projects.

- 10 years experience on off-campus IQP, local org put forward the projects. Help connect students with community
  - How much interaction with community?
    - Could be virtually beforehand
    - Mostly upon arrival: rurally embedded vs. remotely
      - No difference on students motivation: student usually self-selected
      - Point of IQP is to encourage students to get out of their comfort zone
  - When students feel less-motivated?
    - Self-actualization is an important principle for students
    - *Can't think of any....*(move on to two)
- On-campus: campus related problem
  - Camp project: strength women in STEM
  - Improve classroom experience in WPI
- Intro to material science: analyze FIS flooring materials

### 2. How do you think these community-based projects contribute to students' self-actualization as we defined before,

- Community-based projects may help with student self-actualization, but not for all
  - Depend on the location and sponsor
- The language barrier, culture shock?
  - Thailand - most challenging: work with locals
    - Communication style differences
    - Teamwork was hard with the community -- everyone learned a lot
    - Different ways to look at the world, leadership difference
- On-campus IQP:
  - Work making a difference, students more familiar with the community
  - Graduated before the action happened: the sense of achievement
  - Challenges with communities: not as large
    - Complicated in a good way
    - Different perspectives and stakeholders
- Compassion and empathy
  - No obvious outcomes
  - Can generate insights
- More than the product, the process that the student used
  - Not just graded on the solution
  - Students learning experience weighs more than customers solutions

### 3. While you were working on projects, how do you balance the needs of student learning outcomes and needs of the community stakeholder

- Center directors: professors who find the projects
  - A project that can be done in 7 weeks
  - Worry about the connection, reputation, and overall experience
  - Haven't been a center director
  - Recent project: refugee in Greece, very difficult
    - Combination of language and culture
    - The vulnerability of the community
    - How much can the students do to provide a usable solution while not offending/hurting the community
- Deliverables
  - Balancing - go back to IQP learning outcomes
  - Students should reflect more and write less. "You don't anything until you reflect"
  - Reflection is required for deeper learning: why do we do things this way
  - Even with the solution not being as great as anticipated, it can still be a good project
  - Other deliverables than a report; something useful
  - Should still be documentation
- Grading
  - Grading the reflection
  - Candidness of reflection
- Reflection, writing, and communication skills through projects (any project)
  - Different domains of development between technical(MQP) and humanity(IQP) projects
  - After IQP, students have more practice on communication

**4. We think there should be more community-based PBL on campus, what do you think of that?**

- *In what area?* - All
- Humanitarian vs. commercial values
- Should be easy to find. Not realistic to apply PBL to all area
  - For faculty to find partners
    - Should be a platform to help match school and community partners
  - Everyone has different interests
  - Time constraints
- But do encourage integrating PBL
- If projects are longer, more realistic
- Do students want that?
  - Yes.
  - 4-year college should students to be better
  - But not responsible for changing students perceptions
  - Peer influence
- How would this change WPI
  - Demographics
  - Attract more women in engineering
  - Different faculty



## Appendix M – Workshop Photos



*Figure 1 Workshop Photo 1*



*Figure 2 Workshop Photo 2*



*Figure 3 Workshop Photo 3*



*Figure 4 Workshop Photo 4*



## Appendix N – Workshop Posters

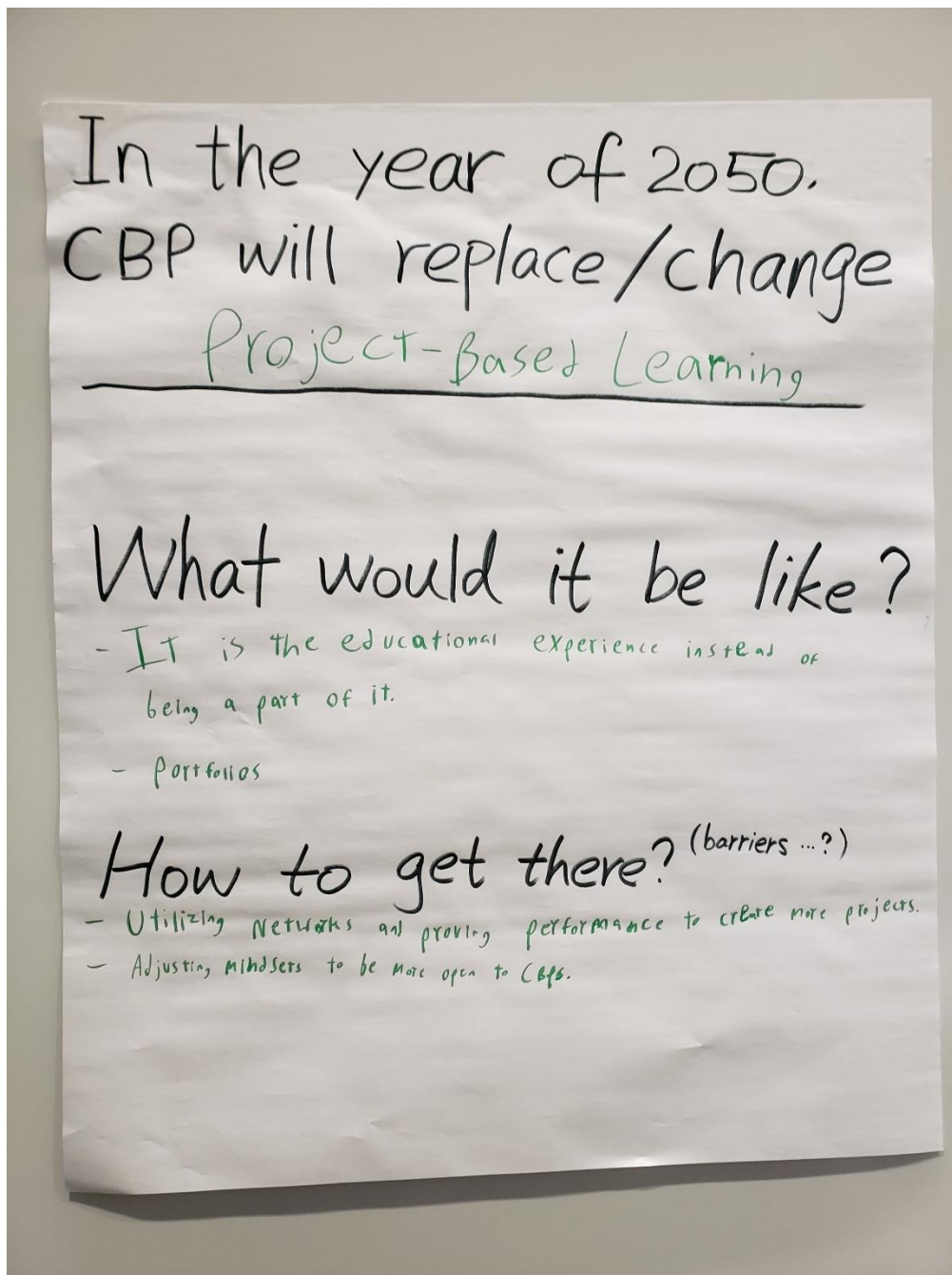


Figure 5 Workshop Poster 1

In the year of 2050  
CBP will replace/change  
many of the traditional classes but not all.  
more pbl will be focused on community.

---

What would it be like?

- less structure in terms of 4 year curriculum(?)
- fewer exams, fewer scheduled classes.
- more things like winter session.
- more flexible ways to prove you've learned WPI outcomes

How to get there? (barriers...?)

- more things like winter session.
- more independent study projects to focus on outcomes.

Figure 6 Workshop Poster 2

## Appendix O – Workshop Guidelines

# Back to the Future



— a guideline for annual WPI  
Future of Higher Education workshop

By Cynthia Teng, Anqi Shen

## What is it

A student-lead program that gathers main stakeholders of higher education together to brainstorm & imagine the future of higher education at WPI.

- Different topics each year
- In the form of an active workshop

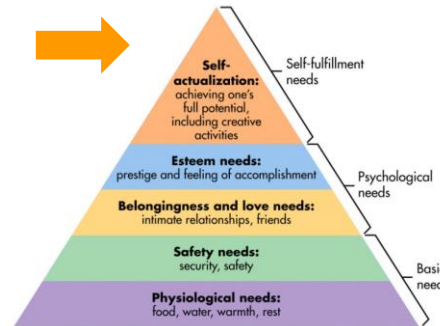
2



## Why we are doing this

### Self-actualization:

- the individual is able to fully understand his or her own talents, core strengths, and development areas;
- the individual has discovered his or her passion and a lifelong goal;
- the individual feels motivated and willing to work toward the goal;
- the individual feels connected to the outside community and feels comfortable communicating with that community.



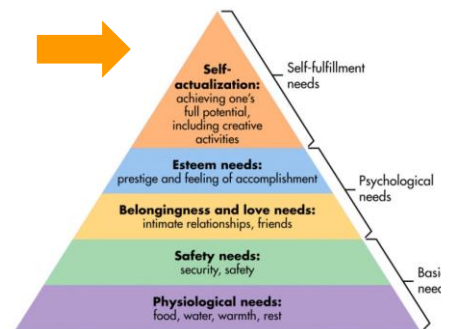
Shape higher education in the future so it allows main stakeholders (students, faculty, staff, and community members) to empower each other to achieve self-actualization

3

## Why we are doing this

### Self-actualization:

- the individual is able to fully understand his or her own talents, core strengths, and development areas;
- the individual has discovered his or her passion and a lifelong goal;
- the individual feels motivated and willing to work toward the goal;
- the individual feels connected to the outside community and feels comfortable communicating with that community.



Shape higher education in the future so it allows main stakeholders (students, faculty, staff, and community members) to empower each other to achieve self-actualization

3

## 2019 Back to the Future workshop

What does WPI look like in 2050? You tell us.

WPI aims to prepare students through its Project-Based Learning (PBL) strategies, but how might we strive to make students become better engineers and global citizens in 2050? We believe students should be engaging in world-relevant experiences to become better global citizens.

**In the year of  
2050.....**

Community-based projects will  
replace \_\_\_\_\_.

- A) Nothing
- B) Project-based learning
- C) Traditional classroom
- D) Faculty
- E) 4-year residential college

5

## Workshop Logistics

**Time:** Jan. 8th, 2019

**Location:** WPI Foisie Innovation Studio

**Topic:** Future of Higher Education and Community-based project-based Learning (CBL)

**Platform:** Winter Session

**Attendees:** 20 people signed up (through Winter Session); 7 people showed up

**Facilitator:** Anqi Shen, Cynthia Teng, Claire Long

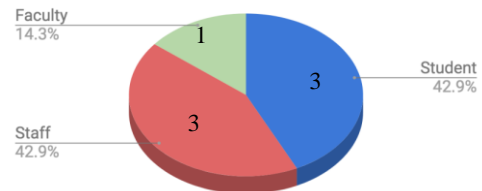
6

## Workshop Attendees

- By using the Winter Session platform, we were able to obtain a fairly diverse group for the workshop
- **Diversity** of the workshop attendees ensures that we could collect inputs from different perspectives
  - Different types of attendees will have different opinions towards higher education

Out of 7 attendees...

### Stakeholder Representation



7



## Workshop Activity: Trivia

<b>Activity Type</b>	<b>Warm Up</b>
<b>Goal</b>	To help attendees imagine what could happen in the future by looking back at WPI 50 years ago.
<b>Duration</b>	15 min
<b>Steps</b>	<ul style="list-style-type: none"> <li>□ The trivia consists of questions of history of WPI in the past 50 years</li> <li>□ The person who could answer the question right away gets 3 points</li> <li>□ If no one could answer the question after three tries, there will be multiple choices, the person who gets the right choice get 1 point</li> </ul>

8

## Workshop Activity: Trivia



Observations	<ul style="list-style-type: none"> <li>□ With the focus on WPI history of learning curriculum, some attendees were able to answer more questions than others.</li> <li>□ If community members were involved, they will not be able to participate much.</li> </ul>
Recommendations	<ul style="list-style-type: none"> <li>□ Have trivia questions about higher education in general</li> <li>□ Other icebreaker activities                             <ul style="list-style-type: none"> <li>□ People bingo</li> <li>□ Two truths and one lie</li> </ul> </li> </ul>

9

## Workshop Activity: Poster Making



Activity Type	Group discussion; Brainstorm
Goal	To start attendees to think of what would happen for higher education in the future, specifically with the influence of community-based projects
Duration	25 min
Steps	<ul style="list-style-type: none"> <li>□ Assign attendees into groups of four</li> <li>□ Proposed topic: "In the year 2050, community-based projects will replace/change _____"                             <ul style="list-style-type: none"> <li>□ Subtopic options: 'nothing', 'project-based learning', 'traditional classroom', 'faculty', and 'four-year residential college'</li> </ul> </li> <li>□ Have teams fill out the blank and brainstorm follow-up questions: 'what would it be like?', and 'how to get there?'</li> <li>□ Each group will present for 2 min</li> </ul>

10

## Workshop Activity: Poster Making



<b>Observations</b>	<ul style="list-style-type: none"> <li>□ With a total of 6 attendees, we divided them into two groups of 3             <ul style="list-style-type: none"> <li>□ Everyone were able to contribute to the discussion</li> </ul> </li> <li>□ Facilitators sometimes need to help initiate/lead the conversation</li> <li>□ Some attendees were not very comfortable with presenting to a strange crowd</li> </ul>
<b>Recommendations</b>	<ul style="list-style-type: none"> <li>□ The activity works for smaller groups of 3-4 people</li> <li>□ Facilitators should             <ul style="list-style-type: none"> <li>□ Understand the objectives of the workshop as well as certain background knowledge of the topic (thorough literature review or methodology) to be able to initiate conversations</li> <li>□ Take notes during discussion</li> <li>□ Be prepared with facilitating skills (see following slides)</li> </ul> </li> </ul>

11

## Workshop Activity: Role Play



<b>Activity Type</b>	Group discussion; Role play
<b>Goal</b>	To have attendees think of higher education from other stakeholders' perspectives, in order to develop empathy
<b>Duration</b>	20 min each segment; 40 min in total
<b>Steps</b>	<ul style="list-style-type: none"> <li>□ Assign roles/characters from different stakeholder groups to each attendee</li> <li>□ Half of the groups will be acting and discuss each poster based on the characters' needs and concerns, while the other half stay with the poster to answer questions             <ul style="list-style-type: none"> <li>□ Comments &amp; concerns will be added onto the poster with sticky notes</li> </ul> </li> <li>□ Switch after 20 min</li> </ul>

12



# Workshop Activity: Role Play



<p><b>Observations</b></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> People prefer having the discussion/role play within a larger group             <ul style="list-style-type: none"> <li><input type="checkbox"/> Both groups were interacting with each other at the same time</li> <li><input type="checkbox"/> Allows more comments from different perspectives and ideas to develop from each other</li> </ul> </li> <li><input type="checkbox"/> The room was not large enough (too many chairs) for people to walk around</li> <li><input type="checkbox"/> People tend to focus on the character/stakeholder's current needs rather than future needs</li> </ul>
<p><b>Recommendations</b></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Stress the importance of empathy before the section; set up ground rules of judgment free</li> <li><input type="checkbox"/> Have the role play for only one whole section (40 min) when everyone could listen &amp; participate</li> <li><input type="checkbox"/> Give attendees certain scenarios to play improv with their characters             <ul style="list-style-type: none"> <li><input type="checkbox"/> In year of 2050, everyone will study online instead of on campus</li> </ul> </li> </ul>

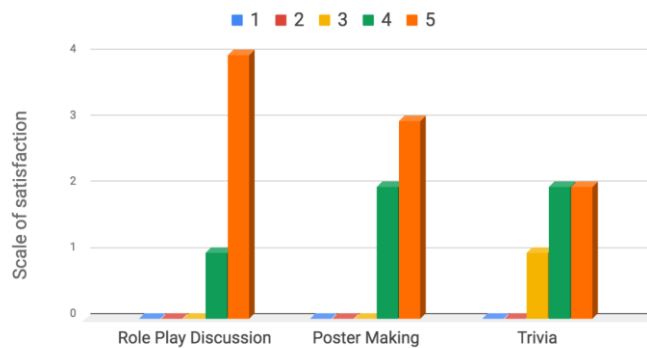
13

# Feedback Analysis

After the workshop, attendees were asked to rate each section of the workshop on a scale of 1-5.

- 1 being not satisfied at all
- 5 being very satisfied

Workshop Sections Feedback



5 attendees filled out the survey

14

## Feedback Analysis *continued*

**Interactive,  
Engaging,  
and Useful !**



- **All** participants of the workshop thought the program was very engaging, and they would like to attend similar workshops in this program
- **3 out of 5** attendees think the workshop was exceeding their expectations
- Participants think the content was “useful”

15

## Feedback Analysis *continued*

**Interactive,  
Engaging,  
and Useful !**



- **All** participants of the workshop thought the program was very engaging, and they would like to attend similar workshops in this program
- **3 out of 5** attendees think the workshop was exceeding their expectations
- Participants think the content was “useful”

15

## Recommendations *continued*

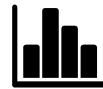


### Recruitment

- Facilitator:
  - Students who are interested in making an impact on WPI campus
  - Facilitation skills training
    - Goat Tank program (pitch/storytelling)
    - ACTIVATE program (conduct/design workshops)
    - Attend other conferences on higher education
- Mentor:
  - A consistent faculty advisor
    - Avoid overlapped topics each year
- Attendees:
  - Use Winter Session platform for recruiting, PR, and funding
    - Pro: Save time & energy; attendees will be more motivated since they express willingness to learn outside of school
    - Con: Time usually not available for faculty & community members

17

## Recommendations *continued*



### Deliverables

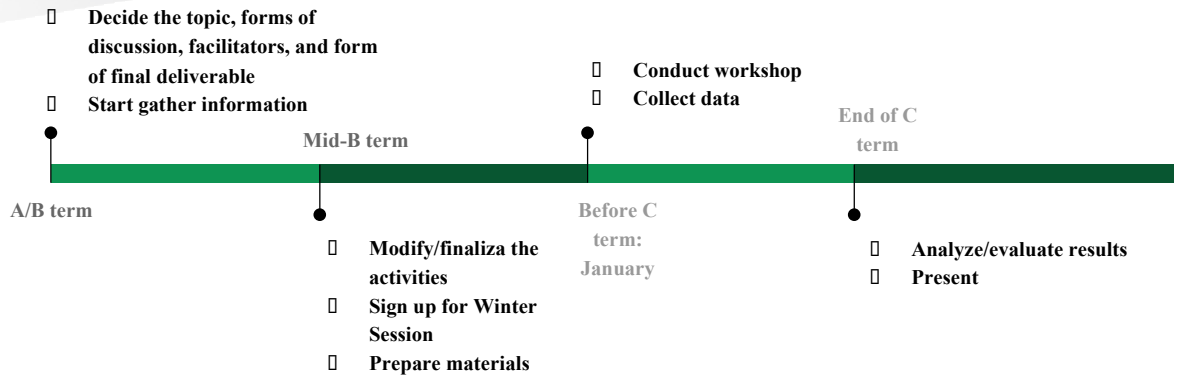
- Predictions for the future
  - Report
  - Presentation/poster
  - Video library
    - TedTalk
- Assessment on the activities
  - Recipe book
  - “Train the trainer”

18



## Recommended Timeline #1

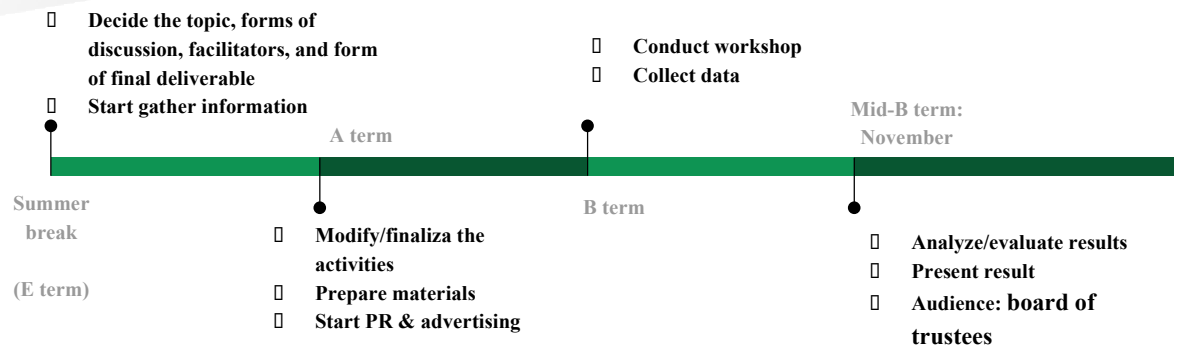
### If work with Winter Session ...



19



## Recommended Timeline #2



20

## Resources

### **WPI Winter Session**

- Organized by LaunchPad  
<https://www.wpi.edu/academics/undergraduate/wintersession>

### **2019 *Back to The Future***

- Presentation  
<https://docs.google.com/presentation/d/1D0z9TaRnmYCZkisNYCoNG3L5iF9TVonl32ARDXyazzw/edit?usp=sharing>
- Role play tages  
<https://drive.google.com/file/d/1hWyONdiKibsyUkZqckvw8hRfwHorgLNS/view?usp=sharing>

### **IQP: Futures of Higher Education Report**

- [https://drive.google.com/file/d/1IKZ6Q\\_583Yv7YypgB7flj\\_Gz3gCm8x8C/view?usp=sharing](https://drive.google.com/file/d/1IKZ6Q_583Yv7YypgB7flj_Gz3gCm8x8C/view?usp=sharing)

21

Thank

22