Supporting Leadership Development through Psychologically Safe Experiential Learning

A Grounded Theory on Engineering Education

E.J. Ritchie

Nov 30, 2020

ENGINEERS WITHOUT BORDERS USA

TU Delft

”Though this be madness, yet there is method in ’t.”

William Shakespeare’s *Hamlet*, 2.2

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by

E.J. Ritchie

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Preface

This research proposal represents the conclusion of my masters thesis in Construction Management and Engineering. The research was conducted in collaboration with Engineers Without Borders USA, a global development non profit organisation that conducts engineering infrastructure projects across the globe. The project counts as the final 32 ECTS towards my Masters of Science degree at TU Delft.

The goal of this paper is to share the graduation research conducted in the past 6 months. This research could not be conducted without the contributions and help of many people. I would like to thank my graduation committee for all of their insight and help up to this point. Yan, thank you for your constant guidance and recommendations. Bauke, thank you for pushing me to delve deeper into the problem. Neelke, I'm grateful to have a chair that can provide a unique and well rounded perspective. Everyone, thank you for your flexibility and help during these unusual times during the Covid-19 pandemic. I am humbled that so many people I have never met have taken time out of their busy days to contribute and coordinate across 3 countries and time zones to make this work possible. As well, I would like to thank Eric and everyone at Engineers Without Borders USA for allowing me to conduct research through the organisation and for their continued support.

This research could not have been completed without the support of many people. During these unprecedented times of Covid-19, I am humbled by all of those that supported me without ever having met me. Firstly, to my committee, I am extremely grateful to have found a committee dedicated to supporting me and helping guide the method behind the madness. Yan, your words of encouragement and wisdom helped me to keep perspective and maintain an eye on the goal. Bauke, thank you for continually pushing me to think critically, and always taking the time to give me feedback on my work. Neelke, your discerning eye always helped me to know where to focus the research. Eric, you took the time out of an already hectic year to make sure this research was a success, and I am appreciative of your feedback and all the interesting people at EWB-USA you put me in touch with. To all of the interviewees, thanks for taking time out of your busy schedules to contribute to this research, I really enjoyed hearing perspectives of many engineering professionals and students.

Of course, I wouldn't have made it without my personal support network. To my family, thanks for always believing in me and being patient while I navigated my thesis and a torn ACL. To my friends and colleagues at TU Delft, from all over the world you provided words of encouragement, and we helped each other persevere through these interesting times. To Courtney for listening and your input in the early stages. To Justine and Becca for being my rocks. To my new Vancouver family, it feels good to be home. And to countless others that have helped along the way. Lastly, I'd like to dedicate this work to my late grandmothers Audrey and Agnes, the strongest women I've known and greatest role models.

E.J. Ritchie
Vancouver, British Columbia, November 2020

Executive Summary

The vast majority of engineering projects deal with universal human needs including access to water, basic sanitation, civil works, and affordable and clean energy [1]. Being intricately involved in the design of these projects, and considering burgeoning population growth paired with resource constraints, engineers are in a unique role to provide leadership for positive societal change. This is echoed within universities and accreditation boards increasing incorporation of leadership development into missions and accreditation criteria [19] [14].

However, interviews of students and educators indicated that there is a gap between the ambitions of universities in developing engineering leadership and the reality that the development opportunities are perceived to be lacking or ineffective. The result is that engineers have typically developed their leadership capabilities on the job [24].

The notion of engineering leadership itself is complex, with many differing perspectives on it both within literature and the engineering population. This paired with resource limitations and curricula trade offs from universities can make it difficult for them to support engineering leadership development. A promising teaching methodology that could allow for both technical and leadership development, reducing curricula trade offs and resource requirements, is experiential learning.

Introduction

The objective of this research is to construct theory around how educational organisations, such as universities, can support engineering student's leadership development through experiential learning methods. The following research question guided the study:

Main Research Question: How can educational organisations support the process of student engineering leadership development in experiential learning contexts?

A set of sub questions was formulated that guide the research by exploring perceptions of engineering leadership, what aspects of experiential learning are felt to be most conducive to leadership development, and what prevents educational organisations from supporting experiential leadership development. Constructivist Grounded Theory research methodology is used. Grounded Theory (GT) is an inductive approach, aiming to create theory, rather than prove or refine existing theory. It was chosen since there is no clear pre-existing theory on engineering student leadership development. It also allowed for input from multiple perspectives whilst ensuring the approach centred the problem from the perspective of those living the process in study. The research result is a theory that aims to conceptualise what aspects of experiential learning educational organisations can influence to support leadership development.

The experiential learning contexts explored are Project Based Learning (PBL), Project Based Service Learning (PBSL), and internships. In PBL, students work on an engineering project in teams, applying technical knowledge to an engineering problem to design a solution. PBSL is similar, except the projects are conducted in concert with communities and the outcome is an engineering design that tackles a community problem. In interships, students participate individually in career related work experience, usually in a company setting and working on real world projects.

This research defined engineering leadership based on the perceptions of engineering students rather than on previous literature. The research was conducted through the organisations TU Delft and Engineers Without Borders USA. Both organisations prioritise developing engineering leadership in their mission statements and offer experiential learning methods that can help development. The organisations are governed quite differently. TU Delft is a large, publicly funded research university. EWB-USA is a non profit, volunteer driven network style organisation.

Research Design

The research design followed a framework for novice GT researchers from Chun Tie et al (2019) [12]. The primary components of GT include data sampling, memoing, coding, constant comparative analysis, and theoretical sensitivity. Data sampling in GT involves a broad initial data set, the purposive sample, in which the research question is explored in a broad sense using multiple data inputs. After the researcher familiarizes themselves with the problem field, they move to theoretical sampling, with a goal of following themes of interest to construct and refine the theory. Memos were compiled throughout the study, whereby the researcher documented their thoughts and development of the theory. The interview data was coded and analysed in AtlasTI 8. Coding proceeded iteratively from open ended coding, to initial coding, intermediate, and finally theoretical coding where the core category emerged that became central to the grounded theory. Constant comparative analysis is an analytical process specific to GT where the data analysis and collection occur simultaneously, as codes, categories and themes are constantly compared to one another as the theory is constructed and refined. The theoretical sensitivity of the researcher considers how a researcher knows they have identified a data segment that is relevant to the GT. It was honed through constantly reading literature, coding progression, memoing, and constant discussion and feedback with the graduation committee who were more experienced in GT.

The data inputs included 13 bachelors and masters level students that had experience in experiential learning contexts, 10 within formal leadership experience within EWB-USA's International Community Program, and 3 with informal leadership experience in a variety of TU Delfts experiential learning opportunities. These students provided the perspective of those experiencing the leadership development process and contributed to understanding what aspects of experiential learning were conducive to leadership development. To provide a balanced perspective, 4 TU Delft and 1 external educator, and 5 members of the EWB-USA staff were interviewed to explore their observations of student leadership development and also difficulties they faced in supporting leadership development through experiential methods. Finally, 2 professional engineers and members of industry with more than 20 years of experience each were interviewed. These further balanced the research by exploring contrasting views on the how engineering leadership is developed outside of experiential learning settings and where the capabilities to support development should lie.

Results

The research consisted of 4 phases. The first phase involved 9 semi-structured interviews and a data set provided by the EWB-USA organisation that helped orient the researcher in the organisational context. It confirmed that both students and the other stakeholders sampled believed leadership was best developed through experience. The remaining 3 phases were conducted through theoretical sampling, with 16 additional interviews and a focus group consisting of 10 members of the EWB-USA organisation. Phase two focused on EWB-USA student samples and explored aspects of the PBSL method that they perceived supported their leadership development. Students perceived the PBSL method more effectively supported leadership development than PBL and Internship methods. Phase three saw data saturation in both students and educators, and the emergence of the core category.

At the intermediate coding level, themes around Subquestion 2 developed relating to perceived factors that support leadership development. The factors pertained to either individual factors, or contextual factors specific to the experiential learning situation. The factors on the individual side were systems thinking, self-efficacy, and reflection. The factors on the experiential context side that respondents felt most affected leadership development were organisational, project, and mentors. Concurrently, themes around Subquestion 3 developed relating to barriers to support experiential leadership development. Barriers were felt by both educators and students, and often manifested from educational organisation system level barriers, highlighting the complexity of the problem field. Barriers faced by educators related to resources, getting student buy in, navigating organisational complexity, adapting grading mechanisms to experiential methods, supporting students based on their development level, and that some educators did not perceive there was value in leadership development in university settings. Students faced barriers in that leadership development was often an unintentional consequence of taking experiential methods for other reasons, in hesitation to elect to try formal experiential methods, and in finding and setting up experiential courses for them to take. By phase three, these

intermediate codes had become saturated and the emergence of the core category of psychological safety emerged.

Throughout the research phases, respondents repeatedly emphasized that in experiential contexts, they felt more supported in their leadership development when they were in a safe learning environment where they felt safe to fail and openly communicate with team members. This core category emerged both in relation to the developmental factors, and some of the barriers for supporting experiential learning methods. The theoretical sensitivity of the researcher allowed for the core category to be labelled psychological safety.

Grounded Theory

Leadership development was approached using a Relational Systems Development (RDS) lens. In RDS, development is viewed as a process-relational phenomenon where individuals and contexts interact to co-develop. Aspects of both individuals and the context should be considered to understand the development process. The context could be viewed on a group level among team mates, all the way up to a societal level with the community they are conducting projects in. The Grounded Theory is that the process of engineering student leadership development can be supported in psychologically safe experiential learning environments. Where:

> "Psychological Safety is a shared belief amongst individuals as to whether it is safe to engage in interpersonal risk-taking in the workplace [42] [20] ."

A model was developed with the aim of conceptualising the theory by showing the development process through an RDS lens that incorporated the main perceived factors and barriers in development. If organisations can incorporate the factors for leadership development, so that they contribute to psychological safety in the experiential context, they can support engineering leadership development. The conceptual model is shown in Figure 1:

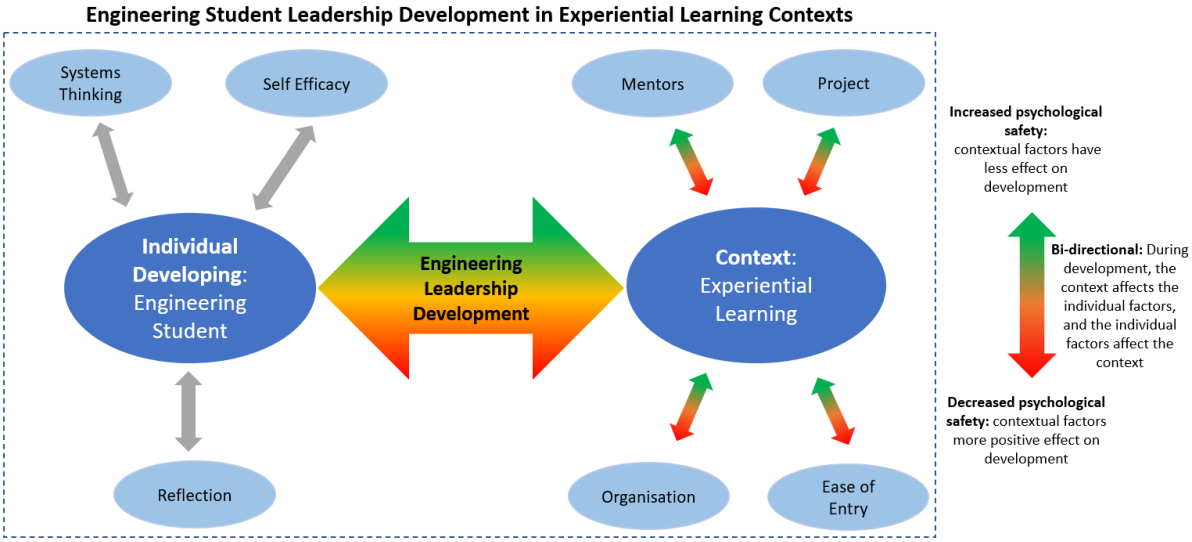

Figure 1: Theoretical Model: Supporting Engineering Leadership Development through Experiential Learning

The model includes bi-directional arrows between all the factors to indicate that Relational Development Systems is applied; there are no passive actors or factors in the development process. Where psychological safety was related to the development factors, the arrows are shown as multicoloured. This indicates that organisations can influence these factors to improve psychological safety, which would result in them more positively supporting an environment conducive to leadership development. The notion is that the presence of the factors that influenced leadership development is not enough, they should also be provided or structured in a way that contributes to a psychological safe environment. The intended use of the model is for organisations to use it to evaluate their experiential learning methods

and spur conversation around how they incorporate the development factors in a way that promotes psychological safety, or not, in order to support leadership development. If they establish a base case, and colour the arrows based on this, they can show where they have the most room for improvement. The arrows relating to the individual are internal and thus aren't affected by psychological safety.

A mapping of the theory to two notable pieces of literature helped to reinforce the validity of the theory and the use of GT as a methodology to study leadership. As the final phase of the research, a focus group was held with members of the EWB-USA headquarters. In the focus group, the grounded theory model was shared, as well as an example of application through rating the different aspects of their experiential learning program. Based on these ratings, a set of recommendations. Outcomes of the focus group allowed the model to be further refined and highlighted areas to make clearer when presenting the research. Overall the focus group confirmed that they agreed with the model and found it to be a useful tool to discuss how they can support students.

Application of theory to TU Delft and Discussion

The grounded theory model was used to rate TU Delft experiential methods based on inputs from students and educators. This was done to show how the model could be applied in different situations and at different levels, from individual experiential courses, to groups of courses, to entire organisations. This application could be improved with input from more sources, but provides a basis for the recommendations that are made in the conclusion.

The role of universities in supporting leadership development was discussed using Bietsa's 3 domains of the purpose of education – namely qualification, socialisation, and subjectification [4]. Qualification relates to knowledge transfer, socialisation to individuals developing their value set, and subjectification to the impact of education of individuals identity as critical thinkers and responsible societal agents as opposed to objects of the actions of others [4]. Leadership development is more closely tied in with socialisation and subjectification, which are not as easily conducted using traditional lecture methods. Both literature and the data collected from students and educators indicated that some perceive that universities have focused on technical engineering knowledge transfer, or qualification, to the detriment of socialisation and subjectification. As a result the historic focus of universities on qualification can help explain why leadership development has not been an explicit focus of universities until recently.

Some of the unexpected and interesting results of the study related to the benefit of service learning over other experiential methods, reflection, and incorporation of formal leadership training into experiential methods. The value of service learning was that it exposed students to more diverse stakeholders and real world projects that provided a stronger sense of purpose than other experiential methods. While reflection was found to be an important aspect of individuals leadership development, it was less clear what form this reflection should occur in. It couldn't be determined whether there is an advantage of outwardly explicit reflection such as journaling over implicit reflection such as thinking back on events and considering what one would improve the next time. Finally, the value of formal leadership training that would share leadership theory with students was difficult to construe. Educators mentioned it in using blended learning methods such as workshops, and some students that had taken formal courses believed it helped their development, however the majority of respondents had not experienced it yet were still able to develop in experiential contexts. Taken together, these unexpected and sometimes paradoxical results are recommended for further research.

Generational, researcher, and educator perspectives played a role in shaping the research, and the use of the Relational Development Systems meta-theory to view leadership development as part of human development all shape the research data collection, data, and resultant theory. The GT approach proved to be effective in exploring the problem of student engineering leadership development without trying to constrain its complexity. While CGT theory is constructed by the individual researcher, and is influenced by their perspective, use of literature throughout and focus group validation helped to confirm broader application and acceptance of the grounded theory presented in this research.

Conclusion

This research contributes to the scientific field in the research areas of leadership, Relational Systems Development, experiential learning, psychological safety, and grounded theory. Recommendations for further research include exploring curricular vs extra-curricular development, leadership development factors in detail, broader applications of the grounded theory in different, and the mechanisms of how psychological safety influences leadership development.

In conclusion, organisations can support the process of student engineering leadership development by promoting experiential learning contexts that optimise the development factors with psychological safety as a key facilitator. The development factors included the ease of entry into the context, mentors, the project, and the organisation. Individual factors also affected development, including systems thinking, self-efficacy, and reflection, however it is more difficult for organisations to influence these aspects. Educational organisations should remain cognisant that aspects of leadership development relate to the individual so they cannot implement one size fits all solution. The conceptualised leadership development model can be a useful tool as a starting point for discussion on supporting student engineering leadership development.

Responses from engineering students and educators confirm that engineering leadership development is rarely explicitly strived for within experiential contexts. However, they also felt that this context was effective for leadership development, and a set of supporting factors and barriers affecting the context were collected from survey responses. In this way, the research shows how organisations can support leadership development using experiential learning, even without having it as a targeted goal. This environment can be made more supportive if done in a way that helps individuals feel psychologically safe to take the interpersonal risks associated with experiencing and developing leadership.

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Abbreviations

CGT Constructivist Grounded Theory.

DST Developmental Systems Theory.

EWB-USA Engineers Without Borders USA.

GT Grounded Theory.

HQ Headquarters.

ICP International Community Program.

JIP Joint Interdisciplinary Project.

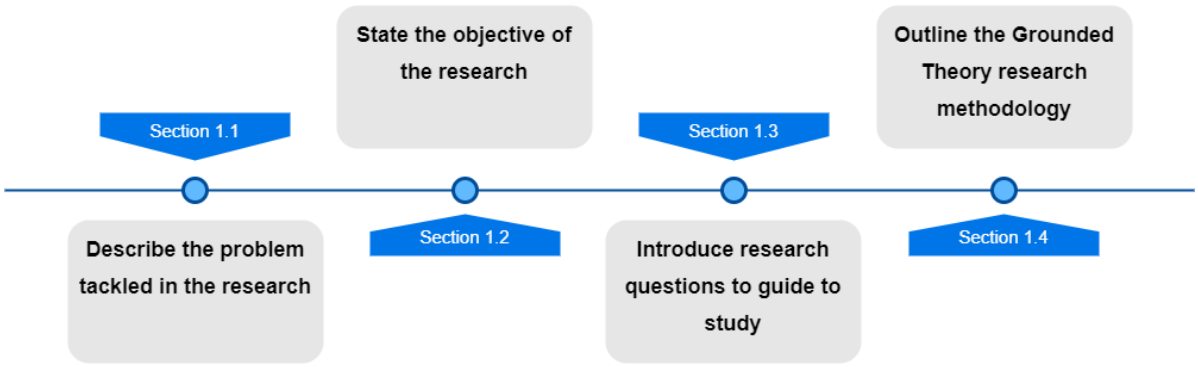
MDP Multidisciplinary Project.

PBL Project Based Learning.

PBSL Project Based Service Learning.

RDS Relational Development Systems.

1 Introduction



By 2030 the worlds population is expected to grow to 8.5 billion, with the 47 least developed countries among the fastest growing and expected to double in population by 2050 [41]. This will put additional strain on countries already struggling with access to water, basic sanitation, civil works, and affordable energy. The vast majority of engineering projects worldwide deal with these everyday, universal human issues, rather than highly technically complex issues [1].

As professionals that design vital infrastructures, buildings, and technology for society, engineers are in a position to contribute to positive societal change by providing engineering leadership. There is an increasing call to develop engineering leadership within university settings, as echoed in the mission statements of technical universities such as TU Delft, and in engineering accreditation requirements.

Leadership is named by ABET, the US Accreditation board, as one of the key life-long learning capabilities that universities should support development of. Criterion 3.5 of the 2020 ABET Criteria for Accrediting Engineering Programs states that engineering programs must support students in developing ”an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives” [14].

This ambition is echoed in The Netherlands. Part of TU Delft’s Mission is to “develop and enhance the expertise of tomorrow’s engineering leaders and educate professional, high-level and responsible engineers throughout their careers” [19]. TU Delft envisages that future generations of engineers should go beyond designing for safety and cost effectiveness and incorporate environmental and social responsibility into their work.

This research will explore the area of engineering leadership development through experiential learning from the perspective of engineering students and educators. Throughout this report, quotes will be shared that were collected from a set of interviews with engineering students, educators, and other involved stakeholders to share their perceptions on the topic. These will be used in parallel with findings from literature to give a more holistic overview of the topic. Through this, the research strives to explore and describe the process of engineering leadership development in students. Understanding this process can better delineate how educational organisations, such as universities, can support engineering leadership development.

1.1. Problem Statement

There is a gap between the ambitions of universities and accreditation boards to support leadership development in students and the perceptions from students and educators on the reality surrounding the quality and quantity of leadership development opportunities. Currently, many educators and students perceive that there is a lack of leadership development opportunities within engineering education. This was described by an engineering educator that had spent time in industry before returning to a university to implement a course focusing on leadership development:

> "What I see happens in our education in general is that we focus and go deeper into learning the engineering or our own expertise. Then we finish our study and go work for a company, and then we are confronted with situations where we have to work in teams, and the majority of us have never done so. Then we are growing in our career and we become team leaders or managers. we simply don't learn leadership because we are busy with our technical study"

Typically, engineers have developed leadership on the job due to a lack of developmental experiences in their engineering education [24]. The result is that many currently feel that the duty for engineering leadership development lies with industry. A former executive vice president of one of the largest Engineering, Procurement, and Construction companies in the US, said of their perception on the responsibility of industry to develop engineers as leaders:

> "The engineering companies themselves took on all of that responsibility. They would take the 4 year student and really what you convinced yourself of corporately was "this person went to college and got an engineering degree, it's hard, so these people are smart and they endured something that was hard" but all you really get out of them is that you learned, or begin to understand that, in college they learned how to learn. … So at the end of the day a college student joining an engineering and construction company quite frankly it's assumed that they don't actually know anything other than that they know how to learn. So the companies take on the real responsibility of "hey we think this person would be a good leader, lets give them leadership training" ... That all is taking place in the corporate environment."

However, by leaving engineering leadership development primarily in the hands of industry, it also a lot of power and responsibility in their hands. The values of these organisations may be profit driven or not match the needs and values of society at large; it may lead to developing engineering leaders that do not share broader societal values. It also places a lot of responsibility on individual employers. For instance, many middle and senior level engineering managers are too busy to mentor younger engineers [24]. In this case, young professional engineers would not get as much support to develop their leadership. While it could be effective, it might also lead to engineers developing leadership ethos not in line with the socially responsible leadership envisioned by universities.

Based on the perceptions shared above, there is a gap between universities ambitions to develop engineering leadership and the reality that most leadership development is perceived to occur later in engineers careers in professional settings. Broadly, this gap can be explained by the complexity of leadership development, by a lack of resources in universities, by the trade offs required to incorporate leadership development into curricula, and by convoluted university systems.

Tackling the problem of leadership development in engineering cannot be done without acknowledging the complexity of leadership and leadership development therein. Leadership is a complex and constantly evolving phenomena, requiring constant exploration; we will likely never converge on a single general theory of leadership [15]. Leadership can be viewed from a multitude of perspectives; its study has roots in the social sciences, the humanities, and the applied sciences such as management and education [48]. From a development standpoint, leadership and leadership development are difficult to measure, and educational designers have historically focused on educational offerings where the learning outcomes are clear. Engineering leadership is sometimes considered to be even more complex than in other industries since it must also incorporate technological aspects, as such there have been calls for more research into how to cultivate engineering leadership at all levels of leadership [24]

Curricula considerations come into play as well. Engineering graduates face a large set of technical requirements to meet to qualify them to be professional engineers [14]. Engineering programs are known to be demanding with little room for additional courses. A significant change to the current curriculum to incorporate more leadership development would likely require a trade off between technical and professional capabilities. Additionally, while accreditation boards set requirements for graduates, they fall short of providing recommendations on how universities can support students in meeting these requirements.

As with any change, resources are required. Educators and universities are trying to accommodate larger student cohorts with limited resources [27]. Another complication lies in the way the current education systems is set up, where research is often perceived to a primary driver. Educators describe feeling under pressure to focus on research. When it comes to teaching, the university requires them to create courses with clear grading methods, which is difficult to do for non-technical skills. An educator touches on this:

> The way universities and research is funded, there is still a large focus on academics to focus on research to bring in money, and to publish papers. So teaching has always been less acknowledged. This is definitely changing, there's not more opportunities to focus on teaching. But its really hard to get recognition for teaching these soft skills. With teaching you have to make things measurable, or hard things easier to measure … But a lot of softer skills are more embedded within subjects rather than a separate subject

Rather than adding leadership development through separate courses, it would be beneficial to explore teaching methods that can support engineering students in leadership development whilst also developing application of their technical skills, thus limiting the trade off associated curricula change. One area that scholars point to improve leadership development in university is the use of experiential learning opportunities like internships, project-based learning, and service-learning [29] [28] [39]. In experiential learning, students develop by applying their technical knowledge to solve engineering problems, typically in the form of projects within their education. In fact, engineering students perceived that 62% of what they learned about professional skills, such as leadership, came through experiential learning experiences as opposed to from within traditional classrooms [9].

Experiential learning is effective because it can emulate the richness of real world problem solving. A student participating in a multi-disciplinary real-world project at TU Delft explained some of this richness and the value of experiential learning:

> "There are much more roads to explore than in a class. … when you're given an assignment it's nicely summarized and you can get a lot out of the text, or it tells you the stakeholders and you can find it on the internet. But in a real project, finding exactly what a stakeholder wants, and how to incorporate that into the project, is different."

Experiential learning could aid leadership development, however developing these courses are also resource intensive, and many educators are already spread thin between their own research, teaching, and supervising graduate students [18] [46]. The result is that its uptake is relatively slow, and generally offered to students as elective and not required courses. In order to bridge the gap between universities ambitions to help develop engineering leadership, it would be beneficial to research how educational organisations can support engineering leadership development through experiential learning.

1.2. Objective

The objective of this research is to construct theory around how educational organisations can support engineering students developing leadership through experiential learning methods in their early education and career. This theory will be devised with the goal of providing organisations to influence the experiential contexts ways to support leadership development in engineering students. Since there is limited literature and theory surrounding this topic already, a qualitative grounded theory approach will be

used. The theory will be constructed based on the inputs from students that have experience in experiential learning contexts in the educational organisations TU Delft and Engineers Without Borders USA. From this, a set of recommendations will be made for universities and teaching organisations. These recommendations will be made realistic by exploring the difficulties educators face in designing and implementing experiential methods. If the research meets these objectives, it will contribute to solving the problem outlined.

1.3. Research Questions

In most research, the research question directs how the study will proceed. As presented is Section 1.4, this research will use a Grounded Theory methodology, which approaches research questions differently to the typical scientific deductive method. Birk and Mills (2015) recommend stating broad research questions and in a way that reflects a problem centered perspective of those experiencing or living the phenomenon the be studied. Given this, and the objectives presented in Section 1.2, the main research question is formulated as:

Main Research Question: How can educational organisations support the process of student engineering leadership development in experiential learning contexts?

The overall research question is broad, both in line with Grounded Theory principles and in consideration of the complexity of the problem. It purposely uses open verbs such as “support” in order to highlight that educational organisations are not solely responsible for addressing the problem, and acknowledge that there are multiple ways to support leadership development. Three sub questions help further break down the overarching question into manageable sections that will be addressed in order to unravel the problem and develop the grounded theory. The first sub question is:

Sub Question 1: How do engineering students perceive engineering leadership?

The first sub question aims to establish how engineering students perceive engineering leadership. This is an important starting point and will establish the basis for the rest of the research. Unlike the other two research subquestions, which will include data from groups other than engineering students, this one is answered solely by current engineering students. This is done in order to keep the results of the research oriented to those experiencing the developmental process so that the outcomes benefit them, the research aims to study the topic from their perspective. It can also help educational organisations determine if their perceptions of engineering leadership are in line with how it is perceived from those actually experiencing the developmental process. After this basis is set, the second sub question is:

Sub Question 2: How do students that have been involved in experiential learning contexts perceive leadership development is supported?

This sub question is tackled by exploring the topic with students in leadership roles in experiential contexts. By focusing on in leadership roles, an important assumption underlying this research is applied. The assumption is that by being democratically elected by equal status peers to a role, the engineering students are perceived to have developed their leadership capabilities, or have shown their ability to develop those capabilities, to an extent that warrants them capable of fulfilling that role. Rather than trying to measure their leadership, this study instead assumes they have developed to a sufficient extent for the role. Since they are in the midst of the process of engineering leadership development, they are closer to the problem, and can provide invaluable insight into what helped them get to that position and what continues to help them develop. The sub question will be farther strengthened based on input from stakeholders in the experiential contexts that have observed these students leadership development.

Sub Question 3: What prevents educational organisations from supporting leadership development opportunities through experiential learning?

The ultimate objective is to be able to provide recommendations to educational organisations, be it formal educational organisations like universities, or informal organisations like non-profits or industry that also play a role. However, understanding the problem from the perspective of those in it, engineering students, as explored in sub questions 1 and 2, is not enough. Any recommendations will not be feasible unless efforts are also made to explore what challenges organisations face when making changes to support students. This question will be answered with the input from educators that are involved in developing or offering experiential opportunities and by students that have experienced these courses. Taken together, the three sub questions will help to answer the main research question.

1.4. Methodology: Grounded Theory

Grounded Theory is a qualitative methodology. The main characteristics of the qualitative methodology include a belief in multiple realities, a commitment to participants viewpoints, researching in a way that minimally disrupts the natural context of the phenomenon, and reporting the findings in a literary style rich in participant commentaries [55]. Qualitative approaches seek to understand a particular process, leadership in this case, through the perspectives of those experiencing it. Leadership is a contextually rich and complex social process, lending itself to qualitative research, even though earlier research focused on quantitative methodologies [15]. Ultimately, the goal is to gain insights and understand people's perception of the world, making a constructivist and qualitative approach most applicable [25].

Grounded Theory in general is used with the aim of constructing explanatory theory to uncover social processes in a substantive area of inquiry [12][5]. More specifically, it aims to explicate a process from the perspective and context of those who experience it, in this case engineering students [5]. Birks and Mills (2015) outline process as an 'ongoing action/interaction/emotion taken in response to situations, or problems' and note that it shouldn't be limited to conceptions of time, phases, or stages but instead occurs in all aspects of the natural, dynamic nature of life. This considered, we will specify the social process in question as: the process of engineers developing the capabilities to lead engineering projects and teams throughout their education and early careers.

Grounded theory represents a method of inquiry and also a product of that inquiry [12]. It allows the researcher to be fully immersed in the data and see patterns as they arise. More specifically, the methodology is Constructivist Grounded Theory, developed by Charmaz [11]. The following list clarifies key components and philosophical underpinnings of Constructivist Grounded Theory, as adapted from Sebastian (2019):

1. **Role of researcher:** To construct, rather than discover theory
2. **Prior knowledge:** It is impossible to escape prior knowledge, instead the researcher must consider how this knowledge influences them and the research.
3. **Role of Literature:** The researcher can decide where literature will be incorporated into the research. Grounded theory often discourages extensive literature review before data collection and analysis since it can constrain theory building [5]. Literature can be used to enhance theoretical sensitivity, as data during analysis, or as a source of theoretical codes [5].
4. **Research Questions:** Are required initially, and influence how the data is collected. They may be adapted as the research progresses.
5. **Coding and Analysis:** Everything must be coded and grouped into categories subsequently.
6. **Theory Created:** Is an interpretation rather than an exact representation, since the theory is dependent on the researchers view.

Constructivist Grounded Theory was chosen over Classic Grounded Theory because it is more realistic in a shorter time frame, and it acknowledges that the researcher cannot remain neutral or escape prior knowledge (Sebastian, 2019). Classic Grounded theory requires both theory generation and verification which must be done in a quantitative way, this would take too much time. As an engineering student, the researcher did not feel that they were distant enough from the context to remain neutral and have no knowledge in the subject. To overcome this, the next chapter will examine the researcher's perspective and be transparent throughout the report how this might influence the research.

Considered alternatives included ethnographic research and longitudinal research. Ethnographic studies see the researcher become part of the group under study so that they can observe behaviour in situ in [25]. Its advantage is that real-time, in person observation gives the researcher more insight into the context and interpersonal dynamics at play. Longitudinal research observes phenomena in the same individuals over longer time frames, it is effective in understanding change and development

[25]. The reason for not conducting this research in an ethnographic or longitudinal way is due to the time frame limit of this 8-month masters thesis project.

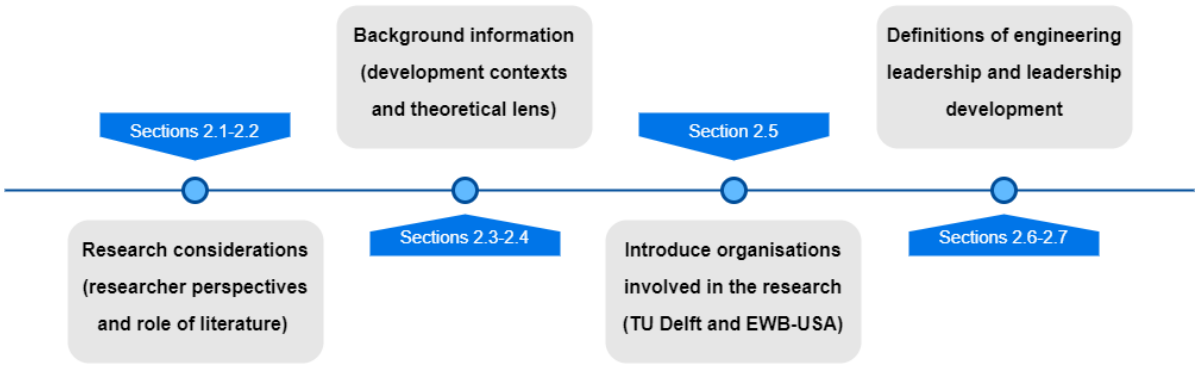
In Chapter 3, a research design framework is presented and the methods used are described in more detail as it will be used in this research. While this method of qualitative research can lead to extremely rich data, it also leads to a lot of data. To aid with tracking, coding, memoing, and analysis, the software AtlasTI was used as a data storage and analytical tool.

1.5. Thesis Outline

The thesis will be structured in 8 chapters, as outline in Figure 1.1

Figure 1.1: Outline of the Thesis Report

2
Research Framing



In constructivist grounded theory research, it is accepted that one cannot escape prior knowledge [51]. The goal of this chapter is to frame the research by being explicit in this prior knowledge, by outlining research considerations, some background information, an introduction to the organisations involved. This chapter also frames the research by providing and provide a definition of engineering leadership and leadership development that will form the basis of the research going forward.

The perspective of the researcher is shared with the goal of highlighting how philosophical viewpoints and biases could influence the study. The use of literature in this study will be done in line with CGT practise to incorporate literature throughout the paper as the researcher sees fit. In this case, literature is incorporated throughout the paper in order to provide background information, to support the grounded theory and help refine it in a more timely manner given the time constraints of an 8 months masters thesis. Literature is incorporated in this section to provide background information on the research context, notably around experiential learning methods and the leadership development perspective of Relational Development Systems.

The research is conducted based on data collected through semi-structured interviews with stakeholders in the TU Delft and Engineers Without Borders USA organisations. These organisations will be introduced, as well as how their goals could influence the research. Finally, definitions for engineering engineering leadership and leadership development are provided, mostly based on input of perceptions from 13 engineer students interviewed in this study. The reason for doing this is to provide a clear basis on the research topic that takes a problem centered perspective of the individuals most affected by the problem. Finally, Relational Development Systems is introduced as a lens for leadership development that will become relevant in later parts of this research.

2.1. Research Considerations: Researcher Perspective

Grounded theory requires the researcher to balance keeping an open mind to allow theory to develop on one hand, and using their own experience and knowledge to be able to recognised theoretically sensitive data [5]. This is no easy feat, and Birk and Mills (2015) recommend that the researcher state their position and assumptions early on the maintain transparency [5]. Notably, the philosophical position, expectations of research outcomes, and concerns around the study.

The research is approached with a constructivism philosophical perspective on education. The basic premise of constructivist theory is that teachers can't simply give students knowledge, rather, the students must construct it in their own minds [53]. Constructivism is a theory that views learners as personally constructing their own knowledge and meaning through experience, and that meaning is always influenced by interaction of previous knowledge and new events. Students obtain knowledge by filtering new experiences and knowledge through their past experiences to construct new meaning [33].

Most notably, this is in line with the researcher's belief that individual students are primary agents in their own learning, they are not passive vessels to be filled with knowledge by educational organisations. It also the researcher's belief that this places some onus on those same institutions to provide educational opportunities in line with this philosophy. As such the educational methods focused on herein, experiential learning methods, are in line with constructivist principles, and other methods are left out of the study.

The researcher believes it's pertinent to highlight the lack of diversity in engineering and compounding effect this has on researching leadership education. For example, research on engineering education and engineering leadership primarily occurs in a western context, and when demographics were included in the papers, the students were predominantly male and of Caucasian ethnicity [59][58][45]. This research acknowledges that by sampling students in universities in the USA and the Netherlands, it does not consider intersectionality in any meaningful way, other than the researcher being a female in a male dominated field. However, attempts were made to keep an open mind, to be transparent throughout, and to create the grounded theory in a way that was not prescriptive or closed to diverse viewpoints.

2.2. Research Considerations: Literature Use in Grounded Theory

As mentioned in Section 1.4, the use of literature in Constructivist GT is up to the researcher, although extensive literature review is discouraged since it can constrain theory building (Birks and Mills, 2015). Literature is incorporated throughout this research paper in different ways.

Where literature is used throughout this paper, the reason for it will be shared. In some cases, literature simply advanced the theoretical sensitivity of the researcher without being directly used in the research. For instance, maintaining a general awareness of topics around leadership, education methods, and development helped the researcher know when they had found relevant data, although not all of this literature is shared or directly adds to the story presented throughout this report. In other cases, literature provided the missing link to weave together the story arising from the data together with the state of the art in order to advance the grounded theory.

Literature was explored early in the research while the decision around the best methodology was still being determined. Early attempts to explore the problem context through literature highlighted a general lack in literature in the topic of engineering leadership development in experiential contexts. A preliminary literature review was also compiled around the topics of educational methods and philosophies, experiential learning and leadership. Some of this early review around experiential learning contexts and the lens chosen to view development in is incorporated into this Chapter where deemed to help frame the research. Other literature helped the researcher gain a broader awareness, around the problem field and the complexity of leadership, leadership development, and engineering education research. This literature was not all included in the final research paper, however it contributed to the researcher developing theoretical sensitivity around the topics explored within the study.

Literature is also incorporated into Chapter 5, where the conceptualisation of the grounded theory

is presented. Notably, in Section 5.4, the grounded theory constructed in this research is compared to 2 other notable theories on leadership development. This mapping allows a more holistic view of the outcomes of this research compared to other theories. It helps to reinforce aspects of the GT, as well as highlight areas where it could be improved in the future. Finally, some literature is incorporated into the discussion in order to further explore points of interest that arose during the research. Much of this helps to provide a different perspective or reinforce aspects of what was found. The result is that this research does not follow a traditional scientific deductive approach in including a literature review early on in the paper. Instead literature is incorporated throughout where it adds to the overall story line.

2.3. Background Information: Experiential Learning Development Context

The context for leadership development that is explored in this research relates to experiential learning. Experiential learning is the process of learning through experience. It is synonymous with active or action learning. The strength of active and experiential learning is that it triggers reflective learning, a theory that was popularized by Kolb [36]. By contrast, traditional, passive learning methods, especially lecture-based courses, have been found to lack the reflective part of the scientific process that helps make sense of and integrate disciplinary knowledge into real world engineering problems [16]. Previous studies into experiential learning have found that they help undergraduate students personal, interpersonal, civic, and professional development [52]. The experiential methods that were explored included internships, project-based learning methods, and project-based service-learning methods.

2.3.1. Internships

Internships involve students participating in career related work experience, outside of the university setting in real work settings [52]. Students are placed in a real-world context where they must apply their discipline related knowledge to real world problems. In some universities, academic credit can be awarded for internship experience, some even build it into the degree as part of a co-op program. In engineering, internships are typically conducted in industry settings with a company sponsor and the supervision of a company representative. They can range in time from 10 weeks to a full year. Students perceived that internship experiences enhanced their understanding of content knowledge, as well as their capacity to achieve their career goals [52]. The major strength of internships was found to be that it enhanced students' ability to integrate theory and practise [52].

2.3.2. Project Based Learning (PBL)

Project-based learning (PBL) is oriented on the application of knowledge [40]. Project-based learning is a student centered, constructivist, experiential learning approach [40]. During project-based learning, the students should have the pre-requisite technical knowledge, typically provided through more formal pedagogical means, and the learning outcome is instead focus on a final product [59]. Therefore, project-based learning has a final product that requires synthesis of technical knowledge and (soft) skills to create an artefact. PBL could be implemented within the university, or outwith it in a professional (internship like) or community (PBSL like) setting. Palmer and Hall (2011) [45] review of literature on project-based learning noted some ambiguity amongst scholars in what constitutes project-based learning in engineering. However, they noted some undisputed points that project-based learning incorporates [45]:

1. Teamwork
2. Solution of a problem or completion of a task within a project, where a number of educational activities drive learning
3. Multidisciplinary projects over an extended period of time
4. Projects that typically result in the development of a concrete artefact (design, model, simulation)
5. Teaching staff take mentorship roles; it is student, not teacher centric
6. Projects often culminate in written reports or oral presentations describing the project process

There is a multitude of research exploring the benefits and challenges in incorporating project-based learning into the curriculum. Project-based learning was found to increase student's motivation and engagement in working in teams on cooperative problem solving [40]. Australian Engineering Students perceived the positive aspects of project-based learning courses to include exposure to valuable teamwork and professional engineering work [45].

Longitudinal studies have started to bear results as well. Gratchev and Jeng (2018) collected data over 3 years of students in geotechnical engineering that were allowed to pick traditional or project-based learning methods in a soil mechanics course. Most students elected the traditional method, indicating a hesitation to try new and more unfamiliar methods of learning [30]. They found that while both groups of students had similar academic performance, the project-based learners reported increased engagement in the learning process [30].

2.3.3. Project Based Service Learning (PBSL)

Bielefeldt et al (2010) define project-based service-learning (PBSL) as an educational experience where students participate in organised service activities to meet community needs and reflect on the experience afterwards. These projects solve real world problems, problems that are not clearly defined and use minimal resources [17]. In PBSL the students and the communities are equal partners and involve full project design and planning prior to implementation. The volunteers learn not just from solving the problem, but through the process of working together as well. Longitudinal studies in service learning found that this experiential method improved students sense of societal responsibility (Astin and Sax, 1998, in [52]).

Research into the positive effects of PBSL on engineer's education has been somewhat holistic, focusing on the overarching benefits of it, without deeply delving into many particular topic. For example, it was found that in addition to integrating core technical engineering competencies in the projects, the students develop communication, critical thinking, teamwork, leadership, ethics, adaptability, project management skills, and global citizenship [52][3] [39] [17]. Engineering students perceived that 62% of what they learned about professional skills, such as leadership, came through their service learning experiences as opposed to from within the classroom [9].

Incorporating PBSL into construction management curricula takes a lot of preparation and effort by the educator, and shouldn't be done without evaluating the feasibility of potential projects [13]. Aspects that make it difficult to incorporate PBSL into curricula include the project timelines falling within the academic schedule, the complexity of projects, and ensuring the project has the right factors to enable learning [13]. These logistical concerns have contributed to a relatively slow uptake of PBSL in engineering education, but more proof on the types of capabilities learned through this educational method could help to incorporate it into universities [13].

2.4. Organisational Context: TU Delft and EWB-USA

The research was primarily conducted within the context of the organisations TU Delft and Engineers Without Borders USA. An overview of the two organisations is shown in Table A.1 in Appendix A. Both of these organisations were involved in engineering leadership development but in different ways. They have different purposes and motivations. Both organisations have it in their mission to develop socially responsible engineering leaders.

The differences lie largely in governance approaches, mainly due to organisational size and mission. The size of the TU Delft organisation is far larger than EWB-USA, this also results in a much more hierarchical and convoluted organisational structure. The organisations also differ in the autonomy they afford engineering students with regards to learning opportunities. As students, the TU Delft students must follow curriculum/ accreditation, although they have some freedom in electing courses. As volunteers, the EWB-USA students' participation is purely self-driven.

2.4.1. TU Delft

TU Delft is a public technological university located in Delft, The Netherlands. It has more than 24,000 bachelors and masters level students within 8 faculties [19]. There are close to 1000 faculty members and almost 3000 PhD students that are involved in both their own research and educating the bachelors and masters students. The university has 8 faculties, as well as 10 departments within the university corporate office. The 4 aspects of TU Delft mission relate to conducting research, developing socially responsible engineering professionals and leaders, developing technological innovations, and continual improvement through professionalism, collaboration, and openness.

2.4.2. Engineers Without Borders-USA

Engineers Without Borders USA is an autonomous non-governmental organisation focusing on global development. EWB-USA conducts water, access, and sanitation infrastructure projects in developing countries. EWB-USA is composed of student and professional chapters that take on projects, and a central project management and administrative body based in Denver, Colorado. In 2019, EWB-USA's 9500 volunteers ran 452 active projects in 39 countries from chapters based across the USA. EWB-USA's volunteers work with local community members to design and build projects, while equipping the community with the knowledge and skills to operate and maintain the systems for their lifespan.

EWB volunteers are mostly multidisciplinary engineering students, though they welcome non engineering students to bring in diverse skill sets and perspectives. In a single project, the United States based volunteers would all come from the same EWB-USA chapter, typically from the same university. There are also professional chapters in cities across the USA, who conduct their own projects but also help mentor the student chapters.

Half of EWB-USA's mission related to conducting engineering projects. The goal is that volunteer chapters are able to pair up with communities in developing nations to design and build small to medium scale infrastructure projects such as water distribution systems, bridges, and sanitation systems. In well established chapters, these community ties are often well developed; collaboration is a key part of the EWB-USA model.

The other half of EWB-USA's mission is to help develop the next generation of engineering leaders. The organisation supports leadership development in several ways. Firstly, they facilitate the chapters and communities project collaboration through their International Community Program. They also help facilitate mentorship for the student chapters. Mentorship from both professional chapters and in some cases academic staff at universities is also available to some student chapters, and this has been seen to be a major factor in the success of university chapters.

The leadership development context facilitated by the EWB-USA organisation that this research will focus on is the International Community Program (ICP). These projects tackle international engineering problems that are not addressed by in-country consulting firms due to funding or technical capability limitations. This ensures that they are not competing against local engineering groups, and that the technical engineering knowledge brought by the organisation can effectively be shared with the local communities in which they are working. An engineering design process is also provided that projects must follow, including the process steps and reporting requirements. This process is shown in Figure A.1 in Appendix A. This process also requires sign off on technical documents from professional engineers, which they have at headquarters and who work with the chapters to ensure the engineering design is sound.

2.4.3. Experiential Leadership Development Contexts

The focus of this research is on students that have experience in different experiential learning contexts, namely PBL, PBSL, and internships, as introduced in Section 2.3. TU Delft offers multiple experiential opportunities that could foster leadership development. Some of the leadership development opportunities considered included, JIP, MDP, Internship, and extra curricular involvement such as DREAM teams. This study will focus on the JIP, MDP, and Internship. EWB-USA offers experiential learning through their ICP. A description of these is given in Table 2.1. The engineering design process followed in the ICP is shown in Appendix A, Figure A.1.

Table 2.1: Summary of the experiential learning programs explored in this research

Program	Organisation	Experiential Method	Faculty	Description (from researcher memo's)
Joint Interdisciplinary Project (JIP)	TU Delft	Project Based Learning	Interfaculty, Masters level	Students work in interdisciplinary (with TU Delft) teams with an industry sponsor to work on a real world engineering problem. Groups are 4-6 students and the program lasts one quarter (12 weeks).
Multidisciplinary Program (MDP)	TU Delft	Project Based Learning	Civil, masters level	Part of the masters faculty, in the MDP students work in interdisciplinary (within faculty) teams to work on real world engineering problems. Typically, the MDP projects are conducted in international settings. However due to Covid most of the projects in 2020 were conducted in country.Groups are 4-6 students and the program lasts one quarter (12 weeks).
Internship	TU Delft	Project Based Learning	All faculties, bachelors and masters level	Students work within a company to gain real world work experience. In TU Delft, internaships can be anywhere from 1 week - 1 year long.
International Community Program (EWB-USA)	EWB-USA	Project Based Service Learning	Extra Curricular	Students join their universities EWB-USA Chapter, which are usually 50-100 bachelors level students. Students work on international service projects that work towards designing and constructing engineering solutions for communities in developing countries. The projects can last up to 5 years, and students are often part of their EWB chapter for the duration of their bachelors.

2.5. Definitions: Engineering Leadership

In line with research sub question 1, engineering leadership is defined first with minimal input from literature and instead based on the perspectives of 13 engineering students interview respondents. This is done purposely since the goal is to develop an understanding of the process of early stage engineering leadership development from the perspective of those experiencing it. The criteria for selecting these students is outlined in Appendix B, Section B.0.1. Based on the students amount of time in leadership roles in experiential contexts, their leadership experience levels were noted as low (<1 year), medium (1-2 years), high (>2 years). This allowed for comparing the perceptions to see if they changed with increasing exposure to leadership. A list of the 13 student interviewees is shown in Table B.1 in Appendix B. To explore their views on engineering leadership, respondents were simply asked what they believed engineering leadership was.

Based on the analysis of the perceptions of engineering professionals and students, engineering leadership encompasses, among others:

- A role that members may take on in a team:
  - Sometimes formally appointed roles
  - Sometimes informally, or ad hoc as the situation requires
  - This role can be shared with others (shared leadership)
- A capability that:
  - needs to be grounded in technical engineering capability
  - is often explained in terms of individuals having other professional capabilities, such as communication skills, adaptability, and humility
- An individual that:
  - empowers others
  - helps guide others to develop themselves
  - motivates others towards a common goal
- An abstract concept:
  - That considers engineers responsibility to society
  - That engineer's perception on evolves over time
  - This perception was only present in more experienced students. Less experienced students tended to focus on leadership as management

Notably, leadership was described as a role, a concept, and an individual possessing certain capabilities, sometimes by the same individual within the same sentence. Quite often respondents had to take a pause to think about what engineering leadership meant to them. Others expressed that it was a hard question. This could indicate the engineers are not socialised to consider the role of engineers as leaders. This further reinforces the complexity inherent in studying engineering leadership, and the difficulty in differentiating leadership from leaders.

2.5.1. Comparison of Perceptions to Literature

Literature on leadership was consulted in order to compare the perceptions of engineering leadership provided by student respondents to various definitions and theories. By comparing the literature to the student perceptions, it became possible see if there were any notable trends in how the students perceived leadership, and whether a theory could be applied to their viewpoints going forward.

Broadly speaking, literature on leadership theory can be split into two paradigms, managerial and process leadership. Some of the key takeaways from these two paradigms are shared in Table 2.2.

Table 2.2: An overview of managerial and processed focused leadership paradigms

Attribute	Management focused leadership	Process focused leadership
Definition	”Management is an authority relationship between at least one manager and one subordinate who coordinate their activities to produce and sell particular goods and/or services”. [48]	”Leadership is an influence relationship among leaders and followers who intend real changes that reflect their mutual purposes” [48]
Notable aspects	Leaders can be born and often have specific traits, but they can also develop skills and behaviours to improve their leadership. Effective leadership requires capable individuals.	Leadership is process, hinging on relationships amongst interdependent people. Effective leadership requires effective relationships.
Main research methods	Quantitative, based on military and political leaders	Qualitative, based on viewing leadership as a social process
Years dominant	1850 - 1970	1970 - present
Notable theories	Great Man Theory (1850) , Trait Based Leadership (1900), Behavioural (1950), Contingency (1960)	Transformational (1978), Servant (1977), Followership (1992), Relational (2000), non western and others
Issues	Ethical dilemmas, effective leaders are not always moral (Ex: Napolean). Inconsistent research results. Studied almost exclusively male leaders [2].	More complex to understand and constrain, unlikely a general theory will ever emerge [15]
Common Governance structures	Hierarchical, command and control	Network, relationship focused
Relevant Sources	[35], [2], [6]	[48] [38] [7] [31], [54]

In comparing the students of leadership with literature, two views of leadership were held. Some students viewed leadership in a hierarchical or management way, they referred to delegating tasks to team members and guiding them towards a goal. Others viewed it in a process way, mostly aligned with process, and more notably, relational leadership theory.

Komives (2006) describes relational leadership as “a relational and ethical process of people together attempting to accomplish positive change”. [38]. In relational leadership theory, the key component of research is relationships, not individuals [54].

The students with low level of leadership experience, except for those that held shared leadership roles, viewed leadership from a managerial perspective. The students with medium levels of experience were split, 2 viewed it as management and 3 viewed it relationally. All of the students with high levels of experience viewed it from a relational perspective. The change in perceptions was noted even more so when more experienced students were asked to reflect back on how their views on leadership had changed since they started experiencing leadership. A list of the individual students leadership perceptions and experience levels is shared in Appendix B, Table B.1.

2.5.2. Defining Engineering Leadership

For this study, based on the data grounded, and considering input of literature, the concept of leaders will lie at the individual level, as in individuals as leaders or individuals holding a role within a group. This goes beyond project management to include leading engineering teams and organisations that are not attached to specific projects. Engineering leadership will encompass a group process whereby team members work together towards a common goal. This reflects the varying perceptions of engineering leadership held by students with varying levels of leadership experience. Individual readers should consider how they view engineering leadership and how this will affect their interpretation of this work.

2.6. Definitions: Engineering Leadership Development

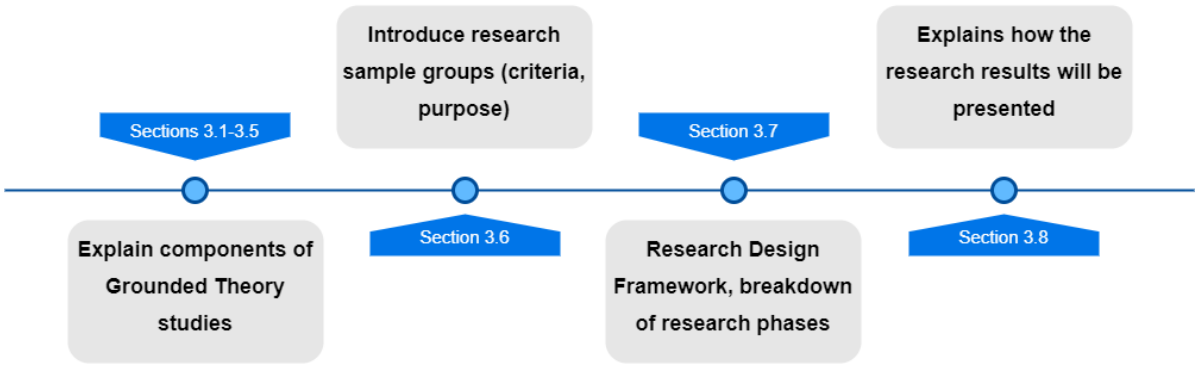
In this study, engineering leadership development will refer to how individuals develop capabilities to perform leadership in increasingly complex contexts whilst maintaining their professional and personal values. The most common problem ran into in leadership development research tends to be how to measure leadership development. By doing this, the focus would be on quantifying leadership and leadership development rather than how to support it. For this reason, this research won't try to quantify or measure leadership and leadership development directly. Instead, as stated in the previous section, it makes some assumptions in studying students that have experience in leadership within experiential contexts.

Rather than start with trying to measure leadership development levels, the assumption is made that if an engineering student is in a leadership role within a project or organisation, and have been democratically elected to do so by their peers, then they demonstrate the competencies, or growth ability, to adapt to that role. This indicates they have developed to be capable of filling that role as a leader. By making this assumption, it removes the complication of trying to measure leadership development. It allows for some ambiguity with the multitude of capabilities and responsibilities required in different leadership roles. The study also assumes that the time spent experiencing leadership roles can be used as a proxy to compare different levels of leadership between students.

The objective of this research is to focus on early stage engineering leadership development through experiential learning. As introduced in Section 2.5, the interview data found that the students started to consider leadership as a more abstract, relational process when they had higher levels of experience with leadership. As they gain more experience in leadership roles, their perceptions around what engineering leadership is seem to shift. This could indicate that later stages of the leadership development process involve shifting perceptions on what engineering leadership is. The theory developed will therefore explore how students develop leadership between these low experience levels, where they perceived leadership as management, to high experience levels, where they perceived it as a relational process.

The method employed in defining engineering leadership and leadership development could also introduce some bias. Notably, by focusing on students that are in voluntary leadership roles, or electing to take courses where they are exposed to leadership, the theory will be grounded from data collected from a specific subsect of engineering students. By taking time outside of their primary studies to be involved in extra-curricular pursuits, the students are likely motivated and driven. As with many qualitative studies, there is also a bias potentially introduced based on the types of individuals that are willing to be interviewed. For this reason, care should be taken when generalizing these results to broader populations, and more research is recommended in this area.

3
Research Design



While Grounded Theory is flexible and allows for an open-minded approach, its major drawback is that it can become extremely complex and overwhelming for the researcher. This is an issue particularly for novice researchers [12].

The purpose of this chapter is to describe the grounded theory research design that resulted through this research. The design was adapted based on the Grounded Theory Research Design Framework for Novice Researchers by Chun Tie et al (2019) [12]. Since GT involves constant comparative analysis, the research design unfolds as the research progresses, it is not developed in advance of the research being conducted. The outcomes of this can be already noted, since some of the interview data was shared in the prior two chapters already.

The key components of grounded theory are sampling, memoing, coding, constant comparative analysis, and theoretical sensitivity. As the research progressed, the framework provided by Chun Tie et al (2019) was adapted, showing how the components of GT were used and helping guide the subsequent research phases and highlight the work done. In the end, a total of 4 research phases were conducted. A total of 25 stakeholders in the TU Delft and EWB-USA organisation were sampled. The research design framework is introduced followed by a description of how the components of GT were used at each phase of the research. Finally, a description of how the outcomes and results will be shared is given.

3.1. Component 1: Sampling

Sampling refers to the data used to construct the theory. The first purposive data set will be broad, and subsequent samples become more refined. As the study progresses, more specific questions and samples to be targeting to accept or refute the emerging grounded theory. Purposive sampling refers to the first data set and helps establish a base line and context for the research to occur within [12]. Theoretical sampling follows, where samples are picked specifically based on the initial codes and themes from the first data set.

The primary source of data was interviews with relevant stakeholders involved in the process of early stage engineering leadership development in engineering students. To gain perspective of the process of engineering leadership development as a whole, the inputs of other experts in the process are also considered. These include university educators, the EWB-USA organisation headquarter staff, and industry members. This helps the research to remain balanced and open, because the problem is explored from multiple perspectives.

Interviews are conducted in a semi-structured manner. This allows for a general set of interview questions to guide the interviews but leaves flexibility in case unexpected themes arise. It also leads to a more natural conversation. The questions were refined as the study proceeded iteratively, questions that did not help build theory were dropped and those that did were focused on. An overview of the groups interviewed and criteria applied follows, a list of all the individuals interviewed is shown in Appendix A, Tables B.1 and B.3.

3.1.1. Purposive Sampling

Purposive sampling involves purposely selecting participants and data sources that can help answer the research question, and provides the initial data for analysis [12]. The first data set will be broad, and subsequent samples become more refined, as coding and themes emerge, allowing the grounded theory to emerge and more specific questions and samples to be targeting to accept or refute the theory. Purposive sampling helps establish a base line and context for the research to occur within. Once this is done, the sampling is adjusted to theoretical sampling where samples are picked specifically based on the initial codes and themes from the first data set.

3.1.2. Theoretical Sampling

Theoretical sampling occurs when the researcher follows leads in the already collected data by sampling new participants [12]. Theoretical samples are informed by coding, comparison, and memo writing that has already occurred [50]. The purpose is to refine the theory by exploring gaps or reinforcing the current theory [50]. The remainder of the interviews were conducted in this manner, with questions being modified and participants being chosen that could contribute.

3.2. Component 2: Memoing

Memoing is key to ensuring the researcher does not get lost in the complexity of the grounded theory methodology. Some use the analogy that if the data in grounded theory is the building blocks, then memoing is the mortar [12]. Memos help the researcher maintain an audit trail of the thought process throughout. In addition, they are used to store the researcher's feelings, thoughts, and intuitive complements throughout the process, a rich source of data that is not explicitized in the interviews for example [12]. Multiple types of memos were utilised. Throughout the project, a research journal was kept. Memos were also created within AtlasTI.

Memos were written both during and immediately after each interview. These included initial thoughts, things that stood out, or where the researcher noted more implicit inferences from the interview. This also include how the interviewer felt about the interview, and started to jot down things they felt important to the theory as it emerged. An example of this is shown in Appendix B, Table B.4. Many of the memos would evolve and become obsolete as constant comparative analysis discounted them. Others would prevail as more data was collected, form the basis of codes and eventually the theory. Both throughout the paper and in the appendices are evidence of memos. All in all, they form an important part linking the constant comparative analysis and theoretical sampling. Qualitative data from the memos are

incorporated throughout this research paper. Many of the appendices include additional data from memos.

3.3. Component 3: Coding

Coding is an integral component of all qualitative research, with grounded theory being no different. Coding is key in turning the qualitative data into theory. This research takes a constructivist GT approach by breaking the coding into initial, intermediate, and theoretical coding, adapted from Birk and Mills [5] [12]. The iterative coding process forms part of the analysis.

The interviews were transcribed electronically by listening and typing out the interviewee responses. This was done in order to become immersed with the data. Familiarity helped initial codes start to emerge. After importing the transcripts into AtlasTI, initial coding was done based on these early stages read throughs. Memo's allowed thoughts on theory to develop. The word count functionality of AtlasTI also allowed some other codes to emerge, since the prevalence of words across preliminary interview phases could be determined and used as codes. Coding was done in an open manner, in line with grounded theory principles, with no codes being pre determined a priori based on literature.

3.3.1. Initial Coding

In initial coding, important words or groups of words are identified and labelled. These codes assign meaning to the data, compare incident to incident, and patterns and comparisons between the codes begin, often captured in the form of memos [12]. Initial coding is complete and moves to intermediate coding once categories start to develop [12]. Concurrently at the end of the initial coding stage, sampling moves from purposive to theoretical [12].

3.3.2. Intermediate Coding

Intermediate coding builds on initial coding by beginning to transform the basic data from initial coding into more abstract concepts that allow theory to emerge [12]. Also, during this stage, categories should be reviewed and subsumed into other categories that become increasingly refined [12]. Gradually, core categories start to become evident as categories form around core concepts, relationships become identified between categories and the analysis becomes increasingly refined [12]. Sections 4.2 and 4.3 in Chapter 4 explore the intermediate codes.

3.3.3. Core Coding

In advanced coding, the findings of the analysis are presented as a set of interrelated concepts rather than simply categories [12]. This is where the categories from intermediate coding are woven back together to create a story of the whole theory. The core code, sometimes called the theoretical code, and results of the grounded theory is introduced in 4 and a conceptualisation of the grounded theory will be presented in Chapter 5.

3.4. Component 4: Constant Comparative Analysis

Constant comparative analysis is the analytical process used in grounded theory for coding and category development [12]. Unlike other qualitative methods, in Grounded Theory the data is analysed concurrently with collection, researchers don't wait until all of the data is collected before analysing [50]. Initially, the analysis compares incident to incident in each code, then initial codes are compared to other codes [12]. As the data collection and analysis progresses, codes are often combined into categories, concepts, or themes, allowing the theory to be built and refined [12]. New data is constantly compared back to the codes and categories from previous data. This paired with theoretical sampling allow for continually refining concepts and theory [12]. Some of the outcomes of the constant comparative analysis will be shared in Chapter 4.

3.5. Component 5: Theoretical Sensitivity

Theoretical sensitivity refers to the ability of the researcher to know when they have identified a data segment that is important to their theory [12]. It persists throughout the research process. Analytical

tools often used in this include constantly reading literature, open coding, category building, discussion and feedback from the supervising committee, and writing reflection memos [12].

3.6. Sample Groups

This research explored the problem from multiple stakeholders to explore different aspects of the problem. Samples were selected and contact facilitated with input from the EWB-USA organisation representative and the committee supervisors. The goal was for the samples to represent different perspectives related to experiential learning methods. Students with levels of exposure in participating in the 3 main experiential methods, PBL, PBSL, and Intership were sampled. Within the student groups, individuals representing varying levels of experience in leadership positions were strived for. Educators were chosen that had been exposed to developing experiential methods, with the goal to interview members from different faculties so that faculty influences didn't dominate over TU Delft organisational influences. Members of the EWB-USA HQ were picked that were representative of the different groups within the organisation, from the education group to project engineers that worked directly with students. Finally, members of industry were interviewed that had long term experience as a professional engineer and were far removed from their university days.

Since sub question 1 pertained to engineering students perceptions of leadership, the results of sub question 1, already shared in Section 2.5, were only contributed to by students. Other groups were asked to describe engineering leadership in order to explore whether there were generational differences, and these results are discussed in Section 7.3.1. Sub questions 2 and 3 were explored with all of the sample groups. A summary of the sample groups and their contribution to the research is shown in Table 3.1. A more detailed description of the groups sampled is included in Appendix B, Tables B.1 and B.3.

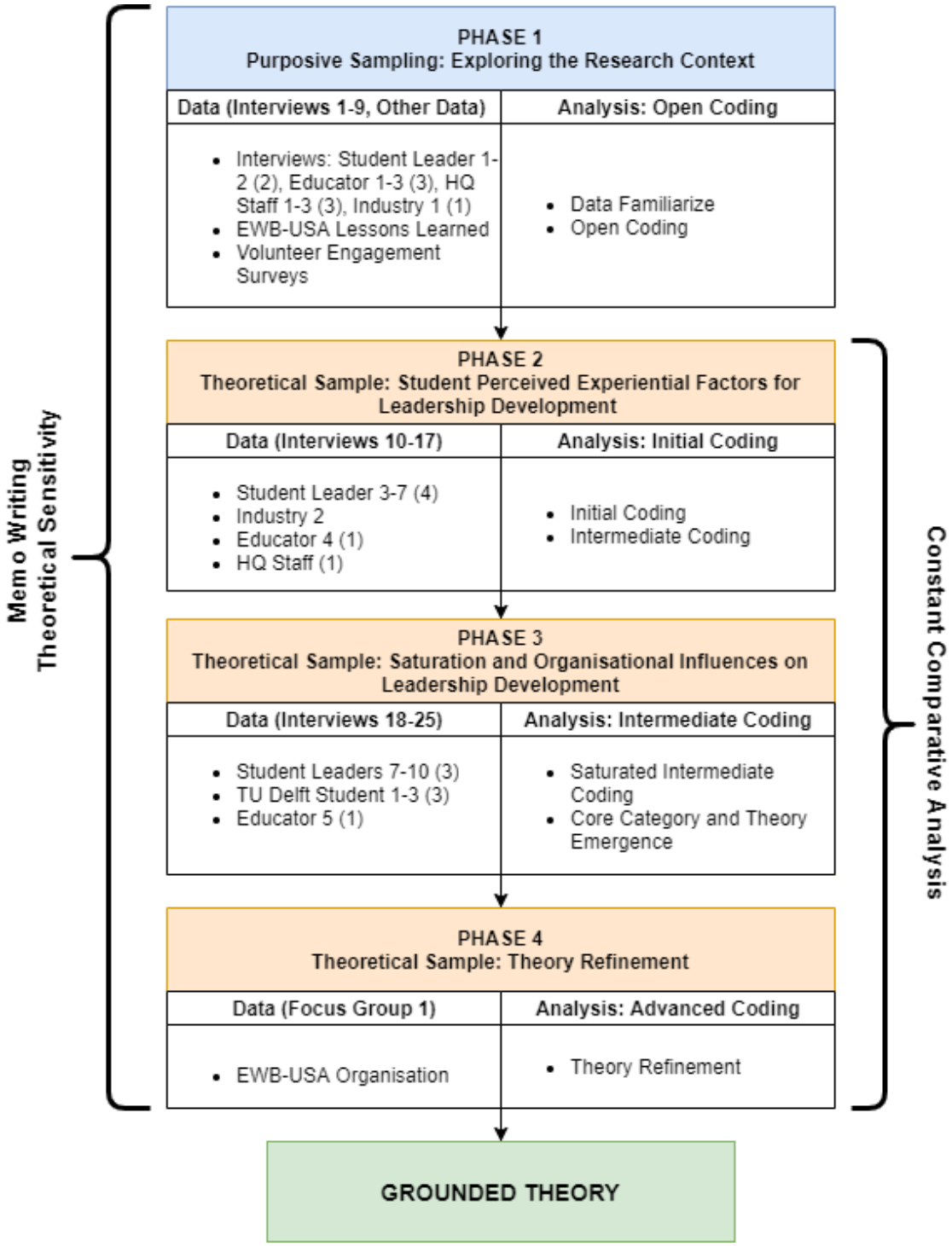
Table 3.1: A summary of the groups interviewed and how they contributed to the research

Group	Sample Size	Sub Question	Phase Sampled	Contribution
Engineering Students (EWB-USA)	10	1,2,3	1,2,3	These students had experience with the PBSL method through EWB-USA's ICP. These individuals provided input for how organisations support leadership development. They were also able to discuss whether there were aspects of PBSL specifically that were specifically supportive of leadership development. Students from 3 chapters were sampled, see a summary of the Chapters in Table B.2.
Engineering Students (TU Delft)	3	1,2,3	3	These students had experience with the Internship and PBL method through TU Delfts JIP, MDP, and Internship Program. These individuals provided input for how organisations support leadership development. Additionally, they were able to discuss barriers faced on the student side in partaking in experiential learning in a formal university setting.
Educators (Experiential Learning Involvement)	5	2,3	1,3	Educators that had involvement with developing experiential courses aiming to develop leadership or other professional capabilities. This group helped explore what prevents educational organisations from incorporating these methods into curricula and difficulties in implementing these courses.
EWB-USA HQ Staff	5	2,3	1,3	Various members of EWB-USA staff contributed to exploring the problem field and how leadership development was able to be supported. They were able to provide confirmation that what students perceived to be important was also observed by others involved in the process.
Professional Engineers in Industry	5	2	1,2	Various members of industry contributed to exploring the problem field and how leadership development was able to be supported. They were able to provide viewpoints on new graduate student capabilities upon entering industry.

3.7. Research Design Framework

In Grounded Theory, the research design is not set from the beginning. A broad initial data set and purposive sampling allow for a broad exploration of the topic. As themes of interest arise, theoretical sensitivity leads sampling to become more purposive and the theory starts to be constructed. As with any qualitative research, the goal is to reach saturation of the data set. During this study, the research was conducted in phases, with different groups sampled at each phase as the coding moved from open, explorative initial codes, to intermediate and finally the core category. These phases, and the overall research design, is summarized in Figure 3.1.

Figure 3.1: Research Design Framework showing the final research design



3.7.1. Research Phase 1: Exploring the Research Context

The purpose of phase 1 was to conduct purposive sampling to start to explore the research questions in a broad sense. This was done through reviewing some documents provided by the organisation and conducting exploratory interviews with 9 interviewees representing diverse perspectives. Some excerpts of the data provided from the Organisations Lessons Learned Database and Volunteer Engagement Survey are shown in Appendix C, Table C.1 and Figure C.1 respectively. Coding at this point was completely open, with anything of interest being coded, as the researcher had a low theoretical sensitivity around the topic. The aim of this phase was also to understand how stakeholders, both students and otherwise, perceived engineering leadership to be best developed. The results of Phase 1 are shared in Section 4.1.1.

3.7.2. Research Phase 2: Experiential Factors for Leadership Development

The purpose of Phase 2 was to focus on positive contributors to leadership development within the experiential context, notably on research sub question 2. In this phase 5 students that had been involved in the EWB-USA PBSL method were interviewed of varying experience levels. The main goal of this theoretical sample was to determine if there were any commonalities or differences within the students based on their experience levels and experiences learning in different types of experiential learning, notably project based service learning vs internships. The results of Phase 2 are shared in Section 4.1.2.

3.7.3. Research Phase 3: Data Saturation

The purpose of the third phase of theoretical sampling was to work towards saturation in the engineering students in leadership positions and to explore any influences of chapter culture or governance. Phase three added the input of TU Delft students, three EWB-USA students, an educator and a EWB-USA HQ member from the educational department. In the case of the EWB students, 3 more respondents were interviewed in order to sample another chapter to ensure the data was saturated regardless of chapter organisational structure or culture. To gain perspectives on different experiential methods and students that had not experienced PBSL, 3 students from TU Delft were also interviewed. Finally, another educator from TU Delft and one from EWB-USA's education department were interviewed. These educators both had experience in academic settings and designing non traditional methods of teaching. Here the focus was on sharing some of the findings on leadership development, as well as further exploring more barriers on why organisations struggle to support leadership development. The results of Phase 1 are shared in Section 4.1.3. The finalised initial and intermediate codes are shown in Appendix D, Table D.1.

3.7.4. Research Phase 4: Theory Refinement Focus Group

The purpose of the focus group was to share the grounded theory and show how the conceptualisation could be used to spur discussion to improve leadership development opportunities. The goal was to validate whether the organisation agreed with the theory presented and saw value in using it as a tool. The focus group attendees are summarized in Appendix E, Table E.1. The focus group slides are shown in Appendix E, Figures E.1 through E.5. The results of the focus group are shared in Section 5.5.

3.8. Next Steps

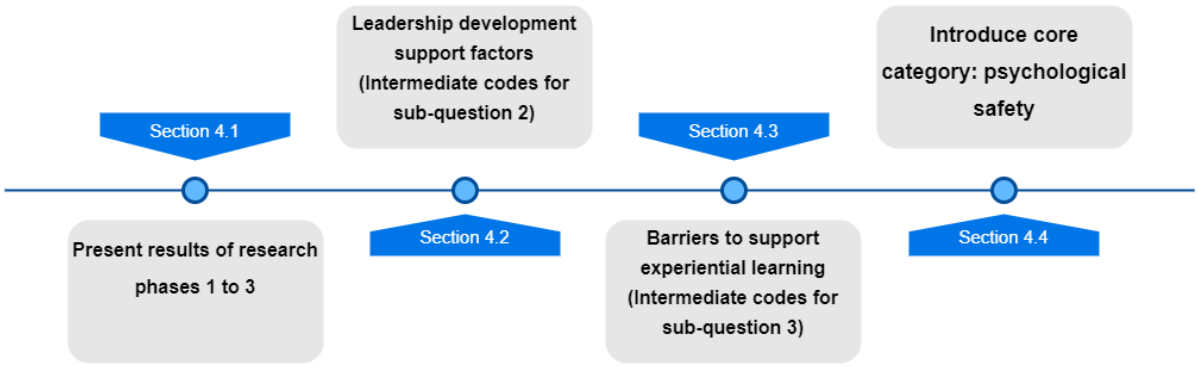
This chapter explains the research design. In line with the constant comparative analysis method used in GT, the research design and research design framework were developed concurrently while the data was being collected and analysed. It was not developed prior to research beginning, as would be the case in a scientific deductive research approach. The research design framework in Figure 3.1, includes the 4 distinct sampling phases, data incorporated at each phase, and level of analysis done. The framework shows the final structure of the study, including the samples and analysis conducted at each phase. The framework was developed by adapting Chun Tie et al's (2019) Framework for Novice Researchers to this research as it progressed. Notably, in GT the research design isn't set from the beginning, since the number of phases will depend on how long it takes for the research data to become saturated. At each new phase, the researcher set out a planned set of data samples and analysis. The results of the analysis helped plan the next phase, refining questions for the interviews

based on codes that had emerged in the previous phase. This helped provide some structure and way to track progress for the researcher in a relatively open methodology. Following the framework was a description of what happened in each research phase.

Since analysis of the results occurs in a constant comparative way, it is not always clear in GT research how to best share the results and analysis. To provide some structure, the results and analysis will be presented in the 2 subsequent chapters based on the level of coding achieved. In Chapter 4, the preliminary results from phases 1 to 3 will be discussed, which sees coding proceed from initial to intermediate to core. The core category will be introduced. In Chapter 5, the grounded theory is introduced, which brings together the intermediate codes using the core code and Relational Developmental Systems theory to outline the process of engineering student leadership development. Chapter 5 also compares the GT to other notable theories in literature, and finally describes how the outcomes of the Focus Group, Research phase 4, further develop and strengthen the grounded theory.

4

Results



The goal of this chapter is to deliver the results of the research in a clear way that shows a story line of how the grounded theory emerged. This is done first by sharing the general research results chronologically by research phase and then analytically based on the intermediate and core codes. The main results in this chapter focus was on sub questions 2 and 3, since the outcomes of sub question 1 on leadership perceptions were shared in Section 2.5 as an important starting point of the research.

A summary of the results are presented based on the first 3 phases of the Research Design Framework (Figure 3.1) by outlining how each phase contributed to the overall theory as well as to each research sub question. The fourth research phase relates to the conceptual model of the grounded theory and is presented later, in Section 5.5. In summarizing the results of research phases 1 through 3, some general findings around each research question 2 and 3 became more clear.

SQ2: How do students that have been involved in experiential learning contexts perceive leadership development is supported: There are **factors** of experiential learning contexts that are perceived by students to support leadership development. The researcher identified individual factors that appear to also play a role in leadership development.

SQ3: What prevents educational organisations implementing leadership development opportunities through experiential learning: Educators that are trying to implement experiential methods, and students trying to join experiential contexts, indicate that there are **barriers** making it difficult.

Intermediate codes had already been compiled by the end of phase 2 based on grouping and merging relevant initial codes in intermediate code groups. However, they still lacked structure and it was unclear how the grounded theory could be conceptualised. The intent of sharing results by research phase was simply to show how the theory emerged and codes became more refined. However, by compiling these general results by research phase, it became clearer to structure the intermediate codes in a more organised and digestible way that related them back to the sub questions they related to. This was done by prefacing the intermediate codes with DEF (for definition, sub question 1), DEV (for development, sub question 2), or BAR (for barriers, sub question 3).

In doing this, it became apparent that there were some intermediate codes that did not fit neatly into answering a specific sub question, but to multiple sub questions, to the overall research question, or to multiple other intermediate codes. These intermediate codes related to developing through experience, in a safe learning environment where students felt safe to fail, and being safe to communicate with team members. Thus emerged the core category of psychological safety, where:

> Psychological Safety is a shared belief amongst individuals as to whether it is safe to engage in interpersonal risk-taking in the workplace [42] [20]

In the case of many of the intermediate codes around factors for leadership development, the presence of psychological safety appeared to facilitate those factors supporting leadership development. In the case of the intermediate codes that related to barriers for leadership development, the absence of psychological safety could help explain what prevented educators from effectively implementing, and students electing to enter, supportive experiential learning environments.

The final results of this constant comparative analysis allowed the saturation of the intermediate codes and the emergence of this core category to occur in Phase 3. As mentioned, the intermediate codes emerged around factors for leadership development and barriers. The factors related to mentorship, organisational, project, and individual considerations and are described Section 4.2. Some barriers occurred at system level, some were faced by educators trying to implement new experiential methods, and others were faced by students entering experiential contexts, the intermediate codes relating to barriers are described in Section 4.3. The intermediate codes that were tied to the core concept of psychological safety are shared in Section 4.4, as well as discussion on why psychological safety might support leadership development in experiential contexts. By sharing the results in this structured way, the reader can familiarize themselves with the grounded theory as it emerged through the research. The grounded theory is conceptualised in its final form in Chapter 5.

4.1. Results By Research Phase

In Phase 1, findings from exploratory purposive interviews confirm the importance of experiential learning in the complex goal of leadership development, as perceived by students and educators. The first phase also begins to highlight some barriers felt by students in entering, and educators in offering opportunities designed to foster development. In Phase 2, sampling moved to purposive, focusing on further expanding on what perceived factors within an experiential learning context contributed to development. Phase 3 continued this thread, with the focus on organisational factors that respondents felt might affect development and working towards saturation of engineering students.

Sub question 1 around perceptions of leadership and leadership development was tackled in all phases by exploring what respondents believed engineering leadership was. Sub question 2 around leadership development was tackled in an increasingly refined way as theory emerged. Sub question 3 around barriers of leadership development was also tackled in all phases, more specifically with educators, but also with students in exploring what prevented them from taking experiential courses in their formal education. At the end of the study, 4 research phases led to the emergence of the core category, psychological safety, as a moderator for leadership development. The results of the 4th phase, which saw the grounded theory shared with a focus group within EWB-USA, will be discussed in Section 5.5.

4.1.1. Phase 1: Exploring the Context

In order to ground the researcher in the organisational context, data sources including the most current Lessons Learned Database from the EWB organisation, some Lessons Learned Summary Reports and a series of Volunteer Engagement Surveys for 2019 were analysed. Exploring these data sources helped the researcher understand the types of projects conducted by the EWB-USA organisation and the engineering design process use in their ICP. However, the data did not relate specifically to leadership and they were not used further. The interviews were held with engineering students that held leadership roles in EWB-USA, 3 educators, a professional engineer in industry, and 3 members of EWB-USA staff. These interviews helped set the baseline and establish some of the preliminary viewpoints. They confirmed that respondents perceived leadership was best developed through experience and practise, thus confirming the focus on experiential learning within this research.

The main findings from phase 1 included:

- **Sub-question 1 (Leadership Definitions):** Perceptions of leadership and leadership development are complex. There was a large variation across generations and experience levels of what engineering leadership was perceived to be. This indicates a difficulty in organisations supporting leadership development, since they might be supporting their perception of leadership rather than acknowledging that the students hold different perspectives. These were already unbundled in the framing section of this report, along with the perceptions from subsequent phases.
- **Sub-question 2 (Development Factors):** Agreement that experiential learning was perceived to be the best overarching method of leadership development. Begin to explore developmental factors.
- **Sub-question 3 (Barriers to Development):** Respondents described two main barriers in supporting leadership development. The first was related to students' motivations around entering context in which they developed leadership; they typically didn't enter these experiential contexts with leadership development in mind. On the other hand, educators described facing barriers when trying to implement new methods that promote leadership development.

The interviews were transcribed, input into AtlasTI and coding conducted completely openly. At the end of this phase there were over 120 unique codes. This did not indicate much at this stage, as the data was not saturated enough to know which codes were important, and the researcher was not theoretically sensitive enough to be able to combine or remove codes that might not be relevant. Some of the more grounded codes did lead to the outcomes of the analysis already described, as well as highlight areas for further exploration in subsequent phases, as sampling moved from purposive to theoretical. This stage helped confirm that experiential learning did provide a good context for

leadership development, helping to confirm the problem formulation and research questions were relevant for research. From this, it allowed the subsequent phases to focus on this context, and narrow down interview questions and theoretical samples. The final step in this open coding stage was to assign these open codes to initial codes by indicating which research sub question they most related to. This was done by prefacing the codes with DEF (for definition, sub question 1), DEV (for development, sub question 2), or BAR (for barriers, sub question 3).

4.1.2. Phase 2: Experiential Factors for Leadership Development

Phase 2 results confirmed that students perceived the PBSL method to more effectively support leadership development that PBL and Internship methods, though it should be noted that these experiential methods occured in different organisations (university and formal vs EWB-USA and extra-curricular) and thus organisational influences could play into this preference as well. This phase also explored how students felt about formal, within university, experiential methods to explore any difficulties on the student side that organisations could face. Codes were refined from initial codes that were divided by sub research question to the emergence of intermediate codes and categories.
The main findings from phase 2 included:

- **Sub-question 1 (Leadership Definitions):** Continue to explore perceptions of engineering leadership in students.

- **Sub-question 2 (Development Factors):** The biggest contributors to leadership development were perceived to be the amount of time spent in various leadership roles in experiential learning contexts. Service learning in particularly was described as an effective development environment, although it did not seem to matter whether it was important for these service project to occur internationally or locally. Other contexts, such as internships, were viewed as beneficial for professional development but not leadership development.

- **Sub-question 3 (Barriers to Development):** Students were not sure if they would learn as much in a formal context, notably since they did not feel they'd have as much support without mentors, and there would be more pressure due to grading in formal courses. In other words, there were limited experiential opportunities the students felt would enter into in university settings.

Throughout, the initial codes were further grounded and more added where necessary. At this stage, the coding also become more refined and categories started to emerge, indicating a shift from initial coding to intermediate coding. Sections Sections 4.2 and 4.3 explore the intermediate codes.

4.1.3. Phase 3: Data Saturation

The main outcomes in phase 3 were that a set of intermediate codes had emerged that related to sub question 2 and 3. For sub question 2, a set of codes emerged that represented factors for leadership development. For sub question 3, a set of codes emerged that represented barriers for experiential methods. The main findings from phase 3 included:

- **Sub-question 1 (Leadership Definitions):** Continue to explore perceptions of engineering leadership in students.

- **Sub-question 2 (Development Factors):** Experiential learning environments that give students higher degrees of autonomy in their learning were perceived to be beneficial to development at later stages. The intermediate codes began to be more refined and saturated, with some factors relating to the individuals themselves and others relating to contextual aspects of the experience.

- **Sub-question 3 (Barriers to Development):** The TU Delft students described difficulties in entering into the context of experiential leadership development due to the complexity of the education system and unawareness of opportunities available. Educators continued to reinforce that they faced barriers from their side, including findings students hesitant to take courses, a lack in value in these types of development opportunities by both staff and students, and a general lack of resources for educators hoping to enact change.

As the intermediate categories became more saturated, the core category also emerged at this stage. The majority of the intermediate categories related to individual or contextual factors that related to leadership development. The categories of 'learning from failure', and 'safe learning environment' persisted throughout the interviews and could be related to multiple other intermediate categories, such as mentors or the organisational culture. Regardless of what aspect the respondents were discussing in regards to supporting their leadership development, they could all be tied back to the notion of being able to practise leadership in a safe learning environment where they felt they could learn from taking risks, and from failure and adjusting their approach. This core category was often talked about in relation to intermediate codes. For example, students would discuss how mentors were key to helping develop leadership because they made it safer for students to take risks and fail. This core category will be introduced in Section 4.4.

4.2. Factors Influencing Leadership Development

The second research sub question related to factors of experiential learning that students perceived to help them develop leadership. As the research progressed, intermediate codes emerged and related to aspects of the individual and of the learning context. On the context side were experiential learning, mentors, organisational factors, and the project themselves. Within these were many of the initial and open codes that related to those themes. These will be described within this section, and we will start to see evidence of the core theme emerging, which relates to developing in a safe learning environment.

By the end of the third phase of research, the intermediate codes relating to perceived leadership development factors were split into contextual factors and individual factors. The contextual factors related to aspect of the experiential learning in which the students partook that related to leadership development. The individual factors related to aspects of the students themselves that were perceived to affect leadership development. Experience in leadership was perceived by students to be the largest factor in leadership development.

4.2.1. Experiential Learning

First, some findings on general aspects of experiential learning were explored with students. The experiential learning methods that were explored were Project Based Service Learning in an international setting, Project Based Learning, and Internships. Factors that were explored as potentially contributing to leadership development included the amount of time spent in leadership positions, the number of internships students had, the number of years in engineering education, the method of experiential learning, and the number of international trips the students had gone on. Comparing the general insights and level of introspection amongst the respondents, it was found that the biggest contributors to leadership development was perceived to be the amount of time spent in different leadership roles in experiential settings. As one student stated:

> Student 4 "Being put into a leadership role and having to account for a group of people is the best way to gain more leadership skills . I don't think you get too much of it in the early years of engineering university."

For those that had partaken in internships, they attested that they did not believe internships contributed as much to their leadership development because they were not actually practising in leadership roles:

> Student 7 "But internships, instead of you being the leader, you are working under a boss or a supervisor so you're getting the other side of it. But most of the (leadership) learning happens when you're doing it yourself."

The value of developing leadership by conducting projects in international service settings was not as clear cut. This is where bias could come into play, since most students joined the organisation with the purpose of helping less fortunate communities, to travel and volunteer. Therefore, they are quite likely to be biased on this topic. However, when asked what was more beneficial to leadership development by working in developing countries, most of the responses described the benefits of working with communities in general, rather than the international nature of those communities.

4.2.2. Mentors

Students consistently highlighted that they believed mentors play an important role in the process of leadership development, and it represented the most grounded intermediate category relating to subquestion 2. Mentoring here follows Roberts (2000) definition as:

> "a formalized process whereby a more knowledgeable and experienced person actuates a supportive role of overseeing and encouraging reflection and learning within a less experienced and knowledgeable person, so as to facilitate that persons' career and personal development" [47]

Notably, mentors do not have to be older than the mentee, they just have to have more experience in the area in which the mentee wants to develop. This allows for mentors to be friends, or even those younger than us. For example, in one case, an EWB staff member asked a much younger volunteer to mentor them towards their goal of achieving a project management designation. Mentors can be sourced anywhere, the learner could network and seek them out on their own, or an organisation could help connect mentees and mentors. More informally, mentors could be peers, and the mentorship moment could be one instance in time where a peer with more knowledge or experience with a specific problem gives advice to their peer. Commonly, mentors are formally appointed by the mentee requesting help, or in the organisational case, sometimes the organisation helps connect mentors and mentees. Particularly in earlier stages of development, it appeared that mentees are less likely to seek mentorship or be aware of the value of it, so organisations can help bridge the gap and make those connections.

The value of mentorship described by respondents was that it provides a support system that makes it safer to fail and learn. Mentors can do this in many ways depending on the particular learner and context. For example, for one student leader they believed their technical mentors helped to safe check technical components of a design, while allowing the student to maintain their autonomy as a leader. As they stated:

> Student 6 "The program director and I could make every mistake possible and come up with a terrible plan but then the professional mentor will look at that plan and say 'these designs are bad, you cant use them'. That's the check and balance. That's what makes sure no one gets hurt, but in a way that allows us to have our agency."

Respondents also described how mentors can help reframe problems or ask questions to guide mentees towards their goal. For another student leader, their mentors helped to facilitate the design and project management process by highlighting the importance of systems thinking and the client perspective. As they describe:

> Student 2 "our mentors would say 'Don't design a plane when you only need a bike'. That's what our project leads and mentors told us. We were going insane with our design and the told us to take a step back. You have to remember the people in Guatemala don't have all the tools we have. Its more about making it simple enough that it does the job, and does it consistently"

As some respondents brought up, they found that there are risks and considerations associated with mentors. These were rarely mentioned by students, but many educators and EWB-USA headquarter staff were aware of them. They felt that there's more to effective mentorship than just presence; mentors should be selected for different aspects and stages of the development journey, and mentors themselves should have experience or training that renders them suitable. Particularly at the earlier stages of an engineer's development as a leader, it appeared that mentors hold a lot of influence power. This is due to the engineers having less experience to compare the advice to. When asking a country office director in Latin America what stood out about EWB-USA Chapters that struggle with project success and community collaboration, he believed that the chapters that struggled were those with mentors that were not giving good guidance.

Respondents believed that this can be mitigated by organisations designing the requirements, training, and variation in mentors into their programs and culture. For example, EWB-USA wants each project to have 3 mentors; one with the technical expertise in the project area, one with construction management experience, and one with global experience. This helps balance out the time needed from the mentors but also ensures the volunteers get exposure to all aspects of the problem. Another educator of an innovation festival held over 7 days shared advice on mentor requirements:

> Educator 4 “They need to be open minded, have some experience in facilitating processes, and have at least 3 years of work experience. They need some level of seniority, not to just be another student. They don’t get in depth but really help to facilitate the process. How involved they are depends on the group. But they’re not full time with the group, they still allow the group to develop on their own”

Mentorship is a relatively simple concept at face that is not that simple. It should be well thought out and not entered without clearly understanding what both parties hope to get our of the relationship and how good the fit is. It is a process in its own right, that can play a large role in process of the development of engineering leaders.

4.2.3. Organisation

Based on responses from engineering students, it appeared that some aspects inherent to the organisation itself also affected the developmental context. Notably, how the organisation was governed, the organisational culture, and the resources provided by the organisation to the individual were perceived to play a role in leadership development.

The chapters had some organisational structure and hierarchy. Within the chapter organisation, students described how they had fostered leadership development through structured leadership roles that gave lots of opportunities for students to experience leadership. Most had an executive board, sometimes with as many as 12 members ranging from chapter president, to diversity and inclusion lead, to fundraising. These roles allowed students to explore leadership roles that catered specifically to their interests. There were also another set of leadership roles for project teams, from project leads to sub team leads. This structure can provide opportunities for experiencing leadership roles, with support from peers.

> Student 5 “Our executive board is 18 people, we specifically intend to have a large executive board because we’re trying to give people positions of leadership. Instead of having 1 person in charge of each department we have 2, and then we have smaller positions of leadership throughout the groups … we like to foster leadership from the very beginning. You can be a group lead as a freshman, we do have 1-2 freshmen at the moment. It’s a lot safer environment to practise ”

While they were run in a hierarchical manner, the fact that other leaders were fellow students and peers, made them feel more supported. An interesting approach by some chapters was to create shared leadership roles, particularly for projects. The leaders switched every 6 months, and held the role for a year, so there was always some continuity to provide knowledge transfer and to support the incoming leader while they got used to the role. They can also fostered a safe learning environment by having peer support from older members. These positions start off with much less complexity and lots of support from more senior members to allow younger students to develop.

> Student 9 “Especially during my younger years when we weren’t interacting with (the mentors) as much outside of certain meetings, then it’s a lot of just learning from your peers. There’s a lot of people you just look up as like, they’re really thinking about the project and they’re really good at helping us get through the harder parts of the project like logistically”

4.2.4. Project

All of the experiential learning contexts explored involved projects. Leadership development in this research revolved around experiences where individuals were team members or leader of engineering projects, or leading organisations that conducted projects. But what kind of project is the right project? Based on the respondents opinions, the project should be reasonably well defined, follow an engineering design process in earlier stages of development, be conducted in a real world setting, and last a longer period of time than a typical quarter or semester long academic course.

Respondents indicated that it helped when the projects were well defined. This was echoed by an educator that designs a 7 day innovation summit where multidisciplinary students come together to build prototypes for startups. The goal of the summit is to help students develop professional skills. The educator understands the importance of selecting the right projects, when discussing what she noticed about teams that really struggled with projects:

> Educator 4 “It doesn’t always have to do with the teams, sometimes the projects that do better are well set up … So you can just have better projects. That also helps with the teams. If the client is there, the project is well written, it also helps in the team dynamics because you’re not fighting over aspects that are unsure, in an already unsure process”

The organisation can also provide important tools like the engineering design process to guide the project. This was perceived to be especially important in the very early days of the engineers leadership development. One student discusses the value of having this design framework in the EWB situation.

> Student 4 “I think part of the learning experience is just figuring it out for yourself and I think they (EWB-USA) provide a pretty good basis to do that. The framework was already kind of there within our chapter. It was more me inserting myself in and learning what others had already learned.”

Further confirming this from the opposite perspective, educators discussed running into problems when they tried to implement project courses for younger students without providing some sort of engineering design process or structure. Once the students matured, they were able to deal with more ambiguity and be given projects without a clear process or approach.

> Educator 3 “I gave them the assignment come up with a maintenance plan for an offshore wind farm. I gave them limited information and let them go. They had really big troubles. Making a plan of approach was the hard part. Deciding what they were aiming for was difficult. So I really had to help them to split up the project. On a weekly basis we took them through the project and gave them the weekly tasks to fulfill. It was too difficult and complex for them to figure it out on their own.”

The students believed that the projects should occur in a real-world setting that provides an interesting purpose and aligns with their values. If the students feel like the results of the projects could have a real-world impact, they described being more drawn to it. One student describes how they developed more through a PBSL experience compared to a PBL course in university because the PBSL experience provided more purpose.

> Student 2 “Freshman year we took an intro to design course, all mechanical engineers have to take it. Our project was to design and build a little robot racecar. We did the design process. But with EWB its really different because we get to conduct more experiments. We get to build bonds with companies. We get to build our professional credibility. And our experience with other people in the field. With the robot we built something but it’s just a toy. The EWB project is a draft control that could potentially help operators save more money for their families and that could decrease their wood intake leading to less trees being cut down, less deforestation. So our little draft control is kind of a domino effect, compared to the little car we build and take it home”

The value of working with real stakeholders was introduced in the scenarios at the beginning of this report. Working with communities can also contribute to this real-world impact and help engineering students develop in a more socially conscious approach. A member of EWB headquarters discusses the change he saw in students before and after working to deliver a project with the community.

> EWB Organisation 2 “something that changed chapters or volunteer’s mindset, that causes a shift in thinking is before coming on the trip and when they actually come. Before coming everything is very technical, very detail oriented. They don’t pay too much attention to the human side of things. they don’t see the community as a living organisation but as a receptionist of the benefit they’re going to provide. They look at themselves (the chapter) simply as a service provider for the community. But when they come and they see these human faces and relationships, how people treat each other, something changes”

Students felt that an important aspect of developing a safe learning environment is feeling comfortable in teams. However, this takes time, and unfortunately many project-based courses in universities do not last long. To develop leadership, by increasing comfort levels and relationship quality within the team, respondents felt that the projects should occur over longer time spans. This is touched on by one of the students:

> Student 6 “In classes you just do the project for a semester then once its done you kind of forget about it. It’s less personal”

4.2.5. Individual Factors

Leadership development was not solely explained by factors that related to the experiential learning context. Throughout the interviews, some aspects related to the individuals developing as well. These were determined by observing nuances between less and more experienced leaders in their responses. It was also possible to gauge based on the length and quality of responses from the volunteers. In the less experienced students, answers were typically shorter, they required more time to be able to answer questions, and they struggled with really open ended questions. By the stage of intermediate coding, these aspects that helped leadership development were reflection, self-efficacy, and systems thinking.

Reflection

Reflection involves individuals giving serious and careful thought on a subject or experience. Through reflection, individuals are able to construct new ideas or modify views on existing ideas, resulting in change and development. Reflection is considered by Kolb to be a factor in learning in experiential learning contexts [36]. Reflections can be based on one’s own experience, or on observing others. Reflections could occur by students observing those in leadership roles above them. Reflections are not necessarily explicit; they do not need to be written in journals or use frameworks or guiding questions to unpack experiences. Students showed reflection in helping them observe and learn from others. Students also indicated that they had reflected on their own past experiences and adjusted their approach based on what went well and what went poorly. Some students indicated that they would tell their younger selves to reflect more:

> Student 8 “The biggest thing would just to be more thoughtful and reflective on leadership specifically. It did take me a while to really learn to value all of the things beyond just engineering. It took me a year or two before I was really valuing my general education classes and all the liberal arts classes I could take and the leadership experiences I got”

Self Efficacy

Self efficacy is related to individuals’ beliefs in their capacity to succeed in particular situations. As noted earlier in Chapter 2, leadership was often explained in terms of other professional capabilities. Many of these fit into the self efficacy component of leadership development. Aspects of self efficacy included the individual being adaptable and motivated. Learning and being able to listen and communicate were highlighted as important and helped students build relationships and more effectively work in teams.

Here, respondents believed that having a strong technical background in engineering fundamentals also contributed. The result was that individuals felt that improving capabilities such as listening, engineering fundamentals, and adaptability increased their self efficacy in their ability to conduct leadership.

> Student 7 “Listening to people is super important. Being cognizant of the people you are leading and how they are feeling about what you’re doing. A lot of the time they wouldn’t even notice what you’re doing, and that’s kind of the goal, they’re just doing what they need to do and you are there as a support system. I think to get good at that you just need to listen to people. Read the world and see how people are responding to the things I am doing.”

As students increase in self efficacy, they found that they were capable of leading in more complex settings, such as in a more diverse group, or of a more complex project. An international student studying in TU Delft described how they had to adapt their leadership to a new culture through listening and communicating, enabling them to more effectively lead a diverse group:

> Student 13 “The culture plays a vital role, you are used to a certain way of leading and communicating with people but it’s so different here between different backgrounds, nationalities, cultures, people. You need to listen more to the people, better understand the person and personality of the person before you can lead them”

Systems Thinking

Systems Thinking is an approach to analysing the world where individuals consider how a systems parts are interrelated and how systems work over time and in relation to other systems. It opposes breaking systems down into separate elements to try and understand the whole, but rather focuses on how parts of the system relate to one another. It was noted during interviews that individuals that were deemed to be more developed in leadership also showed higher levels of systems thinking. Systems thinking required an open mind that is comfortable with ambiguity, with individuals that were more experienced in leadership showing increasing self awareness, team awareness, and cultural awareness of others involved in the experiential context.

As students developed, they showed a greater self-awareness of themselves and the world around them. They developed an awareness of their team mates, From initial exposures as formal leaders of small groups of 2 peers in project sub teams to leading the entire chapter of 100 volunteers, the students increasingly became aware of the bigger picture. Students also developed increasing awareness of problem complexities and ambiguity. They describe considering wider perspectives that just the technical engineering sides of problems. One student describes this shift in thinking:

> Student 1 “I used to think how to make the design good. Now I have such a different perspective on it. Like how is it going to be manufactured, will they (the client) understand how we built it, will they understand how it works, can we explain to them how it works, how can we make them trust us to provide them a solution that works. It’s a lot more than just engineering at this point ... We need to learn this new way of looking at things.”

Many of the students described developing leadership through increasing awareness of the other stakeholders in the projects. They described being aware of the capabilities of their fellow teammates.

> Student 8 “Having the perspective to be able to step back and re analyse a situation and be comfortable and humble without knowing, not to be all knowing. Every person you work with and everyone on the team can offer a different perspective and you can learn from everyone, everyone can bring something positive to the project.”

Some of the most experienced leaders had started looking beyond the team, project, and organisation, to consider wider systems awareness. For example, one leader describes beginning to critically reflect on their social responsibility as an engineer providing projects in developing countries:

> Student 7 “The whole concept, of us going to Africa or Latin America and giving them a water system, its been on my mind recently. And how do I reconcile with helping people but also lifting up them… its not about us, it’s about them, I think about this a lot. The conclusions I’ve come

> to, I think EWB does it pretty well where we're not just going in, building a system and leaving, we're trying to build community partnerships, but I've just been reflecting on how to make it even better. I think communication is really what it all comes down to"

4.2.6. Summary: Factors for Leadership Development

This section outlined the factors related to the individual and the context of experiential learning that contributed to leadership development. On the experiential learning side, the main factors included mentors, the project itself, and how the organisational context affected things. On the individual side, reflection, self-efficacy, and systems thinking all contributed to leadership development. These factors were all based off of intermediate codes developed throughout the research relating to the second sub question.

4.3. Barriers to Supporting Leadership Development

The third research sub question related to barriers felt by educators in developing, or students participating in, experiential leadership development. As with any complex problem, barriers faced at an individual level often manifested from barriers at the systemic level. For example, the system level barrier of siloed faculties leads to educators that are unaware of colleagues making similar initiatives in other faculties, which leads them to feel lacking in support and resources, and manifests into few opportunities for experiential development opportunities for students.

A large part of the complexity is systemic; the current education system was described as putting a lot of pressure on professors to prioritize research output over educating the next generation of engineers. This sentiment was echoed by multiple educators. The result was that they felt many educators prioritized research over teaching. This is a known problem at all levels and most also believed change was coming, it will just take time.

> Educator 5 "a big barrier is that there is already an existing educational system. Which promotes a certain way of thinking, in our case very technical. This is not starting to gradually change, more and more people are starting to talk about the people side of engineering"

These systemic barriers should be considered in reading through the rest of the barriers faced at the educator and student level.

4.3.1. Educator Barriers

Educators view was that students were hesitant to take experiential courses, that the importance of leadership development is not fully understood by students or professors, and that it is hard for professors to offer these courses because it's hard to get credit for them.

Resources

The biggest barrier was a lack of resources for educators. Many of the educators highlighted the energy and effort required to create new experiential opportunities. Others pointed to more systemic issues where it was tough for them to get allocated teaching hours because leadership development didn't fit into a specific subject. Those that were successful in incorporating new opportunities did so with a combination of the resources of a larger team, organisational support from above, and outside consultation in areas where they were lacking knowledge. Difficulties in incorporating project-based learning methods are also explored in literature. For one, educators are often not comfortable, or confident in delivering classes using this method [40]. They need to develop a structure that works for them, and that gradually helps learners develop maturity and autonomy [40].

Student Buy-in

Educators that created new experiential opportunities sometimes faced a barrier of getting students to buy in and join the course. One educator had been hired by the university specifically to develop a project course for leadership development in one of the faculties. The drive came from the faculty head and from engineering alumni giving feedback that more leadership development opportunities would be beneficial in their studies. The course was developed by an educator hired specifically for the

task, who managed to create a blended learning environment where students conducted projects with industry sponsors and mentors whilst receiving workshops on professional skills that would aid their development. However, once they implemented the course, the educator described how hard it was to get student buy in:

> Educator 1 “The biggest challenge was pitching students to come on board. It was a battle, only 12 students wanted to do the systems engineering course, but not many wanted to do the project. They didn’t seem sure about working in teams. Of the 12 students that finished the course, only 5 wanted to do the project. I pitched them, encouraged them but I still don’t understand why they weren’t interested … there is some sort of barrier to start for the first time”

Organisational Complexity
A large barrier related to the organisation of TU Delft being complex and hard to navigate. Educators described bureaucracy and organisational complexity. The complexity came partly due to the size of the organisation and partly due to siloed faculties. In the problem formulation section, an educator described organisational barriers in relation to developing an interfaculty PBL program for professional development, including bureaucracy and difficulties related to siloed faculties. Another outcome of the siloed faculties was that it was noted that the educators interviewed often were unaware of similar initiatives in other faculties.

It was noted during interviews with educators that they themselves were not aware of all of the experiential opportunities outside of their faculties for students to develop leadership. Research memos indicated there was a general feeling of fragmentation. Efforts being made to develop leadership were siloed by faculty and driven by individual educators or groups of educators rather than by a clear joint effort at higher levels. The size of the organisation and this fragmentation between faculties made it difficult to get an overall picture of leadership development opportunities within this organisation.

Experiential Grading Mechanisms
The presence of grading is a constant struggle in experiential learning methods. This is partly because these methods help students develop themselves, they are not about transferring knowledge, and as such are difficult to grade. However traditional education has always placed an importance on grades as an indicator of student qualification.

Efforts were described to quantify the outcomes of experiential learning. Educators utilized methods such as peer feedback and self-reflection to grade how much students learned and developed within courses. One educator explained issues they were having getting a new course approved because they wanted to grade students on a pass-fail system, rather than providing grades. They wanted students to feel that it was ok for them to fail as long as they reflected on the failure and learned from it. However, there was pushbacks from higher levels.

Student Developmental Level
Catering to the learning maturity level of students was also a barrier. The main barrier was around structuring courses in a way that provided enough challenge for the students to learn, but enough structure that they were not completely lost. Two educators described trying to give 1st or 2nd year bachelors students projects with minimal guidance and structure and running into a lot of issues. On the other hand, they found that by the start of their masters, students had teamwork capabilities that enabled them to handle more ambiguity and challenge in the projects.

Perceived Value
Educators did not become aware of the need until they either went into industry and realised there was a gap, or reached leadership positions themselves within education. One educator echoes this:

> Educator 5 “So leadership skills for example, whatever you mean with the term, but the interesting thing I find with leadership is that most academics or people lecturing would only receive training in leadership once they get to a leadership position. So as long as you call leadership as something you can only have once you get to a certain level in an organisation, I think its very limited.”

An outcome of this was that for many experiential opportunities discovered within the university (though not all), the educators responsible had been hired specifically because they had experience in industry and a good network. Notably, this barrier was described by educators in relation to other educators, the perspective of these educators was not explored in interviews themselves.

4.3.2. Student Barriers

Students faced barriers in leadership development since they did not explicitly plan to develop leadership, and since they were either hesitant or had difficulties in joining experiential learning opportunities. These are described in detail in the following sections.

Unintentional Development

Students don't appear to perceive leadership development as important until they are into the professional world, or inadvertently develop it through extra curriculars. For students that did develop leadership through extracurriculars, it was not a driving factor in them choosing to join it. For example, most student leaders did not join the organisation with the goal of developing leadership, or professional capabilities. When asked why they joined, most said they wanted to partake in engineering projects that held value for communities. The students made much more reference to team work and learning how to interact with stakeholders than they did to leadership. It was only later on that they reflected back on the experience and realised the value of it for developing leadership, as described by a student:

> Student 1 "I thought it would be classical engineering, that id go in, see an engineering problem, and have to fix it. Going in I never expected how much I would get out of it; never thought I would get to be a project manager. Its something id never have gotten if I wasn't as involved as I am. It is out of my comfort zone, but ive grown a lot"

Finding Development Opportunities

The students did highlight the difficulty in finding and entering these experiential learning contexts, which required a lot of effort. In the case of one student, they faced difficulties finding projects due to outdated websites, getting exam board approvals, finding supervisors and companies. These experiences also weren't weighted very highly compared to the effort required. For example, a JIP project that required 40 hours in the company office per week, a student only got 10 credits. Another student described a months long process to set up a 10-week project for 10 credits. A lot of this is summarized by a student that took part in a Multi-Disciplinary Project:

> Student 11 "There's a lack of projects as well, that's why I think they don't want to bring it up, there's not really a project worked out and they don't update them either. So everyone that wants to do a project you have to ask teachers and hope they can think of something. … I have to say the supervisors we did find are really eager to help. Once we got through the bureaucracy of the university and set it up, the supervisors were really eager to help"

Formal Experiential Learning Hesitations

The main barriers at the student level was that students were hesitant to choose experiential learning opportunities. When they did enter the context, it was usually because the purpose of the context interested them, not because they wanted to develop leadership of professional capabilities. Students were also unaware of the value of these experiences until much later, when they had reflected back on them. This ties directly in with ease on entry into the developmental context. This could manifest in multiple ways.

For diverse students, they may resist taking a course because they do not feel it will be an inclusive environment, one professor encountered this when they had no international students enrol for a leadership development course. On the other hand, in the EWB-USA case there was a higher proportion of women engineers than in their classes. Several of the women indicated that this made them feel more supported and less scared of taking on leadership roles within the organisation.

Students were also hesitant to enter formal development contexts because they did not feel that it was a safe learning environment due to the grading system and how hierarchical it was. One student

believed that there would be too much pressure since they'd feel more accountable to the professor and to their peers. Other students simply didn't enter the context because they were unaware it existed or there were significant bureaucratic barriers to entry. One student in a multidisciplinary design project described a multiple month endeavour in setting up a project that was scheduled to last only 10 weeks. Challenges were faced from outdated websites, to difficulties in finding academic supervisors with time or interest to help, to getting approvals from exam boards every step of the way.

4.3.3. Summary on Barriers for Leadership Development

This section outlined the barriers relating to leadership development in experiential settings. Barriers occurred at the system, educator, and student level. The educator barriers related to resources, getting student buy in, dealing with organisational complexity, adapting to student needs, and being unaware of the value of leadership development. The student barriers related to unplanned learning outcomes, and difficulties and hesitations to finding experiential opportunities. Given the factors for development and the barriers, the core theme began to emerge.

4.4. Psychological Safety as the Core Category

The overarching core concept discovered was that of development being easier in a psychological safe environment. This core concept emerged from the theoretical sensitivity of the researcher in recognising that the most grounded intermediate codes fit many aspects of the concept of psychological safety. The most cited definition of psychological safety is:

> "Psychological Safety is a shared belief amongst individuals as to whether it is safe to engage in interpersonal risk-taking in the workplace [42] [20]."

Any developmental challenge is at times a risky and arduous endeavour. Psychological safety is seen as an aspect of the learning environment of an organization or team. In a psychological safe space, team members would feel able to take interpersonal risks such as speaking up, admitting they don't understand something, or trying new methods in their work that might not work. They would feel respected, accepted, and included in the team. Early theorists argued that psychological safety helped individuals overcome the defensiveness, or learning anxiety, that happens when they are presented with information that contradicts their expectations or hope [22].

4.4.1. Psychological Safety in the Data

This core category was discovered through analysing the most common categories mentioned amongst engineering students with experience in leadership roles. Notably, they were asked how they perceived engineering leadership to develop. Implicit is that they are considering themselves to have developed as leaders by answering this question. The most grounded intermediate themes revolved around developing from experience and practice in leadership roles, learning from failure, develop through communicating, and through learning from others.

Ultimately, the theoretical sensitivity of the researcher helped to connect the intermediate themes to the core category. Common in these intermediate themes is the idea of development through learning, failure, and communication, which are key facets of psychological safety. Both prior to and throughout this study, the researcher had an underlying interest in psychology and management, and often read articles on these topics. Whether through interest, or within courses, they had at some point in time been introduced to the notion of psychological safety in building effective teams. This helped make the link between the intermediate codes that emerged in this study and the core category of psychological safety.

Survey respondents repeatedly discussed the importance they placed on learning leadership through personally experiencing it and trying new methods, but also in a safe to fail environment:

> Student 1 "trial and error is the only way I believe you can learn something as complicated as leadership. I think you can take classes and read about it, but when it comes down to it, experience is how you perfect it and figure out what works … It's a lot of testing the waters and

> figuring out what works."

Of course, while leadership development does occur within the individual, student leaders felt support systems can help. One student discussed the importance of being able to autonomously develop leadership, but how support systems from others can help make the environment more safe to learn in:

> Student 5 "I think you've got to be able to fail, to have your own agency to fail, otherwise you're not actually in charge. I think that's why I love the professional mentor system"

In two student chapters, respondents discussed how they had implemented shared leadership positions to support the transition period for new project managers, which they felt made the environment more psychologically safe.

> Student 10 "We have our project teams which each have 2 PMs , those PMs are the only roles that serve for 2 consecutive years, they transition one out and one in every year to help and make sure there's always experience on the project because they're quite complicated and that way there's never a gap in knowledge."

All of these indicate that the individuals felt they took interpersonal risk to develop their leadership. In some cases, it was trying new communication styles based on the team. In others it was leading the engineering team to design their own solution, but having experienced professional mentors that were able to safe check the designs before they were implemented, so the risk of project failure was perceived to be less likely. In others, it was using shared leadership systems that allowed the less experienced incoming leader to feel like they had a safety net as they adjusted to their new role.

Development can be improved in teams where members view the others as their equals, and there are no perceptions of hierarchy. For example, in one study, when employees felt that they were more engaged and likely to speak up in teams where they perceived less of a status gap between themselves and their teammates (Bienefeld and Grote, 2014, in [42]). This makes the university years ideal for leadership development, since the projects are conducted in teams with peers that are also students. One student discusses the safety felt by this:

> Student 5 "Being a middle manager, there's a lot of safety in that position and there's always people you can reach out to and get help from. You're not really anyones boss which is also nice, these are your friends."

Some of this grounded data indicate that the perceived presence of psychological safety and the developmental factors were believed to support students in their leadership development. In the next section, literature will help explore why psychological safety might play such an important role in development.

4.4.2. Psychological Safety's Effect on Leadership Development

Leadership development inherently requires an individual to learn and change. An extensive literature review on psychological safety found that the interpersonal experience of psychological safety was generally found to enable behaviours essential to learning and change, whether at the personal, team, or company level [22].

The idea of openly admitting a failure and seeking advice from team mates without fearing negative consequences is an example of the type of interpersonal risk that would be more tolerable in a psychological safe environment. Not only is this notion of failure intrinsic to the definition of psychological safety, research also backs it up. Psychological safety can assist individuals to learn from failure [10] [34] (Wilkens and London, 2006, in [42]). Of course, failure itself is a normative notion, and norms specific to the socio-cultural environment will determine if something is perceived to be a failure [34]. Hetzner et al (2011) found that learning from errors were a significant predictor of reflection, with psychological safety playing a mediating role. In one study, psychological safety was linked to seeking and giving feedback (Wilkens and London, 2006, in [42]), which is an important part of learning from past mistakes. Failure does not mean that the entire project failed, it tends to relate to interpersonal conflicts, or team

members trying new approaches to leadership and finding they don't work. Often failure is not felt by anyone but the individual themselves.

Being able to openly communicate is intrinsic in the notion of psychological safety. At the most basic level, psychological safety helps individuals in teams feel safer to speak up and communicate (Detert and Burris, 2007, in [22]). More specifically, in a psychologically safe environment, individuals are more likely to voice concern around practices, incidents, or behaviours in teams, as well as to voice ideas that might improve work practices (Liang et al, 2012, in [22]).

Psychological safety is seen as especially important for contexts characterized by high stakes, complexity, and essential human interactions [21]. If the goal of engineering leadership development is for engineers to be able to perform leadership in increasingly complex contexts whilst maintaining professional and personal values, it makes sense the psychological might play a role.

4.5. Summary of Results

Chapter 4 walks through how the application of grounded theory principles resulted in the emergence of the core code of psychological safety. In Section 4.1.3, it was shared how through 3 research phases, and a total of 25 interviews with various stakeholders in experiential learning contexts helped to explore the main research question and sub questions from multiple perspectives. A summary of the outcomes of each research phase is shown below in Table 4.1.

Table 4.1: Summary of the Results by Research Phase

Research SubQ	Summary	Phase	Results
1	**Perceptions** of engineering leadership are complex. **See Section 2.5 for more detail*	1	There are variations in perceptions across generational levels. The perceptions of engineering students are held primary in the research. The differences across generations is discussed further in Section 7.3.1.
		2	There are variations across experience levels. Less experienced engineers are more likely to view leadership as management. More experienced engineers are more likely to view leadership as relational.
		3	Data saturation. See Section 2.5 for more detail
2	There are **factors** of experiential learning contexts that support leadership development	1	Agreement that experiential learning was the best overarching method of leadership development. Begin to explore developmental factors.
		2	The biggest contributor to leadership development was perceived by students to be the amount of time spent in various leadership roles in experiential learning contexts. Intermediate codes relating to factors emerge.
		3	Data saturation. Factors for leadership development coded at intermediate level, with some relating to the individuals themselves and others relating to the experiential learning context. See Table 4.2 for intermediate code summary.
3	**Barriers** are faced by educators trying to implement experiential methods and students entering experiential contexts	1	2 main barriers emerged in supporting leadership development. The first was related to students' ease of entry into the experiential context. The second related to barriers faced by educators when trying to implement new methods.
		2	Barriers for leadership development coded at intermediate level, and split by whether they were faced by students or educators. See Table 4.2 for intermediate code summary.
		3	Data saturation. Barriers related to either students or educators, and often came from larger systemic issues. See Table 4.2 for summary.

In Sections 4.2 and 4.3, the intermediate codes around the research subquestion themes of development (sub question 2) and barriers (sub question 3) were shared. From these intermediate codes the core category of Psychological Safety emerged. A summary of these intermediate codes and how they relate to psychological safety is shown below in Table 4.2.

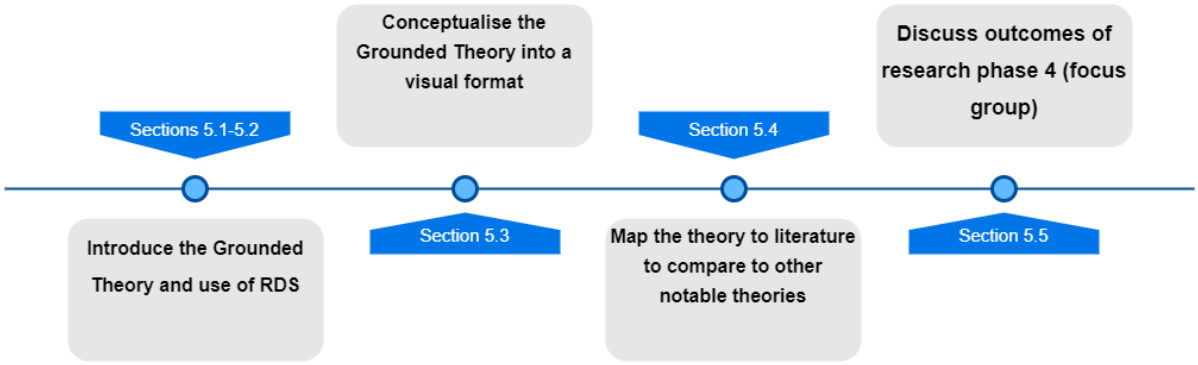
Table 4.2: Summary of the Intermediate Codes by Subquestion

Sub Question	Theme	Relates to	Intermediate Code	Facilitated by Core Category (Psychological Safety?)
2	**Factors**	Individual	Systems Thinking	
			Self Efficacy	
			Reflection	
		Context	Experiential Learning	✓
			Mentorship	✓
			Organisation	✓
			Project	✓
3	**Barriers**	Educator	Resources	✓
			Student Buy In	✓
			Organisational Complexity	✓
			Grading Mechanisms	✓
			Student Development Level	✓
			Perceived value	
		Student	Unintentional Development	
			Finding Opportunities	✓
			Hesitation to try formal experiential methods	✓

Finally, in Section 4.4, Psychological Safety as the core category was described and backed up by the data. The next chapter will aim to explain and conceptualise the theory and how the codes relate to one another. A conceptualisation will be presented, and an example of a practical application to an organisation in a focus group will help refine it and prove its applicability. The development process will be explained in the next chapter through the use of Relational Developmental Systems Theory, a prominent theory in current human development studies.

5

Grounded Theory: Leadership Development in Psychological Safe Experiential Learning



The goal of this chapter is to describe and conceptualise the grounded theory that emerged from the results presented in Chapter 4. Chapter 4 described how the first 3 research phases led to specifying the intermediate codes by research sub questions, with SQ2 relating to factors and SQ3 relating to barriers affecting support of leadership development in experiential contexts. Throughout the research, memos were compiled to try and relate these intermediate themes to one another and develop the theory. However, until the core category of psychological safety emerged and a developmental lens, Relational Development Systems theory, was applied, the grounded theory remained unclear.

Relational Development Systems (RDS) theorizes that human development is a dynamic process based on interactions between individuals and their environment [43]. Viewing leadership development as an aspect of human development rather than something that can be taught allows us to view it as a complex, dynamic, relational process. This lens also aligns with the perceptions of many of the student respondents that the best method of developing leadership was through experiencing it, as discussed in section 4.1.1.

The Grounded Theory is that the process of engineering student leadership development can be supported in psychologically safe experiential learning environments. This is described in detail in Section 5.2. Organisations can support this process by promoting psychologically safety within learning environments. These learning environments are most effective when they use experiential learning methods, and are affected by factors of mentorship, the organisation, the project within the experiential method, and ease of entry into the development context. If organisations can structure these factors in a way that contributes to the experiential context feeling psychologically safe to the individual, it will facilitate their leadership development. Individual factors of self efficacy, systems thinking, and reflection both help the individual develop and are strengthened through experiential learning and leadership development. By applying an RDS lens to development, it enables a conceptualisation

of the grounded theory to be developed.

In order to make the grounded theory more comprehensible, a conceptualised model was developed. The conceptual model is introduced in Section 5.3. Two approaches were taken to determine the validity and applicability of both the theory and the conceptual model. First, a brief literature review was conducted to compare the theory to other relevant theories in literature. Secondly, as phase 4 of the research, a focus group was held with the EWB-USA organisation headquarters. The expectations that the literature and focus group would be able to help further refine the theory by providing feedback and points for comparison based on other researcher views. The focus group helped to highlight that the theory and model were valid for the EWB-USA organisations leadership development contexts. The literature helped strengthen that some of the most grounded intermediate themes had been discovered by other researchers.

By adopting an RDS lens on development, and considering the intermediate and core categories that were introduced in sections 4.2, 4.3, and 4.4, the conceptual model shown in Figure 5.3 was developed. The model is abstract of time, place, and specific people and helps to describe the core process of engineering student leadership development in the primary context of experiential learning. The value of the model is that it can be adapted to different organisations and situations in order to spur conversation around how organisations can support engineering leadership development. In Chapter 6, this will be done for the TU Delft organisation in order to give a set of recommendations on how they can support leadership development.

5.1. Developmental Lens: Relational Development Systems

Throughout the research, the researcher recognised that the theory should consider the lens through which they were viewing leadership development. Was leadership something that is viewed in relation to knowledge and learning, or experience and development? Is it something that can be taught through theory, or must be developed through experience? Until this point, literature on both development and learning had been explored so that the researchers theoretical sensitivity could be honed, but an open mind was kept to allow the development lens to emerge from the data. A key outcome from answering sub question 1 on how stakeholders perceived engineering leadership, discussed above in Section 2.6, was that it was complex, and perceptions on it evolved over time. It would thereby be beneficial to find a lens that allows for integration of this complexity and ambiguity around the developmental process. It had already been found during intermediate coding that there are individual and contextual factors that affected students leadership development. Therefore, leadership development should be viewed through a lens that allows both sides of the development context (the individual and the context) to be considered. A meta-theoretical paradigm that incorporates the aforementioned considerations is Relational Developmental Systems (RDS) theory.

5.1.1. Background Information on Relational Development Systems

Relational Developmental Systems Theory (RDS) theorizes that individuals have agency to shape their development, but the degree to which they can enact this agency will vary based on contextual circumstances [56] [57]. RDS occurs in a subsect within socio-cultural human development, called Developmental Systems Theory (DST), that individual development and culture cannot occur separately, they are co-constructed, co-determined, and co-developed [43]. In other words, using an RDS approach, it is not possible to explain development without considering the individuals attributes and the developmental context [8]. Simply put, this means that as much as students may want to develop leadership, the context they are in will affect influence how effectively they can do that.

RDS is derived from a process-relational paradigm, focusing on process, holism, relational analysis, and the use of multiple perspective and explanatory forms [43]. This is in contrast to the Cartesian view that favour theories that emphasize understanding subjects by studying them at different levels of organisations and re-combining them to understand the whole [44]. On the context side, RDS can include many levels, including relationships amongst members, cultural contexts, social influences and norms, and the organisational context [8].

5.1.2. Applying RDS to Engineering Leadership Development

RDS posits that development is a dynamic process, the interacts in 1 stage are the products of earlier stages [32]. For example, based on students perceptions of leadership, initially, the process goal could be considered to be able to lead engineering teams and groups of engineering teams, however, that goal is in itself not stagnant. A key component of the process of engineering leadership development is that it is one of lifelong learning. There is no defined end goal, it is a constantly moving target. Every new project, team, or organisation could represent another process input, with new lessons to learn and capabilities to develop in leadership. Students that had more experience with leadership shifted their focus and goal to instead be able to perform leadership of organisations and projects in ways that took more systemic views on the problem, considering greater impacts on society before accepting projects.

In RDS emphasis is on the combination of the person and the context as the main unit of analysis for understanding development. In RDS, development is bi-directional. RDS also allows for the acceptance that in participating in a developmental context, the individual is both affected by, and affects the context. This bi-directionality also indicates that coaction of the individual and context involves the entire developmental system [8]. This is often shown using a bi-directional arrow showing the individual<–> context interaction for development. Figure 5.1 shows how engineering leadership development is explained through RDS as the co-interaction between an engineering student and experiential learning, the primary developmental context.

The intermediate codes of the study helped highlight factors that affected leadership development

Figure 5.1: The engineering leadership development process using RDS

from both the individual and contextual side. These factors are specific to experiential learning and are not considered to be all encompassing for other experiential contexts. Instead they show how RDS can be used to explore leadership development contexts. In RDS, individuals are treated with more autonomy and capability in choosing the contexts they engage with. As a result, the focus of educators should shift to providing support for students that helps them engage with the developmental contexts in a way that helps them take agency in their own development. RDS also promotes a less hierarchical approach to development, it emphasizes that for greater overall development in the system, there are mutually beneficial individual <–> individual relations within the individual <–> context system. This cascades into a less hierarchical approach to leadership, as a relational process rather than a way of managing people and projects in a hierarchical sense.

RDS is a valuable lens here because it can be tailored to specific experiential contexts and to specific individuals. At a larger scale, it can be used by organisations to explore trends among groups, such as new graduates, or engineering students, to discuss holistic approached to leadership development for general populations. It could even be tailored to minority groups to try and determine methods of spurring leadership development in specific groups. Individual project groups could even use it to determine how to spur development amongst their group members or to check in on how they are contributing as an individual to fostering a developmental environment for others within the context. RDS also allows for incorporation of the core category of psychological safety into the conceptualisation.

Consulting the literature around how psychological safety affects development led to 2 articles by Wanless that introduce Relational Systems Development Theory and posit that psychological safety can play a role in human development [56][57]. Psychological safety has mostly been studied in the fields of business and organisational behaviour, however more recently efforts have been made to use it in relation to human development using Relational Developmental Systems Theory [56]. Decreasing restrictions on individual agency could enhance the ability to grow and develop, and psychological safety can act as a facilitator to decrease those restrictions, thereby enhancing development [56]. In regards to psychological safety, it can act as a moderator of the factors that affect the context in which individuals are developing. If we consider the individual <–> context interaction, increased psychological safety would make the arrow <–>, the interaction, be more positive and more supportive in development. So increased psychological safety in the developmental context, here experiential learning, would result in more positive development. Combining the developmental lens, RDS, the core category, psychological safety, and the intermediate codes relating to the individual and contextual factors and barriers that were perceived to support leadership development allow the Grounded Theory to be introduced in the next section.

5.2. Grounded Theory: Supporting Engineering Student Leadership Development in Experiential Contexts

Based on the data grounded, it appeared that if learning organizations can structure and provide experiential learning contexts in a way that promotes psychological safety in project teams, they can support engineering leadership development. Ultimately, students perceived that they best developed leadership by practicing leadership in experiential settings.

Psychologically safe project teams were perceived by students to support their agency in taking the interpersonal risks associated with developing individual aspects that were observed as playing a role in engineering leadership development. The individual aspects that were observed to correspond to leadership development included systems thinking, self efficacy, and reflection. Systems thinking related to a bigger picture awareness of the complexity of engineering problems beyond technical

design. Self efficacy included capabilities such as listening, adaptability, communication, self confidence, and technical knowledge. Reflection involved looking back on learning experiences and careful thinking about how they went and how to adapt to future situations. More experienced engineering student leaders were perceived to have more developed systems thinking, self efficacy, and reflection.

Developing these individual aspects required taking interpersonal risks. These interpersonal risks could include speaking up with dissenting views, with taking on formal leadership roles they were unsure they felt ready for, or with taking risks in the project such as trying new project management techniques. These were risky because they could involve loss of face in a team, team conflict, or setbacks in projects. However taking these risks was important, since many respondents indicated they developed leadership mostly through trying new approaches, some of which worked, and some of which failed and they reflected on before adjusting the next time.

The experiential (context) aspects that respondents indicated as contributing to psychological safety in teams were related to the project, the learning organization itself, mentors, and how easily the individuals could enter the experiential learning context.

In using relational development systems theory, this GT highlights that development is a dynamic process in which individuals and contexts impact each other. This implies that individuals can also affect the leadership development of other project team members in the experiential context. This is in line with process leadership theories. Since this research was focused on engineering students (1-5th year), these findings are not necessarily generalizable at later stages of engineers development. For instance, at some stage other factors such as formal leadership training or management theory might become more pertinent.

5.3. Grounded Theory Conceptualisation

The grounded theory is conceptualised into a model to make it easier to understand. As noted by Glaser, the most important aspects when it comes to conceptualizing grounded theory are that the concept are abstract of time, place, and people, and that the concepts have enduring grab [26]. The theory doesn't need to describe an entire unit, but a core process within it [26]. In this case, the aim is to conceptualize how psychological safety contributes to the process of engineering student leadership development in experiential learning contexts.

Expanding on the basic RDS conceptualisation of engineering leadership development introduced in Figure 5.1 based on the core and intermediate categories helped develop the model, shown Figure 5.2. The conceptualisation shows engineering students developing engineering leadership in the context of experiential learning using a bi-directional arrow. It incorporates the most grounded intermediate categories perceived by interview respondents to aid leadership development based on whether they related to the individual or the context. It also includes a barrier of ease of entry, where the absence of psychological safety led to a barrier to individuals entering the developmental context.

The bi-directional arrows indicate how components of the development process interact in ways that support development or not. As stated, the GT theorizes that psychological safety influences the effectiveness of these interactions in supporting development. As a phenomenon felt in team settings, psychological safety is incorporated into the bi-directional arrows that indicate interaction between development factors that involve 2 or more people. The interactions influenced by psychological safety are shown as multicoloured so that they can be adapted for an experiential context and coloured to indicate whether psychological safety leads to a positive interaction (green, there-by supporting development) or a negative interaction (red, undermining leadership development potential of the experience). Psychological safety is not necessarily the only contributor to the effectiveness of these interactions, but it was perceived by students interviewed to be important.

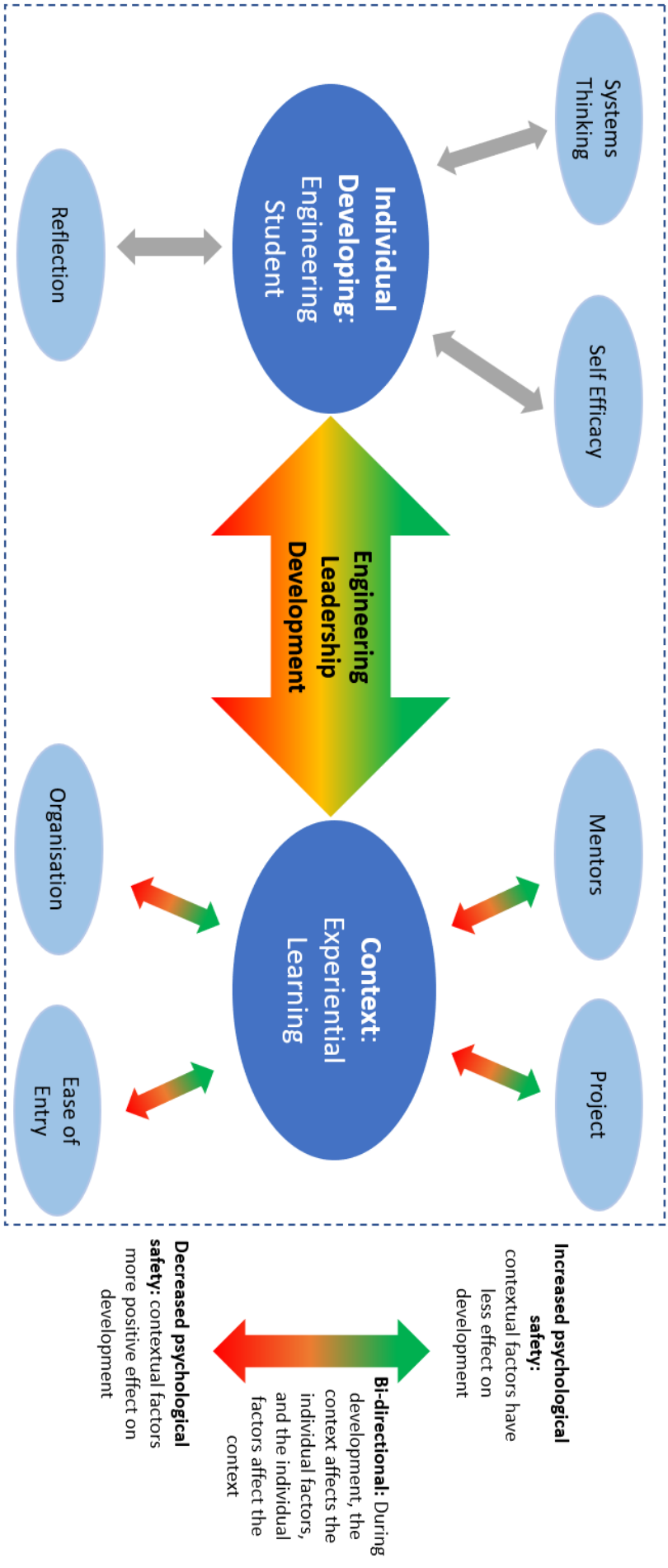


Figure 5.2: Theoretical Model: Supporting Engineering Leadership Development through Experiential Learning

The process of leadership development is an intersection of a variety of factors relating the the individual and the context in which they are developing, as indicated by the individual <–> context. Every new project, team, or organisation could represent another process stage, with new lessons to learn and capabilities to develop in leadership. This is why this model aims to remain abstract of time, place, and people, it will hopefully be applicable for engineering student leaders in many experiential learning contexts. An important note is that by using RDS, the model and theory can be applied at various levels. For instance, it could be applied within a single project team, or for an experiential learning course, or for an entire organisation in relation to the experiential learning contexts they utilise.

The most notable factors and barriers that students and educators perceived to support leadership development included the project, mentors, ease of entry into the context, and organisational factors. Structuring these factors in a way that leads to psychological safety in the team could help support leadership development. For example, in a real world case, if mentorship was incorporated in a way that improved psychological safety, then the arrow would appear green for that case. This could help highlight areas for improvement for organisations or groups to support leadership development. This model therefore could be applied to help organisations to better assess and support leadership development in engineering students.

As engineering students develop in their roles as leaders of engineers and engineering projects, their learner maturity and experience increase. The result of this is that their perceptions on leadership itself will change, and they will become capable of dealing with increasing complexity. This complexity could come in the form of more complex projects, or leading in more abstract settings, such as the leader of an organisation, or a leader in society. Individual factors affect the context, although they are not affected by psychological safety, with these arrows being shown as grey in the model. This is because psychological safety relates to interpersonal risk, it cannot be used at an individual level. The arrows are still bidirectional to indicate that they still work in the (individual <-> context) development view of RDS.

The contextual factors perceived by engineering leaders as having an influence on their leadership development were explored during the interviews and the findings presented in Chapter 4. These factors can be influenced by both the individual developing leadership and by the context in which they do it. Based on the data collected, some of the contextual developmental factors will be unbundled, as well as how psychological safety plays in.

5.3.1. Mentors

Mentors were the most grounded intermediate theme in relation to engineering leadership development. Students felt both technical and professionally focused mentors helped them develop by fostering psychological safety. On the technical side, students could explore more creative and risky solutions to problems knowing that there was a check from the technical mentor that the engineering fundamentals were sound and the design wouldn't fail. Failure in this case would be high, it could result in loss of integrity of a structure or water tower that could either hurt people of endanger their water supply. So in this case the mentors aid leadership development through allowing team members to pitch and explore more unconventional solutions in a safer way.

On the professional side, mentors were even more perceived to contribute to psychological safety. Students felt that most of leadership related to team work and relationships. When leaders ran into issues within the team, mentors provided an experience eye that could help them explore the issue and discuss constructive approaches to solve the issue. Mentors could provide examples of their own experiences, helping the student realise how common interpersonal issues are in teams and feeling safer to engage with the team to reach a solution. Or in some cases mentors could provide resources such as books or even videos on common issues new leaders face to help them develop capabilities such as conflict management or working in diverse teams. These are some examples of how the presence and quality of mentors can influence psychological safety of students in their leadership development.

5.3.2. Organisation

Organisational culture related to team norms, values, and expectations. An important way organisations can contribute psychological safety is by promoting a safe to fail culture. Organisations can promote this by more openly sharing and discussing their own failures. Doing so shows that we all make mistakes, but that it is ok provided we learn from them. On the other hand, if organisations punish any failure, or shy away from discussing how to improve upon failures, it instils a culture where members feel that they cannot try methods or approaches to problems. Not only does this stifle the development of the individual because they cannot try new behaviours and learn from them, it also stifles organisational development since members feel less safe to voice creative or novel approaches that could solve organisational problems.

When the organisation measures performance this can also stifle development. Performance measures could occur at either an individual, team, or project level. For example, individuals receive grades in university settings and performance reviews in their professional lives. If these are given in a way that punishes the individual taking risk, or trying new things that could potentially fail, they could stifle development. In a classroom, an individual could try a leadership for the first time and risk that they might not perform well, since it is their first time, and receive a poor grade since their performance is not good. Some projects try to balance this by giving the same grade for all members of the team. This too does not necessarily promote psychological safety; it doesn't reward interpersonal risk taking or value development over project outcomes.

Organisational structure refers to the system that organisations use to direct certain activities in order to achieve their goals. The main role considered was how the hierarchical structure of the organisation affected leadership development, where more hierarchical structures often led to students viewing those above them as having more status, particularly educators. While this status is deserved, these perceptions of status can also make individuals feel less psychologically safe. The result here is that rather than perceiving educators as mentors or that they can easily approach them for help, students indicated that they sometimes felt that educators are not approachable. Since they do not feel psychologically safe to approach them, they miss out on valuable opportunities to learn from educator's wealth of knowledge. On the other hand, some hierarchy within student projects helped development through gradually increasing role or project complexity as students conducted leadership in more complex situations. They key here seems to be that hierarchy in itself didn't necessarily affect psychological safety. Rather, the tendency of hierarchical systems to lead to perceived status differences did.

5.3.3. Project

Most experiential learning contexts require students to work on projects. The format of these projects could vary wildly, from 10 week research focused projects in internships, to 2 year project in extra-curricular settings where students are just exposed to a small portion of the overall project. Students felt that longer projects were more beneficial for fostering psychological safety. A key aspect of psychological safety is feeling comfortable in a team environment, and longer term projects allowed team members to establish relationships and trust that made the environment safer. Based on the students developmental profile, different aspects of projects will provide different levels of psychological safety for them to develop in. These aspects include the complexity of the project, and the size of the project team.

In the early stages, students indicated that they felt safer to take on leadership roles when it was for a smaller team. They were responsible for a smaller part of the project and had fewer teammates relying on them as a leader. They found project structure also helped, for example by having a clear project outline or by following a standardised engineering design process. They felt this structure helped them feel less overwhelmed by other aspects of the project itself so they could focus on their personal development.

As things progressed, students required more challenge and either took on more ambiguity or complexity, leading larger projects or groups of people. In later stages, students described not even needing formal leadership roles in team projects, they were comfortable with the team and their ability to have different people lead based on the task at hand. In this case, there was enough interpersonal trust

and safety to carry out projects without formal team roles. Students were also more capable of dealing with more diverse stakeholders, and challenge could be added by working directly with communities or non-engineering stakeholders.

Central through all of this is that the context that students found best developed leadership in depended largely on their current level of leadership development. Educators felt that throwing students into situations for which they were not ready led them to become overwhelmed and shut down, they did not feel safe and as a result were unable to develop effectively. To improve psychological safety in early stages of development, the projects could be structured more through either a clear engineering design process being provided or a clear road map. Smaller groups in these earlier stages also seemed to be considered safer spaces for development.

5.3.4. Ease of Entry

A major barrier to leadership development, as viewed by educators, was that students do not choose to take experiential opportunities that promote leadership development. There is some sort of barrier that prevents them entering the experiential leadership development context. Psychological safety may play a role here, in particular in academic settings. In education, any courses must be graded. It is theorised that the grading mechanism in particular makes the developmental context much less psychologically safe since it explicitly punishes failure.

Ease of entry could also apply to social or cultural barriers that make minority groups feel less psychologically safe to take on leadership roles. Engineering is typically a male dominated study. Female students that participated in EWB believed that because there was a higher proportion of women in the organisation, they felt they had more peer support to take on the risk of trying leadership roles. The same could be said for different cultures entering into developmental contexts. One educator that created a project course around leadership development in TU Delft described her dismay that she could not get any international students to join the course.

Ease of entry could also occur more informally for leadership at a group level. For instance, if an engineering team or project group has a high level of psychological safety, it could help individuals to feel more empowered to take on short or informal leadership roles when they are dealing with aspects of the project where they have the self-efficacy to lead the team. It could help explain benefit of the EWB step wise approach to helping students experience leadership development in increasingly more complex contexts. Students were introduced to leadership roles by leading small sub teams of 2 other students and gradually taking on larger teams and responsibilities within the chapter. It was relatively easy to get involved in a low risk environment, they didn't need to jump to taking on a lot of complexity and responsibility.

5.3.5. Individual

The individual developing is both part of the context, and is influenced by the context. Factors inherent in the individual therefore also contribute to leadership development. This allows for some aspects of the individual to be considered. It also allows for us to break away from a strict definition of leadership and allow the individuals perceptions to take hold. The individual factors are not universal, or all encompassing, but were perceived to to effect leadership development from the individual's side. The main factors included self-efficacy, systems thinking, and reflection. Notable, as the individuals develop, these individual attributes are also become more advanced.

5.4. Mapping Theory to Literature

The goal of this section is to determine where the grounded theory presented relates to other theories in student leadership development. The most notable theories found included Komives (2005) Leadership Identity Theory, and Eich's (2008) Theory on High Quality Leadership Development Programs. These pieces of literature will be introduced, as well as how they relate to and reinforce or refute aspects of the grounded theory discovered in this research.

5.4.1. Komives Leadership Identity Theory

A prominent scholar is student leadership development is Komives, with her theory on Developing a Leadership Identity and Leadership Identity Development Model [37] [38](Komives, 2005) (Komives, 2006). The type of leadership strived for is relational leadership [37]. Straussian Grounded theory was used to situate the theory in 13 college student leaders experiences, as based on interviews. The research goal was to identify the dynamic process they experienced in creating a leadership identity, from childhood to the time they were students. They equate leadership development with leadership identity development, where leadership identity is the core category in Komives theory and "the cumulative confidence in one's ability to intentionally engage with others to accomplish group objectives" [37]. In other words, Komives postulates that by determining how individuals view leadership, they can determine how developed their leadership is. Central to this is the idea that development isn't linear, but cyclical and complex [38].

The Core Category in Komives theory is leadership identity, and the theory is that students develop leadership through 6 stages of shifting leadership identity, although they might not necessarily progress through them all. Within the process itself, leadership was developed through developing self with group influences, this in turn influenced a changing view of self with other from dependence to interdependence and resulted in a broadening view of leadership, which gradually developed from an external, hierarchical view of leadership to viewing leadership as a collaborative process. Also included were 4 aspects of developmental influences that facilitated this leadership development. These developmental influences included adult and peer influences, meaningful involvement, and reflective learning. The theory was informed by Bandera's Social Learning Theory, and Kegan's constructive development theories on orders of consciousness [37]. Both of these theories consider individuals to develop based on the environment they are in, but neglect the idea that they also shape that context. In other words, it does not go as far as relational development systems theory. Komives LID theory is conceptualised in Figure 5.3.

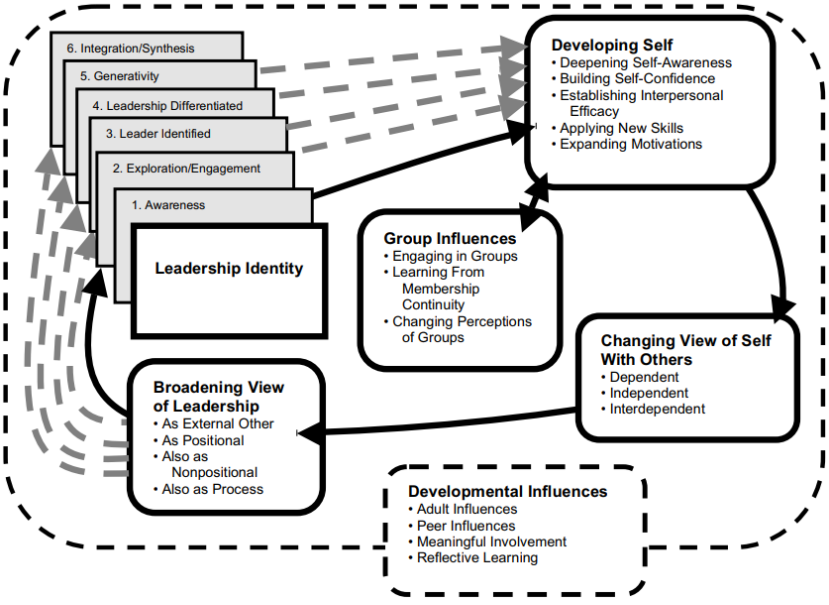


Figure 5.3: Komives Grounded Theory: Developing a Leadership Identity - Illustrating the Cycle

Aspects of Komives theory can be directly related to the GT of this research. The developmental influences are representative of the environmental context in which leadership (identity) developed. Adult influences directly compared to mentors within my conceptualisation. Peer influences and meaningful involvement were encapsulated in the organisation and project. Reflective learning was the same as reflection on the individual side. While not explicitly labelled, aspects of psychological safety were presented as reasons for these developmental influences being valuable. They directly refer to adults creating "safe spaces in classes and organisations where students learned to communicate" and peers

affirming individuals that they were capable of leadership as well as establishing positive group climates [37].

This research determined that students held evolving views of leadership over time, and viewed leadership through a more managerial lens in earlier days, and a more relational lens with increasing experience (See Section 2.5). This shift is reinforced by Komives core category of leadership identity. The difference lies in that Komives believes leadership development can be measured directly by how students perceived leadership (their view on leadership identity).

The main differences between these theories lay around how leadership development was defined and how leadership capabilities were assumed. Komives assumes students have developed leadership by having them nominated by educators, whereas this research did so by selecting participants that are democratically elected to leadership roles by peers. My theory focuses less on what stage the individual developing is in, and instead tries to unearth what contextual factors contributed most to their leadership development, regardless of developmental phase, and why. The why is explained in this research through the core category of psychological safety. Thereby this research concerns itself less with measuring development, and focuses more on supporting development.

The main drawbacks of the LID theory lie in how leadership development is equated with leadership identity development. More specifically, the concept of leadership identity is defined differently throughout the paper, and the reasoning behind why leadership identity development is the same as leadership development in unclear. Additionally, despite focusing on student leadership development, Komives study mostly explores how individuals developed leadership identities since childhood. Additionally, the focus isn't on engineering students specifically. As such the contextual factors are more broad, and it is less apparent how organisations hoping to support engineering leadership development can influence the process. On the other hand, Komives theory goes more in depth into how the individual experiences leadership development, and the internal factors in that process. This could be seen as a broader, complementary theory that helps to situate individuals developing into particular phases of leadership development.

Another weakness is that while stating to be student centered, the students are deemed to have developed leadership based on professor perceptions. By doing this, Komives leaves ignores that perceptions of good leadership may be generational, and assumes that the values of the older (professor) generation, match that of the student generation. Also ignored potential biases of the professors, and doesn't consider the diversity in perspectives of the professors, which could vary wildly from the diversity of the student group. This could perpetuate an older generations perception on effective leadership. This theory, by contrast, focuses on students that are deemed to be leaders based on peer perceptions. This reinforces it as a more student focused theory.

As discussed, aspects of Komives LID Theory provide evidence to validate my theory, notable around the developmental influences presented by Komives, which were encompassed by the contextual factors of mentorship, organisation, and project. The notion of psychological safety is implicitly discussed in adult and peer developmental influences, though not recognised as such, potentially since psychological safety had not yet emerged as a prominent idea at the time of Komives research.

5.4.2. Eich's Grounded Theory on High Quality Leadership Programs

Eich's (2008) grounded theory of high quality leadership programs tackles leadership development from a different angle. The goal of this research was to identify what attributes of leadership programs contributed most to undergraduate student leadership development. Eich defines leadership as a *"process in which all individuals have the capability of developing and engaging in whether they hold a formal position or not"* [23]. This research selected 4 programs considered to represent a diverse sample of high quality leadership programs. The programs were all from different universities in the US and included a single semester interdisciplinary leadership course, a week long leadership retreat facilitated by a non profit organisation, a 4 year co-curricular program, and a 4 year service leadership program. Leadership development is not specifically defined, but rather the programs were deemed to by high quality and deliver leadership development based on student perceptions shared in the

interviews. The method employed is also Constructivist Grounded Theory. Interviews were held with 62 people, 45 students and 17 educators involved in the programs. This study also highlighted the importance of both service and experiential learning in leadership development.

Eich identified 16 attributes that most contributed to leadership development based on student perceptions. These attributes were further refined into 3 clusters of attributes, which are shown in Figure 5.4. After introducing each attribute, actions of how the programs put those attributes into practise are exemplified, as well as explanations of some of the student outcomes. Cluster 1 focused the environmental context within the programs, with participants that engaged in building and sustaining learning communities. Cluster 2 focused on the experiences themselves, and promoted experiential learning experiences that were student centered. Cluster 3 focused on educator responsibilities to continually develop the programs based on the most recent research.

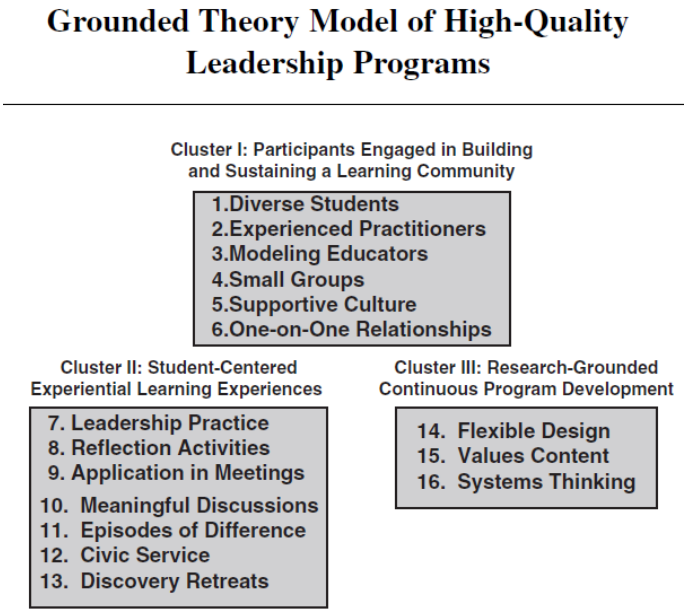


Figure 5.4: Eichs Grounded Theory: Model of High-Quality Leadership Programs

No core category emerged in this research, and the conceptualisation does not attempt to relate the categories, or clusters, to each other. This makes it more difficult to compare the theory to mine, however some notable categories are shared in common. The attribute of supportive culture is in close relation to psychological safety. Eich states that: “participants challenge each other to risk and learn from mistakes, ask difficult questions, and think for themselves, all within a safe, encouraging atmosphere”, this atmosphere could be described as psychologically safe [23].

There are some notable weaknesses to Eich’s theory. Firstly, as is often the case with grounded theory, it is lacking in structure and is hard to follow. The study also does not provide strong reasoning for why the 4 programs picked were deemed to be high quality. Throughout the paper, multiple styles and definitions of leadership are used, and it is not clear what is meant by leadership, or leadership development.

As with any constructivist grounded theory, the theory is an interpretation rather than an exact representation; it cannot occur without the researchers viewpoint [51]. So while it does not try to relate any of the attributes to one another, and does not consider the individuals context, it shares many commonalities and generally agrees with the data grounded in this research. Therefore, this theory could complement mine and provide an additional checklist for reference for educators and organisations trying to support leadership development.

5.4.3. Outcomes of Mapping Literature

Mapping the grounded theory constructed in this research helps to explore its broader validity and applicability. Komives theory on Leadership Identity Development helped reinforce some of the developmental factors for development. It also provided more structure to the idea of evolving perceptions of leadership through the use of leadership identity as the core category. Eich's (2008) Grounded Theory helped to highlight specific aspects of experiential learning opportunities that could be valuable to supporting leadership development. In this way he provides a tool that may provide value, in conjunction with this grounded theory that is more applicable at various levels, for educators while developing experiential methods.

Aspects that could be related to psychological safety could be found in all of the papers, however it was never deemed a core category or moderating factor for leadership development. Key differences lay in how they measured leadership development. All of the research, myself included, sampled primarily from US based universities. Further research would be required to deem their applicability in different cultural contexts.

5.5. Focus Group: Application of Grounded Theory

As the fourth research phase, a focus group was held with 10 members of the EWB-USA headquarters. The purpose of the focus group was to share the grounded theory and show how the model could be used to spur discussion to improve leadership development support. The goal was to validate whether the organisation agreed with the theory presented and saw value in using it as a tool. The members included those from the projects, learning, and volunteer engagement departments, as well as an intern that had also volunteered with the organisation for 4 years as a college student. The focus group attendees and slides are detailed in Appendix E.

The grounded theory model was adapted based on how the researcher rated the experiential learning context of EWB-USA's International Community Program. The organisation scored high in project, mentors, and ease of entry, and medium on organisation. The adapted model for this case is shown in Figure 5.5.

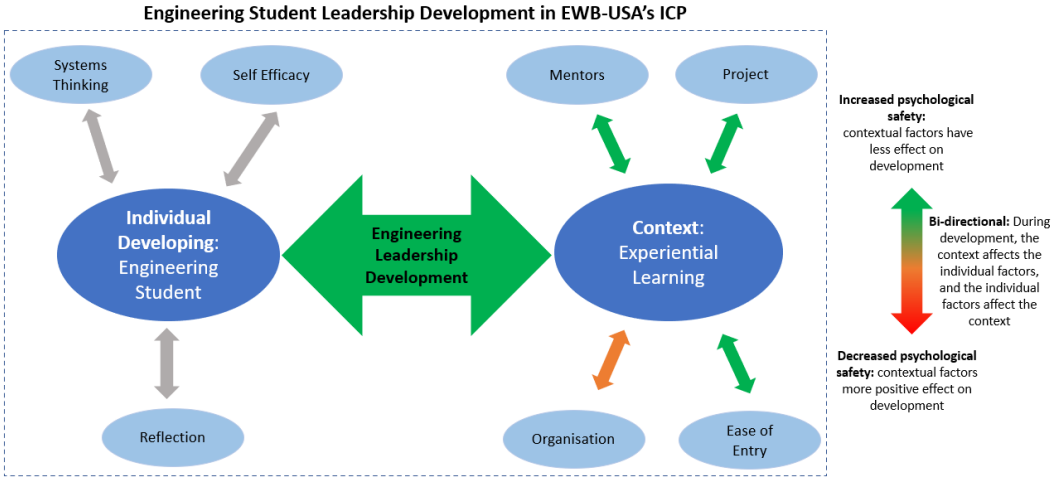


Figure 5.5: An adaption of the conceptual model to show how the EWB-USA organisation supports leadership development

Recommendations were made to adjust the experiential context to improve psychological safety and thus support leadership development. Table 5.1 breaks down the ratings and recommendations.

Table 5.1: Summary of the Ratings of the EWB-USA organisation related to leadership development

Aspect	Factor (Rating)	Promotes Psychological Safety	Could improve psychological safety
Context	Project (Good)	Strong engineering design process allows students to focus on personal development. Working with communities fosters communication and collaboration with non engineers. Longer term projects, teams become more comfortable with each other.	Promote quality over quantity of projects. Promote collaboration with communities and diverse viewpoints.
	Mentors (Good)	Multiple mentorship model	Mentors with more diverse background
	Organisation (Medium)	Country office model effective as they faciliated communication and cultural awareness with communities. Chapters are given autonomy. Design process and mentorship included. Shared leadership approaches. Low status differences: leaders are peers.	Promote safe to fail culture, go beyond lessons learned and embrace failure. Be wary of power / status dynamics that could make environments less safe to develop in (chapter - community, hierarchical chapters, mentors)
	Ease of entry (Good)	Projects provide a strong purpose to attract students. High proportion of women makes it a safe environment for them to practise leadership in.	Consider how accessible organisation is to all students / non engineers. Provide more projects in country to help accessibility / diversity
Individual	Systems thinking	Exposure to clients with different viewpoints, culture, technical backgrounds	Systems thinking not prioritized. No formal training
	Self Efficacy	Lots of opportunities to practise in leadership roles formally and informally during projects. Mentors help facilitate personal development	
	Reflection		Promote active reflection and feedback

5.5.1. Focus Group Feedback

The program manager of the ICP found the tool to be helpful, and indicated that it helped highlight some advantages of the ICP that had not previously been considered. Notably, having longer term projects had previously been seen as a negative at headquarters since it made knowledge transfer more difficult. On the other hand, the model showed it as a positive for leadership development since it allowed students to become more comfortable with their team mates and promoted leadership and personal development. This highlights the complex and paradoxical nature of project success and individual development; aspects that might cause difficulties in projects themselves might provide better environments for individual development.

An intern that had spend 4 years as a volunteer in the ICP program in university noted that value of the model in dealing with the issue at multiple levels. She indicated that it not only showed leadership development on a personal level, but also at a higher systems level. For example, she said that at the end of trips to communities, she could see that better relationships between team members and the community led to higher psychological safety and it was a safer space to discuss and reflect on how the project went. The team felt more comfortable admitting where they didn't know the answer and discussing how to improve their approach in the future. The result was that leadership was developed at multiple levels, within volunteers, community members, and as a group.

Another member gave the feedback that the model should be clearer around defining failure and promoting it as a good thing. For instance, for the entire project to fail technically wasn't a good thing; it could lead to a bridge collapsing or a water tank leaking. The outcomes of this was that a clear distinction of failure is included in the report Section 4.4.2, and how it related to psychological safety.

5.6. Summary of Grounded Theory

The purpose of this chapter was to describe and conceptualise the grounded theory results introduced in Chapter 4. Relational Developmental Systems was introduced as a socio-cultural human development paradigm that considers individual and contextual factors for development. Using RDS, a conceptualisation was developed that shows how both individual and contextual factors can were perceived by interview respondents to contribute to leadership development. Mapping the grounded theory to similar theories in literature helped situate it in the larger research field. A focus group discussion helped refine areas of the theory to discuss and refine. In the next chapter, the model will be applied to some of the TU Delft organisations experiential courses to show how it can help organisations assess how they support leadership development.

6

Applying the Theory: TU Delft

The purpose of this chapter is to show how the Grounded Theory and theoretical conceptualisation can be applied in to help organisations assess how their experiential methods support leadership development. The Grounded Theory, as introduced in Section 5.2, is that organisations can support engineering leadership development by offering experiential learning opportunities that promote psychological safety in project teams. If the experiential opportunities promote psychological safety, students are more free to take agency in developing their individual aspects of leadership.

The model, as introduced in 5.3, provides a visual aid for parties to assess the current state of their experiential learning methods. By assessing the current state, and assigning colours to each contextual factor for leadership development, it becomes clearer where the efforts can be focused to improve psychological safety in the experiential opportunity. An example of this application was already done in the Focus Group, where the EWB-USA ICP (a PBSL experiential method) was assessed using the theory and conceptualisation to provide a set of recommendations for improvement. At that point, comments feedback helped strengthen the perceived usefulness of the tool by the EWB-USA organisation and provide further data saturation to strengthen of the theories applicability.

The other organisation that was involved in this research was TU Delft. This chapter will use the GT conceptualisation to explore how the researcher perceives that TU Delft currently supports psychologically safe experiential learning opportunities that can contribute to engineering leadership development. The experiential opportunities considered are those that were explored with students, namely internships, the Multi Disciplinary Program (PBL method), and the Joint Interdisciplinary Program (PBL method). Time constraints prevented a more comprehensive exploration of all of the experiential methods offered at TU Delft.

Assessing the current state of how TU Delft supports engineering leadership development helps highlight where there might be room for improvement. Of course, this application is done solely based on the researchers perceptions and inputs from the interviews with students and educators at TU Delft. It should also be noted that these ratings are based on perceptions of fewer students (3), as compared to the EWB-USA case. The outcomes could be improved by input from a more knowledgeable group of educators, and from more students. The point therefore is not to provide a definitive ranking or set of recommendations for the organisation, but to show how the GT can be applied in other settings to help organisations establish a base line of their support for engineering leadership development.

6.1. TU Delft Experiential Method Rankings

The researcher ranks the overall rating of the experiential methods in promoting psychological safety in experiential settings as medium. The organisations experiential methods considered scored medium in all of the factors for leadership development. In all the contextual factors, there were aspects of experiential methods that promote psychological safety within project teams, and others where they hindered it. For projects, positives included that many opportunities helped cater to diverse student needs, however there was a general lack of structure and limiting short time span within them. Mentors were also often present but there was no cohesion around ensuring an adequate quantity and quality of mentors to enact psychological safety. Contexts were often difficult to enter due to students being unaware of them, and professors not having enough resources to provide more opportunities, or opportunities of greater value. The organisations focus on performance measures as a keystone of education largely reduces psychological safety in experiential learning settings.

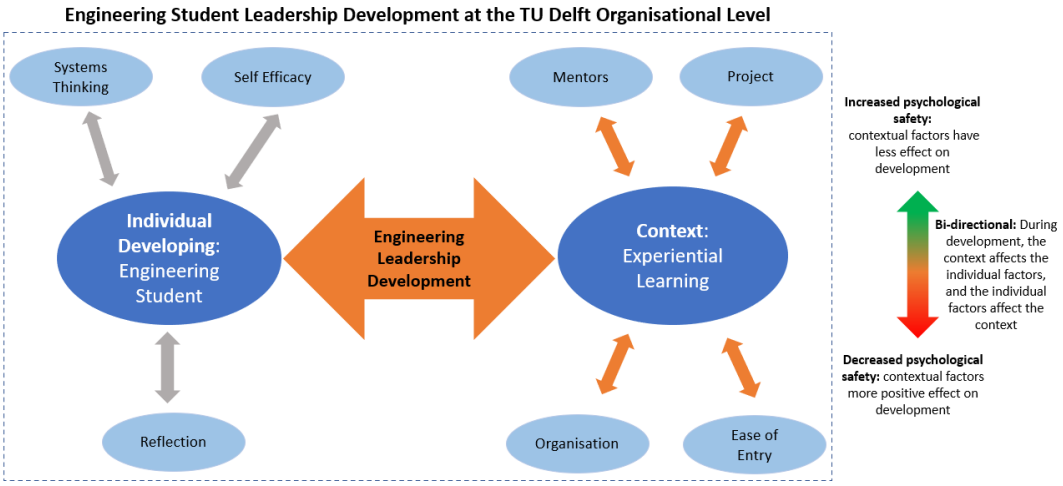


Figure 6.1: An application of the GT model to show how the TU Delft organisation supports leadership development in the JIP, MDP, and Internship programmes

6.1.1. Mentors: Medium

Based on input from the student respondents, access to mentorship varied by experiential course, by project, and by faculty. There were variations in both the quantity and quality of mentors students experienced. In some course students described having to set up a set of supervisors for their project, who in turn acted as mentors. Others joined courses where they were paired up with an industry sponsor and there was an industry provided mentor. The students felt that the accessibility and quality of the mentors seemed to vary. Some described an industry mentor that was available every day and provided good guidance throughout the experience. Others described how they were responsible for finding their own mentors, and struggled to find mentors, typically educators or PhD students, that had the expertise, interest, or time to effectively mentor them. All in all this indicates that there is no cohesive approach to mentorship within experiential opportunities in TU Delft. A large part of it is left to luck of the draw on whether the students are provided mentorship by the company or whether they are able to find mentors within the university that they feel provide them help.

6.1.2. Organisation: Medium

Based on viewpoints of educators and students, the biggest weakness in the experiential contexts related to the use of performance measures, namely grades, and to perceived status differences due to the hierarchical structure. While the grading systems varied from course to course, there was a requirement for educators to grade students on a scaling system from 1 to 10. One professor described pushback from their supervisors when they tried to implement a pass-fail grading method that promoted students learning by playing with ambiguity, purposely failing and reflecting back on it. They argued that this promoted student development and learning more since students weren't as focused on achieving

a high grade. However, organisational support was difficult to get.

Another professor described issues where they tried to use peer feedback as an input for grades, but found all students graded each other the same, preventing a valuable learning opportunity for constructive peer feedback. The difficulty in grading around aspects such as leadership development is that it requires professors to quantify complex capabilities that are difficult to measure. Grading also required professors to be transparent in grading schemes and make up front normative statements about what is considered to be good leadership, or good leadership development. This limits their autonomy and does not allow for recognition of diverse approaches that they may not have considered until they see students exemplify them.

6.1.3. Project: Medium

A positive was that there was a myriad of experiential opportunities for students, ranging from Multidisciplinary projects that are often conducted internationally, to Joint Interdisciplinary projects conducted with other faculties and an industry sponsor. In the time of this research, no projects that fit the PBSL context were discovered, however this may be due to time limitations and not being able to navigate the complexity of the organisation to find them. Overall, however there were lots of opportunities for students to get involved, provided they were motivated to seek them out and set them up. This was a positive since it allowed students to tailor their education to their needs, provided they wanted to.

The students that were interviewed around experiential courses in TU Delft indicated that they were set up in a way that did not require them to take on roles within the team, or promote learning about team work or leadership. This aligned with one educator's response that universities used to expect that students learned about team work by working in teams, it shows that they may be viewing leadership in this way as well. This indicates that it might be beneficial to provide more team structures and roles to project courses, particularly in earlier stages of development where students are not capable of dealing with as much complexity and ambiguity.

Currently all of the offerings discovered in TU Delft occurred over extremely short time spans of 10 weeks. It would be beneficial for the sake of establishing team relationships to allow projects to last longer. The courses could be weighted the same and split over 2 or more quarters. This also holds the advantage of giving individuals time to reflect on their experience and adjust approaches, which was a key enabler for experiential learning. This approach also allows for a more structured approach to occur and for students to have more time to explore problems in a systematic way, rather than feeling pressure to produce results right away.

The most restrictive aspect of projects conducted within TU Delft seemed to be that they were limited by the length of time of the quarter system. Most of the experiential learning opportunities, from JIP to MDP to internships, were conducted as high ECTS projects that lasted a single quarter of 10 weeks. This setup makes it more difficult for students in project teams to establish relationships and team psychological safety.

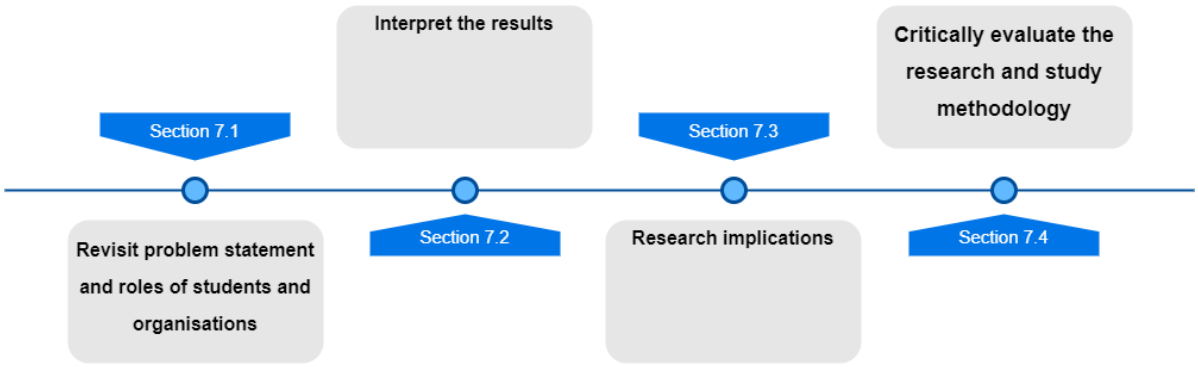
6.1.4. Ease of Entry: Medium

Students were often unaware of other experiential opportunities, even ones they could participate in. TU Delft students that were interviewed had often not heard of opportunities other than the ones they were a part of. Opportunities were typically discovered through word of mouth amongst their network. This mirrored through at the educator level, where educators were typically only aware of the experiential opportunities within their own faculty. Even then, they were not aware of all of the options or other professors working on similar initiatives. Educators indicated that while they had support from their director of Education to develop new programs, they were unaware of professors in other faculties spearheading similar initiatives. The outcome of this is that there potentially repeated efforts, wasting valuable educator time and resources, and that there are missed opportunities for collaboration between faculties. Overall, the issues around ease of entry at the organisation level of TU did not appear to relate to lack of support for students or educators. Rather, they refer to lack of awareness and resources for individuals that make it harder to either develop, or join, an experiential learning context.

6.2. Overview of Theoretical Application

The Grounded theory conceptualisation was applied to the TU Delft organisation to situate how well they are supporting leadership development through their experiential learning methods. The organisation received average scores on all aspects, with both positives and negatives highlighted. This application shows how experiential methods can be assessed using the GT presented in this research. Ideally, experiential methods at TU Delft would be ranked individually, based on input from more respondents. For this reason this application should be used for example purposed only, to show how the GT and GT model can be used in real settings. However, student and educator perceptions did highlights areas for organisational improvement, which will be given in Section 8.3.

7 Discussion



This discussion aims to interpret some of the results, explore some other perspectives, justify the use of the grounded theory approach, and provide some critical evaluation of the theory. Firstly, the problem statement will be revisited and discussed in relation to the results to see if any more light can be shed on the problem and in particular on the problem ownership. Next, some of the results will be discussed more in depth, in particular those that were not easily explained by the data itself and those that might be worthy of further exploration. The chosen perspectives at the beginning of the research will affect the outcomes as well, which will be discussed in relation to generational, researcher, and the development lens perspective chosen. Finally, an evaluation of the Grounded Theory research approach and overall research will be conducted. The goal of this discussion is therefore to explore the meaning, relevance and importance of the study results.

7.1. Revisiting the Problem Statement: Problem Ownership

In using GT, the research broadly starts with a topic of interest and broad research question. To keep it open, it does not aim to constrain the problem too much either, allowing it to be explored and unfold throughout the research. The problem statement, in Section1.1, did not posit a specific problem owner, but rather aimed to describe the problem holistically from the various perspectives involved; namely students, universities, and industry. Initial literature explored suggested that there is no clear consensus on whether educational institutes, or industry, should bear the main responsibility for supporting engineering leadership development.

The problem ownership was explored throughout the research, and the professional respondents (professional engineers in industry and educators) were asked about their perceptions on who was most capable of supporting for leadership development; universities or industry. Overall, no consensus was reached from the data collected in this research. Members of industry felt they were most able to support development, since they had more resources. On the other hand, many educators felt universities should take a larger responsibility so that socially responsible values could be prioritised and development could start earlier in engineers careers. Some felt that ultimately individuals must bear responsibility for their own development. Rather than trying to determine where responsibility for the problem lies, a more constructive approach will come out of discussing the roles that each stakeholder can play in the process.

7.1.1. Students Role in Leadership Development

An unexpected barrier to engineering leadership development was that students rarely joined contexts in which they developed it with it as an explicit goal. More often than not it was a side effect of joining an experiential learning context for other reasons. Even more surprisingly, many students didn't consider the value of their leadership development until they reflected back on it. On the other hand, the research found aspects related to individuals that were both affected by, and affected, their engineering leadership development. This agrees with constructivist principles, that students are not merely vessels to be filled with knowledge, they bear some agency in developing themselves too. Therefore engineering students are partly responsible for their development, though the question remains how to spur them to take agency when they are unaware of the value of leadership development. This is where educational organisational, be it universities, or otherwise, can help support this development particularly in the early stages.

The perceptions shared by the students in this study on engineering leadership falls in line with those held in another GT study exploring professional engineering perceptions of engineering leadership. In it, it was found that professional engineers commonly resist the idea of engineering leadership, since the identity they associated with engineering were incompatible with their view of leadership [49]. The engineering professional respondents in Rottmans study believed that the idea of engineering leadership promotes an elitist and hierarchical way of thinking [49]. Based on this, this study expands on Rottman's research by indicating that engineering students also are not socialised to think of themselves as leaders.

From these considerations, the concept of engineering leadership remains elusive, mostly because many engineers do not appear to like to consider themselves as leaders in an abstract sense, outside of managing projects. This is paradoxical to the inclusion of developing engineering leadership in many universities' missions and accreditation boards list of requirements. This deepens the problem but also indicates an importance for universities to be clearer in what they intend by engineering leadership when they list it as a goal of curricula and programs.

7.1.2. Universities Role in Leadership Development

Some educators pointed to difficulties universities could face since leadership development is rarely an explicit learning goal requested from students. Some even questioned whether it is the responsibility of universities to address this, rather than wait for individuals to enter to workplace and have more exposure to learning experiences in real world engineering contexts. Some educators argue that technically focused engineering specialists are vital to society and becoming increasingly rare in universities, so educators should not be pressured to spend more time teaching students and developing courses.

All of these considerations form part of a larger discussion on what roles universities should be playing in leadership development. To explore whether organisations should support leadership development, it is beneficial to take a step back and consider the purpose of education as a whole.

Bietsa argues that education must be viewed as a professional, rather than an economic, transaction between the student and the university [4]. In an economic transaction the customer knows what they want. However, in a professional transaction, such as going to the doctor to find out what is wrong, the customer isn't aware what they want but trust that the professional will find the reason and suggest treatment [4]. As students, we go to university because we want to receive an education, we trust educators and the system to provide this without knowing explicitly what we want [4]. This ties in line with the finding that students rarely realised they wanted universities to provide leadership development opportunities until after they had gone into the workplace.

The role of universities in leadership development can be discussed using Bietsa's 3 domains of the purpose of education - qualification, socialisation, and subjectification. Qualification related to transmission and acquisition of knowledge, skills, and dispositions [4]. Socialisation refers to initiating students in traditions, and values – these could be cultural, professional, political, or even religious. Subjectification considers how education impacts students as people and how they are developed to exist as independent, responsible, and critical subjects or simply become objects of the actions of others [4].

The barrier relating to student's hesitation to explicitly elect to take leadership development opportunities, could be related to socialisation. As Rottman (2015) found, engineers are not comfortable with the idea of leadership development because they are not socialised to view themselves as leaders in society [49]. This was in line with noticing that some students did appear uncomfortable when defining engineering leadership. Alternatively, because educators often do not consider leadership development until they are in formal leadership positions, this could be a trickle down effect in students not considering it important because their professors do not view it as important. This was also noted in some interviews, where students had to pause before answering on what engineering leadership meant to them because they had never considered the idea before.

On the other hand, some argue that leadership development is often a side thought because its complexity makes is difficult to make it a subject in its own right; it and other professional capabilities are more effectively developed embedded in other subjects. This is because developing leadership is more related to subjectification and socialisation of students than to something that can be explicitly taught. This agrees with the perceptions of respondents that leadership was best developed through experience, and with the RDS development lens used. As a result, it is less clear cut how to more explicitly incorporate it as a goal in education. Not only that, it makes it harder for educators to get recognition for efforts that address it.

Some students and educators noted that they felt universities focused too much on technical engineering capabilities. While technical knowledge is paramount to effective engineering leadership, this could indicate that universities have focused on qualification of students to the detriment of socialisation and subjectification. This trend to focusing on qualification has been noticed on a wider scale as well, and is seen as negatively affecting both students and educators [4]. As a result, universities do not contribute as much as they could to students developing a strong professional identity, value set, or development of responsibility and initiative. The result of this is that students develop it either of their own accord or once they enter the workplace. The ambiguity surrounding universities approach to leadership development might be purposeful since it is not a subject that is easily taught. However, based on the incorporation into accreditation lists and mission statements, universities have an ambition to develop a particular style of engineering leader within society, holding values relating to social responsibility and able to question systems rather than just exist in them. As a result, of their non focused approach to the problem currently, they might be missing a valuable opportunity to structure development opportunities that help them meet their mission.

7.2. Interpreting the Results

Some interpretation of the results are discussed in this section, including the importance of service learning, reflection, and the role of formal leadership training. Most importantly, it should be noted that the factors that support leadership development in this study do not aim to be all inclusive. It is possible that further research, or research in different contexts, could find more factors that can be leveraged to support engineering leadership development. Since the focus of the research question and objective lay around how organisations can support leadership development, less time was spent exploring the individual factors that affected leadership development.

7.2.1. Examining Project Based Service Learning

Several experiential learning contexts were explored with educators and students. The main experiential learning context that was explored in the EWB-USA ICP case was that of Project Based Service Learning. As shared as a result of research phase 2, in Section 4.1.3, engineering students perceived that PBSL was more supportive of their leadership development than PBL and Internships. This begs the question of what it was about service settings that contributed to leadership development.

Implications of Service Learning

A previous study that found that when students spend more time in service learning settings within community based programs, they led to greater problem awareness and commitment to societal responsibility (Astin and Sax, 1998 in [52]). This promotes not just exposure, but longer term exposure, to service settings and reinforces the finding that longer term experiential learning is preferrable, as shared in Section 4.2.4 and explained through psychological safety in Section 5.3.3.

Literature helps expand on the advantages of service learning. By working with communities, students were exposed to much more diverse viewpoints, something that most project based courses in universities lack. They had to learn to communicate more effectively with non technical stakeholders and clients, to explore the problem from non engineering standpoints. They gained exposure in working with different cultures who may have very different norms and values. This added a layer of project complexity that helped students increase their systems thinking capacities. Another advantage of working in a service context is that it is not profit driven, many project based courses that partner with industry are. This could help promote engineering leadership that values societal good over company profit, directly contributing to the mission of TU Delft.

On the other hand, working in developing countries had the potential to lead to unequal power dynamics if the project was not tackled from a collaborative mindset. There were systems, such as the country offices, that helped this dynamic be more managed in a way that promoted the local culture, but it did take effort and consideration. It would be possible to mimic many of the positives that the service aspect added to the project based learning experiences by conducting projects locally, not internationally. For instance, universities could conduct projects in partnership with local municipalities, or primary schools. Conducting projects locally could also make them much cheaper and less resource intensive.

The greater problem awareness and societal responsibility mentioned by Astin and Sax) (1998 in [52]) was also echoed on the individual side in relation to PBSL, where systems thinking was introduced in Section 4.2.5 as a factor that both helped individuals develop, and was developed in individuals throughout experiential learning. Systems thinking was noted in students of low experience level that had exposure to PBSL, but also in students that had exposure to PBL in real world settings. Systems thinking was less apparent in the student that only had internship experience and exposure to PBL in a university specific setting. There was not enough data to conclusively say that PBSL or real world PBL projects were more supportive of developing systems thinking and socially responsible leaders. However, these qualitative findings indicate there would be value in further exploring how service learning supports individual leadership development factors of systems thinking.

PBSL projects also helped address some of the barriers to leadership development. They can be less resource intensive for educators since community groups or stakeholders can provide some of the resources, such as access to mentors or project ideas. PBSL project also tend to provide a

strong purpose, or interesting projects, to motivate students to enter the context. They also cater to more diverse student interests since they tend to be less technically focused than many project based courses developed solely in universities. This can help individuals develop a more well rounded set of leadership capabilities.

Designing PBSL methods
Based on interview responses, PBSL experiences should be designed in a way that incorporates mentors, from both technical and professional development standpoints. The university can help provide some support through a standard design process for students to follow. Rather than the typical small student groups working on their own projects, conducting the project with the whole class and creating project sub teams could both help emulate a real-world organisational experience and provide more structure to students around experiencing different team roles. Within this structure, more care should be taken to support all students to experience all roles, and awareness kept that diverse students often do not feel as psychologically safe to try leadership roles when they are the minority. If these roles unfold naturally early on, it is quite possible that the students that feel the most psychologically safe to assume those roles, typically those in the majority, will fill them, and get more opportunities to experience and develop leadership, reinforcing systems that continue into the workforce.

All things considered, the project based service learning context provided some clear benefits in aiding engineering student leadership development. Working internationally had the benefit of exposure to different cultures but the added complexity of managing power dynamics. Conducting projects locally would make projects more feasible from a resources standpoint and still provide the benefits of exposing students to clients with diverse backgrounds.

7.2.2. Structure of Reflection
Any literature search regarding experiential development is likely to bring up the Kolb Learning cycle, which is one of the key theories on experiential learning. A key component of the Kolb cycle is reflection on the experience as a step in learning from it [36]. Reflection was found in this research, as introduced in Section 4.2.5 to play a part on the individual developing leadership. However, reflection was rarely structured or formal. None of the students had used journaling to explicitly reflect on their experiences. Instead reflection occurred as conversations with teammates or mentors, or self reflection.

Given this, it is unclear what constitutes the most effective reflection. For instance, some of the students indicated that the research interview was the first time they had really reflected back on their experiences and realised the value of the experience in their leadership development. Does this indicate that they didn't develop as leaders until that moment when they really reflected on it? This is unlikely, since they were elected to those roles and deemed by their peers to be effective leaders. On the other hand, given those experiences, had they been more explicit or structured in their reflection, is it possible they could have developed more leadership from the same experience? All of these questions are worth exploring more in future research, as they could help organisations determine how to best promote reflection as a tool for development.

7.2.3. Value of Formal Leadership Training
One area that remained unclear based on the data was the value of more formal theory on leadership and aspects related to it in leadership development. Several educators indicated that they used blended teaching methods to share theory to help students become more aware of research on leadership. These were most often in the form of workshops that focused on a central aspect, for example giving and receiving feedback, teamwork, or communication. In Eich's Grounded Theory on components of high quality leadership programs, incorporating up to date research and theory around leadership was an important aspect of programs [23]. From this, it is apparent that introducing formal theory or training around leadership can contribute to leadership development. However, it was rarely mentioned by students to be important other than those that had elected to take leadership training or courses seperately.

This leads to a bit of confusion and paradox around the value of formal training. Many students managed to develop leadership without formal training in it. Most of the students in this research

indicated that they did not think formal training or workshops would help them much. Others indicated otherwise; the one student that had taken a formal leadership course within his schooling indicated that it was beneficial to understand some of the theory behind leadership.

It is possible that the presence of formal training could help students develop more leadership, or faster. They may not have realised its value simply because they weren't exposed to it. It is also possible that because the students in the EWB-USA context were in a psychologically safe environment due to other factors, this made up for the lack of formal training. On the other hand, in the case of Eich, it could be that because he studied more formal leadership development contexts that weren't purely experiential, they by nature had formal theory in them, but that didn't indicate it actually helped. Finally, formal training could simply represent another developmental context that can help develop leadership, however it is less important within experiential learning. As with any of the factors, it could also vary student by student. In any case, it is not possible to determine the value of formal training based on the data is this study. As such it is recommended as a possible are for future exploration.

7.3. Implications of Research Perspectives

At the outset of the study, as introduced in Chapter 2, some perspectives and theoretical lenses were adopted that influenced the study. The first of these was choosing the focus the research on the perspectives of engineering students. The second was that development was viewed through the lens of Relational Development Systems. These perspectives and lenses shape the research in different ways and it is worthwhile to briefly discuss the implications therein.

7.3.1. Generational Perspectives on Leadership

The grounded theory was based on student perspectives on leadership and leadership development. However, the other interview respondents were asked similar questions to explore whether there were different perceptions on the topics. While general themes remained the same, there were some differences generationally.

As far as perceptions on leadership, more experienced professional engineers did view leadership in more abstract ways, and less linked to a formal role or management of projects or people. However, particularly the oldest generation of engineers interviewed, the industry members with more than 20 years of experience each, appeared to view leadership in a more hierarchical manner and referred less to engineering leadership and more to corporate leadership. This could be due to the hierarchical systems that they were more involved with throughout their career. It could also be due to engineers not being socialised at all in leadership when they went through university. Alternatively, it could be simply that they had moved into more general management roles in their companies and had started to develop perceptions of themselves as more general leaders, not engineering leaders, and as a result incorporated more business acumen into their views.

Some developmental aspects were echoed throughout generations, namely mentorship and the organisation. Ease of entry and the project were less mentioned by more experienced professional engineers. This could indicate that as individuals develop leadership, and improve their self efficacy, these factors become less important at later stages. The self efficacy in an individual could remove the need for ease of entry to be made more psychologically safe, and for projects to be more structured. Though more research would be required to confirm this, it does show that some of the factors for leadership development were perceived to be less important later in a professional engineers life. On the other hand, these engineers tended to refer more to formal training or leadership theory as helping them develop. This indicate that formal training becomes more beneficial or valued later in the developmental pathway. Overall, this confirms that the process of engineering leadership development is dynamic, one of life long learning, and is supported in different ways based on the development profile of the individual. It means that the theory presented in this research should only be considered to be applicable to engineering students.

7.3.2. Implications of Relational Development Systems Theory

Implications of using an RDS meta theory also show how organisation development can be related to leadership development. If organisations want to develop organisational leadership, the best method of doing this is by developing individual leadership within the organisation, as these individuals directly influence the organisational context. From this it could be inferred that it is important to develop all individuals within the organisation in order to most positively affect the organisational leadership. This promotes a more relational, process view on leadership, and helps organisations depart from a hierarchical view.

In an educational context, this view promotes the autonomy and ability of both students and educators as shaping the context. This gives a positive view for systems change. This means that if educational organisations want to create systemic change, they can consider the effect of the individuals that are within the organisational context as the greatest change affecters of the whole system. For instance, by creating partnerships with industry, those actors enter the developmental context and will change the type of organisational leadership developed. Or, if the university shifts to admitting students of more diverse backgrounds, they could expect that this diversity would bring students that can contribute different systems thinking views that can affect the developmental context, and in turn other individuals within that context.

On a personal level, using RDS also implies that individuals in experiential settings directly influence the leadership development of other members of the team, since they are a part of the context as a whole. This helps strengthen the idea of leadership and leadership development as a dynamic and shared process. This was perhaps best exemplified in the EWB-USA case, where students often felt that other students leaders helped them develop their own leadership, and that they tried to foster leadership development in less experienced students by encouraging them to take on leadership responsibilities. In this way, they were contributing to a more psychologically safe context by improving psychological safety related to entering the development context and practising leadership.

7.4. Evaluation of Study and Approach

At the end of the research, it is now possible to reflect on whether the selected methodology of Constructivist Grounded Theory was effective in answering the research questions and meeting the research objective. Additionally, the quality of the resultant theory can be evaluated to discuss areas for improvement, and applicability of the results.

7.4.1. Justifying the Grounded Theory Approach

Grounded theory proved to be an effective method in exploring leadership development in engineering students. It allowed for the richness and complexity of leadership and leadership development to be maintained and not reduced to quantitative measures. The grounded theory approach was effective for this since it allowed more ambiguity around the subject. It allowed perceptions of leadership to unfold and shape the research rather than being bounded by a definition that might not have been agreed upon by all the interviewees. It allowed for individuality to be maintained for students developing their leadership, as the topic was explored from their perspectives. This was a uniqueness of this study, the grounded theory created reflects the viewpoints of those directly involved in the developmental context, it is not viewed from an outsider perspective.

The grounded theory approach was chosen knowing that it is a complicated method and not commonly used by novice researchers. Some issues that arose during included developing theoretical sensitivity, and developing interview skills. Developing theoretical sensitivity and knowing how to scope down from the large amounts of data collected in a grounded theory approach was a challenge. Part of this took time, exposure and personal development on the part of the researcher. Constantly exploring the literature helped expand my awareness of viewpoints on both leadership and engineering education, in turn helping me become more sensitive to what data was valuable. However this was sometimes time intensive and confusing. Listening back to interviews and noting when questions could have been asked in a more open-ended manner, or where I used verbal cues, helped me hone my interview skills. Becoming more adept at reading interviewees and what topics got them excited also helped

highlight areas of importance to ask more in depth in future interviews. Consulting literature on how to conduct grounded theory studies also provided some good guidance [12] [50]. Finally, the input of the graduation committee and their expertise in grounded theory helped highlight areas of theoretical interest, and provide advice for effective interviewing.

7.4.2. Critical Evaluation of the Study

In using constructivist grounded theory, it means that the constructed theory is an interpretation that depends on the researchers view and can't occur without it (Sebastian, 2019). This means that a different researcher could analyse the same data and come to different outcomes that could also be valid. To maintain transparency and help the reader maintain awareness of how the researcher's perspective, the framing section included a section on the researcher's background knowledge and potential biases. Efforts were made in the findings section to maintain this transparency through chronologically explain how the theory emerged. From this the reader can compare with their own perspectives to come to their own view on the applicability and validity of the theory.

The Theory was conducted in the specific context of engineering students participating in experiential learning activities. As a result, this grounded theory does not attempt to be universally applicable or try to describe leadership development for groups other than engineering students. This is not to say it is not applicable to wider audiences, but the data from which it emerged only deals with engineering students in experiential learning contexts. Before applying it in any other situations, researchers would need to test its validity and transferability to the population and context they are hoping to apply it to.

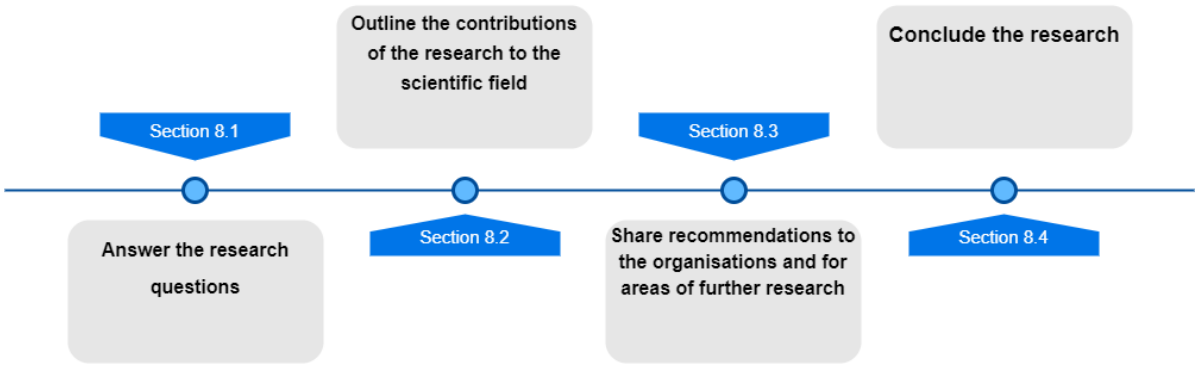
The theory is also not fully comprehensive. In exploring leadership, it quickly emerged that the topic was complex and perceptions on it were constantly evolving at an individual level that was influenced by personal experience. For this reason, it should be noted that the grounded theory does not try to incorporate all aspects of the individual experiences, since this would try to overgeneralise a complex topic. Instead, the components presented, including the core category, are those that were more universally experienced by engineering students during leadership development. On both the individual and context side of the theory around leadership development, other factors could be at play.

The engineering students that were interviewed for this study could all be considered to be intrinsically motivated. The experiential learning contexts they were part of took effort to join. In the case of the internships, joint interdisciplinary project, and multidisciplinary project, applications were involved, supervisors had to be found. All of this typically took more effort than simply signing up for a more traditional lecture style course. In the EWB-USA case, the students were choosing to be part of the ICP extra-curricular; they did not receive credit for the work they did. As a result, this grounded theory is based on data sampled from a set of students that may not be representative of the larger group.

Finally, the data was collected from sources that were educated in western contexts. As such, the theory only tries to be applicable to engineering students in western contexts. While the notion of psychological safety did appear to support engineering students developing leadership, this core category might not be as relevant in different social or cultural contexts. In addition, perceptions of leadership might vastly differ in different cultures or even generations. Readers should consider this in reading and applying the theory, and be wary of making normative judgements around what constitutes effective or socially responsible leadership and how transferable that is in different contexts.

This grounded theory should be considered as a tool for organisations hoping to support leadership development. It helps to spark the conversation around what factors organisations can influence to support leadership development. Consideration should be made for the specific organisation and specific context. The use of the theories of Eich and Komives can also provide valuable insight into where the engineering students currently stand, and what the leadership development programs can include.

8 Conclusion



The purpose of this section is to conclude the research. First, the research objective will be met by answering the research subquestions and taking their contributions to help answer the overall research sub question. A summary of the contributions of this research to the scientific field help situate it in the broader research realm.

Next a set of recommendations is provided. These recommendations are made for the organisations involved in this research and how they can support engineering leadership development. Further recommendations are made on areas for future research that can help further explore the topics introduced in this research. Finally, the research will be succinctly summarized and concluded.

8.1. Answering the Research Questions

The objective of this research was to construct theory around how engineering students develop leadership in their early education and career so that those with ability to influence the process can maximize educational opportunities for engineering students to develop leadership in experiential learning contexts. The research questions were developed to aid towards achieving this objective, and the answers are summarized below.

Sub Question 1: How do engineering students perceive engineering leadership?

Engineering students perceived leadership as a role members may take on in teams, as a capability, as an individual that empowers teams to achieve goals, and as a more abstract relational concept that considers engineering values and responsibility. Engineering students' perceptions vary based on their experience with leadership. Younger and less experienced students tend to view leadership as management, involving project management and delegating tasks to team members. More experienced engineering students view it as a relational process, where teams work together to enact change and different team members can act as informal leaders at different times.

Sub Question 2: What factors are perceived to support engineering leadership development by students that have been involved in leadership in experiential learning contexts?

The main factors that were perceived to support engineering leadership development were mentors, organisational support and structure, ease of entry into the experiential learning context, and aspects of the projects they worked on. These factors related to the experiential learning context and were facilitated by psychological safety. Individual factors also played a role, notably reflection, relationships, self efficacy, and systems thinking.

Sub Question 3: What barriers prevent educational organisations implementing leadership development opportunities through experiential learning?

The main barriers preventing educational organisations from implementing experiential leadership development opportunities related to those faced by educators and those faced by students. Educators struggled with a lack of resources, whether it was time to develop the courses, getting credit for teaching hours, or knowledge resources. They also struggled to get students to elect to take experiential opportunities, and found it difficult to cater courses to their particular developmental needs. The complexity of leadership also provided difficulties as it is not an easy to measure outcome, and thus hard to grade. A final barrier was that some educators had encountered others who were not aware of the value of leadership development in university settings.

On the student side, students faced a barrier in entering experiential learning contexts. Some of this was because they struggled to find projects or opportunities for experiential learning and did not feel supported in accessing them. On the other hand, some were aware of opportunities but were hesitant to join them because they did not feel they were conducted in a safe learning environment. Finally, students rarely joined contexts with leadership development in mind, more often they recognised experiential learning as a valuable development opportunity later after they had reflected back on them. These student barriers compounded to barriers for educators where educators sometimes struggled with student buy in.

Main Research Question: How can organisations support the process of student engineering leadership development in experiential learning contexts?

Organisations can support the process of student engineering leadership development by offering experiential learning opportunities that promote psychological safety in project teams that allow students to focus on individual aspects that help them develop leadership. Psychological safety can be improved by leveraging developmental factors. The development factors related to the experiential context included the ease of entry into the context, mentors, the project, and the organisation. Organisations should remain cognisant that aspects of leadership development relate to the individual so they cannot

implement one size fits all solution. The conceptualised leadership development framework can be a useful tool as a starting point for discussion on supporting student engineering leadership development.

8.2. Contributions to Scientific Field

Given the results presented in Chapter 4, the theory presented in Chapter 5, and the discussion in Sections 7.1 through 7.4.2 of this Chapter, it is worth summarizing the contributions of this research to the scientific field at large. These are summarised in Table 8.1.

Table 8.1: A summary of the scientific contributions of this research

Topic	Relevant Report Sections	Relevant Literature	Description
Leadership	2.5, 7.3.1	[15] [48] [54] [49]	The research confirmed that leadership is a complex topic, of which it is unlikely a single unifying theory will ever emerge. There was a trend in leadership perceptions among engineers and engineering students to view it in a relational sense as they became more experienced in it. Many engineers are not socialised to view themselves as leaders in society.
Relational Development Systems	4.2.5, 4.2	[8] [57]	Development was found to be influenced by factors related to both the individual and the developmental context. There was a feedback loop between the two where the two sides of development affected each other, this agreed with RDS principles and reinforces the use of RDS in researching development. It also indicates that leadership development can be viewed through the lens of human development.
Psychological Safety	4.4, 5.3	[42]	Psychological safety research has previously focused on how leaders can instill psychological safety within teams to improve performance, this research shows that it can also be used to show how leaders themselves can develop when psychological safety is present. This reinforces psychological safety as in important theory that affects interpersonal risk taking and team dynamics.
Grounded theory	3.7, 5.4, 5.5, 7.4.2	[37][23]	Grounded theory methodologies are effective in constructing theory around leadership development. Several GT studies on leadership development unearthed similar supporting factors, despite dealing with different samples and using different perspectives.

8.3. Recommendations

Throughout the research, and notably unbundled through research sub question 3 The first set of recommendations are for the organisations studied, and refers to policy and practise at the organisational level that could help them structure their efforts to support leadership development through experiential learning. These recommendations are based on input from the interviewees, and common issues noted throughout. The second set refers to recommendations are for further research.

8.3.1. Recommendations: Both Organisations

The following list outlines recommendations for both TU Delft and EWB-USA.

1. **Improve external partnerships:** External partnerships can be used to access projects and mentors. They also have the benefit of potentially lowering the resource burden on individual organisations, through improved collaboration and knowledge sharing.

2. **Work to improve exposure to diversity in the experiential methods:** The female students interviewed in the EWB-USA felt that a higher proportion of females was perceived to create a more psychologically safe development environment compared to the more male dominated courses they partook in in university. Not only that, more diverse project members, whether from the community or within the project team, helped expose participants to more diverse viewpoints that could help them develop systemic thinking by making it more psychologically safe to discuss differing views.

3. **Explore leadership perceptions at organisation level:** As discussed in Section 7.3.1, there were variations in perceptions of leadership in different generational levels of engineers. Organisations should explore whether their views on engineering leadership that they hope to support development of aligns with student perceptions.

4. **Use the leadership development conceptualisation to assess experiential methods:** This will help locate areas for improvement in current and new experiential methods in order to support leadership development in engineering students.

8.3.2. Recommendations: TU Delft

The following list highlights recommendations specific to TU Delft based on the GT and the researchers analysis of the input from students and educators involved in experiential learning.

1. **Establish an organisation level steering committee:** There should be a more cohesive driving force behind organisational support linking the university's mission and actual educators on the ground trying to implement change. A centralised steering committee, composed of representatives from all faculties could help create a more cohesive approach to support engineering leadership development. They could also serve as a single point of contact to provide tools and help educators network educators to more effectively share resources and lower resource needs.

2. **Assess organisational experiential methods:** Chapter 6 assessed some of TU Delfts experiential methods using the GT model. However there was not sufficient time to collect more input from other students or on other experiential methods offered at TU Delft. Doing so would help establish a clearer organisational baseline.

3. **Offer more Project Based Service Learning opportunities:** As discussed in Section 7.2.1, there were benefits of the PBSL method over PBL and interships. More PBSL opportunities should be implented that incorporate the support factors introduced in the GT. Conducting projects in conjunction with external communities can also lower resource requirements.

4. **Offer longer term experiential opportunities:** Regardless of the type of experiential method, it is recommended that more offerings that occur over longer periods of time be implemented.

5. **Improve educator support:** Methods of supporting educators that choose to prioritize teaching and developing new courses over research should be implemented. Naturally, respect for the

value and autonomy of the valuable researchers that work on cutting edge technology must be maintained.

6. **Explore trade-offs required in prioritizing experiential learning:** Changing the curriculum would result in trade-off, whether defunding other programs to focus on experiential programs, or hiring less research focused professors to focus on education focused educators. These could affect the other ambitions in TU Delfts mission statement. Examining these trade offs can help the university prioritize how and where to implement change.

8.3.3. Recommendations: EWB-USA

The following list highlights recommendations specific to EWB-USA based on the GT and the researchers analysis of input from students involved in their ICP program, and staff members at headquarters.

1. **Promote Safe to Fail culture at organisational level:** A key way to improve psychological safety in project teams is to instil an organisational culture that promotes the idea that there is no such thing as failure, as long as students learn from it.

2. **Improve ease of entry through in country offerings:** A notable barrier to enter the EWB-USA context was that many projects involved travelling out of country. This limits students that are unable to afford to take part. Conducting more projects in country would make the experience more accessible whilst maintaining the benefits of the PBSL method utilised by EWB-USA.

8.3.4. Recommendations for Future Research

Some areas for further research were also discovered during the research. These are recommended below:

1. **Deeper research into the Leadership Development Factors:** This study focused on a holistic level, but did not explore any of the leadership development factors in depth. Future research could focus on specific factors that were unearthed in this research and try to further constrain how to structure them to optimise psychological safety and development. For example, it would be benefitial to research specific organisation structures and cultures that most promote psychological safety, or the best ways to ensure effective mentorship. On the individual side, exploring reflection more might help understand whether better structure or methods of reflection are more effective.

2. **Exploration in Project Based Learning:** PBL represented a very large umbrella of potential experiential learning approaches. A larger sample size exploring it's effectiveness, particularly in relation to the developmental level of engineering students, could help develop more specifics to provide to educators around designing experiential opportunities.

3. **Research on applicability of the grounded theory in different cultural settings:** This study was conducted in a western context, with western values and educational backgrounds influencing the researcher and interview respondents' views. To explore whether the findings relate on a more global scale, it is recommended that further research be conducted in different cultural settings.

4. **Research on curricular vs extra-curricular experiential methods:** The primary leadership development context explored in this research was an extra-curricular one. It is unclear if there is a difference in curricularized vs extra curricular use of experiential learning.

5. **Research the nuances within Psychological Safety:** A key intermediate theme was that an experiential learning context was more supportive of leadership development when individuals felt safe to fail. However, failure in itself is a relative concept, and what one might consider a failure another might consider a success. Therefore, it is recommended that further research focus on exploring how psychological safety affects individuals.

6. **Research on applicability of the grounded theory in the broader engineering population:** This study was conducted primarily with motivated students. It should be explored whether the findings and theory can also be used for less motivated students.

7. **Explore structures of reflection:** While reflection was found to be an important individual factor affecting leadership development, it was rarely done in an explicit form. Understanding whether different styles of reflection are more effective in the leadership development process can help optimise it in the future

8.4. Conclusion

This research was conducted to tackle the problem of how organisations can support student engineering leadership development through experiential learning. A set of research questions guided the research using a constructivist grounded theory methodology and a method of interviews. A research framework for novice grounded theorists was adapted to structure the research. A total of 25 survey respondents represented engineering students with experience in experiential learning, educators that had developed experiential courses, members of industry, and members of a non profit global development organisation that conducted projects through the Project Based Service Learning Experiential Methods contributed multiple perspectives on the issue.

Perceptions of students, educators, and engineering professionals alike confirmed that engineering leadership is a complex notion. While viewed by some as being an individual responsibility, it is viewed by others as being a more abstract group process. Leadership development is part of a dynamic process, one that is rarely explicitly strived for by students or course designers. While students indicated that they believed experiential learning helped support their leadership development, they rarely joined those contexts with that goal in mind. Additionally, the experiential contexts explored weren't usually designed with leadership development as an explicit outcome. This may be because leadership is a difficult outcome to measure. It is also possible that a focus by universities on technical qualification has led to a trade off in the subjectification and socialisation of students as socially responsible leaders. All of this considered, engineering leadership development will likely continue to remain an elusive to measure goal. However, this research contributes to the larger field by presenting a set of factors of experiential methods that organisations can use to support leadership development. They can do this by structuring experiential learning methods in ways that promote a feeling of psychological safety within student engineering teams.

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A

Organisation Background Information

Table A.1: An overview of the organisations involved in this research: TU Delft and EWB-USA

Organisation	TU Delft	EWB-USA
Main Purpose	Conduct research and educate students	Conduct engineering projects in developing nations
Main Funding Source	National / EU Funding, Grants	Corporate sponsors, individual donations
Vision	”Delft University of Technology contributes to solving global challenges by educating new generations of socially responsible engineers and expanding the frontiers of the engineering sciences.”	”EWB-USA’s vision is a world in which every community has the capacity to sustainably meet their basic human needs.”
Mission	• Perform world-class research by combining science, engineering and design in a socially responsible manner. Thus, we advance and share the benefits of technology. • **Develop and enhance the expertise of tomorrow’s engineering leaders and educate professional, high-level and responsible engineers throughout their careers.** • Help to develop and deliver technology-driven, innovative solutions to societal problems through collaborations with leading national and international partners whilst being firmly rooted in Delft. • Continuously improve our collective effectiveness, performance and organisational resilience through the principles and practice of professionalism, collaboration and openness.	EWB-USA builds a better world through engineering projects that empower communities to meet their basic human needs and equip leaders to solve the world’s most pressing challenges
Experiential Opportunities	Joint Interdisciplinary Project (JIP), Multidisciplinary Project (MDP), Internship, many others	International Community Program (ICP)
For credit?	Credited, but elective	Extra-curricular
Organisation Structure	Hierarchical. Faculties themselves may have their own unique cultures.	Flat / Network – central HQ, geographically dispersed chapters that sometimes work together. Chapters themselves have their own unique organisation structures and cultures.
Source	[19], researcher memos	EWB-USA website, researcher memos

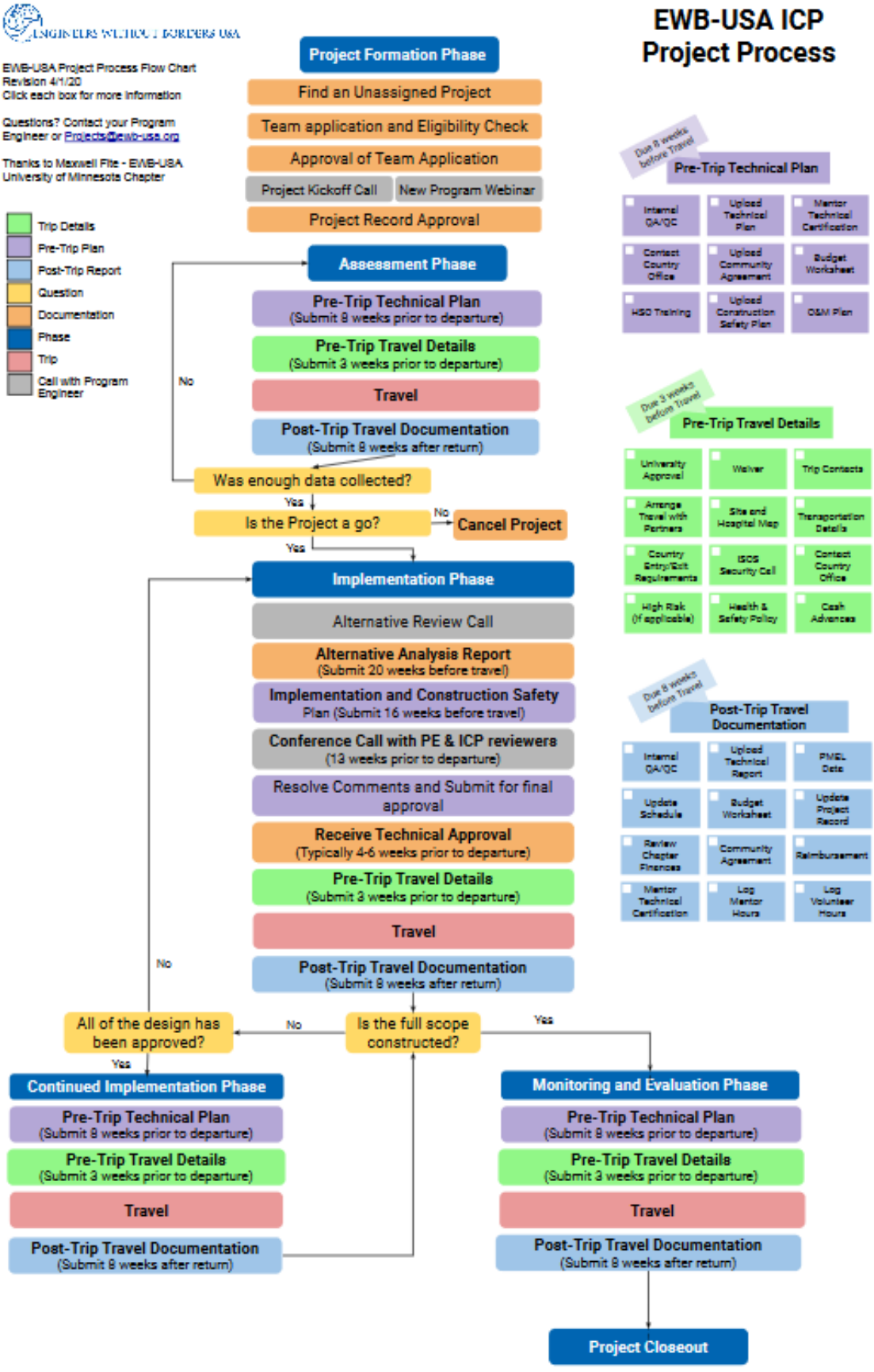

Figure A.1: The engineering design process used in EWB-USA's International Community Program

B

Interview Information

Criteria for Sample Groups Interviewed

It is common for Grounded Theory to purposively samples participants that are at various points in the process under research [50]. Since the focus of the research is to study the process of engineering leadership development, students were picked that represented different stages within the process. Multiple other actors that are involved in the process are also interviewed to gain a more holistic view.

B.0.1. Engineering Students

Purpose: To explore perceptions of leadership and the leadership development process in engineering students that were currently involved, or had been recently involved in experiential learning methods. Students involved in different experiential settings, namely internship, PBL, and PBSL, were interviewed. A summary of the students interviewed is shown in Table B.1

Criteria (EWB-USA):

- Currently in, or have completed in the last year, bachelors or masters degree in engineering
- 3 or more years in university
- At least 3 months experience holding formal leadership roles within EWB-USA's International Community Program. These leadership positions could range from engineering technical design leads for projects, to project managers, to chapter leaders.
- Sample represents a variety of formal leadership experience levels:
  - Low: those that had been in a leadership role for less than a year
  - Medium: at least 1 full year in a leadership role but no more than 2 years
  - High: 2 or more years of leadership experience
- Sample represents a variety of EWB university chapters. The reason for this was so that the micro-cultures that occur within different chapters do not bias the results. For information on chapters, see Table B.2.

Criteria: (TU Delft)

- Currently in, or have completed in the last year, their bachelors or masters degree in engineering
- 3 or more years in university
- Sample represents a variety of TU Delft experiential learning methods. For information on experiential methods, see Table 2.1
- In order to gain some nuance around the effect of practising in engineering leadership roles within different experiential contexts. While these students did not hold formal leadership positions, they partook in relational leadership within their projects and their perceptions on leadership were explored based on their experiences.

Table B.1: List of Students Interviewed

Label	Details	Leadership Experience Level	Leadership Perception
S1	3rd year Mechanical Engineer. Project co-lead (Cardamom Drier). 1 trip (Guatemala)	Low	Relational
S2	3rd year Mech E. Project co-lead (Cardamom Drier). No trips. 1 year in EWB.	Low	Relational
S3	3rd year Civil E. Project Manager (School house). 2 internships in E+C. 2 years EWB. 2 trips (Guatemala).	Low	Managerial
S4	5th year Architectural Eng. Chapter president, previously project manager for other projects. 4 years EWB. 4 trips (Guatemala).	High	Relational
S5	4th year Environmental Eng. Design Lead (Water Project). 3 years EWB. 1 Trip (Panama).	Medium	Relational
S6	3rd year Environmental Eng. Hydraulics Lead (Water project). 2 years EWB. No trips.	Low	Managerial
S7	5th Year Environmental Eng. Chapter president (previously Head of Uganda program). 4 years EWB. 2 internships. 2 trips (Uganda)	High	Relational
S8	4th year Enviro Eng. Incoming Chapter President. 2 previous leadership roles. 1 trip (Thailand)	High	Relational
S9	4th year Mechanical Eng. Chapter Diversity and Inclusion Committee Lead. 2 previous leadership roles. (No trips)	Medium	Managerial
S10	5th year. Civil Engineering. Outgoing Chapter President. 4 years in leadership roles in 5 total EWB years. (No trips)	High	Relational
S11	1st Year CME Masters Student (TU Delft). Experience in MDP program	Medium	Relational
S12	2nd Year CME Masters Student (TU Delft). Experience in JIP program	Medium	Relational
S13	1st Year CME Masters Student (TU Delft). Experience in Internship program.	Medium	Managerial

Table B.2: Information on EWB-USA Chapters

No.	Student ID's	no. Volunteers	State	Faculty Engagement (As Provided by EWB-USA)	no. Projects (Country Office)	no. Projects (no Country Office)	Memos based on interviews
1	1-3	68	Massachusetts	Medium	2	2	Ran quite hierarchically, efficient (lots of projects completed considering number of volunteers). Younger volunteers weren't as aware of how larger organisation ran. Lots of volunteers get to travel, multiple times
2	3-7	51	Milwaukee	High	2	0	Network ran. Shared leadership. Technical only university. More technical projects (vehicle bridges common). First mechanical projects (cardamom drier) that follow the design process of the industry sponsor, not the EWB design process. Limit trips vols can go on (2 max).
3	8-10	93	California	Low	1	1	Network ran, very large Exec-board to give opportunities for leadership. Shared leadership. At the project level, shared leadership employed to ensure incoming leaders are supported. A lot of remote implementation, travelling much rarer and less of a reason for volunteers to join chapter. Social side of engineering much more present and discussed in this chapter, likely due to faculty advisor from social sciences

B.0.2. Educators - Course Coordinators

Purpose: Can provide a different perspective on their experience with engineering leadership development through experiential learning. They could also help explore the problem, and the capabilities and responsibilities of different actors to support student / early career engineering leadership development
Criteria:

- Have developed experiential courses that help engineering students develop non technical and professional capabilities
- These courses are qualified for academic credit at TU Delft
- Represent different faculties within the university

B.0.3. Professional Engineers in Industry

Purpose: To gain perspective from professional engineers that had a lot of engineering experience. They could also help explore the problem, and the capabilities and responsibilities of different actors to support student / early career engineering leadership development.
Criteria:

- Experience in leading engineering projects
- Exposure to working with engineering new graduates of various backgrounds
- Ideally close to the end of their career, to get a generational perspective
- At least involved in the construction / civil industry

B.0.4. Organisation Headquarter Staff

Purpose: To get a balanced perspective from those that have watched student engineering volunteers develop leadership. To get perspective on common issues faced in student leadership development, that students may not be aware of themselves. To understand organisational approaches to professional development. Also some perspective from professional engineers that are mid career, to see generational perspectives on leadership.
Criteria:

- Experience in leading engineering projects
- Exposure to working with engineering new graduates
- Variety of roles within HQ:
  - Education
  - Volunteer Engagement
  - Country Office
  - Project Engineer

Table B.3: List of Non Student Interviews

Group	Label	Details
Educators	Ed1	Educators designing novel methods into TU curriculum (Physics Design Programme). Also has industry background
	Ed2	Educators designing novel methods into TU curriculum (JIP Programme)
	Ed3	Educators designing novel methods into TU curriculum (CME 1200 – Collaborative Design)
	Ed4	Educators designing novel methods (outside of TU) DORP Coordinator
	Ed5	Educators designing novel methods into TU curriculum (Industrial Design)
EWB organisation	EWB1	Project Engineer – Interact with volunteers during project design phase (approve engineering plans)
	EWB2	On the ground (country office, Nicaragua) – see volunteers first hand and can report on their development
	EWB3	On the ground (country office, Guatemala) – see volunteers first hand and can report on their development
	EWB4	Volunteer Engagement – knowledgeable on volunteer needs/wants
	EWB5	Education – helps design new educational offerings. Aware of student requests for new educational offerings. Also academia background (psychology)
Industry	Ind1	Engineering + Construction experience (30+ years USA and global). Was on EWB Board of Directors.
	Ind2	Aerospace engineering experience (20+ years). Mentor in EWB professional chapter for years.

Example of Interview Questions - Students

Introduction / Demographics

- Can you introduce yourself (educational background, experience within EWB-USA, previous internships)
- Why did you choose to volunteer with EWB-USA
- What type of professional development opportunities does your chapter offer?
- Are any of these specific to leadership?

Leadership Perceptions

- What do you believe engineering leadership is?
- How do you believe you best develop engineering leadership?
- Do you think your view on leadership has changed since you were a college freshman? How?

Leadership Experiences

- How is leadership typically conducted in your project team?
- How is leadership conducted when you travel to the community? Does this change as you get to know them better?
- Do you reflect on your EWB work, either before or after?
- With respect to leadership development, is there anything that makes the EWB experience stand apart from your project-based courses in university?
- What experiences within your schooling (separate to EWB) do you think most affected your leadership development?
- In your opinion, do you think the international travel aspect of EWB projects has aided your leadership development in ways it wouldn't if you did a similar project in country? Why / why not?
- For women: Do you think the higher proportion of females in EWB than in educational settings affects your leadership development? If so, How?
- Can you give an example of really good or bad leadership, and explain what happened?

Reflection

- Could anything change in the EWB model to help you with your leadership development?
- What could universities do to help you develop your leadership during your bachelors?
- When you reflect on your EWB experiences, how have they changed how you view the engineering profession and our responsibility as engineers?
- What advice would you give to your younger self around leadership development

TU Delft Students

- What got you interested in joining this experiential learning course?
- How did this experiential learning course contribute to your leadership development?
- What else did you learn in this course that is difficult to learn in a lecture style course?
- Was it easy to set up this opportunity? Can you walk me through the steps required?
- What aspects of this experience most contributed to your leadership development?

Example of Memos collected during interview

Table B.4: Example of Interview Memo

Label	Interview Date	Notes
Ed1	June 26, 2020	• leadership has many guises • call from alumni started the drive for curriculum change. Also from university when they saw many physicists ended up in systems architect roles • leadership and professional courses at TU Delft are typically elective, not compulsory • faculty drive. • Convincing students is hard • The more applied, research oriented faculties (applied science) seem to have professional development less ingrained in the curriculum. • Students often pick courses and projects based on what they want to do (quantum computing big right now) so in this way they plan their education for industry, even if education isn't planning with industry directly" • Students are often against, or struggle to see the value in, taking courses not directly applicable to their expected career path. They want to see a direct link between learning and outcome. • Alluded to problems getting more complex. But also faster paced. Much research focus on things that will help in 30 years, but not its 20, 10, smaller time frames. • On a human level, group work is difficult, especially at first, at people are hesitant to put themselves out of their comfort zone, unless there is a strong reason • Peoples 'life altering experiences' are typically in completely different avenues (theatre, in her case) • When I asked about her leadership philosophy was when she became most animated, shared 'thickest story' / data

C

EWB-USA Data

2019 Volunteer Experience Survey Report

EWB-USA values each and every volunteer who contributes to the important mission of the organization. We have a responsibility to engage, equip and cultivate strong relationships with volunteers who make a lasting impact. The feedback gathered through the annual volunteer experience survey helps us understand the extent to which volunteers are satisfied with their overall role in the organization and make improvements in accordance. We strive for nothing less than exceptional.

Quantitative Results

Most of the survey questions ask volunteers to provide ratings from 0 to 10, and the proportion of responses that are very positive (8 to 10) is a strong indicator of positive sentiment. There were three significant findings from the quantitative results.

Finding 1: Most survey questions ask volunteers to provide ratings from 0 to 10, and the proportion of responses that are very positive (i.e. 8 to 10) is a strong indicator of positive sentiment.

The increase in these positive ratings was highest for the ease of the volunteer process which saw a 20% increase from 2018. This was followed by an increase in the belief that EWB-USA provides the resources needed for volunteers to be successful (14%). The smallest increase was with the opportunities for seasoned volunteers and belief that volunteer efforts further the organization's mission. A graph showing the changes in 8-10 responses between 2018 and 2019 is below:

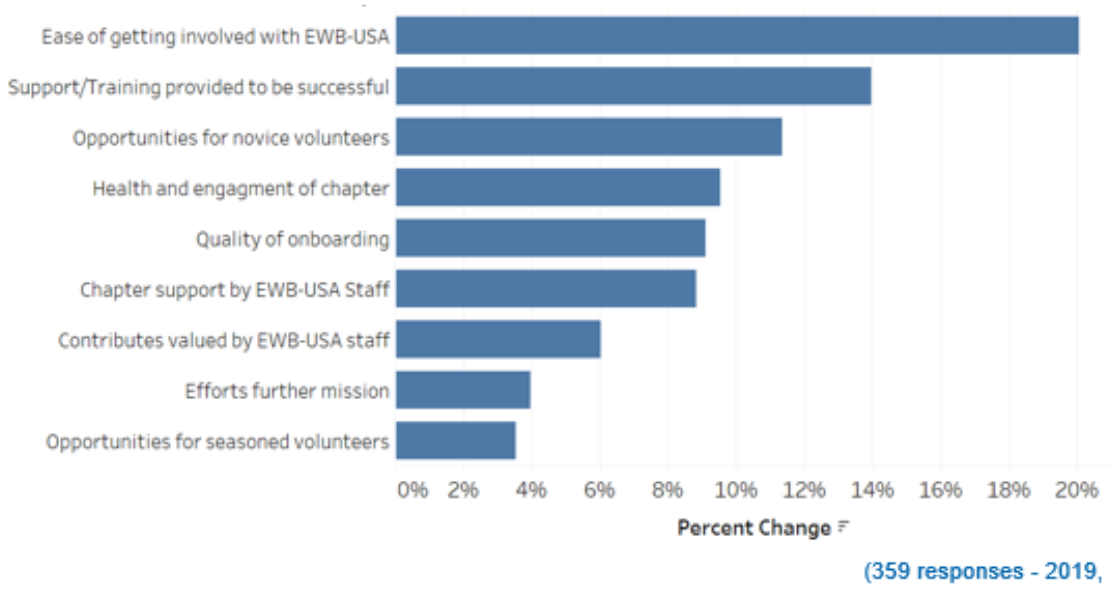

Figure C.1: An excerpt from the EWB-USA Volunteer Engagement Survey

Table C.1: Excerpt of Lessons Learned

Country	Broad Category	Sub Category	Lesson
Guatemala	Construction	Contractors	Add pictures to materials lists that are sent to the contractor. Also, include the contractor in the conversation when getting a material cost estimate.
Uganda	Design	General	When designing a water pumping system for a water source with high levels of iron, it is important to regularly flush all pipelines where the iron may have the chance to settle.
Bolivia	Community	Communication	The community of Colani operates under more of a democratic form of leadership as opposed to Azacilo's single leader policy. This should be kept in mind as the community likes to maximize the number of members available to make a decision instead of just one person.
Guatemala	Community	Communication	Continuously asking for input from male and female heads of households in addition to community leaders promotes trust and understanding and allows systems to be customized to fit the wants and needs of each family. While sometimes it may appear easier to try to implement one-size-fits-all systems, ultimately the quality and functionality of each system will be improved if it is tailored to a family's needs. Additionally, families feel more ownership over their systems when they are shown proper respect and asked for continuous input on construction decisions.
Uganda	Travel / Logistics	Logistics	Be prepared for things not going according to schedule and have a variety of schedules for each day. this way if one thing doesn't work out or takes longer than anticipated another task can still be completed without wasting the day.
Guatemala	Community	Communication	Community leadership needs experience and technical support to properly identify and prioritize community infrastructure needs. We need to be more pro-active in terms of making recommendations and providing explanation to facilitate and support improved decision-making from community leadership.

D

Initial and Intermediate Codes

Table D.1: List of initial codes comprising each intermediate code

Theme	Relates to	Intermediate Code	Initial Codes (times grounded in data)
SubQ 2: Factors	Individual	Systems Thinking	comfortable with ambiguity (1), cultural awareness (10), open mind (8), self awareness (5), stakeholder awareness (4), systems think (6), team awareness (5)
		Self Efficacy	adaptable individual (3), build relationships (7), communicate (4), listen (4), motivated individual (6), self confidence (5), teamwork (4), technical background (5)
		Reflection	reflection (21)
		Experiential Learning	experience (24)
	Context	Mentorship	mentors (16)
		Organisation	give students autonomy (7), organisation culture (7), formal training (5), organisation governance (7)
		Project	engineering design process (3), challenge (6), length of involvement (2), problem solving (3)
SubQ 3: Barriers	Educator	Resources	resources (9), university funding system (2)
		Student Buy In	student hesitancy (8), enlisting diverse students (1)
		Organisational Complexity	bureaucratic system (7), complex system (6), unclear accountability (4), siloed faculties (4)
		Grading Mechanisms	grading (4)
		Student Development Level	student maturity level (2), how to incorporate theory (2)
		Perceived value	educator experience (7), educators unaware of value (4)
	Student	Unintentional Development	unintentional development (5), students unaware of value (5)
		Finding Opportunities	few experiential opportunities (1), lack formal opportunities (3), students dislike e-learning (2)

E

Focus Group Data

Table E.1: List of focus group attendees (September 30, 2020)

No.	Group	Perspective added
1	Engineering	Program Engineer: The engineering group has first hand experience signing off on chapter technical engineering designs. They can give perspective on the technical engineering design work of student chapters, and their perceptions on volunteer leadership development.
2	Education	Director of Education: The education group is responsible for determining volunteer and mentor education needs and providing them, most often through their e-learning platform. Work closely with volunteer engagement group to determine which education offerings to prioritize. Requested more detail around recommendations for organisation
3	Education	E-Learning Developer: Already interviewed in primary interviews (Figure B.3, EWB5)
4	Intern	5 years experience as a student volunteer in the ICP. Gave feedback that framework provides a good way to think about development.
5	Engineering	Program Engineer: The engineering group has first hand experience signing off on chapter technical engineering designs. They can give perspective on the technical engineering design work of student chapters, and their perceptions on volunteer leadership development. Asked for clarification on definition for ”safe to fail”, if the project itself fails, it isn’t good.
6	Programs	Senior Program Manager: Many years of experience with the organisation, and has seen the organisation grow and change. Agreed with many of the issues brought up by the research, such as the value of non technical mentors. Highlighted that it brought up some good advantages of their ICP as well, namely longer term projects.
7	Programs	Engineering Service Corps Coordinator: Coordinates in country programs. Could give the perspective on how PBSL would work in country, how transferable the framework is to a local setting.
8	Engineering	Chief Design and Build Officer: Already interviewed in primary interviews (Figure B.3, EWB1)
9	Volunteer Engagement	Volunteer Engagement Manager: The volunteer engagement group is responsible for helping volunteers feel engaged in the work, and looking for areas where the organisation can better support them. As such they have some insight into typical issues volunteers face.
10	Engineering	Program Manager: The engineering group has first hand experience signing off on chapter technical engineering designs. They can give perspective on the technical engineering design work of student chapters, and their perceptions on volunteer leadership development.
11	Volunteer Engagement	Volunteer Engagement Manager: Already interviewed in primary interviews (Figure B.3, EWB4)

Leadership Development at EWB-USA - Findings

Eilidh Ritchie
Construction Management and Engineering
Masters Thesis
Sep 30, 2020

1

Agenda

- Research Approach (5 min)
- Data – Interviews (5 min)
- Results – Leadership Perceptions (5 min)
- Results – Leadership Development (10 min)
- Theory and Recommendations (10 min)
- Discussion (20 min)

2

Research Question and Method

Research Question: How can organisations support engineering students leadership development in experiential learning contexts?

Grounded Theory Methodology:

- Qualitative
- Open minded
- Explorative
- Student centered

3

Assumptions / Perspectives

- I wanted to leave room for individual approaches to leadership development too, won't ever be a one size fits all approach
- Most research on engineering education done in a western context, will introduce bias (myself included)
- Assumption: By being elected to hold leadership roles, the students are considered by their peers to have developed leadership capabilities to fill the role

4

Figure E.1: Slides 1-4 shared in the focus group

Data: Interviews

Group	#	Notes
EWB Student Leaders	10	Varying experience levels 3 Chapters
Engineering Students TU Delft	3	Construction Management Engineering Masters students
Professors TU Delft	4	All design/coordinate courses dealing with "softer" engineering capabilities
Professional Engineers	2	Both had >20 years industry experience
EWB Staff	5	Various backgrounds
Other Educators	1	Director of 7 Day Innovation Summit
Total	**25**	

5

Results - Student Leadership Perceptions

Students believe engineering leadership is:

- A **role** that members may take on in a team (formal, informal, or shared)
- A **capability** that:
  - needs to be grounded in strong technical engineering capability
  - is often explained in terms of individuals having other professional capabilities, such as communication skills, adaptability, and humility
- An **individual** that empowers others to share ideas, develop themselves, and work towards a common goal
- An **abstract concept:**
  - That considers engineers responsibility to society - This perception was only present in more experienced students
  - Younger students described leadership more as project management (less about responsibility to society, empowering/developing others)

6

Quotes – Leadership Perceptions

"Making an environment where people are totally comfortable with throwing ideas out there – that's the most important part of leading an engineering team." (Incoming Project Lead - 2nd year EWB)

"You need to foster an environment where people can take responsibility for their own work and feel like they're contributing to something." (Incoming Design Lead - 3rd year EWB)

"It's being able to guide a group of individuals or a team to complete a task or goal" (Incoming Project Lead – 2nd year EWB)

"Leadership is setting an example so that other people follow you" (Outgoing Chapter President – 5th year EWB)

7

Results – Leadership Development

Leadership was best developed through practising in leadership roles:

- Internships and number of times travelled had less perceived impact
- Working with communities / real clients helps and is what EWB offered that universities struggle to
- No noticeable differences from chapter to chapter. Exception one that had a more socially oriented faculty advisor

8

Figure E.2: Slides 5-8 shared in the focus group

Quotes – Leadership Development

"Being put into a leadership role and having to account for a group of people is the best way to gain more leadership skills . I don't think you get too much of it in the early years of engineering university" (Incoming Chapter President – 5th year EWB)

"But internships, instead of you being the leader, you are working under a boss or a supervisor so you're getting the other side of it. But most of the (leadership) learning happens when you're doing it yourself" (Outgoing Chapter President – 5th year EWB)

"I think a lot of the leadership skills I learned was mostly from within my own chapter. Even things that have nothing to do with the EWB project, like organising our E board, reviewing our constitution, getting people to do recruitment on campus, I think that's a lot of what I learned." (Incoming Chapter President – 4th year)

TUDelft

9

Theory - Psychological Safety

- Leadership Development can be fostered in psychological safe learning environments

"Psychological Safety is a shared belief amongst individuals as to whether it is safe to engage in interpersonal risk-taking in the workplace" (Edmondson, 2002)

- Interpersonal risks examples:
  - Speaking up in teams
  - Admitting to not understanding something
  - Trying new methods that might not work
  - Accepting and learning from failure
- In psychologically safe teams individuals feel respected, accepted, included

TUDelft

10

Quotes – Psychological Safety

"You've got to have your own agency to fail, otherwise you're not actually in charge. I think that's why I love the professional mentor system. Because the program director and I could make every mistake possible and come up with a terrible plan but then the professional mentor will look at that plan and say 'these designs are bad, you cant use them" (Incoming Design Lead - 3rd year EWB)

"You develop leadership by making a lot of mistakes. … I think to get good at that you just need to listen to people. To read the world and see how people are responding to the things I am doing" (Outgoing Chapter President – 5th year EWB)

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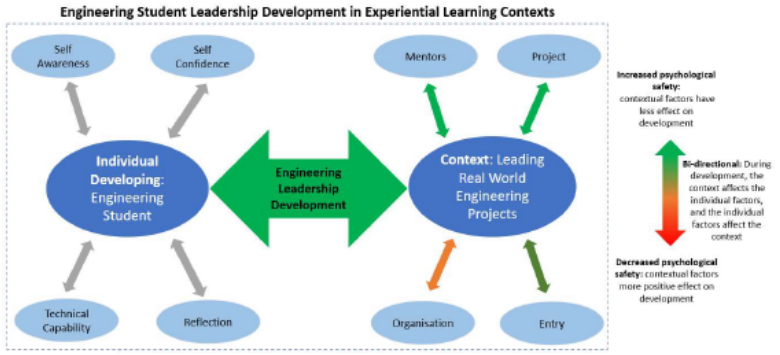

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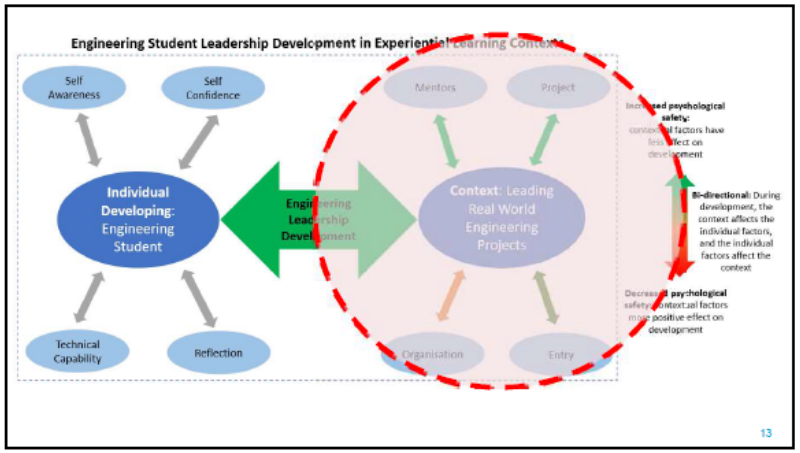
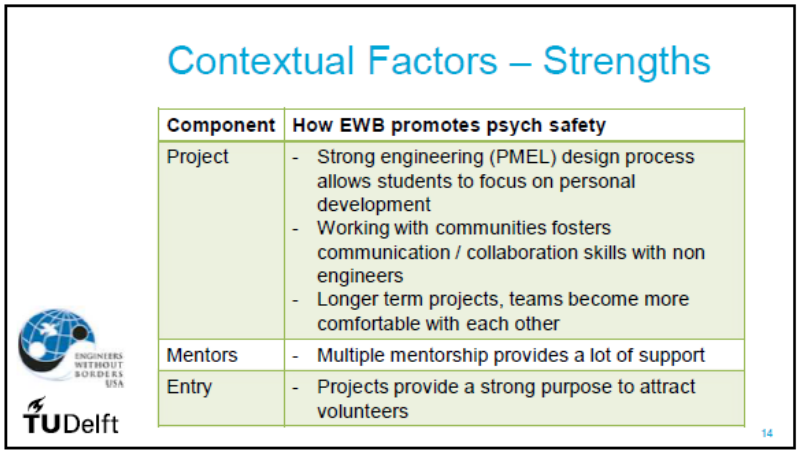
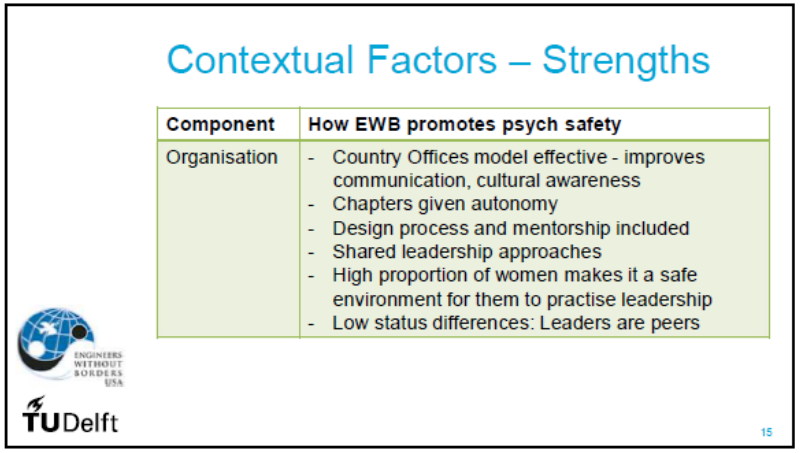
Figure E.3: Slides 9-12 shared in the focus group







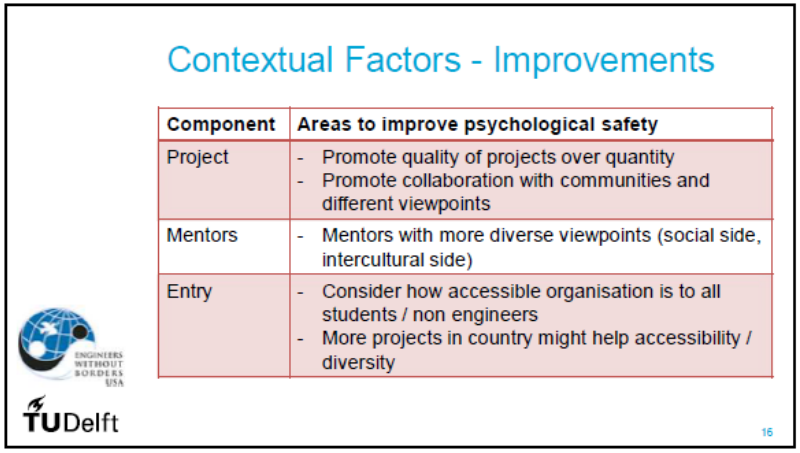


Figure E.4: Slides 13-16 shared in the focus group

Contextual Factors - Improvements

Component	Areas to improve psychological safety
Organisation	- Promote safe to fail culture: Go beyond lessons learned, embrace and more openly talk about failure - Be wary of power/status dynamics that could make environments less safe to develop in (chapter – community, hierarchical chapters, mentors) - Explore HQ perceptions on leadership, do they match with students?

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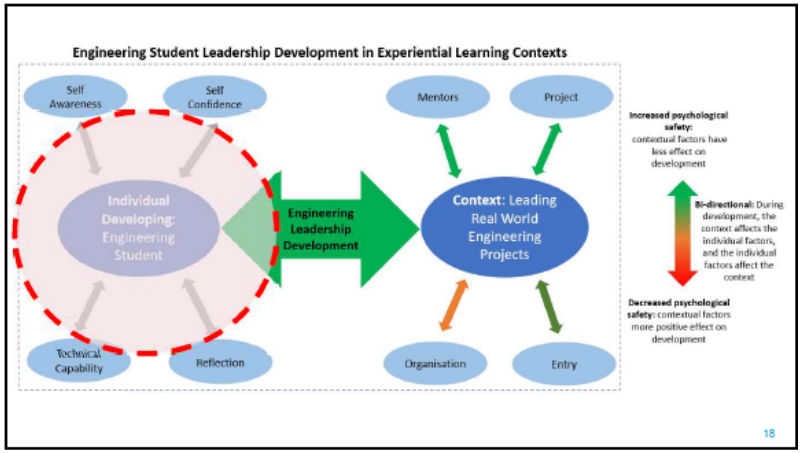

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Individual Factors - Strengths

Component	How EWB promotes this
Self Awareness	- Exposure to different viewpoints (communities)
Self Confidence	- Opportunities to practise in leadership roles
Technical Background	- Technical mentors
Reflection	- Conferences

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Individual Factors - Improvements

Component	Areas EWB could help with
Self Awareness	- Promote cultural awareness (own as well) - Teamwork training (communication, conflicts etc)
Self Confidence	
Technical Background	
Reflection	- Promote more active reflection – main mechanism for learning in experiential learning - Promote giving and receiving feedback

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Figure E.5: Slides 17-20 shared in the focus group