# Future of Higher Education

An Interactive Qualifying Project

Submitted to the Faculty of

Worcester Polytechnic Institute

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more importantly, broadened my understanding of WPI project-based collaboration with the community.

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# Abstract

A well-qualified engineer in the future should provide human-centered technical solutions to not only solve real-life problems but also prevent more problems. As the main incubator of engineers, a higher education institution should ingrain Community-Based, a step-up of project-based Learning (CBL) method to develop the *world-readiness* and *self-actualization* of engineering students.

This project is the continuous sector of IQP - Future of Higher Education conducted last year, focusing on the community partner's perspective on existing projects with WPI, how CBL has both benefited students' development and community growth, and the feasibility of increasing CBL at WPI.

# Executive Summary

This project continues exploring the future of higher education under the Project-Based-Learning(PBL) curriculum at Worcester Polytechnic Institution (WPI) started in the early 1970's, with a focus on collaborations with community members with regards to students professional, personal development and social engagement. WPI's founding motto of "Theory and Practice" provides a distinctive approach to not only STEM but also humanities and arts education by balancing rigorous academics with hands-on learning. Students go above and beyond traditional classroom education.

While the academic projects have provided students with a good platform to apply the knowledge learned in classes to the creation of technical products, which puts WPI students at an advantaged position for the job market, it has become more clear that a focus on employability alone is not sufficient to prepare socially responsible engineers. From the previous part of this research conducted in 2018 done by Anqi Shen and Cynthia Teng, two concepts were focused: *world-readiness* and *self-actualization*, both of which proposed that competent engineers for the future should be equipped with both the ability to identify and solve problems effectively, to perceive and appreciate the wider social context in which they work. We then hypothesize that Community-Based Learning (CBL) curriculum can better prepare students with engineering professionalism, social awareness and personal growth, as well as benefiting the society with more innovative, effective, and cultural-appropriate solutions.

In 2018-19, 1030, more than 70% of students completed an off-campus project either the Interactive Qualifying Project (IQP) or Major Qualifying Projects (MQP), sponsored by a local businesses, government, or community organization (WPI, 2019d). However, in the 135 credit hours required for graduation, only 21 credits are entirely project work. If these projects are the only community-based experience, less than 15% of a student's academic work could be called community-based. It may be possible, and valuable, to connect more academic work, including courses, with community partners.

Hence, we proposed CBL, a step-up of PBL, which will bring in more project opportunities with the community, based on the existing project system - IQP, and MQP just mentioned, and Great Problem Seminar (GPS) that was introduced only 13 years ago. CBL will encourage the students to work on problems that community members are facing, with both technical knowledge and

necessary skill sets like communication, motivation, connections with community groups, and mindfulness to give back to society. Beyond that, CBL is not limited to academic projects; it also covers the scope of extracurricular events, such as volunteer work. The CBL curriculum involves students, faculty, and community members as the main stakeholders of the study.

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 conducted focus groups or interviews for each of the stakeholder groups. From conversations with students and interviews for faculty last year, we got both groups' affirmation on CBL that it could help students with their academic achievement and self-development which are both crucial for getting students world-ready. Despite most of the time positive outcomes, CBL did challenge students and faculty during the projects, such as tight schedule, mismatched interests of stakeholders, and imbalance of the academic requirements and community needs.

This project will focus on the community members' perspectives on CBL, and will talk more details about the CBL prototyping event that made up the absence of community members in last year's Winter Session workshop, by having community partners over. I interviewed 2 people who are involved in some of the under-represented fields: K-12 STEM education and Innovation & Entrepreneurship, instead of talking to community groups that work with the three major projects: IQP, MQP, GPS. These 2 representatives are either from community organizations or working closely with community groups. I gained a better understanding of their project experiences with WPI, outcomes of those projects, and expectations towards future collaboration. They expressed this common problem which will be further discussed in this report:

- More formalized structure of the collaboration, such as shared resources, promoting methods, and public recognition of projects.

Last year's workshop focusing on CBL during Winter Session, brought up an active discussion on WPI campus about how higher education could better prepare students and the institute for the future. This event achieved the following goals:
- Engaged main stakeholders in discussing the future of CBL
- Collected data for future implementation of CBL at WPI.

We received positive feedback from the workshop participants, and they would like to attend similar workshops in the future. However, due to time constraints, the discussion was limited among the WPI community.

In order to collect more comprehensive data, including community members' opinions, I partnered with WPI Innovation & Entrepreneurship Center to host a design thinking workshop: Solve-A-Thon: Prevent Amazon Fires. This event acted as a great platform for WPI and the rest of the community to come up with creative solutions through human-centered design approach. It was also a prototype of CBL, as it engaged WPI students, faculty, and community members to solve the ongoing Amazon crisis, even though the solutions were at the ideation phase. I also did follow-up talks with some of the participants, and they have given the following points as things that we did good:

- Good arrangement of inviting knowledgeable guest speakers passionate on the issue of Amazon Fires.
- Overall good structure of the event, including Intro to Issues, and Solution & Value Proposition Development.

And here are the things that we can do better:
- Control timing, so that participants would have more time to brainstorm solutions.
- Encourage participants to be more engaged with the speakers.
- Step up the pre-event marketing, so that more people know about this event.

Finally, to bring in more CBL to WPI campus, we proposed suggestions targeting both internal reformation and external outreaching:
- Encourage the flexibility to designing learning outcomes and expectations based on students' interests and community's needs.
- Change projects to outcome-driven, instead of time-limited.
- Incorporate CBL in more courses.
- Consider adding incentives for participating non-academic CBL.
- Step up market for non-academic CBL within WPI community.
- Formalize structure for non-academic CBL.
- Create a platform for finding community partnership.
- Enhance consensus on project expectations between faculty and community partner.

We also hope to see more future research being done on WPI's approach to CBL, and other inputs being made to keep WPI constantly thinking of the changes and advances in higher education and society.

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# Introduction

What do qualified engineers do? Should they be able to fix a broken computer? Should they be able to calculate complex mathematical problems? Or should they be able to write thousands of lines of code that runs without errors? Those skills certainly come in handy at some point, but the future requires more than just those skills from engineers. The "New Engineer" of the future will be a well-rounded professional who is proficient in engineering skills, as well as socially and environmentally responsible(Beder, 1998).

The major global challenges we are facing today, including climate change and, the fourth industrial revolution, require experts from multiple disciplines to work together on topics of economy, society, environment, and technology. In addition to high-added-value, knowledge-based solutions, the importance of calling for sustainable development and implementation has also emerged(Elmaraghy, 2011), which requires a designer's humanitarian perspective.

Higher education, especially colleges and universities focused on STEM fields, is the incubator of engineers and, should prepare students with two following skills. First, engineers should have the technical skills to generate efficient, effective, and professional solutions. Second, engineers should also have the ability to insert themselves in the flexible globalized workplace which specifically examines a lot of non-technical competencies in areas such as communication, project management, leadership, and teamwork, in addition to the acquisition of theoretical knowledge partly required by the first skill(Conlon 2008).

However, the reality is that there has been a separation or even misunderstanding of the humanities in STEM education. According to Scott Harley's book *The Fuzzy and The Techie*(2017), a polarized culture of the humanities students, the *fuzzies*, from the engineering students, the *techies*, at Stanford University. This reflects a broader problem in the society (Harley, 2017). Harley argues that research in the humanities is no less important than research in science and engineering (Harley, 2017). The *fuzzies* were who can identify social needs, gather resources, find cheap and accessible technical help, and build successful businesses. Harley showed evidence that the *fuzzies* are more successful because higher education in the humanities gives them the mindset to create value, which challenges the common assumption that an engineering education is better preparation for the careers of the future.

For the past 50 years, WPI's science and engineering programs have used the project-based-learning strategy to introduce students to the most cutting-edge technology, encourage students to apply their technical knowledge on projects, and more importantly, equip

students with competencies, such as communication, teamwork, and leadership which will be required for the rapidly changing future.

WPI also exposes students to many of the world's most pressing challenges by bringing them to more than 50 different project sites around the globe. As students work to address the challenges, they fortify their technical, scientific, business, and creative skills. It is more than just their know-how that distinguishes WPI students from other college students, but also their initiatives, self-awareness, and social responsibility under the broad context of the world.

But not until my team started this project, did we realize that such a PBL system still has its flaws and imperfections. As the continuous sector of IQP - Future of Higher Education from 2018, this project will continue exploring the limitations of current PBL, including the project logistics, and students' takeaway from the projects. From last year's interactions with students and faculty, we found that despite the emphasis on multifaceted skills development, professional and technical skills tended to be the major motivator for students participating in PBL. We believe that there is a need to further emphasize the community elements in projects, so that students could step up their *self-actualization* and *world-readiness*, and have better project experiences. This project also fills the absence of community members' opinions on current PBL, as they are one of the major stakeholders of PBL.

Last year, we proposed 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. Besides the Winter Session hosted last year, a CBL prototype event Solve-a-Thon, was introduced to WPI campus, a design-thinking workshop to generate and refine solutions revolving an ongoing social challenge, as part of this project.

With the goals to access the PBL benefits and challenges for the primary stakeholders, and make recommendations for PBL, we aimed to make the WPI a campus that is constantly engaged in active thinking of the purpose of higher education and adapting the learning programs to changes and challenges that the future brings. We can meet these goals by addressing each of the following objectives:
1. Conduct focus groups/interviews with students, faculty, and community members to gather their opinion regarding the current state of PBL at WPI.
2. Develop a workshop at WPI to brainstorm possible futures for higher education.
3. Deliver recommendations to WPI faculty for future CBL implementation based on three main stakeholders' views
4. Host a CBL event prototype to practice and collect feedback.
5. Propose recommendations for future studies to collect more thoughts and inputs on how to make WPI's projects more community-focused.

We hope this research will be a step towards improving students' learning experiences through different projects, helping students become well-rounded, and preparing them better for future challenges. We think that CBL will help students practice and develop their skill sets, and further help their self-development as they learn and solve the problem. At the same time, CBL would benefit the community with more engaged, and well-rounded students, and therefore, create greater values in the community. 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"(Shen & Teng, 2018).

In conclusion, this project will provide detailed information of community's perspective on current WPI PBL and future expectations on CBL by discussing the outcomes of both community focus group and Solve-a-Thon.

# 1. Background

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

This chapter discusses the possible changes in a social context and the challenges for higher education, particularly in the STEM 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 theoretical knowledge to a practical tool that solves 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 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 accuracy. They believe that technologies will be even more integrated into humans' daily lives, changing 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 the *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 need for physical labor would be replaced by machine development, and the needs for human mental labor would start to be replaced by artificial intelligence, referring to those who 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 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 decisions 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.

## 1.1.2 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).

## 1.1.3 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 which 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 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.

### 1.1.3.1 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 met:
- 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, 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*, states 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 strengths 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

A 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 they needed to learn. Klenowski, Askew, and Carnell studied 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 classes because of curiosity or career advancement plans, which gave them a 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 of 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 a 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' training. 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; most of the time, 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 impacts 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 experienced 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 skillsets 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 exist 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's 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 provides 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 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 supports 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 its social impact through service learning; although service learning still remains a voluntary-based program, it has been highly recommended and praised.

**1.2.3.2 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 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 expect 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 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 the 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><li>Students want an effective, fun learning experience.</li><li>Students wish to be employed after graduation.</li></ul> | <ul><li>Employment after graduation will remain as one of the students' needs in the future.</li></ul> |

|  |  |  |
|---|---|---|
|  | ● Students wish to be supported mentally and academically by mentors on the college campus. | ● Students will become more motivated and wish to learn what they want to learn.<br>● Through higher education, they will learn more about themselves and the world to achieve long term happiness. |
| Faculty | ● Faculty want to continue doing research while teaching.<br>● 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.<br>● Many faculty care about their reputation among students, and their student evaluations are reviewed by the department. | ● Faculty, in the future, will still want to continue doing research while teaching.<br>● They will want to keep their jobs.<br>● Faculty in the future will be more willing to help students inside and outside of the classroom. |
| School | ● The institutions want to see higher admission and retention rate to make it more competitive.<br>● The institutions need more funding and grants for infrastructure and learning programs.<br>● To establish a good reputation, institutions want to produce the most desired students by employers. | ● Higher education institutions will want to stay competitive against other schools.<br>● They still want to produce the most desired students by employers.<br>● In the future, the institutions might want to keep their students living on campus, to compete with online schools. |
| Community Members | ● They want to have enough cash-flow and funding to be sustainable.<br>● They need human resources, preferably people that are | ● They may still need fundings to solve their problems.<br>● They need young people to continue working on these social issues. |

| | | |
|---|---|---|
| | passionate about the same mission.<br><br>● Many non-profit organizations' goal currently is to promote social justice. | ● Many non-profit organizations' goal will continue to service to the pursuit of social justice.<br><br>● They will need more awareness of social justice from other social institutions. |
| Employers | ● Employers want competent employees in their corporations.<br><br>● To stand out among other competitors in the fields, employers want to build a good reputation and develop more innovations. | ● The employers still want to hire competent, innovative employees<br><br>● As companies, they will want a good reputation and be more competitiveness in the fields. |

# 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 more involvement of community members working more on projects with students and faculty in the future. In this chapter, different methodologies we used to gather and analyze inputs from the key stakeholders: student, faculty, and community members will be analyzed. Note that the following topics will be not explained in detail as they have been covered in the previous part of the project report. Please refer to *Future of Higher Education: a Study on Community-Based Project-Based Learning at WPI.*

## 2.2 Focus Groups

We decided to use focus groups as the main method to collect qualitative data about insights and information from a couple of stakeholder groups of higher education, considering the requirements and constraints of our data collecting as following:

- Need to gather information in less than a month,
- Given three main stakeholders, we need a way to gather a group of people at a time
- It would be better to get a sense of the most immediate feedback from focus group participants, instead of deciphering through some research paper
- Limited budget

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 the tele-focus group, internet focus group, video focus group, or mini-focus group. We also used some of the variations of focus groups, depending on the needs of each stakeholder group, which will be explained later in this chapter. Before we decided on focus group, we have compared multiple other ways to collect data, and ended up choosing this method for our project research because it allowed us to capture immediate perceptions, comments, and feelings towards our research topic from groups of people who would potentially influence or be influenced by changes in PBL 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.

## 2.2.1 Advantages and Disadvantages

After we established that focus groups would be the appropriate research method for our project, we evaluated the advantages and disadvantages of this research method. This allowed us to understand what techniques would yield better results, and 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 were because of its efficiency. It allows us to gather a big group of people and collect information from multiple participants in one sitting. Ideal, we would bring in representatives from each of the three main stakeholders: students, faculty, and community members, and conduct group discussions for each group. Additionally, the accuracy of focus group results was the other reason we chose it. Keeping the group sizes relatively small, we were able to record, probe, and analyze participants' comments easily. Participants' facial movements, body language, and speaking tone, which we could detect from direct interaction with them, are all worth looking into. Furthermore, with the small budget for our study, the focus group method would be the best choice since it would not cost as much as a wide-range survey would.

However, there are still limitations to this focus group method. First, recruiting representatives for focus groups could be challenging. Not only must we identify and reach out to our candidates given such a short time, but we also had to convince them to share their personal thoughts regarding their experiences on PBL. Second, despite incentives, candidates would be still not willing to take an hour or two from the busy schedule for the focus groups. It would be even harder when it comes to coordinating community members since no community member (i.e., non-WPI faculty or staff) were involved in our project advising. Luckily, we were referred to a list of community candidates by our advisors that we could potentially reach out to. As a compromise, we adjusted the research method to a direct one-on-one video interview, which will be discussed later. Third, participants' responses would likely be influenced by others' talking in a group setting, resulting in different responses regarding their own attitudes toward the questions. And lastly, they might be daunted to share their opinions with a group of total strangers. To overcome these challenges, we designed an icebreaker activity prior to the group discussion to allow attendees to get more comfortable among others and to get them into thinking mode.

## 2.2.2 Progressive method

We chose the progressive approach over static method to conduct our focus groups, which means the set of questions would be based on the results from previous focus groups. While the static method may be appropriate for studies involving horizontal comparison, the progressive method

would be more suitable for our research. Since we planned to conduct three different focus groups with three main stakeholders, each focus group should have its own set of prompts, but at the same time, interrelated with other groups, as those three groups work hand-in-hand together in PBL.

Without the presence of faculty, the students could give their unrestricted suggestions based on their current experiences at WPI. But the role of faculty is more than just the grader when it comes to advising a project. It is necessary for faculty to hear both students and community member's voice, since they bridge between those two groups. Faculty should find a balance between bettering student's project learning experience, and showing the world with WPI students community involvement as well-qualified global citizens. In order to stress the connectedness of these three stakeholders, we developed questionnaires for faculty and community members based on students' responses. And faculty could shed some light on what questions would be appropriate for the last focus group with community members. The results of students and faculty focus groups would be analyzed to generate lists of questions for the annual workshop program.

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.

## 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 in charge of 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.

We went through the IRB application process for the permission to conducting focus groups on WPI campus before recruiting the students' representatives, During the process, we analyzed the potential human risk for the subjects of the groups and were educated with the importance of respect and subjects' consent, during the research. We created the form of consent attached in appendix B, where the subjects would grant us the consent to analyze the information they provided during the focus groups. We received the approval for our IRB application and proceeded to the next step of recruiting 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 has helped students feel "world-ready," which refers to the skills that were needed to achieve a sense of readiness when students graduate, including but not limited to communication, teamwork, presenting, developing empathy, decision-making, problem-solving, and much other skillsets that the participants of the society would value(Shen & Teng, 2018). After researches on the benefits of PBL and service learning, we hypothesized that CBL would fulfill the needs of professional skills learning and acquiring the skills to help students become "world-ready." So we would like to hear from the students about their self-development through CBL.

Screener questions(Appendix C) were distributed along with the sign-up forms to students so that we could obtain a diverse group of students with various levels of experiences with WPI's current PBL curriculum. We were looking for candidates who had done at least one of the following projects: IQP, MQP, GPS, and extracurricular projects. We were also interested in getting a general, quantitative idea of their students' level of satisfaction with PBL experiences. We ended up receiving 34 survey forms from students, 32 of whom were interested in participating in our focus group. We then selected two groups of 5 to 8 students, with the senior students 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.

Before the discussion, a notecard(Appendix D) with the definition of *"world-readiness"* and *"self-actualization"* would be given to each participant in the focus group. Its purpose was to help participants understand this new concept that our research is revolved around.

The discussion started with a quick introduction and presentation of the research team and topic. And ground rules were introduced 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 confusion 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 of the faculty interviews was to explore WPI faculty's thoughts on the impact of PBL on students' development, particularly self-actualization, as well as the feasibility of further integration of community-engagement with the current curriculum. We also hoped to understand how project advisors balanced between ensuring the achievement of student learning outcomes, and the needs of community sponsors. We identified the challenges of establishing more community-based PBL for WPI students. In addition, we would like to explore potential solutions to these challenges with the faculty.

At first, we were given a list of faculty who were more experienced with the WPI curriculum and PBL concepts by our advisors. After brief background research of each of these candidates, we found that they have been highly involved in designing and advising IQP, MQP, and GPS programs on campus. They were the advocates of integrating PBL in courses contents. We then reached out to those candidates via email to see if they would be interested in participating in our focus group. Considering 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 limitation, we had to adjust our focus group to one-on-one interviews at times that work the best for the faculty members.

Even though we developed a full list of questions shown in Appendix E, we had to cut them down to only four questions due to time constraints. And we would prioritize them according to the importance of our research topic. Unlike the previous student focus group, we chose to read our definition of "*world-readiness*" and "*self-actualization*" to the faculty participants.

## 2.2.6 Community Member Focus Group

The community member focus group was designed to survey the WPI community partners about their involvement, relationships, values, and expectations in their past PBL program experience; questions protocol see Appendix F. 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 in 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 this information,

we could synthesize a report that the project advisors could use to better integrate CBL with learning outcomes(Shen & Teng, 2018).

Using the objectives and questions developed by two teammates from last year, I reached out to a list of interview candidates provided by my advisor via email. Those candidates are either work closely with the community or from community organizations. While I hope to get more generalized opinions from the community members, I understand the time and location constraints of the interviewees, so I picked the proper interview time and method to accommodate their needs, and limited the length of the interview to 45 mins the most.

I get to talk to two representatives from two different fields: K-12 education and innovation & Entrepreneurship. For the one interviewee from WPI K-12 Outreach Center, who works closely with the Worcester public schools, I had an on-site, face-to-face interview with her. The other interview with the representative from Innovation & Entrepreneurship organization was conducted through Zoom. Our conversations were 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 CBL Prototype Event

Besides the workshop held on January 8th during Winter Session last year, I also collaborated with the WPI Innovation & Entrepreneurship(I&E) Center to host a design thinking workshop revolving around the topic of ongoing wildfire in Amazon. Partly similar to the goals of last year's workshop, this Amazon Fire design thinking workshop aimed to bring the main stakeholders, namely the students, faculty, and community members to have discussions and come up with creative solutions collaboratively for preventing wildfires from happening, therefore, sustainable forest development.

However, slightly different from the format and purpose of last year's workshop, this design thinking workshop engrains the method of Solve-a-Thon, a term came up with by the Graduate Student Council(GSC) in Massachusetts Institute of Technology(MIT). Solve-a-Thon describes an action-oriented event focused on using technology and innovative thinking to address and solve the world's greatest challenges(MIT, 2019). Instead of having stakeholders to discuss the future of higher education, we brought out this pressing crisis happening in Amazon as our focus, which is a more tangible and impactful problem.

Solve-a-Thon emphasized the rapid ideation, refinement, and prototyping of solutions to the Amazon Fire challenge. We invited subject matter experts, including a mural artist from Brazil, two experts who have had extensive knowledge on the Amazon rainforest, and a Fire Protection

Engineering post-doctoral at WPI to give participants insight on this issue from different disciplines. Based on the system thinking model proposed by one of the experts, we would divide the participants into four categories: intention, behavior, culture, and system, then assign representatives from those four categories to one group. First, the representatives from the same category would do the research together, and experts would be mentoring participants throughout the research phase. When participants return to the home team, they would ideate and develop an idea, solution, or value proposition for one of the expert categories that will contribute to helping out the complex Amazon Fire issue. After teams prototype their solutions through some kind of art and visual representation, they would test their solution by pitching to get feedback at the end of the event. In order to encourage participants to ideate, we even designed prizes for winners. First prize would be a certificate and a rainforest photography book; second prize would be a rainforest photography book; third prize would be a donation in the winners' names for protecting amazon land through the Rainforest Trust. Detail agenda see Appendix G.

Additionally, this workshop would be a prototype of future CBL model, since it gathers the three main stakeholders: students, faculty, and community members to contribute to solving a world pressing issue, which is the microform of IQP, MQP, or GPS, but costing way less time, funding, and effort to organize. We would evaluate the turnout of the event to dissect the event feedback participants' motivation and roles during the discussion, as well as the awareness of social issues. In the future, we might consider bringing more events like this to push the WPI community involvement to a greater extent.

# 3. Results and Analysis

## 3.1 Student Focus Groups

### 3.1.1 Overview

The purpose of the student focus group was to get a better understanding of students' opinions on WPI's community-engaging Project-Based Learning(PBL) regarding their professional and personal development. Two student focus groups were conducted during the research last year, and eight students in total participated in the focus groups, with four in each group. We kept the group size relatively small due to time conflicts of the students. The first focus group consisted of four female students: 2 seniors, 1 junior, and 1 sophomore; the second group consisted of 3 senior male students and 1 junior female student. All of these students had been involved in both traditional higher education forms, such as lectures, exams, and non-community-based projects, and community projects, whether it was part of a course, degree requirement, or extracurricular activities. Here are some of the key points extracted from the student focus group:

- Two groups expressed different takeaways from project work: development of practical skills vs. self-actualization
- There were situations when students' motivation for working with community got deteriorated
- Both WPI project advisors and community members acted as mentors for students

We compared the data collected from our students focus group and the one from 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. These surveys studied the long-term impact of project work on three main categories: professional, world view, and personal. Although the surveys focused on the comparison between on and off-campus projects, most of our focus group findings aligned with the ones from the surveys.

### 3.1.2 World-Readiness and Self-Actualization

After understanding the meaning of these two phrases 'world-readiness' and 'self-actualization' in the context of higher education, students reflected that the projects helped them become more world-ready. However, on the topic of self-actualization, two groups of students had slightly diverged opinion. The first group discussed more about their self-actualization through projects, while the second group emphasized the practical skills that would get them world-ready rather than self-actualization. In the 2012 survey, the off-campus group rated 86% of 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, which include the following qualities mentioned frequently by both groups of students:
- Teamwork skills
- Communication skills
- Adaptation to new environments
- Problem-solving skills for open-ended cases
- Research and interview skills

Beyond skills that students developed during the projects, they discovered more about themselves and some even became more self-actualized by feeling motivated and realizing their strengths and weaknesses. Working on a project that had practical meaning made students feel "useful and helpful, and they would get more internally motivated to do what they believed to be the right things, in which case is to help the community partners. Our findings from the focus group aligned with the conclusion in the Alumni report that they(students) had "feelings of being able to make a difference" and "feelings that own ideas are valuable" through project work (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. When it comes to strengths finding, they would immerse themselves in trying different roles and learning new skills.

While the surveys did not explicitly ask about self-actualization, 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

All of the students focus groups participants 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. The ways that they connected with the communities including through research, emails, interviews, face-to-face meetings, living with the communities for 7

weeks, and sometimes even through translation apps. Some expressed that they developed empathy for the external communities during projects. By listening to the community's needs, students were able to tailor a solution better fitting the community. The connection with outside communities motivated students to seek for better project outcomes. While some participants put community engagement in one of their priorities when working with the communities, here are some cases that would lower the student's willingness to work with communities:

- When the project goals were not clearly defined
- When student's grades directly correlated with the completeness of the projects
- When the development of technical skills becomes the main motivator for students
- When misalignments between students and community's expectation cause frustration

The fourth bullet point above could be proved by my talk with an off-campus IQP team during the 2019 fall semester. The team was doing their ID2050 at the moment, where they would complete a well-developed project proposal. At the beginning of the project, they were not given any instruction or project objectives, which made them quite uncertain and lack of confidence in their project. Through discussion among the team, they gained more insights on defining the project goals. But things got turned over after their first conversation with their sponsor in Albania, since the sponsor wanted them to provide technical help to implement a working drone, instead of doing community investigation that the IQP wanted to. Here shows a misalignment between community member's goals and the students', so it would be more accurate to say when students' and communities' goals do not align, students might feel less motivated to work with the community members.

## 3.1.4 Mentorship

When discussing self-development, we were also interested in the mentorship students developed through their projects. The main roles of the mentor are to aid the students' self-actualization process, help with the projects, and to connect with the students on a personal level. From the analysis of the student focus groups, we found that interestingly, while WPI faculty advisors being the most popular choice of mentors, the community members and fellow students also acted as mentors for some students.

Faculty advisors had helped students towards success mainly in terms of project completion, career advice and inspiration, personal support and motivation. On the other hand, students oftentimes developed friendship and received motivations from their peer mentors and community partners, rather than obtaining content expertise advice.

### 3.1.5 Challenges of CBL

Participants discussed the challenges they faced in their past CBL projects, and they included the following:
- Time conflicts
  - Task assignment and time management within the team
  - Team schedule and community partner schedules conflict
- Different expectations of students from those of community sponsor
- Different needs identified by the faculty advisor and the community partner

In conclusion, the students felt that if the expectations of the community sponsor and the faculty advisor were clearly communicated and agreed upon prior to starting the project, it would make CBL go smoother.  While some students might consider dealing with conflicts like these would be good learning lessons that helped them become more world ready and self-actualized, others thought that these struggles were just unnecessary hindrances to their overall learning experience. While the students could not provide solutions on how to balance the line between the positives and challenges, we did obtain insights from the faculty interviews on these challenges brought up by the students.

## 3.2 Faculty Interviews
### 3.2.1 Overview

As mentioned in the methodology section, the faculty focus group turned out to be one-on-one interviews due to inevitable time limitations. Four faculty participated and there were three females and one male. From the interview, we developed the following findings concerning the impact of CLB on the WPI campus from the faculty perspective :
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 for 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 multidisciplinary 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.

Through observation during the projects, faculty noticed that students became more motivated in the problem-solving process, as well as completing the work assigned to them. One of the faculty participants believed the reason of students being more motivated doing projects, 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.

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. From not aware of community groups' struggles to understanding different needs of different groups of people, students had developed empathy and compassion through the process of working directly with the community, and even self-reflection. 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" (Shen & Teng, 2018).

Faculty participants did agree that connecting and communicating with community members was a non-technical, yet fundamental challenge. Discomfort caused by cultural shock during CBL might contribute to students' hesitance of working with the local community. But some faculty argued that cultural differences should be expected and was beneficial to prepare students to work with people from different backgrounds.

### 3.2.3 Challenges with Expectations

The most pertinent challenge from faculty, especially project advisors, was balancing between ensuring the achievement of student learning outcomes and the need for community sponsors with CBL. From the various examples 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 needs of community members(Shen & Teng, 2018).

During interviews, all of the faculty participants believed in the importance and necessity of students' learning objectives, which include 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, as one participant would describe meeting those objectives as the "core of (project) advisors' job".

One potential solution to this dilemma suggested by participants was to communicate and negotiate with students and community members beforehand so that they would also understand the importance of learning objectives. However, our faculty participants stressed that the students' learning objectives were enforced by WPI, so even though the importance of common objectives and expectations for CBL were explored, we found that there was not an official, effective, and generally applied solution for the dilemma.

## 3.2.4 Expansion of CBL at WPI and Challenges

For question on whether there should be more CBL on campus, 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 skillsets more effectively, and also help the school with changing demographics. Bur faculty participants also expressed some concerns over the expansion of CBL. Some main challenges were then further explored in the interview:

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

If we were to fit more learning objectives in CBL, 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. Knowing that community sponsors tended to focus on the results rather than students' process of problem-solving, faculty participants argued that certain subjects should remain being taught in the traditional curriculum, namely, in a traditional classroom setting and where students would be examined.

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

If the current grading system which consists of two major forms final deliverable: a paper and a presentation (sometimes optional) were to be continued over the long run of the expansion of CBL, students' creativity would be limited and failed to show the complete result of CBL as suggested by some faculty. This inflexibility of the grading system did not evaluate students' skills that they had developed through the project, such as communicating with sponsors or community members. Another challenge is finding one grading standard that fits all projects caused by project variety since it was all up to the students to pick their approaches to solving the problem given the advisors.

In conclusion, faculty participants expressed their wish to see more detailed instructions for grading CBL on not only academic achievement but also skill sets acquisition.

3. **Faculty had a difficult time connecting with community groups due to time and resource constraints.**

If there would be more CBL on campus, faculty participants predicted that they would be responsible for finding community partners for the students.

There were two major challenges in faculty finding the community partners: time commitment and resource limitations. Adding more tasks of connecting with community members would take up other CBL tasks' time, including preparing course materials, advising students and evaluating their work. Many participants also remarked about the difficulties of finding community partners without any 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. Faculty worried that seven-week was too short for the students to learn and reflect through CBL, as the development of empathy or self-actualization required time and real interaction between students and the community members. Faculty predicted that a long time for CBL would ensure a better learning outcomes for the students, including learning academic content, practicing skill sets, and reflecting on self-development.

From the faculty interviews, 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 Community Interviews

## 3.3.1 Overview

The community member focus group was designed to survey the WPI community partners about their involvement, relationships, values, and expectations in their past PBL program experience, specifically in the following aspects:
- Understand the roles that community partners played in the project both on the professional and personal levels.
- Understand how community members perceive their involvement in the projects.
- Seek solutions to problems brought up by the student and faculty interviews.

Similar to the faculty focus group, the community focus group was conducted in the form of one-on-one interview due to time and location limitations. Two people participated in the interview. I talked to two representatives from two different fields: K-12 education and Innovation & Entrepreneurship. Although the representative from K-12 education was not strictly someone outside of WPI, she worked closely with the Worcester community through non-academic projects that would benefit the Worcester public school system, and WPI students. So it would be valuable to hear her partner experience with the community.

In the interviews, both representatives shared more details about their programs, and how WPI students got involved in these programs. They also talked about expectations for future collaboration between WPI and the community. Detail notes see Appendix H.

## 3.3.2 Community Involvement in Non-academic Projects

I found that the community members mentioned in our conversations had similar roles when it comes to collaboration with WPI - providing platforms, and resources for WPI students' development, as well as benefiting from the collaboration. For example, the STEM Career Night launched by the WPI K-12 Outreach Center, where WPI students are invited to talk about the potential STEM career paths to educators. It gave WPI students a chance to learn more about the education field, and at the same time, educators got a better idea of what tech companies might look for future employees so that they could get their students world and job-ready.

The representative from Worcester CleanTech Incubator aimed to provide both physical and networking resources to the WPI students in support of bringing their ideas to market through mentoring programs, such as the Tech Advisor Network event(TAN).

Unlike other project-based programs, these non-academic programs are usually not graded. Without the grade as a strong motivator, students tend to be less motivated to participate in these community-based non-academic programs. The incentives of doing such projects will be discussed more in the later section.

In general, the community member's role in non-academic programs is quite similar to that in academic programs, i.e. IQP, MQP, or GPS.

## 3.3.3 Recruiting Students to Non-academic Projects

Representatives pointed out that students participating in their programs were overall pretty interested in the subject matter. As mentioned above, those projects were mostly volunteer or interest-based. For the K-12 education program, students participated by teaching at local

Worcester public schools, either out of the desire of giving back to the society, or wanting to gain experience teaching to prepare for their teaching license. And for the TAN event in the innovation and entrepreneurship field, students participated mostly because they were passionate about making their ideas become potential businesses. Since the main way of promoting these programs was word-of-mouth, they were not known widely on campus. One of the questions we raised from our discussion is that, how are we going to get students care enough to participate. Was it only interest?

To promote programs like those to a broader market, representatives suggested to partner with departments that work closely with students and let them bring out the events to the public, and at the same time, talk to WPI faculty to see if it would be possible to give students credit for participating in such programs.

## 3.3.4 Building the Collaborating Relationship

As mentioned earlier, students participating in such programs might not get anything concrete as rewards, as they would with other WPI academic PBL: MQP, IQP, or GPS. When trying to build a potential collaborating relationship, it all came down to pinpointing the goals of the projects. Will this event fulfill what the students and community members want from it? As the person who connected WPI resources with the Worcester public school, one representative said that finding the shared goals or desire is the key when looking for the proper partners. Through the extensive amount of investigative work on potential partners, she could tell that if the shared interest was authentically there on both sides. Moreover, she even considered if that shared goal was the partner's priority; otherwise, one party would end up doing all the heavy lifting in this project. In general, compared to other academic programs where the partnership is built upon the uncertainty of shared goals, the partnership within the K-12 outreach program wouldn't be established unless both parties have agreed upon the goals.

However, I was not able to get as much information on the topic of finding new partners from the other representative from Innovation & Entrepreneurship, since she just joined the organization a couple of months earlier, and a lot of partners were given to her based upon previous collaboration.

## 3.3.5 Current Challenges and Future Expectations of CBL

Instead of worrying about whether or not students' learning objectives would be met, community members had a completely different view on the challenges and current issues of CBL from the faculty's, including:
- Lack of formalized structure

- ○ Matrices for resources measurement standards
- ○ Not enough promotion
- ○ Fail on emphasizing the mutual contribution
- ○ The internal structure of the organization is not stable
- Funding, and timing constraints
  - ○ Make the incentives of participating more concrete

Lack of formalized structure was the most prominent issue that both community representatives have experienced, especially the one from the innovation and entrepreneurship field. The representative said that if there was more sharing of resources, data, and matrices, their organization would become more formalized in terms of identifying students' backgrounds so that they could better tailor their support package to help the students to pitch their ideas. Not enough promotion is another consequence of informalized structure. Since WPI just started the innovation and entrepreneurship (I&E) center recently, a lot of the logistics and rules are still not as mature. As the major avenue of bringing the Worcester CleanTech Incubator to WPI community, TAN hosted by WPI I&E center, attracted students, alumni, and advisors from IQP and MQP. Students entrepreneur teams got to work with advisors to bring their ideas to life. However, the community representative from WCTI hoped to by being a part of TAN, consolidate something where participants of TAN would know that the WCTI was a great resource that they could use, or even engage the mentors from TAN network to become the mentors of the organization's members. The K-12 outreach program was facing marketing challenges for both students and community members. Representative said that often times, students and community members heard about either teaching volunteer work and collaboration opportunities through just word-of-mouth. Such informalized marketing skills reduced the efficiency and accuracy of both internal and external communication. Therefore, she wanted to bring in more students to participate in her program by promoting events through school departments that worked closely with students and work with more community partners that were willing to give advice to K-12 kids regarding STEM career path. Representatives also felt the need of emphasizing mutual contribution from each party when setting the partnership ground rules; otherwise, the imbalance of task distribution would not bring long-term benefits to any stakeholders. Informalized program logistics also caused an unstable internal structure of the organization. The representative from WCTI had witnessed a human resource transition in her organization, which made it harder to assign tasks to staff, finding new partnerships, updating with current partners, and even seeking fundings. Although the organization had ramped back up, a lot of remnants from the transition phase still had effects on their current stage work.

Another big challenge for both representatives was timing and funding constraints. As it's known that WPI students have busy schedules with the seven-week terms. When receiving the information of a certain kind of volunteer work, students tend to get hesitant about participating

because of potential conflicts with their existing schedules. In the case of the K-12 outreach program, a full day of teaching at public schools was already a huge time requirement for WPI students. And the difficulty of finding classes after teaching made students even less willing to volunteer. One solution to this, proposed by the representative was to convince the academic committee to credit student volunteers for their teaching. That way students would feel more rewarded and motivated volunteering teaching. Additionally, community partners' hectic schedule also made coordinating every stakeholder's schedule harder when it comes to organizing events. But the representative from K-12 outreach program figured out a way to make the logistics planning easier for the community members by scheduling meetings at the partner's office. By doing so, she saved a lot of community partners' traveling time and showed her sincerity of working with them. Funding restraint was more of a challenge for the WCTI. As one of the main resources that WCTI offered for its members, this kind of funding heavily depended on the donors; namely, it is not a steady stream of income for the organization. Without enough money, the organization had had a hard time hosting consistent workshops, and training for its members, and even maintaining regular operation within the organization.

In general, community members were happy about the partnership with WPI, whether or not that partnership was new or established. However, if those challenges mentioned above, including informalized structure, and timing and funding constraints could be addressed, WPI students, faculty, and community members would benefit from a more mature CBL environment.

## 3.4 Winter Session Workshop

### 3.4.1 Overview

During Winter Session in January 8th, 2019, we conducted the *Back to the Future of Higher Education* workshop, and 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.

Most participants had confidence in CBL that could potentially replace PBL in the future. Having more CBL projects on campus, WPI would transform from traditional classes to a more flexible and diverse learning style, with a focus on individual students' portfolios.

In terms of possible barriers in the way of achieving more CBL, participants identified two main challenges: lack of platforms and awareness. Based on the existing PBL at WPI, participants explained that limited platforms for project instructors to contact interested community groups would increase the difficulties of establishing more CBL. This statement aligned with our findings 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 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 accept 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.

## 3.5 Solve-a-Thon - CBL Prototype Event

### 3.5.1 Overview

A two-hour design thinking workshop on the ongoing Amazon Forest fires was hosted by WPI I&E Center and me as a prototype of future CBL. The WPI community, artists, entrepreneurs, and the Worcester Community came together to unfold the Amazon fire scene through community-based learning. Participants applied a human-centered design approach to develop creative solution ideas that would have a positive social impact in the Amazon and highlight the complexity of issues surrounding the prevention of forest fires, such as deforestation, climate change, farming, logging, monitoring, and ethics.

Solve-a-Thon emphasized the rapid ideation, refinement, prototyping, and feedback on solutions to the Amazon Fire challenge, as well as using systems thinking to give participants direction during the problem-solving process.

Besides the four subject-matter experts, an additional eight people participated, including five students, two faculty members, one community member. Event turnout and feedback from participants will be discussed in detail in the following section.

### 3.5.2 Event Preparation

Prior to the event, we spent a good amount of people recruiting experts and participants. The list of candidates was from word-of-mouth. The director of the I&E Center knew about some scholars at WPI who were quite familiar with the Amazon Fires crisis, so we reached out to them and discussed the objectives and tentative event structure. In order to give participants the technical knowledge on fire protection, we reached out to the WPI Fire Protection Engineering

Department to see if any person would be interested in coming. We were hoping to use their fire protection demo lab to do a short demonstration on how a forest fire could be put out. But instead of transiting people to a different building, we figured that using a video demonstration would also achieve the purpose, despite it being less powerful.

After we decided on the experts that could make it to our event, we finalized the event structure. First, we would have a 40-minute panel for four experts and participants to gain insight and empathy towards this Amazon Fires crisis. Then, during the Jigsaw/Ideation phase, participants would be assigned to groups representing multiple aspects, and be shown some human-centered example solutions that would get them into the thinking mode. The guest speakers would help groups gain deeper knowledge about the topic. As the participants return to their home group, they would teach their teammates about the knowledge that they just learned with the experts. And that is the CBL, where the team works together to solve a real-life problem. Third, in the Solution & Value Proposition Development, we would encourage participants to prototype their human-centered design using some kind of art or visual representation. And finally, all the groups would pitch their ideas and get feedback from the audience, so that they can reiterate and improve their solutions.

As the event was during WPI Arts & Science week, we would integrate arts elements to contribute to WPI Arts & Science education and make our event more interactive. We thought about multiple ways, including having participants use playdough or paint to model their creative solutions. But considering the sanity constraints at the Foisie building, we decided to go with using post-it notes for ideation. Lastly, participants would test their solutions by pitching to the audience to get feedback. The guest would evaluate each solution and pick the most feasible and creative ones.

As we finalized the event structure, we put up event posters (Appendix I) around campus and send out invitations via email and social media. On the day of the event, participants showed up as shown in Appendix J.

### 3.5.3 Introduction to Problem Statement

One of the challenges that we faced while planning this event was figuring out a way to give participants enough knowledge, and connectedness of different aspects to this Amazon Fire crisis. Although most of the participants had heard of this tragedy from social media more or less, a lot of factors that accounted for this issue remained undercover. So we figured that only did we invite the first responders, would our participants have full understanding of the issue. We were fortunate enough to have the best candidates possible at our event to talk about the cultural, political, technical factor that caused this fire, within a limited amount of time. The

Brazilian mural artist shared with us in her native voice on the impacts of Amazon Fire on locals' lives, and how she had used her art to drive awareness. The second expert was the founding member of the Mbaracayú Forest Reserve in Paraguay. He gave us extensive knowledge of climate, human activities and politics played into this fire. The third expert was a visiting faculty from Brazil's UNICAMP, who was also very knowledgeable about this issue. The last expert was a postdoctoral in WPI Fire Protection Engineering, and he dissected the technology of how a fire could start and spread..

### 3.5.4 Four Quadrants of Change Framework

We used the four quadrants of change framework first come up by Ken Wilber to help participants identify and address the different aspects of changes in the Amazon Fire. The Four Quadrants are shown in Appendix K. The framework divides the change into four types: quadrant 1 deals with intention, personal identity, and ways of perceiving; quadrant 2 with behavior and how it is developed; quadrant 3 with culture, beliefs, and values; and quadrant 4 with the structures and processes of social systems. The framework suggests that a successful strategy must address all four change challenges(Waddell, 2012). Since the Amazon fires had been a complex issue involving lots of factors, such as personal behavior, politics, and climate. Having this framework as a guideline, participants would be inspired to come up with solutions that fit in those quadrants much easily. We encouraged participants to undertake strategic interventions to ensure effective changes that were proceeding in all the quadrants.

Some of the examples come up by participants were, for behavior: educate the locals about the importance of having a sustainable developing plan for Amazon rainforest instead of focusing on deforestation which might have brought short-term benefits; for intention: regulate the frequency and scale of people cutting down trees; for culture: encourage the locals to support sustainable tourism in the Amazon rainforest; for system/society: update the rest of the world with news in Amazon, bring more awareness and international help to stop the fires from further spreading.

Using this integral framework, participants were able to situate the various change theories, and approaches and determine the most comprehensive solutions to this human-center problem for sustainable development (Integral Business Group).

### 3.5.5 Roles of Stakeholders

In this event, the director of WPI I&E Center was the main facilitator who was in charge of the event flow. Another staff from I&E Center and I were the people that encourage other participants to be active. The rest of the participants, including WPI students, faculty and community members joined the discussion. The four experts that we invited were all part of the

WPI community; but different from the faculty members in traditional PBL, these faculty members were more like the sources where students could get thorough advice on not only project logistics but also technical and professional guidance on the subject matter. With their background working in the community, they provided extensive support and authentic, first-hand information during students' construction of the solutions. Therefore, they acted as both advisors and sponsors in this Solve-a-Thon project, who provided students with the problem statements, direction and resources to approach the problem.

### 3.5.6 Post-Event Feedback and Debrief

Given such short notice, we had tried every effort we could to pull different resources and recruit participants. We had a post-event follow-up with some of the participants, and a debrief among the team. Here is the thing that we did good based on participants' feedback and our self-reflection:

- **Good event structure**
  Bringing guest speakers that had dealt with the Amazon Fires and related issues was the best and most direct way to give participants exposure on the subject matter. Speakers' lively talks triggered the audience's empathy towards the Amazon rainforests. One of the participants said that it was great to hear the political issues from the indigenous voice. And the student participants enjoyed hearing the thoughts of all the different speakers, and the Ideation activity at the end that encouraged discussion between members.

However, here are the things that we could do better on:

- **Better timing control**
  This was the biggest issue reported by the participants. We first started off late since we were waiting for one of the speakers. And we experienced technical issues changing the slides back and forth for different speakers, which took some of our time. And the guest speakers took way more time to present their topics than expected, which left not enough time for participants to brainstorm ideas to combat forest fires and pitch their ideas. We were facing a dilemma where if we cut off the guest speakers' time, participants might not get a comprehensive understanding of the issue.

  During our team debrief, we came up with a solution that could alleviate the timing shortage. We could let those guest speakers have lighting talks with a brief introduction of their expertise and relevance to Amazon Fires, then let them give guidance to the groups as they hover around.

- **More interaction between guest speakers and participant**s

The second biggest issue we observed was the deficiency of interaction between guest speakers and participants. Despite the lively talks from guest speakers, participants were not motivated to ask questions.

To make the discussion more like an open-conversation style, we could consider the following methods:
1. Change the setting of the room, like sitting in a circle, so that participants would feel more comfortable opening up, instead of a traditional classroom lecture style.
2. Emphasize the Jigsaw, enforce people to learn different concepts and come back to teach teammates, which is part of community-based learning.
3. Emphasize the competition and challenge in the event, stress the prizes and incentives for coming up with creative solutions.

- **Recruit more participants**
  We did not have any K-12 students and teachers as planned, even though we did our best inviting them, because our event either conflicted with their schedule or was not supported by their system since it would require chaperones. One thing we discussed in our debrief was how we would've done things differently if K-12 students and teachers present at our event? High school students are used to traditional classroom settings, so we would have needed to stress the design thinking method way more explicitly at the beginning. Also, some of the terms talked about by our guest speakers might be slightly harder for K-12 students to understand, so we would have asked the speakers to use as simple ways as possible to explain the subject matter.

## 3.5.7 Summary

Overall, this Solve-a-Thon event was a great platform to test CBL on the WPI campus in the following ways:
1. Gathered main stakeholders: students, faculty, and community members to solve world pressing issue.
2. Required much less budget, time and effort than planning an actual project.
3. Provided great insights for educators, school committee members to better plan the future CBL on WPI.

For the IQP team that participated in our event, it helped them with their IQP in the sense that they got a lot of perspectives about the firefighting issue, which was what they worked on for IQP. And it inspired them to look into varying perspectives for their project, especially with determining the feasibility of using drones in firefighting.

# 4. Discussion and Recommendations

## 4.1 Summary of key findings

### 4.1.1 The Benefits of CBL

Through the focus groups with WPI students, faculty and community members, as well as the Solve-a-Thon this year and Winter Session workshop conducted last year, we found that participants had confidence in founding more CBL on WPI campus. CBL would be more beneficial to the main stakeholders in one way or another than the traditional classes. As mentioned at the beginning of the report, we focused on two main areas of development throughout our project: world-readiness and self-actualization. World-readiness refers to the skills that made the students more prepared for professional careers. Self-actualization emphasizes personal development, attitude, and motivation.

#### 4.1.1.1 World-Readiness

The student focus group participants thought that given the problem statement in CBL, they had learned to contextualize knowledge learned in class and apply it to real-world problems. CBL had also given them opportunities to further develop other professional skills, such as teamwork, communication, and research, all of which played important roles in CBL. When interacting with outside communities, students learned to embrace cultural differences and gained new perspectives. The faculty advisors reported that they had noticed improvements in students' communication, negotiation, and other non-academic skills in CBL. From the community member perspective, partnering with WPI almost always guaranteed good turnouts of the collaboration. WPI students immersed themselves in the environment provided by the community, whether that be Worcester public schools or social innovation & entrepreneurship organization. Given a complex setting, students learned to be flexible, eloquent and dedicated so that they could navigate through to bring out the best outcomes for stakeholders. Students, faculty, and community all believed that students' professional skills obtained through CBL would make them more prepared for working in a professional environment and more desirable in the job market. They welcomed more CBL because the students' past experience with community-engaged projects helped them become more world-ready(Shen & Teng, 2018).

#### 4.1.2.1 Self-Actualization

Not only did CBL contribute to students' academic and professional development, but it also facilitated the self-actualization process. While helping the community members, the students felt that they were needed, and learned to put themselves in the community's shoes, truly caring about the well-being of the community. Students got more than just grades from CBL. They felt a sense of achievement when being recognized for their help to the society. They discovered more about their strengths and weaknesses when they worked on the projects; therefore, they had

a clearer understanding of themselves and their future paths, which could be proven by one of the community members' experiences that students realized that teaching was not really his/her passion after volunteering to teach at a public school. After experiencing cultural shocks for some students, they re-evaluated their own lives and choices to become better global citizens. Faculty advisors commented that culture shock was actually beneficial to students' personal development because it pushed students to consider their situation from new perspectives. Students also became more self-actualized during the student focus group discussion and reflection. 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, by noticing that students were more motivated to do work when community interactions were involved. Even if they encountered obstacles from time to time, knowing that they were needed by the community, students grew to be determined and persistent about coming up with solutions to help the community.

## 4.1.2 Challenges for Further Integrating CBL

We identified some current challenges that the main stakeholders had faced in their community-engaged projects. These data were gathered from focus groups/interviews, Solve-a-Thon and the Winter Session workshop. By identifying these challenges, we hoped to provide recommendations for WPI to further integrate CBL within courses and projects in the current curriculum. A list of challenges that we found through this project includes the following:
- Some communities had no clear need or did not have any needs when they proposed projects.
- Hard to enforce the shared interests or goals when finding community members for partnership
- Students were frustrated by conflicting requests from the advisors and community members, which made them more hesitant to work on community-based projects.
- Students were not motivated to work on CBL due to a busy schedule.
- Challenge of established CBL given only seven-week terms
- 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 faced difficulties in developing relationships with community groups due to time and resource constraints.
- Short of marketing of non-academic CBL projects.

- Lack of formalized structure for non-academic CBL projects.

# 4.2 Recommendations for WPI

## 4.2.1 Internal Changes

In order to increase CBL, we had some recommendations on changes that the WPI community could take to overcome some of the main challenges that some community-based projects face.

### 4.2.1.1 Learning Outcomes and Expectations

Misalignment of student expectations and learning outcomes set by faculty happened occasionally during community-based projects. We recommend that faculty should communicate the learning outcomes and 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 1would produce well-designed solutions.

Also in order to accommodate students who spend all day doing CBL projects, while still need academic credits, the school committee might consider providing online recording courses for them, just so students wouldn't be restricted the day time class schedule.

**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 fewer 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 may be too short for community projects. In this case, many sequential classes in specific major requirements may help students 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.

**4.2.1.4 Incentives for participating non-academic CBL**
From the community interviews and Solve-a-Thon, we noticed that students were not as passionate participating even though we set up prizes for the winners in Solve-a-Thon. Besides feeling good about helping the community, could we come up with some tangible rewards for students who participate in non-academic CBL, such as giving them equivalent course credits, and offering summer intern or co-op opportunities at the organization that they had worked with if they were interested?

**4.2.1.5 Marketing for non-academic CBL**
The most popular CBL projects have been IQP, MQP, and GPS, which leaves non-academic CBL projects little space to thrive. In order to bring more students to participate in CBL projects other than just the popular ones, we suggest school departments should help promote those non-academic projects on campus so that more people know about them. Also taking advantage of more than 200 clubs and organizations on campus, we could get them spread the words.

**4.2.1.6 Formalized structure for non-academic CBL**
Including the marketing mentioned above, a formalized structure plays an important role in the establishment of CBL. More aspects that could be formalized include:
- Make programs consistent
- Have a back-up plan for partnership just in case community partners back off
- Come up with some sort of platform that can inform CBL project opportunities

## 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 and Solve-a-Thon at 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 the 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.

Also, we have received positive feedback from the Solve-a-Thon with regard to the format of the event. They liked that they were given a pressing world issue, and able to hear different perspectives from experts. And it was a great platform to gather three main stakeholders. In the future, we would like to continue such a summit or panel, with better time control on the event flow, and a more engaging way to present the topics.

## 4.3 Suggestions for Future Research

### 4.3.1 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 afterward, 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 about the purpose of higher education and recognize the importance of it.

The Solve-a-Thon could be another platform to bring main stakeholders together to work on a social issue. It would be better to promote this event to a broader audience. The topics around which the event would revolve would depend upon the organizer's research.

### 4.3.2 Grading Criteria

We hope to see some flexibility of the grading system for WPI's community-based projects. Besides focusing on how many tasks the students have accomplished within a given time frame, the advisors or graders should also look into students' learning outcomes from those projects, such as the skills that they develop from the project, and community member's feedback on students' performances. While it is still important to let students follow the strict guideline for report writing and presentation, as writing and presenting professionally is an important competency for students to be world-ready, WPI faculty should implement a more comprehensive grading spectrum for students' project work.

If we were given more time, we'd like to research other engineering institutions' current method of evaluating student project work. Therefore, we recommend future research on more possible changes for the evaluation and grading criteria for community-based projects.

## 4.4 Project Conclusion

In the future, engineers will 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 these problems. 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 have gotten overall positive outcomes from PBL at WPI, they identified challenges in further integrating CBL within the current curriculum. We recommend a series of changes both at WPI and with 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 and Solve-a-Thon.

# Appendices

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# Appendix B - 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 C - 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 D – 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 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 the 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?
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?

# Appendix G - Solve-a-Thon Agenda

1. Introduction / Team formation (5 min)
2. Human-Centered Design:  Intro to Issues, Jigsaw Activity/Ideation – Part 1 (80 min)
   a. Intro to the issues (40 min) to gain stakeholder insight and empathy;  Problem/Opportunity Identification. Each person presents for about 5 minutes and then fields questions from audience for 5 minutes.
      i. Panmela Castro – Getting her native voice and perspective on importance and impact on their lives, etc and how she has used her art to drive awareness or impact, etc if she has.  She can take this in any direction.  I put her first since I think she will need to leave immediately after.  I don't know where she is painting.
      ii. Martin Burt - Quite familiar with crisis. Founding member of  Mbaracayú Forest Reserve in Paraguay (Interior Atlantic Forest now burning;  Paraguay, Bolivia and Brazil are suffering fires now. Knows relation between soy, beef & deforestation, how these fires start, how rain patterns are changing, and how politics plays into this. Works with the Sustainable Amazon Foundation, so he knows what's happening there.
      iii. Roberto Martin, Visiting Faculty from Brazil's UNICAMP.  Also very knowledgeable about issues.
      iv. Ben Betting (Post-Doc in Fire Protection Engineering – From France)
   b. Jigsaw / Ideation, Solution & Value Proposition Development (40 min) – Marc opens with example solutions/video and highlighting the impact of the solution on other issues. When they return to home group, they ideate and develop an idea/solution/value proposition for one of the expert categories that will contribute to helping out the complex Amazon Fire Issue.  Speakers will help expert groups gain deeper knowledge about the topic. (Reduce # of expert topics depending on the number of participants.  If the panel/presentation discussion is rich, we can possibly skip the Jigsaw and go directly into ideation)
      i. Behavioral
      ii. Intentional
      iii. Cultural
      iv. Systems
3. Human-Centered Design – Part 2 (30 min)
   a. Prototyping Art/Visual Prototyping of Solution/Story (15 minutes)
   b. Testing solution by pitching to get feedback (15 minutes)
4. Wrap Up and Awards Presentation (5 min)

# Appendix H – Community Interview Notes

<u>**Community Interview 1**</u>

**Background about Interviewee**

1. working with Upward Bound programs helping high school youth prepare for and apply to college, and engaging in educational policy and politics.
   - Bring educational access and equity into educational communities to ensure all students are engaged in meaningful STEM experiences.
2. Boys & girl's club in Worcester
   a. possible projects (or internships) with Teacher Prep program;
   b. what are their needs?
      i. Career path explore

**Questions:**

1. What community projects have you been involved in? And tell me about it.
2. How did you decide which partners to work with? How did you set up these projects with them? What were the challenges you and your team running into?
3. Are any WPI students involved in any of these projects? In what way?
   a. How do students find out, and what they want to get out from these projects?
4. Is there any preparation for the WPI students before they work with the community partners?
   a. Purpose of spending time with students?
      i. Teacher Prep program (join sophomore year, IQP, MQP)
   b. Details
5. How would you describe the outcomes of the project(s)? And why?
   a. Do the outcomes meet your expectations?
      i. Students and community partners love it, it's a pretty helpful program
      ii. But some cases students realized teaching is not what they want do for career, they choose to do educational coaching etc.
   b. Is your personal and your organization's expectations usually align with community members?
   c. To what extent were they met? How did they change along the way?
   d. Challenges during the collaboration
      i. full day of teaching for students, hard to get classes after teaching
      ii. Hard to align the balance between students and partners busy schedules
         1. Have proposed solution: like get the same disciplinary class after their teaching

2. Count teaching as part of their academic required credit
6. Expectations on collaboration with WPI
   a. Work with more community members, bring more partners to the table to get collab ideas to produce a greater outcome
   b. Hope community understand the importance of mutual contributions, instead of having just one contributing party
   c. Want depts that work closely with students to promote events
   d. More partners that can give advice to kids regarding STEM career path

**Transcripts:**

*Q: this could be both like the upper round or the Boys and Girls Club that you work with… so what kind of community projects have you been involved in and what exactly do they do?*
A: to do even more than that you want other than looking at anything that you know I have worked in education in the city for over the past 10 years, a lot of my involvements either working with students to think about how to have more access to either could be to colleges which is something I work with Upward Bound. Or high quality STEM opportunities. Or I work with the educators and their system, helping them to think about how they could partner with people, or how they could bring in people from WPI to give those opportunities to their students.

*Q: when you go pick what kind of public schools you want to partner with, what kind like criterion are looking at? - good question*
A: yeah so one thing about the partnership that I've learned is that it has to feel sort of easy to connect with someone. And that doesn't mean you always reached them the first email, because community partners in my experience in education, tend to be very busy. But it's about you realize that you have some sort of shared goal or shared desire for something, and you can tell that that is authentically there on both sides. That's the biggest criteria is really doing that investigative work to decide 'do we want the same thing? Or am I bring an idea to the table that you know sounds good, but it's not actually a priority of yours. Because if it's not a priority of yours, I'm gonna end up doing all the heavy lifting, and I will almost have to beg you to work with me on it, as opposed to if we both realize how this will move us to the shared goals. Even if one does more than the other at times, we are both going to be invested in our work.

*Q: so taking the example of boys and girls club, what kind of things they look for for WPI? And what the whole WPI STEM center look for from the Boys and Girls Club?*
A: Their main focus is making sure their kids have access to everything and anything, and they know that in the future, the kids will be STEM. So what they want… They are open to many different.. Like positive partnership, form an IQP there. I have a colleague who is a merit, like a

volunteer, so he works here at the office for a year,  and he has set up the coding club to have in there, He and I and a team of others have created this STEM career night that is little bit nontraditional, so it has people from all different backgrounds, like people from food industries, in places where you see STEM, but it's not as obvious that it's a STEM career. And we hold that at the BGC. So they are very interested in anything that can help their kids learn more to have more of an opportunity in STEM. And for me, what I realized is, again because they are so busy, because their club is open till 9 o'clock at night every night, and they serve dinners to students and their families. They have many different things going on. So for me, what I've learned is that I tend to try to pick the projects where I see an immediate, there's a short term goal that can happen really quickly. And then we re-evaluate the STEM career night that I went two summers ago. I asked the executive director if she would be interested in hosting this idea I had for STEM career night, and she said yes and so we work together towards that and had it in October, and it was a really big success. So for me having that early win like that like oh this one's really well or else this didn't work well and why didn't work well is important before you invest in a long project, with maybe the outcomes won't be as immediate, because you're more likely to have other things come up and have people drift off.

Q: *The Boys and girls clubs is a nonprofit organization, correct?*
A: Yes


Q: *When you first heard about the partners, how do you usually reach out to them? Is it via email or in person visit?*
A: So I tend to 1, I've been involved in a lot of different places in the community over the years, so chances are, I know someone who's been connected to them(BGC) or something we were connected on, but they don't remember that. So having ways that you can have that introduction is really helpful if it all possible. I typically start with an email. "Hi, I actually heard about you from so and so. Actually we served in a committee together" If you have that, it would be helpful, although not essential. And then I just give brief overview(of the program) to see if they are interested, and then I give times that I could meet to follow up. Because I find that if this is someone I don't already have a partnership with, a face to face meeting is really necessary. So that we can make sure we are on the same page to build that relationship


Q: *it seems like before you carry out an event with that community member, you have gone a lot of negotiations, talks or discussions about what both of you guys want to achieve. But is there a case where you and your team went into challenges collaborating with partners, like you said, during the collaboration, one of the partners drifted away, Is that ever happened to you?*
A: (Yes), taking the STEM career night, I was prepared to do a lot of the work the first time to see if it would be successful. While we shared pieces like outreaching to presenters, I did most of the logistics work behind the scene for the event. But I knew that I didn't have the capacity to do

that every year, like I don't run programs as my primary role. So I don't do that every year moving forward. So there was a little bit of a challenge, kind of everyone wanted to start planning for this year's event, which is in October, much earlier than last year in the spring. But it was hard to pull people back together, because spring is a busy time - school is getting ready to end, an BGC is in transition of school programming to Summer programming. It was a little hard to get some traction going that they feel like it's a priority. So what I found was actually helpful was one, just scheduling the meeting. We usually meet here(WPI STEM center), now the meeting was actually at the Boys and Girls Club. So I determined they were the busiest, so I brought the meeting to them, so all they have to do is just walk out their offices. I also engaged a couple new community members to help plan, who I have been doing small things along the way with, and who I knew the partnership that they could possibly have a good partnership with the BGC as well, so they are mutually beneficial.

Q: So you just bring more Community partners to strengthen the importance of this event, and make it more convincing.

***Q: So I think one of your main jobs is connecting the WPI students, bring in volunteers from WPI to the community. Besides the volunteering, are there other ways the WPI students involved in this project?***

A: I would say the WPI students are not involved very much, it's more like in very small ways.For example, at the STEM career night, a couple students have volunteered in the past, and hopefully we will do something this year as well. To stand for the WPI admissions table. One of the volunteers was fluent in Spanish, so we helped one of families translate. But a lot of the work I do right now is more connecting lots of the people in the community, including WPI faculty. If you are really interested in what we are doing here, come join us. So I think it'll be really cool if we could bring in WPI students more. I think the harder part is figuring out like WPI students schedules tend to be so busy and community partner schedules tend to be busy too, so trying to figure out what would be the right balance of collaboration.

Q: Actually I have a friend that used to work with the Boys and Girls Club and I don't know if you know him Darvin.

A: no, but that's awesome!

Q: He graduated like two years ago and he just told me like usually goes after class like 4 or 5, and just teach the kids stuff. yeah

A: There is the boys and girls club, and a program called ACE that students can volunteer at, as long as they have a set schedule that they can commit to showing up.

***Q: How do you students who don't hear about this kind of volunteering work?***

A: So for me, I think a lot of them hear about it through students activities office, others hear about it through sort of word-of-mouth. So there a club that has a particular similar mission or vision, and one club member learned about organization in Worcester that has a similar mission

or vision, or there's overlap. Some of the other smaller offices, like the Office of Multicultural Affairs had some students work with a group and then, now they know that that group likes WPI students, so they can share that information. For me, it's been really random. I was literally at a talk one day, then there was a student from Worcester, and had grown up in Worcester, and like to give it back or something. So I am like hey, I am having this event, would you be interested? But yea I wish there was a way for promoting that wouldn't be overwhelming. Sometimes I think students get oversaturated with information. How do you determine what's important or not but I wish there was an easier way to put like "Oh, these are times students can volunteer for". As an office that doesn't get engaged with students regularly like Academic advising.

Q: So you want to like just partner with departments that work closely with students and let them just bring out to the public.

***Q: When the WPI students want to participate in this volunteer work, do they have to prepare anything prior to the volunteering work?***

A: There have been times where the case is yes. One of the ways we do regularly connect with students, although it's a small group is, the Undergrad Teacher Prep Program that is run through our office. So the students who are graduating with a teaching license in addition to their degree for teaching K-12 in MA.

***Q: do they get their license through WPI?***

A: They get certified to have it through WPI. And they apply for it through the state. So sometimes, there was one student who was in that program and he loved presenting about aerospace. So there was a time where we heard about GPS that they were doing a project and they were looking for presenter, and we were like "hey, you'll be great for that". But a lot of times there are opportunities to just show up and. (For example), we have these things called STEM kits that are very simple to use. There are basic instructions in there, and it's pretty accessible for most people. So even if you are preparing for a hands-on thing, you can just use our STEM kit for preparation

***Q: how long is the teacher prep program lasting?***

A: so you join your first or second year, and there's a class you have to take at the end of your sophomore year. And then you do a student teaching, either IQP or Independent Study in your Junior year, a semester long. And then senior year there's a seminar that meets a couple times. And a few course requirements in addition to that.

***Q: For the IQP that they have to do, is it like working closely with the community partners, then let them try teaching there?***

A: Yea, so they are actually partnered with a long-time educator for a fall semester(mentor program)

**Background about Interviewee**

- WCTI provides both the physical and network resources that companies need to propel their ideas to market.
-  Involved in  project-based work with partners

**Questions:**

1. What exactly is you and the WCTI do? Who do you work with? Give any examples?
2. How did you decide what partners to work with? How did you set up the work relationship with them? What were the challenges that you ran into when you first reach out to them?
    a. Clean tech industry only?
        i. Open to every industry, just get the funding from the worcester
    b. Given for her, how to improve, no history,
    c. Tech advisor and network program (TAN)
        i. 8 students entrepreneur teams
        ii. Pitch their ideas
3. How did you hear about WPI? What was the first project that WCTI work on with WPI?
4. Are any WPI students involved in any of these projects? In what way?
    a. In what way do you usually market the collaborative projects to WPI community, and other stakeholders?
    b. What do you expect the WPI community to get out from this collaboration?
5. How would you describe the outcomes of the project(s) with WPI? And why?
    a. Do the outcomes meet your expectations?
    b. Are all the stakeholders' outcomes align in a way or another?
        i. To what extent were they met? How did they change along the way?
    c. Challenges during the collaboration
6. Future expectations on collaboration with WPI
    a. Formalization of collab
    b. Consistent events, skill train

**Transcript:**
*Q: brief intro of the interview and what my IQP does.*
Confirming WCTI's role: providing both physical and networking resources to the companies that want to market their ideas, and you specifically involved in a lot of project-based work with the partner.

*Q: Could you elaborate a little bit about what you and your organization does?*
A: So we provide low-cost space and equipment for businesses to grow. Beyond that, we also work with a lot of partners to create mentoring and networking opportunities for members. So the goal of ours for the next year or two is to step up the programming, to make sure people are getting more of a consistent opportunity for networking and mentoring, as well as working on skills that are necessary for growth, such as accounting skills. Some of those basic things when you have an idea, you still need to translate it into very formalized structure in order to become an established business.

So you know we have a lot of community partners, and office, an accounting that we work with. Just getting those to more formalized planned. Every month we are gonna do this office hour to open up opportunities for our members.

*Q: For my understanding, your organization is like a median between the small startup companies and other professional organizations, connect those two together, and give the small startups the professional skills that they need? Is that what you guys mostly do?*
A: yes, I think that's a big part of it, as well as bringing people lower cost of space. Because you know we have a floor of the printers building. If you would have rent this entire floor, it would eat out all your finances. We also offer coworking. For those really small startups, you just need a place to be, then you can grow. We offer office spaces if they grow beyond that. And they want physical location, where they can keep their stuff. We have conference rooms for everyone, if they want to have meetings here. It's almost like making these small businesses become more established than actually are, because they kind of want a peace meal out of our space for that.

And it is cheaper because it is in Worcester, not Boston. A lot of incubators are currently in Boston, which is a lot more expensive there.

*Q: How often would you organize a platform or expo that brings all the stakeholders together? Is it all dependent on them, or you start the initiatives?*
A: you know we have partnerships with a lot of people and those bring along these events on a yearly basis. For example, we are majorly funded by **Mass Clean Energy Counsel**. They come to our space when they have grants, and things coming up, they will do office hours at our space. So that happens probably on a quarterly basis, depending on what grant. Right now it's a catalyst grant, for very small startup, who are in the cleantech industry, kinda getting their fist seat funding. So they came last month. They sat in a room, and just open for anyone who wanted to come from the community, and from our space.

So that's one partnership. And another partnership is we work with the Chamber Commerce. So the Chamber Commerce has this program called Startup Worcester, and it is basically a 12 co-work companies that can be in our space for free for one year. And during that year, they get programming from all three parties, which is the Adventure Forum, us, and the Chamber Commerce.

So with that we have a yearly-cycle of events. There's a pitch night, which I believe happen in the Adventure Forum. At the end, they have an event here, kinda like a wrap-up, presentation of what their products look like now, and what their next steps look like. They also have induction around the same time, because they end in May. And co-work starts in June. So we have two events in those two months. Bye old people, Hello new people!

We also are involved in the selection process, which is another event where it's almost like speed dating - all the businesses presenting at their own tables. So that's specifically for Startup Worcester.

And then beyond that, all the events are planned and implemented by us. So there could be events with a speaker from different business, who I believe used to be our incubator, and coming back to share his experience. And then we did the movie night on climate change.

Upcoming next month, we are planning an event for connecting women business owners together, and that's partnered with Center Photo Enterprise.

So what I found is that if we work with partners on events and we will get better turnouts, just because our recognition of WCTI isn't there yet vs. someone knows the Chamber of Commerce much more. And we understand that that event is open to them as well.

***Q: One thing I am curious is that the name of your organization is Worcester Clean Tech. So the partners that you work with, do they have to be in the clean Energy Tech industry, or is open to other stuff?***
A: No, not everybody in our organization is in clean tech industry. The reason that we were established as a clean tech incubator is because of our funding. We are funded by the Mass DEC. They fund us because we bring about the clean tech Industries

We actually have about 20 companies, I would say six of them are clean tech. So for 14 companies that are not clean tech, 12 of them come from Startup Worcester- co work. So to be a startup Worcester Co-work, you don't have to be in clean tech industry.

*Q: so when you go out to find partners to work with,what kind of criteria do look for on a partner? How do you set up the work relationship with them?*
A: Most of the partners are just given since I joined the organization back in May. Lots of the collaboration just come on to face-to-face meetings. And we can talk about how we can improve. If you come from a side of we are gonna improve this program kind of partnership, it's never gonna be an issue. If you just complain this this this never happen, you are not gonna get the result you want.

It is kinda nice to be a new person, because you don't know any dark history of ny bad blood. So you can just kinda come to it and say "Hi, I am new, this is what I am doing, and let's continue this partnership". And recently, I am getting more engaged up in WPI. Have you been to a TAN event before? (Tech Advisors Network)

*Q: no*

A: It was incredible, so many alumni come back, and mentor all these IQP, MQP projects. I think there are 8 students entrepreneur teams, and they have to work with that advisor to bring that program to life. So that was a great opportunity for me to go, to meet new people and understand what WPI is, and makes me want to engrain in the TAN and help. So we can solitate something where they(participants of TAN) know that the clean tech industry is a place, so that those projects coming from TAN don't have to move to Boston. Just stay in Worcester, come to our incubator. Or engage the mentors from TAN network to become the mentors of our members. And a lot of our members are WPI grads, so it is kind of nice balance.

*Q: Say you know about the student entrepreneur projects from the TAN program, and what kind of support would you consider providing to those student groups?*
A: there are multiple student projects. One of them being Robox, from Marc. His company, he is an incubator already. Then Andrew is also incubator, from the TAN network. So we sorta like have this weird mish and mash funnel of once they become TAN, they learn about WCTI. They will be like oh yea I can go in here!

I am trying to make it a little bit more formalized, get a time either bring the TAN network to us, and have a networking event, where people can learn about our space, we can learn about the projects, or even just matching the people in the incubator, "oh you work on 3D printing, we have this member who does a lot of marketing. You need more marketing, and they have an online platform to support. If this is a good match, you can partner with their services.

So there's always so many good opportunities, just to get so many people in the same room.

Because this partnership is already happening, and it just on a slower process, and you try to further improve it. Exactly, and so doing things like meeting with the head of TAN in the next couple weeks, they are gonna come to our incubator, and we can show "look, there are so many good opportunities here. We definitely have a lot more opportunities to work on our side of things. However, we could really use the help from institutions like WPI, which actually help startups at the beginning.

So this partnership just kinda like there at the background, all it needs just a formalized, and here is what they do for us.

*Q: Yea, I feel like WPI provides great recruitment of students entrepreneur, and in the future, they can probably hand it off to you guys, bring in more industrial experts, let students get more exposure on how to really work on your business.*
A: yes

*Q:Before you and your organization collaborate with the student groups, do you guys come to an agreement on what expectations your organization has on students, vs. what students want to get out from this collaboration?*
A: it really comes down to funding, you know, if you want to be a member of our incubator, it is a paid membership, and it's much less than renting an office in Worcester, but still there. So there's collaborating on events and collaborating on programming and things like that which are open to the public. And you know easy for us to say yes please come for free. But if they want to receive space, use our equipment, use our mentorship or network.That requires membership fee.

*Q: so it depends on different tiers of membership?*

A: yeah. But again, if they want to become a Worcester StartUp Coho, they get our space for free for a year, and we can connect people to that program.

I mean it's not totally free because it's sponsored. We do get funding for it, not as much as like covering the full membership. But for us it's valuable because we get all these new spaces and a lot of people stay after that first year

*Q: Can you tell me a little bit more about the StartUp Worcester program?*
A: It's a partnership with Adventure Forum and Chamber of Commerce. So there is,

basically a pool of candidates, and 12 of them are picked out from that pool. So 12 companies, or really some of them are just ideas. And they receive, match with a mentor through Small Business Administration(SBA). And then they receive opportunities to pitch to venture capitalists people and they also receive our space for a year.

So it's very formalized, you get inducted in June, even May, and that's mostly been implemented on the programming side from StartUp Worcester, where we seem day to day in the office.


*Q: How would you describe the outcomes of previous projects you worked with WPI so far?Are they mostly positive, or negative?*
A: I would say most of them are very positive. Our issue again is, nothing is formalized. If there is more sharing of resources, data, matrices and things like that. We can become more formalized and say: this many people are referred to us by WPI. This many people use our equipment from WPI.

And I think that's kinda what the next step should be, for WPI in general, because you guys just started the whole innovation thing. So I was at a meeting with Donna Living yesterday. And she said one big thing is capturing matrix in the future and make sure we have a formalized matrix. Just like us, we have a lot of informal things.


*Q: So to me, the formalization you talked about is like a measurement of the existing resources that both partners share. But would you also consider on your end, maybe you could improve the kind of support or activities collaborated with the partners? Have you thought about that as well?*
A: Definitely, I think really the big thing is programming, and making sure that our events are consistent.  Again, formalize ourselves.So we can say, we offer this many trainings for this many office hours with accountants and lawyers for these WPI projects, or regular projects, or members. So yea definitely making a more consistent plan of skills based trainings really gets the job.

*Q: is the major marketing way to WPI through the I&E center?*
A: Yes they are the main contact, but also TAN. I think TAN works more, because our exec director at the moment is a TAN advisor. So he is a mentor for student groups in the TAN network.So he has connected a lot of students groups with our organization in the past couple years.

Donna and Curtis are kind of new on the scene since last year was the first year the department rolled out. So that's a connection that needs to be continuously grown.

***Q: Have you run into any challenge when you first reach out to partners or even during the process of collaborating with the students and the professionals?***
A: A lot of challenges I have had are financial, being able to collaborate without money at all, because WPI doesn't really have a lot of money to invest in outside or their campus. And we don't have a lot of money that is not tied up to grants to invest in events for partnerships.
So we both have to come to it with resources and time, money and sometimes people don't have the time and the resources to put into something. And that's why it doesn't grow if there isn't money or some sort of compensate.

***Q: is there any situation where during the collaboration, the partner sort of just drift away? Like they change the idea or they just sort of drop off during collaboration?***
A: it hasn't happened to me since I have been here. But I do believe that, so we have an interim exec director, and I think a lot of ways we have backed off on our partnership because we were in transition. We didn't have an exec director, our main exec director left in October. And the interim exec director Joe Bush runs his own company. And Mataya who worked at my position before was here on a daily basis. So the board was sorta scrambling. So for a couple months there, there were drop-off. And we weren't able to accomplish the things that we thought we would.

But now we're ramp back up. I've been added to the team. Monica, the exec director is coming in October. And she will be here more like a full-time basis. So she's been added to the team, and she's been helping out on a volunteer basis before she takes on her new role. So there is more people on our side, and there's more tension, more like we need to change this. We need to update everybody on we are doing what we are saying.

***Q: Is there a qualification for groups to get the fundings?***
A: WPI has tinker box, but we don't have that, but we can connect people to resources. Such as the Mass UCAC have grants for small businesses. Or the SBA, or the Accounting Development. We can bring those people to us, and hold office hours and tell people to come, these are the applications coming up. But with us not having the money, that also posts us challenge.

***Q: Suggestions on my project, given the goal of it?***

A: I went to Clark, majoring in community development planning, and a lot of my courses were community based, we did the opposite of what WPI does, first understand the community, the needs, and then thinking about the development and tools to fit those.

So maybe it would be beneficial for you to talk to a prof at Clark, or IDC?(Lorrie Ross, works on non-profits, teaches classes that work with non-profit), can give you more advice on how to develop human-centered approach.


*Q: What do you think about the Solve-a-thon?*
A: It was a great event, wish there was more time. A lot of times I feel like there's lack of interaction, engagement, like sitting in a circle. Open up the conversation, so that it's less extractive. It's great to hear the political issues from the indegious voice.

Maybe connect with Clark, have students who work on land rights or international development to come to events like this, since they can provide opinions in between.
Clark and WPI really can use some help from each other. Clark students really do need some technical hard skills, and the human-centered stuff seems to be what WPI needs.

# Appendix I: Solve-a-Thon Poster



Figure 1 Solve-a-Thon Poster

# Appendix J: Solve-A-Thon Picture



Figure 2 Solve-a-Thon picture

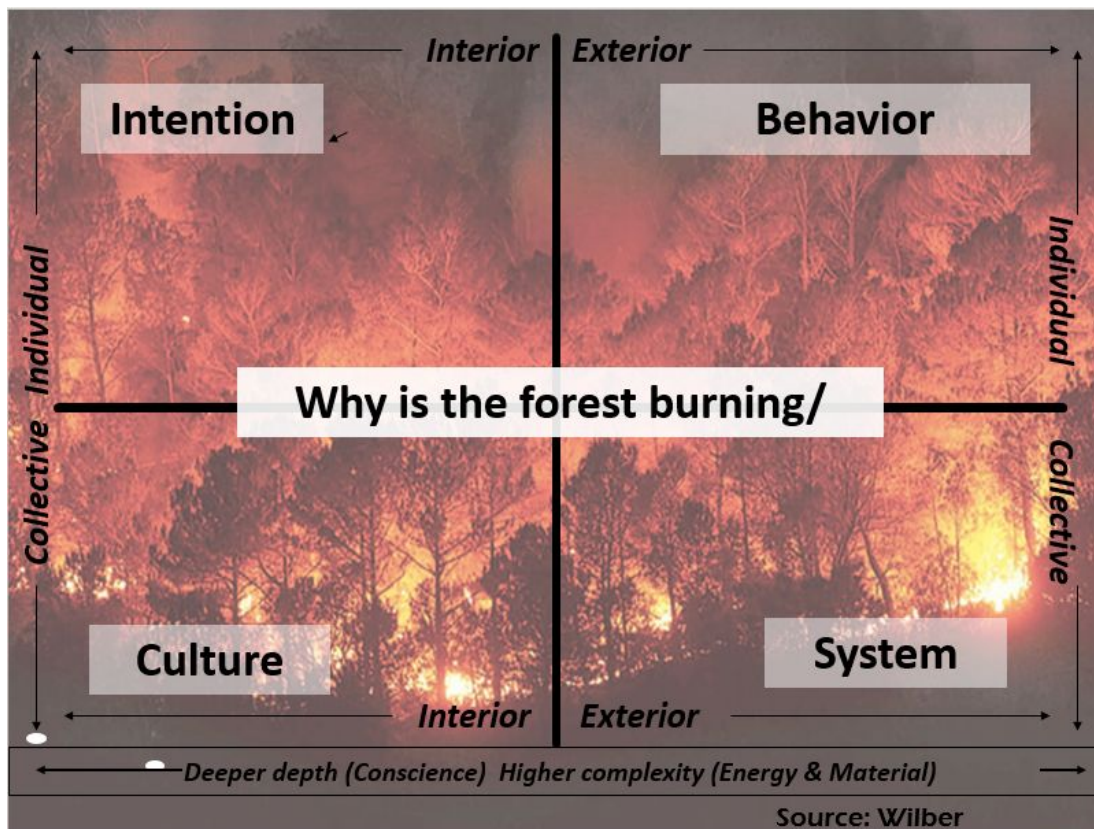# Appendix K: Four Quadrants of Change Framework



Figure 3 The Four Quadrants of Change Framework

The **Upper Right Quadrant** is the physical manifestation of the individual – our brains, physical bodies and behaviour as individuals and collectively come together in organisations – described using the objective 'it'.

The **Upper Left Quadrant** is the individual's interior, my sense of self, my consciousness, my way of making sense of the world – it is described using subjective 'I' language.

The **Lower Left Quadrant** is our culture and worldviews that inform how me make sense of the world, that provide the rules of the game – the collective and intersubjective 'we'.

The **Lower Right Quadrant** is the social systems and environment in which we and our organisations exist – described using the interobjective 'its'.