CHALMERS
UNIVERSITY OF TECHNOLOGY

Bridging the Academia-Industry gap: Upskilling engineering students for future work life

A case study of the UNITECH International Leadership Development Programme

Master's thesis in Learning and Leadership

ANNA MARTINSSON & EMELIE JÄGERSTRÖM

DEPARTMENT OF COMMUNICATION AND LEARNING IN SCIENCE

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2024
www.chalmers.se

MASTER'S THESIS 2024

Bridging the Academia-Industry gap: Upskilling engineering students for future work life

A case study of the UNITECH International Leadership Development Programme

ANNA MARTINSSON & EMELIE JÄGERSTRÖM

CHALMERS
UNIVERSITY OF TECHNOLOGY

Department of Communication and Learning in Science
Division of Engineering Education Research
Chalmers University of Technology
Gothenburg, Sweden

Bridging the Academia-Industry Gap: Upskilling engineering students for future work life

A case study of the UNITECH International Leadership Development Programme

ANNA MARTINSSON & EMELIE JÄGERSTRÖM

Supervisor: Greta Braun, Department of Product and Production Development

Examiner: Philip Gerlee, Department of Mathematical Sciences,
Chalmers University of Technology

Master's Thesis 2024
Department of Communication and Learning in Science
Division of Engineering Education Research

Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone +46 (0)31-772 1000

Illustrations: Emelie Jägerström
Printed by Chalmers Reprosercive
Gothenburg, Sweden 2024

Acknowledgements, dedications, and similar personal statements reflect the author's own opinions.

Title: Bridging the Academia-Industry gap: Upskilling engineering students for future work life
Subtitle: A case study of the UNITECH International Leadership Development Programme
ANNA MARTINSSON & EMELIE JÄGERSTRÖM
Department of Communication and Learning in Science
Chalmers University of Technology

ABSTRACT

The industry's skill demand is an emerging issue and concerns about skill gaps have increased worldwide in the past few years. This study focuses particularly on the academia-industry gap, meaning the skills gap between the skills practised in engineering education and the industrial skill demand. Several studies stress the necessity for soft skills and there is an ongoing shift within industry towards softer, value-based, and human-centred skills. Employers look for people that possess interpersonal and social competencies as well as the technical skills and to bridge the gap between industry's demand and the supply of workforce, upskilling programmes have emerged on the market.

While previous studies have primarily focused on skill gaps in general within leadership development or upskilling programmes, this case study, conducted at UNITECH International's leadership development programme for engineering students, aims to provide insight into the specific skill gap referred to as the academia-industry gap. Additionally, it seeks to map out the influencing factors in the design of such upskilling programmes, with a particular focus on didactics. This is essential as previous studies have shown a lack of deeper exploration of the didactical perspective, which is crucial for enhancing effective learning and development.

The study was conducted through observations carried out during two separate weeks of in-person coaching modules, where students received education and coaching aimed for personal growth, enhancing their leadership abilities and equipping them to effectively navigate future challenges. Surveys were also administered to gather students' perceptions of their previous engineering education and their participation in the program.

The case study reveals an existing gap between engineering education and industry skill demand, encompassing four key areas of skills: *Creative Thinking, Motivation and Self-awareness, Empathy and Active Listening,* and *Leadership and Social Influence.* Additionally, the study indicates that UNITECH International in general bridges this gap effectively, with the exception of Creative Thinking, which requires an increased focus. Finally, the study identifies 33 sub-categories of influencing factors in leadership development programmes, classified into six overarching categories: *Programme Relevance*, *Organisation and Structure*, *Teaching*, *Social Environment*, *Fostering Growth*, and *Working Life Orientation*. These findings can be valuable for educators, coaches, and programme designers to successfully and effectively equip engineering students with the necessary skills for their future careers.

Keywords: skills gap, academia-industry, soft skills, skill demand, upskilling, bridging, influencing factors, programme design, leadership development programme, engineering education.

ACKNOWLEDGEMENTS

We would like to start by expressing our sincere gratitude to our supervisor, Greta Braun, at Chalmers University for the support and guidance throughout this thesis journey. You have patiently encouraged and inspired us from beginning to end. Additionally, we extend our heartfelt thanks to everyone at UNITECH International, particularly the UNITECH Office, all the coaches and all the UNITECH students, for warmly welcoming us and facilitating our work. Your assistance during observations and willingness to answer our questions have been greatly appreciated. Furthermore, we would like to thank the President of the UNITECH board, Torbjörn "Toby" Lundh for initiating this thesis. We would also like to extend special thanks to all the participants who took the time to respond to the surveys in this study.

We would like to extend our sincere thanks to Yommine Hjalmarsson at Chalmers Library, Aila Särkkä at the Department of Mathematical Sciences, and our examiner, Philip Gerlee, for generously sharing your knowledge and expertise, and for taking the time to assist us when we reached out to you. We also express our gratitude to the other librarians, research assistants, and course mates from the university who have impacted and inspired us throughout this journey.

Lastly, we would like to express our heartfelt gratitude to our families and friends. Your unwavering support and belief in us has been instrumental in keeping our spirits high and our motivation strong throughout this entire process.

Emelie Jägerström and Anna Martinsson, Gothenburg, 2024

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

AI	Artificial Intelligence
RQ	Research Question
WEF	World Economic Forum
STEM	Science, Technology, Engineering and Mathematics

1. INTRODUCTION

In this chapter, the background to this thesis is introduced, followed by the aim and research questions selected to capture the subject matter. Subsequently, this chapter presents the scope and delimitations as well as an outline of the thesis.

1.1 Background

The engineering profession is said to have evolved in the late 19th century during the era of Taylorism, when the work at the lathes that had previously been characterised by a professionalism built on skill and experience, was optimised and standardised (Berner, 1999). Even at that time, the engineering profession primarily was focused on purely technical aspects such as measurements, experiments, instrument development and documentation (Berner, 1999) and despite substantial societal changes and the evolution of the engineer's role, a predominantly technical perspective on engineering persists in many contexts today. The Cambridge Dictionary defines an engineer as "a person whose job is to design or build machines, engines, or electrical equipment, or things such as roads, railways, or bridges, using scientific principles" (Cambridge Dictionary, n.d.). Although technology serves as a fundamental pillar of the engineering profession, there are significant social aspects inherent in the profession that cannot be ignored. There are numerous examples in the techno-sociological and technological-historical literature that support this, and even the matter of testing, perhaps seemingly straightforward and uncomplicated, can be viewed as a negotiation process influenced by various interests and social dynamics affecting how uncertainty is managed (Berner, 1999). A well-known and debated example is the Challenger disaster in 1986, where engineers, with concern, pointed to data from previous tests to halt the launch, while the same data were considered irrelevant in the context by those who made the decision to proceed with the launch (Pinch, 1993).

The notion that technology is inseparable from social and political relations (Pinch, 1993) is an insight that also struck Pius Baschera, a former CEO of Hilti. In a conversation in year 2000, with the former principal of ETH Zurich, Konrad Osterwalder, Baschera expressed his concerns about engineers' limited capacity to address the social aspects of their work (Ward & Schwarz, 2023):

"Your students come to the company with an excellent knowledge. However, if the issue requires a solution that is not technical in nature, then they struggle to make an impact".

Baschera and Osterwalder agreed that recent engineering graduates frequently lack the non-technical, interpersonal skills essential to the industry. It was with the aim of addressing this gap that they founded The UNITECH International Society in 2000. Since then, the organisation has offered engineering students in Europe the opportunity to supplement their engineering studies with for instance leadership courses, cross-cultural experiences, language training and industry exposure, through participation in the UNITECH International leadership development programme. This allows students to develop the additional interpersonal skills that the founders, as industry representatives, deemed necessary.

Skills can be defined as “the ability to apply knowledge and use know-how to complete tasks and solve problems” (Baartman & de Bruijn, 2011), while skill gaps can be defined as “gaps between the skills that employees possess and those that industry players consider necessary” (Rikala et al., 2024). Today, the industry's skill demand is an emerging issue. According to a literature review by (Braun, 2023), numerous studies highlight the current skill gaps within the industry as well as other sectors. Another review indicates that concerns about skill gaps have increased worldwide, especially in the past few years (Rikala et al., 2024). Additionally, the European Commission proposed the year of 2023 as “the European year of skills”, aiming to address skill gaps in the European Union and boost the EU skills strategy (European Commission, 2023). In line with the need identified by UNITECH's founders, there also seems to be a more widespread consensus that the industry is in increasing need of workers with non-technical competencies. While Industry 4.0, a term coined in 2011 for the fourth industrial revolution, focused on purely technical aspects, the emphasis in Industry 5.0, recently defined by the European Commission, has shifted towards softer, value-based, and human-centred skills (Braun, 2023; Saniuk & Grabowska, 2022; Saniuk et al., 2022).

To effectively address this demand, the future workforce, including engineers, need opportunities to develop complementary non-technical skills, whether through their ordinary university programmes or in leadership development initiatives like UNITECH. To do this efficiently, it's essential to first understand the existing need as well as the gap between the skills practised in engineering education and the industrial skill demand (Babic et al., 2022). The latter represents a specific type of skills gap that could be referred to as the *academia-industry gap* (Valstar, 2019) and which is often of significant magnitude. On an average, only 50-60% of the skills required by the companies are acquired by the students in higher educational institutions (Kirti & Saini, 2022). Subsequently, it's crucial to ensure that the education provided to students is designed with relevant content and in a manner that fosters learning and ensures students acquire the desired skills.

Therefore, there is a need for examining the current state of the academia-industry gap as well as what influencing factors that need to be considered in the design of education to effectively close the identified gap. While there are multiple studies examining important aspects to consider in leadership development programmes or upskilling programmes (Braun et al., 2023; Rottmann & Kendall, 2022; Yemiscigil et al., 2023), they do not specifically have a focus on bridging the academia-industry gap, and there seems to be a lack of deeper focus on the didactical perspective, enhancing effective learning and development.

1.2 Aim and research questions

The aim of this study is to *identify the existing academia-industry gap within the engineering field and examine how a leadership development programme can effectively bridge this gap*. The objective is to offer valuable insights for education providers in designing or developing leadership development programmes. In the longer run, our vision is to ensure a relevant and skilled future workforce through bridging the skills gap between engineering education and industrial skill demand. With this purpose and objective in mind, the following research questions were formulated:

> RQ1. What is the perceived gap between the skills practised in engineering education and the industrial skill demand?
>
> RQ2. How effectively does the UNITECH leadership development programme bridge this gap today?
>
> RQ3. What are the influencing factors in the design of a leadership development programme to effectively bridge the skills gap?

1.3 Study context

For the implementation of the study, a case study was conducted at UNITECH International, a European International Society organising a STEM leadership development programme for engineering students. The organisation was founded in 2000, stemming from an idea conceived the same year during a dinner with Pius Baschera, a former CEO of Hilti and the then-rector of ETH Zurich, Konrad Osterwalder. During a conversation they emphasised the need to better prepare engineering students for their professional careers by complementing their traditional studies with international exposure and management training. The aim of funding the society and the programme was, and still is, to develop talented young STEM students, enabling them to successfully manage future challenges in global industry and by doing so, help bridging the gap between the corporate and academic world (UNITECH international, 2024).

At the time of writing, the UNITECH society consists of a network of nine leading European technological universities or Academic Partners, 14 leading industrial companies referred to as Corporate Partners, a cohort of 70+ students selected each year as well as an alumni community with around 1'500 alumni, all of them spread out across Europe. The programme has a duration of just over a year and includes a semester-long study exchange at one of the European universities affiliated with the program, an international internship placement at one of the Corporate Partners as well as three coaching modules in three different countries, spread out during the year. The coaching modules aim to foster personal development (UNITECH international, 2024) and consist of lecturing, exercises, group work, as well as targeted professional coaching for both individuals and groups. The three distinct coaching modules are referred to as the Start-Up Week (Module 1), the Mid-Term Week (Module 2), and the End-of-Year (Module 3). Module 1 for a new cohort runs simultaneously with Module 3 for the graduating cohort. The teachers,

who also serve as coaches, in these modules are employees provided by the Corporate Partners. This setup not only offers valuable insights into the programme for the Corporate Partners but also ensures substantial contributions from industry perspectives to the programme's development. During Module 1 and Module 2 for cohort 23/24, around 12-14 coaches attended at both Module 1 and Module 2.

1.4 Scope and delimitations

While skill gaps exist in various contexts and forms, this study specifically targets the academia-industry gap within the engineering field. Therefore, it excludes, for instance, skill gaps within the existing workforce as well as skill gaps in other fields. In exploring the gap, the World Economic Forum's list of the top ten demanded core skills of 2023 (Di Battista et al., 2023) serves as a reference for the industrial skill demand. Thus excluding some of the fastest emerging skills such as AI skills and Green skills (Di Battista et al., 2023; World Economic Forum, 2020) as well as skill demands identified by other organisations such as the IDG Framework (Inner Development Goals, 2021).

The research is conducted by studying a one-year-long leadership development programme over a seven-month period. Consequently, an additional delimitation is that the investigation primarily focuses on one cohort (2023-2024) and only during a limited part of their programme. Moreover, this research focuses on the students as a collective entity, rather than tracking the development of skills and learning on an individual level. Additionally, although the programme includes an exchange semester and an internship at an industrial company, our research primarily centres on the coaching modules, engaging a didactical perspective. Furthermore, collected data will only be analysed and presented in the report if it is relevant to answering the research questions

1.5 Thesis outline

This introductory chapter outlined the topic and underscored its significance. The following chapters will be structured as described below.

Chapter 2, *Theoretical background*, introduces fundamental concepts essential for comprehension of the issue and the current conditions in the industrial context in which the research is situated. The chapter begins with relevant definitions, followed by an exploration of skill gaps relevant to this thesis. Subsequently, it concludes with concepts related to leadership development programmes and important aspects to consider when designing such a programme.

Chapter 3, *Methodology,* initially describes the methodological approach, research design and reasoning method undertaken for this study, followed by a comprehensive description of methods deployed for data collection and data analysis, accompanied by motivation for those choices. The chapter also highlights the ethical aspects considered for this study, including a brief account of the use of Artificial Intelligence.

Chapter 4, *Results,* presents the main findings of this study. It is structured into three main sub-chapters, one for each research question. To enhance clarity and readability, the sub-chapters corresponding to the second and the third research questions are further divided into additional, lower-level chapters.

Chapter 5, *Discussion*, begins by highlighting key findings and essential insights from the results, whereupon their contributions to the research field and practical applications are illuminated. Subsequently the methodology and potential threats to validity are discussed, followed by an overview of future research directions and practical recommendations for moving forward.

Chapter 6, *Conclusion*, provides a concise summary of the key ideas presented in this thesis, integrating the findings with the overall aim and long-term objectives of the study.

2. THEORETICAL BACKGROUND

This chapter begins by presenting relevant definitions. Subsequently, it provides insights from previous research in the field of skill gaps, as well as findings from other researchers in the domain of engineering leadership development programmes. Further on, theories are presented alongside the results of the thematic analysis in section 4.3 in order to make the presentation more coherent, with the exception of a vital theory on human needs relevant to programme design that concludes this chapter.

2.1 Skills gap and skill demand

Skills can be defined as "the ability to apply knowledge and use know-how to complete tasks and solve problems" and is something that enables individuals to do something in practice, in contrast to knowledge where it's more about possessing information (Baartman & de Bruijn, 2011). To effectively bridge skill gaps, there must first exist a clear definition of the concept of skill gaps. After conducting a literature review about skill gaps definitions, Rikala et al. (2024) proposed a definition of skill gaps as follows:

> *"Skill gaps are gaps between training outcomes and industry-specific skill needs and, therefore, gaps between the skills that employees possess and those that industry players consider necessary. Consequently, a skill gap can be understood as a difficulty in providing the right skills to the right people at the right time to enhance employee productivity, improve and advance organizational performance, create value, support digital transformation, and narrow gaps in business realities and labor markets."*

This definition refers primarily to skill gaps that exist within the current workforce. Since this study focuses on engineering students, and the training outcomes primarily linked to their education, we henceforth refer to the gap within the *future* workforce. This gap is in some contexts referred to as the college-to-career gap, defined as the distance between what colleges teach and what industry needs (Kelly et al., 2024) or as the education gap, referring to the gap between employers´skill needs and the offer of education providers (Braun, 2023). In this thesis however, it will be referred to as the academia-industry gap, meaning the gap between industry expectations and students' academic experience (Valstar, 2019).

As a consequence of digitalisation within organisations, the industrial skill demand keeps changing (Braun, 2023). Industrial revolutions, a green transition and generative AI all lead to new skill demands in the workforce. Jobs that have previously been performed by humans are now done by machines and researchers argue that workers have more time to use skills like problem solving, creativity, adaptability and perform coordination tasks. Not only are skill demands driven by technology and a green transition, but a demographic change of a declining working population in society stresses the challenge of finding workers with the right skills. To identify the skill demand, WEF have performed studies where they asked organisations what core skills they require by workers today (Di Battista et al., 2023). In their "Future of Jobs" report 2023, they list the ten most in demand skills by industry in 2023. These skills are listed below, and will further on be referred to as *the top ten core skills.*

1. Analytical Thinking
2. Creative Thinking
3. Resilience, Flexibility and Agility
4. Motivation and Self-awareness
5. Curiosity and Lifelong learning
6. Technological Literacy
7. Dependability and Attention to Detail
8. Empathy and Active Listening
9. Leadership and Social Influence
10. Quality Control

Out of these ten skills, seven of them are related to personal or social competence (all but skill number 1, 6 and 10), areas where engineers are deemed to lack competence according to a study carried out in 2022 (Saniuk & Grabowska, 2022). In this study, business professionals and managers from manufacturing companies were asked to evaluate the level of competence represented by the engineers using a 5 point Likert scale. The evaluation was conducted based on four groups of competencies: *Social Competencies*, *Methodological Competencies*, *Technical Competencies* and *Personal Competencies*. The study results indicate that engineers perform at a high to very high level within Technical Competencies and at a medium to high level for Methodological Competencies while for Social Competencies and Personal Competencies the perceived level was medium to low. In concluding this study, the authors emphasise the importance for engineers to develop soft skills essential for communication, collaboration and interpersonal relationship building as well as for sustainable development. They also suggest development of support programmes for academics to cultivate them with the skills necessary, as students lack up-to-date and practical knowledge in their dynamically changing environment.

In addition to mentioned study, several other studies also emphasise the academia-industry gap existing within the engineering field. Garousi et al. (2019) performed a meta-analysis showing that 20 out of 35 studies highlight the significance of soft skills. Hence, they stressed the necessity for enhancing students' soft skills throughout their university education. Further research on skills gap among software engineer graduates, found that among the non-technical skills, these three were the least developed (Groeneveld et al., 2021):

- Devoting oneself to continuous learning
- Being creative by approaching a problem from different angles
- Thinking in a solution-oriented way by favouring outcome over ego.

Except from the top ten core skills identified by WEF (Di Battista et al., 2023), the emphasis on personal and social skills is a recurring theme also in other skill sets listed. The organisation Manpower reported that *Reliability and Self-Discipline, Creativity and Originality, Critical Thinking and Analysis, Reasoning and Problem-solving* and *Resilience and Adaptability* are the top five most important skills in the future (Braun, 2023). The UN developed a list of skills required to reach UN's goals of sustainability for 2030 (Inner Development Goals, 2021). Among these competencies, three out of five key areas include self-awareness,

interpersonal skills, and social collaboration abilities. Additionally, as previously highlighted, the emphasis in Industry 5.0, has in comparison to Industry 4.0, shifted towards a softer, value-based, and human-centred focus of skills (Braun, 2023; Saniuk & Grabowska, 2022; Saniuk et al., 2022). The soft skills, also referred to as social-emotional skills, have additionally been argued to have a positive impact on other skills like creativity, problem solving, decision making and critical thinking (Kassie, 2023).

2.2 Educational programme design

In this section, three previous studies on upskilling programmes and leadership development programmes are presented. First, findings from a study of the purposes of leadership development programmes are introduced, followed by successful strategies for such programmes as a result of another study. Subsequently, in section 2.2.3, a map of influencing factors in upskilling programmes for engineers is presented, which has been a point of reference in our observations of UNITECH International. Finally, a vital theory on human needs is explained and applied to programme design, as this was a recurring frame of reference during the observations in this study.

2.2.1 Purposes for leadership development programmes

As previously mentioned, the aim for UNITECH International is to develop talented young STEM students, enabling them to successfully manage future challenges in global industry and by doing so, help bridge the gap between the corporate and academic world (UNITECH international, 2024). Looking at leadership development programmes in general, Rottmann and Kendall (2022) argue that there are four purposes of educating engineering students in leadership that programme developers must consider to ensure that such programmes continue to be impactful, forward-thinking and relevant. Their research findings include factors not only related to practice of skills, but also programme content on a more structural level. They argued that engineering leadership education must be driven by

- The Pursuit of Knowledge
- Personal Growth
- Professional Preparation
- Social Transformation

The Pursuit of Knowledge relates to the content in the programme. It must be based on research in engineering leadership and engage students to foster curiosity through inquiry projects (Rottmann & Kendall, 2022). *Personal Growth* can be cultivated through personality inventories, activities with interpersonal interactions, case studies or guided reflections on experiences and exercises. By emphasising personal awareness and growth, students are prepared for the world beyond school and helped to build their confidence as social actors. *Professional Preparation* clearly relates to the development of skills according to skill demand, but Rottmann and Kendall (2022) further described internship and close ties to industry as a structural path to reach such goals. As the authors emphasise, this is also a desired outcome for students participating in such programmes, because students want to be practically prepared for working life. The purpose of *Social Transformation*, on the other hand, implies that engineering students must be trained to

consider a broader public and use their problem-solving skills not only for the interest of their employers, but also to drive a change in societal challenges such as social justice, equity and sustainability. The authors highlighted the importance of prioritising Social Transformation just as high as Personal Growth, Professional Preparation and The Pursuit of Knowledge.

2.2.2 Strategies for leadership development programme designers

Through studies of what makes leadership development programmes successful, Yemiscigil et al. (2023) listed seven strategies for programme designers to address, in order to make out most of the programme for its participants in the long run. These seven strategies are summarised below:

1. Focus on whole-person growth - not only focus on professional contributions but also skills like self-awareness and resilience.
2. Provide opportunities for self-reflection and meaning-making - facilitating sufficient time to reflect on purpose enables participants to gain life-changing insights and shift perspectives.
3. Offer targeted programmes to support leaders with acute or chronic stress - meaning that leadership development programmes can reduce stress.
4. Do not underestimate short, intensive programmes - shorter programmes, like two or four days, often lead to large improvements.
5. Acknowledge and address psychological barriers to growth - prepare with motivation and select programmes for individual needs.
6. Ensure that short-term growth leads to sustained, long-term impact - it is easier to measure short term improvements, but the article suggests that organisations should prioritise ensuring long term impacts.
7. Embrace online learning - remote work is increasingly becoming a norm. Their studies show that online programmes have no significant difference in results.

The authors stated that leadership development programmes have the possibility to impact on personal growth and a deeper level of wellbeing, and when they do so, the outcome is more impactful than those programmes that primarily focus on short term performance outcomes.

2.2.3 Influencing factors of upskilling programmes

Braun et al. (2023) performed studies on bridging skill gaps in industry and presented a scheme over challenges and success factors of an upskilling programme for engineers participating in the national programme *Ingenjör4.0*. The scheme consists of 5 themes with two or three sub-categories according to figure 2.1. The themes are explained further below.

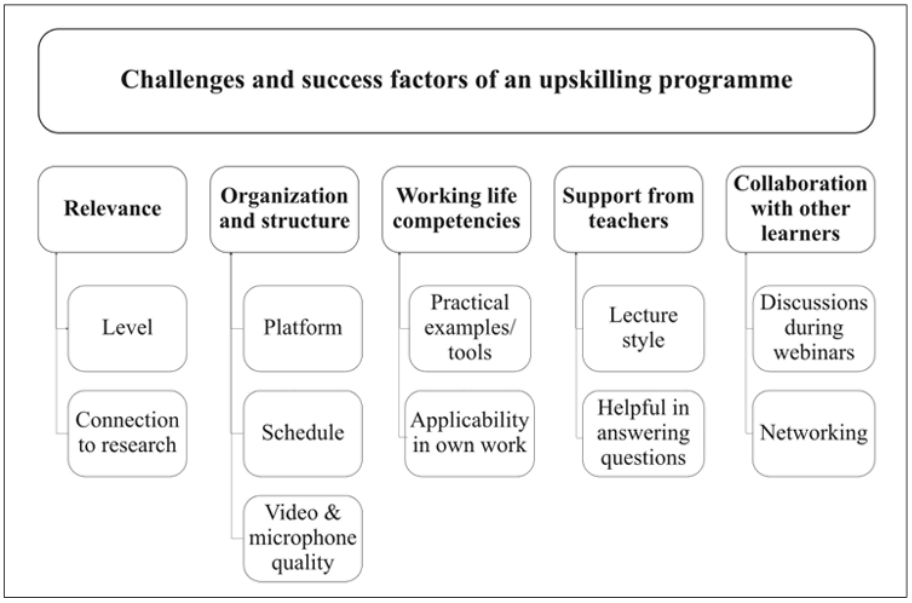

Figure 2.1: *Challenges and success factors of an upskilling programme according to Braun et al. (2023)*

The theme *Relevance* relates to both perceived level of content as well as its connection to research. Braun et al. (2023) found that an influencing factor to ensure state of the art content is to collaborate between universities, professors, experts and industry.

Organisation and structure relates to the functioning of the platform, the scheduling in the programme and the quality of microphone and video. Further, a framework for learning modules is an influencing factor to obtain better organisation and structure. Timing of modules and their schedule is also part of this theme.

The theme of *Working life competencies* relates to how well the content was perceived as applicable in working life through practical examples and tools. By enriching teaching with practical examples and tools, students become more prepared for working life.

The fourth theme *Support from teachers* highlights the importance of competent and knowledgeable teachers. The two identified sub themes in this theme are lectures and helpful in answering questions. Feeling supported and receiving feedback are also mentioned as motivational factors in further research (Braun, 2023).

The last theme is *Collaboration with other learners* and relates to opportunities to talk to and work with other students, with the purpose of both practising collaboration and expanding the network for participants (Braun et al., 2023). Both interactions during seminars, and the possibility to network on your own, are listed as influencing factors. Further research shows that not only interactions during a programme is essential, but also afterwards through a continuous network (Braun, 2023).

2.2.4 Programme design based on human needs

Abraham Maslow created a model named *Hierarchy of Needs*, where he argued that an individual's potential to learn depends on what need is prioritised in that moment (Bates, 2023). He arranged human needs in five steps, where the lower steps include physical and physiological needs and the top level need relates to self-fulfilment. Learning progress can take place only once the lower level needs are fulfilled. Transferred into programme design, Maslow's theory visualises concrete factors to consider in order to facilitate learning (Bates, 2023):

1. Physical - Relates to aspects such as indoor environment with good ventilation, breaks for refreshments, drinks and recovery.
2. Physiological - Meaning freedom from uncertainties and fears and implies a structured organisation, well-planned lessons and a good classroom climate.
3. Affiliation - A social environment built up on respect and acceptance, both in between peers and between students and teachers. This highlights the importance of interactions between peers.
4. Esteem - Implementation of opportunities for students to show their development and achievements for each other, preferably followed by praise, or other formats of feedback which acknowledges their competence. Requires opportunities to apply new knowledge in group work or other formats of assignments.
5. Self-fulfilment - Meaning access to reach full potential and encouragement in taking the next step forward. This step is not prioritised or sought before the prior steps are fulfilled.

Similar to Maslow's Hierarchy of Needs, Clayton Alderfer argued that human motivation can be divided into different categories - *Existence, Relatedness and Growth* - where a progression towards growth is driven by satisfaction of existential and relational conditions (Bates, 2023). Existence relates to basic needs such as comfort and proper heating and lighting. Relatedness refers to interpersonal and social relationships. Finally, Growth refers to respect and self-actualisation. Unlike Maslow, Alderfer argued that regression in the hierarchy is not necessarily a bad thing and stresses the importance of addressing all steps simultaneously.

3. METHODOLOGY

This thesis presents a case study on the leadership development programme UNITECH International. Both qualitative and quantitative methods were employed to ensure a comprehensive and valid outcome, providing a broader understanding of the case. This chapter outlines each step of data collection and analysis. Prior to these descriptions, the methodology approach and research design are explained.

3.1 Approach and research design

To best achieve the purpose and address the research questions of this study, a mixed method was employed as the methodological approach as a whole, meaning that data collection was of both qualitative and quantitative nature. This approach enables researchers to draw upon the strengths and minimise the weaknesses of each respective research approach (Williams, 2007). However, when considering the specific research questions of this study, data collection was either quantitative or qualitative, or a combination of both (mixed method) depending on the nature of the question.

The selected research design for the data collection was a case study conducted at a European leadership development programme for engineering students. A case study involves studying and describing a specific unit among others, such as a programme, and can include various data collection methods, all of which have in common that they are limited in time and space (Christoffersen & Johannessen, 2012). The purpose of conducting a case study is often to illustrate a more commonly occurring phenomenon, even though a common criticism of case studies is indeed the extent to which it is possible to make empirical generalisations from them (Alvehus, 2019). However, case studies as a research strategy are specifically suitable for studying phenomena that are complex and dependent on their context, as with social contexts (Jensen & Sandström, 2016). Priya (2021) also argued that this kind of investigation of phenomena in real-life context provides a holistic understanding of the case. With those arguments in mind, a case study appeared to be a suitable research strategy for studying how a leadership development programme prepares engineering students for the professional world.

Our approach to theory shifted somewhat between the different research questions. While the approach for RQ1 and RQ2 was mainly deductive, for RQ3 abductive reasoning dominated as the reasoning method. Abductive reasoning emerged in the tension between deductive and inductive reasoning and as argued by Tavory and Timmermans (2019), it serves as a response to grounded theory's leading position within qualitative research and its distancing from existing theories. The core of the abductive approach is indeed to connect observations to existing theory (Tavory & Timmermans, 2019). As researchers, we entered this study with a multitude of theories and models acquired from our master's programme in Learning and Leadership, which, despite our efforts to remain objective, served as an inevitable filter when observing and analysing data. Furthermore, as will be explained in more detail later, both our observation protocol and our analysis arguments were based on existing theories, which would make it unethical to claim that we had a completely inductive approach. With an inductive approach, one starts from the empirical material, without any theoretical preconceptions, and builds conclusions solely based on this (Alvehus, 2019). At the same time, for RQ3, we were more theory-generating (inductive) than theory-consuming (deductive). This

balance between induction and deduction is a challenge that many researchers address. Alvehus (2019) argued that pure induction and deduction should probably be seen as ideal types that are not realistically attainable. Similarly, Christoffersen and Johannessen (2012) and Repstad (2007) discussed this balance and suggested that researchers inevitably enters the field with their theoretical background, assumptions and expectations, which act as a filter for observations, while they also need to maintain an openness to the new and surprising aspects of the data collected. This openness to surprises is precisely what characterises the abductive approach (Tavory & Timmermans, 2019) and it is what permeated the thematic analysis of our observations, related to our third research question.

3.2 Case definition and selection

For this study, a holistic approach was adopted (Yin, 2003), meaning that data collection was limited to one single unit of analysis, in our case, one single leadership development programme; UNITECH International. Although multiple case studies, with multiple units of analysis, may be considered to provide higher validity and even though Yin (2003) argued that multiple cases are always better than one single case, the number of cases needed to be related to the resources available for data collection. Alvehus (2019) argued that this balancing is important as studies of multiple cases, with limited resources available, will result in each case being studied more superficially while the main point of case studies is precisely the depth of the investigation. With a limited timeframe and a limited amount of resources for this study, it was assessmed that a single case would provide greater benefits for this study by allowing for deeper exploration and thereby increasing validity.

The primary objective of the UNITECH programme is to better prepare students for careers in the industry by addressing the skills gap experienced by employers in the engineering field. Therefore, the selection of this programme as the study object appeared logical, even though the primary selection criteria was accessibility and hence the opportunity to conduct an in-depth research study participating in critical events while observing.

3.3 Methods

To identify and measure skill gaps, a holistic approach is needed, and there are some crucial steps which are important to conduct (Rikala et al., 2024). These include understanding what companies need and want (Maheso et al., 2019), exploring the skill gaps among employees (Adepoju & Aigbavboa, 2021), as well as understanding the coverage of these necessary skill sets in training and education (Akdur, 2021). In this research, the first step is represented by the WEF's top ten core skills (Di Battista et al., 2023), serving as a reference for industry skill demand. The second step addresses this study's investigation of the students' perceived practice within this skill set (RQ1). Finally, the third step is reflected in RQ2, involving the students' perception of practising the skill set within UNITECH, as well as data from observations.

As previously mentioned, data collection was of both qualitative and quantitative nature considering the study as a whole, while the data related to specific research questions were either qualitative or quantitative. To facilitate readability and provide an overview, the three research questions are presented in table 3.1 along with a brief description of the methods employed for data collection and analysis, which will be explained further in the subsequent text.

Table 3.1: *An overview of the methods employed to address each research question.*

	Research question	Data collection	Data analysis
RQ1	What is the perceived gap between the skills practised in engineering education and the industrial skill demand?	Surveys: ● UNITECH Students ○ Aug 2023 ○ March 2024	● Quantitative compilation and statistical analysis of surveys
RQ2	How effectively does the UNITECH leadership development programme bridge this gap today?	● Surveys with UNITECH Students: ○ Aug 2023 ○ March 2024 ● Observations: ○ Module 1 and Module 3 Aug 2023 ○ Module 2 Jan 2024	● Quantitative compilation and statistical analysis of surveys ● Skill-coding and compilation of observation data
RQ3	What are the influencing factors in the design of a leadership development programme to effectively bridge the skills gap?	● Creation of observation protocol based on previous theories within learning and leadership ● Observations: ○ Module 1 and Module 3 Aug 2023 ○ Module 2 Jan 2024	● Coding of observation data ○ Open coding ○ Coding events as success or challenges ● Thematic analysis of coded data

3.3.1 Data Collection

This section provides a detailed description of the data collection methods outlined in the table above, along with the scientific rationale behind the methodological choices made for this study. First, the survey-related methods are described, followed by an explanation of the observation methods. The methods for data analysis are then outlined in the following section, and the chapter concludes by shedding light on ethical aspects relevant to this thesis.

3.3.1.1 Surveys

To define and approach the actual skills gap as closely as possible, data from education providers, employers, and (future) employees need to be considered, as all these three actors play a crucial role in addressing the skills gap (Braun, 2023). Even if the survey respondents only represented one of these groups (e.g. future employees), the survey questions encompassed all three perspectives when using the WEF's top ten core skills as the framework for industry skill demand and surveying the students on their education experience.

Both surveys were distributed to all 73 UNITECH students in the current cohort (2023/2024), one in August 2023, just before Module 1, and one in March 2024, after Module 2. Respondents were asked in both surveys to rate their own performance within each of the top ten core skills identified by WEF in the Future of Jobs report (Di Battista et al., 2023), choosing among the five response options: *Very unsatisfied (1), Unsatisfied (2), No opinion (3), Satisfied (4)* and *Very satisfied (5)*. In the March 2024 survey, the students were also asked to estimate the extent to which they had practised each skill during: a) their engineering education, b) Module 1, and c) Module 2, using the five following fixed response options: *Not at all (1), To a minimal extent (2), Moderately (3), To a significant extent (4),* and *Extensively (5)*. In both surveys, the ten skills were defined as follows:

1. *Analytical thinking* - The ability to systematically analyze information, identify key components, and draw logical conclusions for effective problem-solving and decision-making.
2. *Creative thinking* - The ability to come up with new and unique ideas, looking at problems in different ways, and finding imaginative solutions by thinking openly and flexibly.
3. *Resilience, flexibility and agility* - The ability to bounce back from challenges, adapt to changes, and navigate uncertainties with ease.
4. *Motivation and self-awareness* - The ability to understand one's own desires and drive, and to maintain a positive and determined mindset to achieve goals.
5. *Curiosity and lifelong learning* - The ability to stay interested, willing to learn new things and keep discovering throughout your life.
6. *Technological literacy* - The ability to understand, use, and adapt to technology effectively, including digital tools and systems.
7. *Dependability and attention to detail* - The ability to consistently deliver reliable and accurate results by being reliable and careful in paying attention to details.

8. *Empathy and active listening* - The ability to understand and share others' feelings while actively listening to their perspectives and experiences.
9. *Leadership and Social Influence* - The ability to guide and inspire others, shaping their thoughts and behaviors positively.
10. *Quality Control* - The ability to consistently monitor and ensure the high standard of products or processes, identifying and fixing defects or deviations.

In designing surveys, formulating the questions poses the greatest challenge and represents the most significant potential source of error (Esaiasson et al., 2017). Consequently, this aspect was given great importance in this study, employing various measures recommended by Esaiasson et al. (2017) to address this challenge. For instance, questionnaires created by other researchers who have previously conducted similar surveys were examined, and literature on formulating good questions was reviewed. Additionally, the surveys were tested on external individuals before being distributed to respondents. Recommendations that specifically were considered when formulating the questions include formulation of response options as well as avoiding leading and consent questions, the latter being because people tend to find it easier to agree than disagree with a statement. The response options were also constructed to be comprehensive and mutually exclusive, meaning that respondents should always find one (and only one) fitting option thus avoiding confusion and frustration. Regarding the question of including a 'middle' option and a 'do not know' option, the choice was made to include both. This is recommended when response options, as in the surveys of this study, are positioned along a scale, and furthermore, research indicates that the use of such options does not impact the relative distribution among other response options (Esaiasson et al., 2017).

Another challenge associated with surveys is indeed the response rate, and in this regard, reminders play a crucial role in striving to achieve the highest possible response rate, often increasing the response rate from a doubtful 40-50% to an acceptable level of 50-60% (Esaiasson et al., 2017). In this research, multiple reminders were sent to participants to encourage a higher response rate and thus obtain reliable data. For the second student survey, which was deemed crucial for the study, an additional contact was initiated during a UNITECH online session. This contact enabled a reminder as well as a designated time-slot for the respondents to complete the survey. Additionally, other crucial factors motivating participation in the survey (Esaiasson et al., 2017) was taken into consideration when creating the survey. These factors include the scope and number of questions as well as the layout and structure, featuring a logical sequence of questions.

3.3.1.2 Observations

Direct observations accounted for the majority of data collection in this study. It is a data collection method commonly used in field research where the aim is to gather knowledge about people in natural settings, focusing on what people do rather than what they say they do (Esaiasson et al., 2017). Therefore, direct observations felt like a natural choice for studying how a leadership development programme, through coaching modules, equips engineering students with the skills deemed necessary by the industry. On the other hand, disadvantages of direct observations include being time-consuming and therefore only feasible to conduct to a limited extent, as well as the risk of bias related validity issues (Esaiasson et al., 2017). In this

study, the latter risk was addressed by, whenever possible, having two researchers conducting observations in parallel and by constantly reminding each other to maintain objectivity and stay critical towards the data collected. The goal with these actions was to avoid the data being influenced by personal opinions or preconceptions and they are both countermeasures recommended by methodology literature to increase validity during observations (Esaiasson et al., 2017). Another advantage of having two researchers is the ability to exchange ideas and discuss during breaks between sessions, helping the researchers to maintain focus and remind yourselves and each other of the study's purpose. This is particularly crucial when utilising observations as a method of data collection, as it's easy to become absorbed in various interesting but off-topic observations (Christoffersen & Johannessen, 2012).

Observations were conducted during two separate weeks, one during Module 1 in August 2023, and another during Module 2 in January 2024. To guarantee focused observations and efficacy, these observations were well prepared through creation of a structured plan outlining which observations were to be carried out by whom, as well as through the development of an observation protocol. The main and initial observation protocol was created based on five main themes that, in previous studies, were shown to be key factors in the design of other upskilling programmes (Braun et al., 2023), as well as on well-known learning theories and models covered in the Chalmers Master's Programme Learning and Leadership. However, the observation protocol was not static as it evolved over time. It underwent numerous updates during the initial observations, ending up to be customised for various purposes. While the main observation protocol, used for teaching sessions and exercises, stayed with the same structure but with minor adjustments, notes taken during coaching and feedback sessions were captured in a narrative format, detailing the discussions that took place. As Esaiasson et al. (2017) suggested, early observations often serve as "trawling," whereas later ones need an increase in structure. Similarly, while emphasising that an important aspect of observations is that data collection and analysis occur simultaneously, Christoffersen and Johannessen (2012) suggested that observing researchers need to start very openly and then narrow down and focus their observations.

Esaiasson et al. (2017) suggested that observation protocols in theory-consuminging studies should be highly structured, whereas in theory-generating studies, they could preferably have a lower degree of structure. Consistent with our abductive approach, where we took a starting point in existing theories and models in the field but maintained a great openness to the new and unexpected, we used an observation protocol with a relatively high degree of structure but took notes very freely. Since we recorded all notes in a digital format, we extensively utilised the comment function to capture as detailed notes as possible and we also used a separate space to take notes of our own reflections made during observations. Detailed notes, as well as separating empirical or descriptive notes from reflecting or interpretive ones, are elements that Esaiasson et al. (2017) highlighted as important for being able to process observational data afterwards. Another advantage during the observational data collection was the accessibility of note taking, eliminating the need to rely on memory. With complete access granted, a passive participation, and full transparency regarding our presence and the study's purpose, during observations we could naturally position ourselves at the rear with our laptops open, diligently taking notes. Another advantage of our passive participation approach during the observations is that we were distancing ourselves from the environment and the

students, in line with the recommendation to not "go native" and become a part of the phenomena investigated (Esaiasson et al., 2017).

Esaiasson et al. (2017) as well as Christoffersen & Johannessen (2012) discussed various types of direct observations where certain aspects can vary along a sliding scale. The features of this study, in terms of these aspects are visualised in figure 3.1. As previously mentioned, our participation was largely passive, meaning we did not actively participate in any exercises or discussions, and the transparency regarding the study's intentions was complete. The environment for the observations was entirely natural, meaning the sessions would have taken place in exactly the same manner, even without our presence and the conduct of this study. Thanks to this and to the passive participation, the manipulation factor was considered to be very low. As also previously noted, the data collection was somewhat between standardised and open due to the abductive approach, utilising a standardised observation protocol combined with free and detailed note-taking.

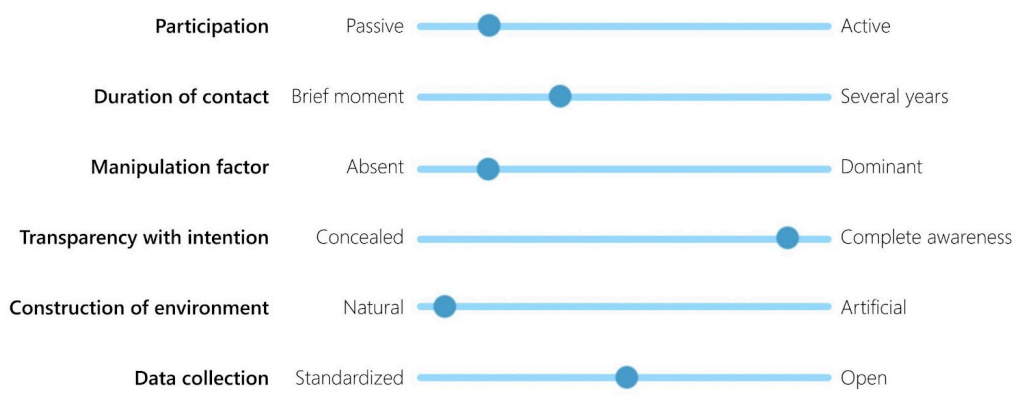

Figure 3.1: *The methodological features of this study, adapted from Esaiasson et al. (2017) and Christoffersen and Johannessen (2012).*

3.3.2 Data analysis

Since the data collection consisted of both quantitative and qualitative data, the analysis methods also differed significantly. For the quantitative data (surveys), statistical analysis methods were used, while the qualitative data (observation data) was primarily analysed through coding and a thematic analysis.

3.3.2.1 Surveys

Hypothesis testing was performed to investigate statistical significance in perceived practice and performance. Since the number of respondents from both surveys exceeded 30, normal distribution could be assumed in all calculations, whereupon t-tests were conducted (LibreTexts, 2021). If samples were smaller than 25, a normal distribution could not have been taken for granted, and a non-parametric test should have been applied instead of the t-test to secure a more accurate p-value. Significance level was set at 5%, which is the most usual (Monk & Munro, 2021). Results were visualised with diagrams and charts.

To answer RQ1, answers from the questions "To what extent have you practised this skill in your engineering education so far?" were analysed. The five alternatives were translated into numbers (Not at all=1, To a minimal extent=2, Moderately=3, To a significant extent=4, and Extensively=5). Each skill was then compared with the reference level of 3,0 through one sample, one tailed t-tests (Monk & Munro, 2021). Skills that were not significantly higher than the reference level, were considered to be included in the skills gap.

Answers from the same questions were also compared with the corresponding questions of perceived practice in Module 1 and Module 2. This was done to assert whether UNITECH bridges the identified skills gap. In these calculations, one tailed, paired t-tests were performed to detect significant increase of practice in Module 1 or Module 2 compared with engineering education. Three respondents did not fill in an answer for all 10 skills, so for these calculations their answers were removed, to be able to perform paired t-tests with same size samples. In these calculations, a Bonferroni correction of value 2 was applied since the data set of perceived practice in education was used two times (Napierala, 2012), first in the comparison of engineering education with Module 1, and second in the comparison of engineering education with Module 2.

Answers from both surveys regarding performance in each skill were analysed to answer RQ2. In this case, individuals could not be tracked due to anonymous surveys. Even though there might have been an overlap, meaning that the two samples were constituted by partly the same individuals, independence was assumed. Therefore, two sample, two-tailed t-tests were conducted to investigate any difference in performance, even though there might have been a dependence in the answers.

3.3.2.2 Observations

The observation data originated from observations during Module 1 (45 observation sessions) as well as from Module 2 (33 observation sessions) and, as can be seen from table 3.1, the analysis of the observation data had two main objectives; firstly, to identify categories and sub-categories of key factors that need to be considered in the design of a leadership development programme aiming at bridging skill gaps (RQ3), and secondly, to determine which of the skills demanded by the industry are trained within the UNITECH leadership development programme (RQ2).

For RQ3, the observation analysis involved coding of success factors and challenges, also referred to as influencing factors, as well as a thematic analysis. The coding of success factors and challenges was justified using a lens consisting of a theoretical framework for the analysis. This framework is built upon research in learning and leadership, emphasising various critical aspects for success, such as in learning situations. It is presented along with the results of the thematic analysis in section 4.3. Additionally, such coding was also justified in situations where a challenge or success was obvious, such as when an action uplifted the students' mood or if the energy level was noticeably low in the room. Coding of observation data was also conducted in relation to RQ2. However, this coding was not conducted with the intention of performing a thematic analysis. Instead, it aimed to identify which of the skills demanded by the industry are trained within the UNITECH leadership development programme. This process involved coding events from the observations in relation to WEF's top ten core skills (Di Battista et al., 2023), whenever the researchers observed these skills being practised. The compilation of this coding primarily provided a qualitative contribution to the

results of RQ2, although it also offered some quantitative insight by showing the number of instances a specific skill was coded. The process of analysing the observation data, connected to RQ2 and RQ3, is illustrated in figure 3.2.

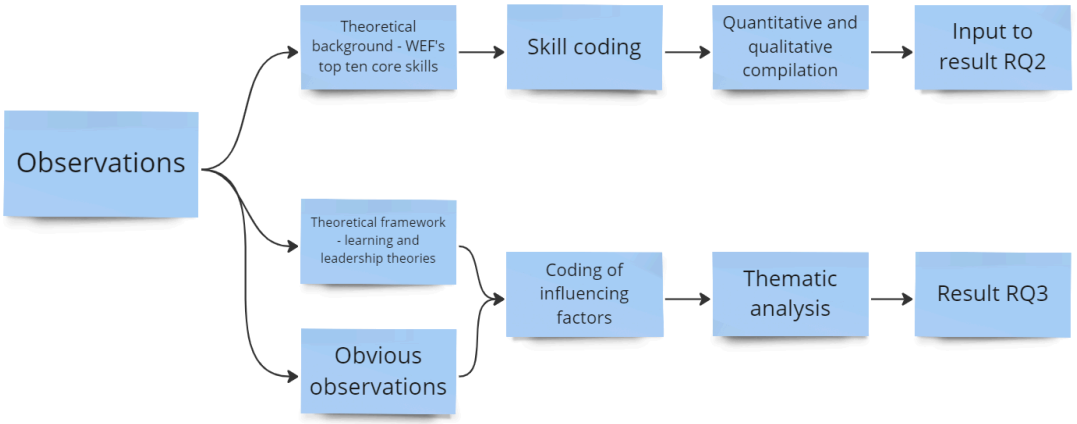

Figure 3.2: *The process of analysing the observation data, related to RQ2 and RQ3.*

As previously mentioned, the analysis was somewhat proceeding in parallel with the data collection, as we narrowed our focus progressively during the observations, thereby allowing the data analysis to commence simultaneously with the observations (Christoffersen & Johannessen, 2012). However, for sufficient scientific distance, it is important to leave the environment for compiling results and report writing (Esaiasson et al., 2017). Therefore, the actual analysis work, such as coding and thematic analysis, was saved until after the observations were completed.

The thematic analysis, related to RQ3, was conducted using the six-phase approach to thematic analysis as described by Braun and Clarke (2012). In the first step, *Familiarising yourself with the data*, we read and re-read our data, making initial notes and starting to find patterns. In the next and second step *Generating initial codes*, we started coding all data potentially relevant for the study while identifying the substance in the data related to the research questions. This step was an iterative process, enabling us to focus our coding over time through modifying existing codes, revisiting and recoding the data. This approach enabled us to ensure all selected data was fully coded and that data relevant to each code was captured, ending up with 433 coded data-rows, and 756 unique codes. In the *Searching for theme*-phase, the third step, the codes were clustered in themes, capturing significant patterns within the data related to the research question. This step of the analysis involved identifying similarities and overlaps between codes, collapsing or clustering them to reflect coherent and meaningful patterns as well as exploring the relationship between themes. In the fourth step, *Reviewing potential themes*, the developed themes were reviewed against the coded data and the entire dataset for quality-checking. First, the themes were checked against the collated data, ensuring alignment and a satisfactory amount of data for each theme while making adjustments such as relocating codes or redrawing the boundaries of a theme. Then, the themes were assessed against the entire dataset to ensure they accurately represent the data in relation to the research question. In the two remaining steps, *Defining and naming theme* and *Producing the report*, an hierarchy was developed and sub-themes were created as well

as descriptions of each theme. The first and second steps of the thematic analysis were initially carried out independently and simultaneously by us two researchers to ensure alignment and objectivity in coding. After finalising coding, the data coded by one researcher were also reviewed and refined by the other. Additional measures to ensure validity included conducting the third step of the thematic analysis completely independently, as well as arranging a focus group workshop in the fifth step to gather valuable input and further refine the results.

During the coding and the thematic analysis a highly structured approach was undertaken. The coding, as well as the original observations, was conducted in a digital format using Excel, making it possible for all data to be labelled with the origin as well as searching for specific data or codes within the data-set. This approach enabled continuous quality checks during the analysis, ensuring that the processed data remained strongly connected to and still reflected the original data from the observations. Labelling the data with their origin is highlighted as an important step of the coding process to avoid losing the original context (Repstad, 2007). In the process of creating a hierarchy with logical relations between themes and sub-themes, a digital board was utilised to provide an overview and facilitate visualisation. Using different overviews and figures rather than just text is also highly recommended during the analysis phase, as it helps in identifying relationships in the data (Repstad, 2007).

3.4 Ethical aspects and use of Artificial Intelligence

To ensure responsible research, societal, ethical, and ecological aspects were considered in both the selection of research questions and methodology. In line with our vision to ensure a relevant and skilled future workforce through bridging the skills gap between engineering education and industrial skill demand, an overarching goal is to promote future technological development led by engineers equipped with the right competencies.

Exploring what are the right competencies and to what extent the ten skills identified by the WEF (Di Battista et al., 2023) are contributing to sustainability is a subject for future research. Of particular interest is analysing their alignment with the UN's Inner Development Goals Framework, comprising 23 skills recognized as critical for sustainable development and the achievement of the global goals (Inner Development Goals, 2021). Nevertheless, it is believed that the findings of this study establish a solid foundation in strengthening crucial competencies for driving sustainable development forward, and thus has the potential for a positive impact on the climate. This since engineers play a crucial role in developing technology for sustainability when designing and implementing innovative solutions. By identifying the academia-industry gap within the engineering field and examining educational programmes for engineers, with the aim of improving their effectiveness, the hope is that this work, along with the expectation that present and future companies strive to minimise their climate impact, can contribute to future engineers effectively leading sustainable development efforts.

As this study is a case study, it was limited to the processes and the group of people involved in the programme for data collection. The selection of observed and surveyed individuals was therefore not consciously made from an equality perspective. However, the focus of observations was not on individual persons but rather on a group level. During observations, consideration was taken to the students' integrity and only appropriate occasions were attended, in consultation with the coaches. Consent was also ensured for all observations. Although Braun (2023) recommends examining skill development on an individual level, our decision to concentrate on a group level was partly motivated by considerations of time constraints and the integrity of the individuals being investigated.

Data collection resulted in a carbon footprint in the form of a flight to Ireland in August 2023. As this trip accounted for approximately 50% of the data collection, it is considered necessary for the research. Otherwise, the work did not require any significant physical resources that have a negative impact on the environment.

To ensure reliable results, established methods in both quantitative and qualitative data collection and analysis were employed, and the influence from previous research and theory was considered. The use of Artificial Intelligence was kept at a responsible level, limited to suggesting synonyms, checking spellings, occasionally translating shorter expressions. It was not used for generating text, translating entire sentences or paragraphs, or analysing data.

4. RESULTS

In the following chapter, all the results from this study are presented. Given that the three research questions were instrumental in achieving the aim of this study, the results are presented under each respective question. Additionally, to enhance readability and provide an overview, the three research questions are again presented in a table (table 4.1), this time accompanied by a brief description of the key components that constitute the results.

Table 4.1: *An overview of the result components for each research question.*

	Research question	Results consisting of:
RQ1	What is the perceived gap between the skills practised in engineering education and the industrial skill demand?	● The UNITECH students' perception regarding the extent to which they practised the top ten core skills during their engineering education.
RQ2	How effectively does the UNITECH leadership development programme bridge this gap today?	● Performance aspect: ○ The UNITECH students' perception of their performance in the top ten core skills in March 2024 versus Aug 2023. ● Practice aspect: ○ The UNITECH students' perception regarding the extent to which they practised the top ten core skills during the coaching modules within UNITECH. ○ A combination of examples from, and count of events where practising of different skills were observed during coaching modules.
RQ3	What are the influencing factors in the design of a leadership development programme to effectively bridge the skills gap?	● A hierarchical map of critical factors identified through the thematic analysis of observation data.

4.1 RQ1 What is the perceived gap between the skills practised in engineering education and the industrial skill demand?

Using the WEF's top ten core skills as a framework for industrial skill demand (Di Battista et al., 2023), the UNITECH students were asked, in the March 2024 survey, to estimate the extent to which they had practised these ten different skills during their engineering education. 40 out of 72 students (55%) responded to the question using the five following fixed response options: *Not at all (1), To a minimal extent (2), Moderately (3), To a significant extent (4),* and *Extensively (5)*. The average ratings from their responses for each skill are plotted in the figure 4.1.

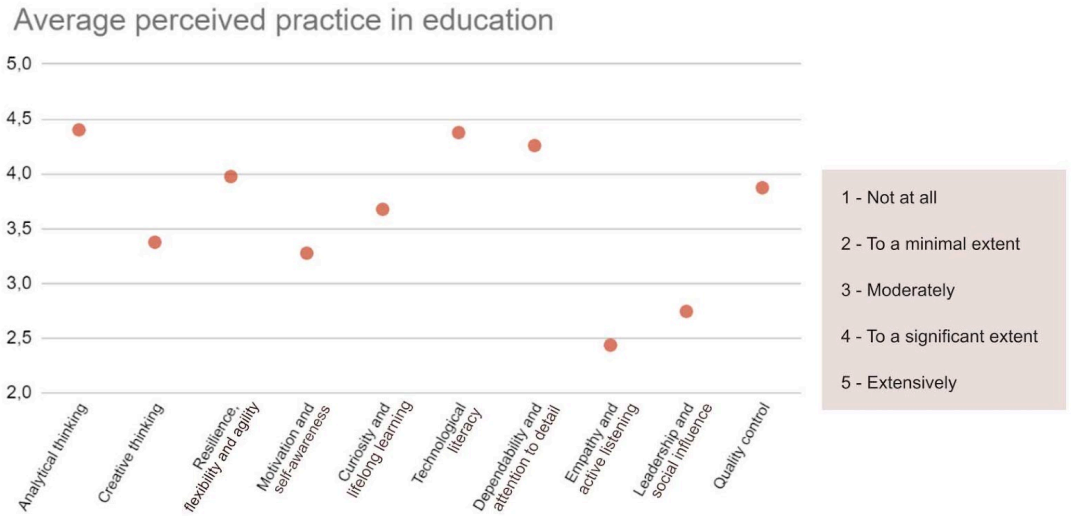

Figure 4.1: *Average rating of students' perception of the extent to which the different skills were practised during their engineering education.*

With a cutoff point set at 3.0 ('Moderately') to define what should be considered an academia-industry gap, t-tests were conducted to identify which of the ten skills could not be assessed as significantly higher than this limit. This approach yielded four skills considered to constitute the gap between the skills practised in engineering education and the industrial skill demand:

- Creative Thinking
- Motivation and Self-awareness
- Empathy and Active Listening
- Leadership and Social Influence

4.2 RQ2 How effectively does the UNITECH leadership development programme bridge this gap today?

The result of RQ2 consists of two main components. Firstly, the performance aspect, involving students' perceptions of their performance before and after participating in the two coaching modules. Secondly, the practice aspect, including student-perceived as well as researcher-observed practice during the coaching modules.

4.2.1 Perception of performance before vs after coaching modules

In the surveys in August 2023 and in March 2024, the students were asked to rate their own performance in the top ten core skills (Di Battista et al., 2023), choosing among the five response options: *Very unsatisfied (1), Unsatisfied (2), No opinion (3), Satisfied (4)* and *Very satisfied (5)*. According to the t-tests, it turned out there was no significant difference in the students' perception of their own performance in any of the top ten core skills, comparing the self rate before Module 1 versus after Module 2. However, the results give an indication of possible slight increase for some of them, as shown in figure 4.2.

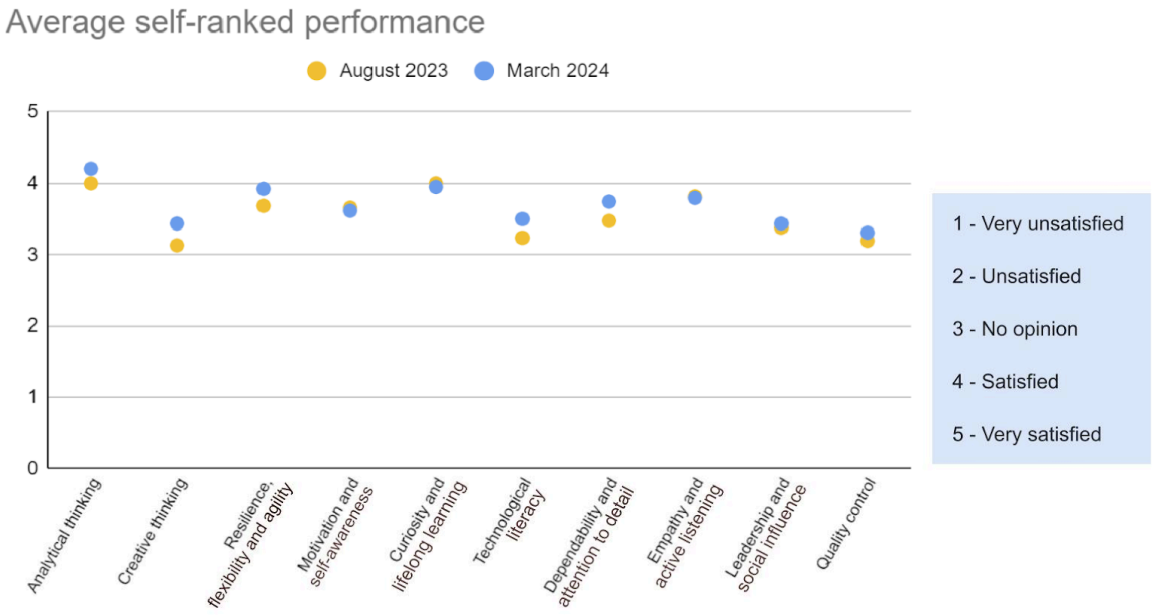

Figure 4.2: *The average of the students' self-ranked performance for each skill*

4.2.2. Observed and student perceived practice during coaching modules

In the second survey in March 2024, the students were asked to rate their perception of to what extent the different top ten core skills were practised during the coaching modules. The response options available for rating were the same as for rating the engineering education practice: *Not at all (1), To a minimal extent (2),*

Moderately (3), To a significant extent (4), and *Extensively (5).* The results reveal that for all of the four skills identified as an academia-industry gap under RQ1, there was a significant difference according to the paired t-tests in the average of students' perceived practice within at least one of the UNITECH coaching modules compared to their engineering education. While this significance is visualised in table 4.2, the corresponding diagrams will be presented later in this chapter.

Table 4.2: *The significance of the difference in students' perceived practice during the UNITECH coaching modules compared to their engineering education*.

Significant difference in perceived practice:	Module 1	Module 2
Creative Thinking	-	✓
Motivation and Self-awareness	✓	-
Empathy and Active Listening	✓	✓
Leadership and Social Influence	✓	✓

Additionally, qualitative data from observations indicate that all these four skills are trained to some extent. In the sub-chapters below, each of the skills identified as the academia-industry gap in RQ1 are presented, along with a diagram showing students' perceived training in these skills in the UNITECH coaching modules and in their engineering education. This is complemented with detailed examples from observation data providing insights on *how* these abilities were trained during Module 1 in August 2023 and Module 2 in January 2024. The frequency of the skills coded in these data also provides an indication of the extent to which each skill was trained.

4.2.2.1 Creative Thinking

Definition used in surveys: "The ability to come up with new and unique ideas, looking at problems in different ways, and finding imaginative solutions by thinking openly and flexibly".

For *Creative Thinking*, a significant difference was found in UNITECH students' perceptions of how extensively the skill was practised in Module 2 compared to their engineering education (figure 4.3). Nonetheless, Creative Thinking is the skill, among the four identified as the industry-academia skill gap in RQ1, that was least practised within the UNITECH coaching modules. These data are supported by the observations, where Creative Thinking is the skill that was coded the least amount of times among the same four. Out of all ten skills examined, it is the third least coded, after *Technological Literacy* and *Analytical Thinking*. The instances where students, according to observations practised Creative Thinking mainly involved brainstorming or some form of idea generation method in group work, presenting and visualising group work results in a creative manner, or, through coaching, responding to challenging questions that encourage new perspectives.

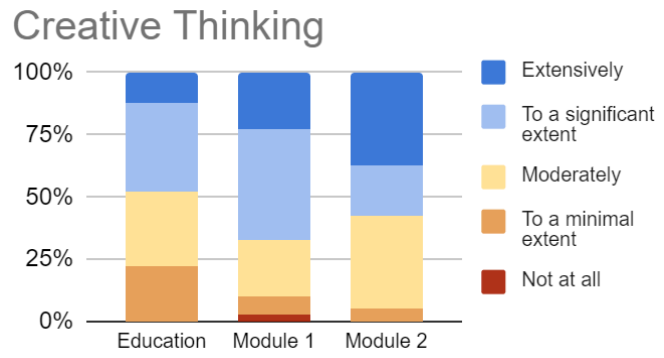

Figure 4.3: *Students' perception of to which extent Creative Thinking was practised.*

Events from coaching modules where Creative Thinking was coded:

- During Module 1, students were asked to, in groups, visualise what defines good leadership through building a model in aluminium foil. Apart from communication skills, this was also a great opportunity to think outside the box.
- At another event in Module 2, the so-called *Ideas fair*, groups of students presented their ideas of how to solve challenges within industry. The students worked in groups to define a problem and come up with innovative and creative ideas to solve these problems. Corporate Partners functioned as critics and audience of this fair, and students had one booth per group, where they communicated their ideas through flipcharts and dialogues with the Corporate Partners.
- A rather short element in Module 2, which included Creative Thinking, was a time restricted task where the students were asked to list 20 characteristics they identify themselves as.
- During Module 3, where voluntarily students had in advance prepared workshops in a desired and optional subject. They planned and performed workshops all by themselves, some in pairs and some individually.

4.2.2.2 Motivation and Self-awareness

Definition used in surveys: "The ability to understand one's own desires and drive, and to maintain a positive and determined mindset to achieve goals".

Motivation and Self-awareness is perceived to be practised to a significantly greater extent within both Module 1 and Module 2 than in engineering education (figure 4.4). The skill ranks as the 3rd most practised skill in the UNITECH coaching modules, based on the average between Module 1 and Module 2 for the ten skills examined. The observation data further supports the survey findings, as Motivation and Self-awareness is the skill that was coded the third most frequently. These observations include instances where students receive (sometimes tough) feedback and coaching, where they are asked to reflect on feelings, task processes or group interactions either in groups or individually, as well as goal-oriented tasks where students are asked to set, share, reflect and receive feedback on their individual goals for career and personal development.

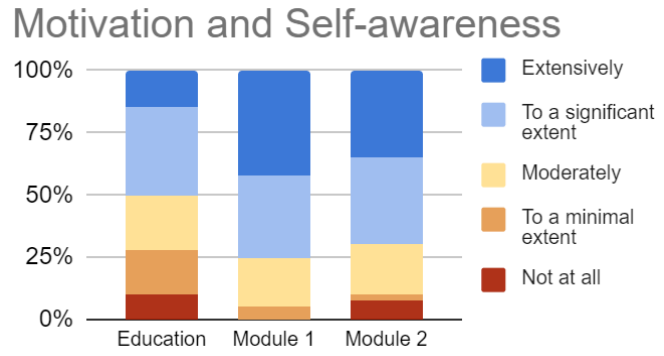

Figure 4.4: *Students' perception of to which extent Motivation and Self-Awareness was practised.*

Events from coaching modules where Motivation and Self-awareness was coded:

- In the beginning of Module 1, students are asked to reflect upon their own desires and list specific goals for their UNITECH year. Coaches helped out in defining specific and reasonable goals and continuously came back to the importance of keeping yourself and others updated on progress.
- Students were challenged to practise peer mentoring, in which they focused on their goals and personal development. In Module 3, students got to practise not only peer mentoring of Module 1-students, but also peer coaching in groups and giving feedback on the received peer coaching, allowing them to increase their self-awareness.
- During Module 2 when students had to practise public speaking in groups while taking on different emotional exaggerations. Alongside feedback from coaches and group members, this enabled the students to see their own tendencies and preferences.

4.2.2.3 Empathy and Active Listening

Definition used in surveys: "The ability to understand and share others' feelings while actively listening to their perspectives and experiences".

Empathy and Active Listening is the skill where the significance of difference in perceived practice between engineering education and the UNITECH coaching modules is most apparent (figure 4.5). Considering the average level of perceived practice within engineering education, this skill is the least practised out of the ten skills examined, while within the UNITECH coaching modules, it is perceived as the most practised. The observation data support this perception, as it was the second most frequently coded skill among the ten. These observations mainly concern working and functioning in different group configurations with other students, including showing consideration and respect, listening to others' opinions, thoughts, and feelings, as well as giving and, above all, receiving feedback and coaching.

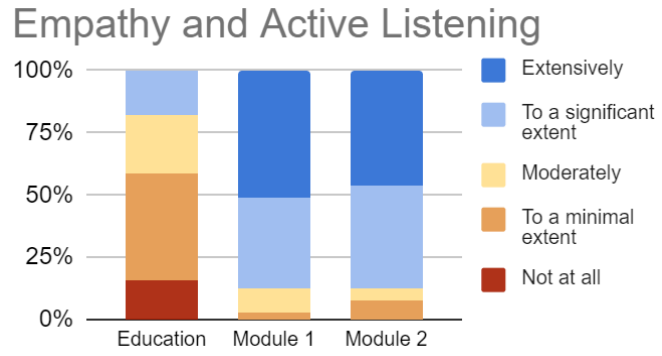

Figure 4.5: *Students' perception of to which extent Empathy and Active Listening was practised.*

Events from coaching modules where Empathy and Active Listening was coded:

- Peer mentoring is a recurring element in UNITECH. All these events were coded with the skill of Empathy and Active Listening. Students coach each other on goals for personal development, meaning that they share both professional and personal experiences, goals and feelings. One specific tool they use for peer mentoring is the *walk and talk.* Students take a walk, two and two, while coaching each other.
- During module 1, students sat in front of each other, two and two, and took turns interviewing each other using only *how*-questions or only *why*-questions.

4.2.2.4 Leadership and Social Influence

Definition used in surveys: "The ability to guide and inspire others, shaping their thoughts and behaviours positively".

Leadership and Social Influence, after Empathy and Active Listening, is ranked as the second least practised skill in engineering education (figure 4.2) and the second most practised in the UNITECH coaching modules, considering an average of practice for all ten skills examined (figure 4.6). The extent to which it is practised during the coaching modules is strongly supported by the observation data, highlighting Leadership and Social Influence as the most frequently coded skill out of the ten skills included in this research. These observations encompass various types of communication, both in pairs and groups, sharing opinions, thoughts, and feelings in the classroom, presentation skills, intercultural training, practising business English, networking and professionalism, among others. This also includes leading and working in projects, prioritising and allocating tasks, managing group dynamics, practising mentoring and coaching, as well as giving feedback.

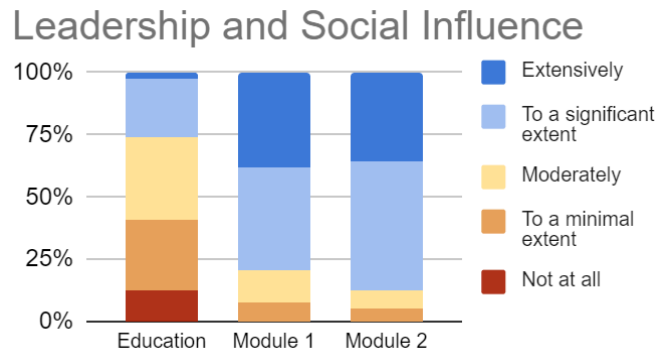

Figure. 4.6: *Students' perception of to which extent Leadership and Social Influence was practised.*

Events from coaching modules where Leadership and Social Influence was coded:

- Two observed events where students presented in front of customers or Corporate Partners were during the Ideas fair in Module 1 and during the case presentations in Module 2. They had the opportunity to pitch their ideas and hence practised the skill of Social Influence.
- During Module 1 there were several collaborative exercises with a competitive element, like games for enhancing a sense of team spirit, where students got to practise taking on different roles and work as a team.
- Throughout the UNITECH year, students work recurrently in host university groups (groups of students who go to the same university for exchange), both in small and bigger projects.
- In Module 1, they wrote their own ground rules for team work, which they were encouraged to read out loud, at the start of each group work session.

4.2.2.5 Overview and summary

In summary, considering the four skills identified as the academia-industry gap in RQ1, UNITECH is to some extent bridging the gap for all of them. To what extent these skills are practised in the UNITECH programme, based on the surveys, is visualised in figure 4.7[1]. *Empathy and Active Listening* as well as *Leadership and Social Influence* are the skills for where UNITECH most extensively bridges the skills gap, followed by *Motivation and Self-awareness* while *Creative Thinking* is the least bridged skill. These findings are strongly supported by observations.

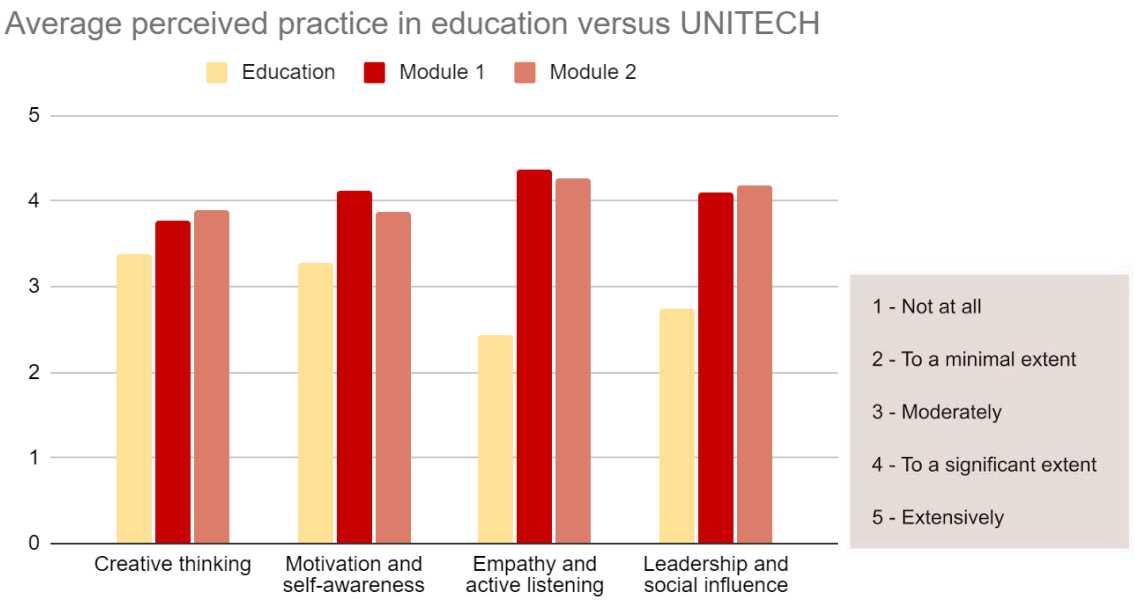

Figure 4.7: *The average of perceived practice within UNITECH coaching modules and engineering education for the four skills identified as the academia-industry gap in RQ1.*

[1] The significance of the perceived differences are presented in table 4.2

4.3 RQ3 What are the influencing factors in the design of a leadership development programme to effectively bridge the skills gap?

The thematic analysis of the observation data resulted in six overarching categories, comprising a total of 33 sub-categories that represent the influencing factors, as illustrated in figure 4.8.

Figure 4.8: *Map of the influencing factors of a leadership development programme.*

Although there are many connections and implications between the various sub-categories, they are presented in a simplified model of a hierarchical map. This, along with subdividing the largest of the six main categories, *Teaching,* into three intermediate categories, aims to enhance visibility and clarity. This section, addressing RQ3, is structured into six sub-sections, corresponding to the six overarching categories.

Under each sub-section relevant theories related to it are included to emphasise the significance of these influencing factors. Subsequently, brief definitions of the identified influencing factors, along with both successful examples as well as challenges, when these were observed.

4.3.1 Programme Relevance

Programme Relevance refers to the alignment and applicability of a programme's content, objectives, and outcomes to its intended purpose and the needs of its target audience or stakeholders. It encompasses how well the programme addresses current challenges, research advancements, and societal or industry needs. Essentially, it assesses the programme's current and future value and applicability and is strongly related to organisational learning. Sub-categories within Programme Relevance are shown in figure 4.9.

Figure 4.9: *Influencing factors related to Programme Relevance.*

For an organisation to stay successful in the rapidly changing world, it needs to equip itself with the ability to counter global changes whereas one of the most important tools for doing this is organisational learning (Saadat & Saadat, 2016). As an organisation aiming for bridging the academia-industry gap in the fast changing industry, organisational learning is an important influencing factor for UNITECH to consider to stay successful. A well cited model of individual and organisational learning is Argyris and Schön's model built up by three loops of learning (Bates, 2023). In this model, the *Single-loop learning* asks the question "Are we doing things right?" and focus on detecting and fixing errors while *Double-loop learning* asks the question "Are we doing the right things?" and focus on prevention of continuous errors. *Triple-loop learning* is the highest level of self-examination and asks the question "How can we be sure what's right is right?". It investigates and questions underlying assumptions and values. While the influencing factors *Monitoring Output* and *Coaching Alignment* mainly constitute single-loop learning, *Content* and *Development* relates to the double- and triple-loop learning.

Content

Definition: Content and its relevance in relation to purpose and objectives of the program. Quality of content depends on its connection to research and whether it is up-to-date with societal challenges.

Successful examples from observations include lectures about stakeholder management, relational skills and how to perform peer mentoring. Challenges include content being weakly connected to research and the lack of content relating to decision management.

Monitoring Output

Definition: Tracking and evaluating achievements of the programme through assessing the progress of participants on a macro level.

Successful examples include surveys sent to students after coaching modules, and a chance for students to present learning outcomes in front of the cohort and coaches at the end of Module 3. Challenges include lack of assessments and accurate measurements of learning and development.

Development

Definition: The process of gathering feedback from students and learning from it. Also the process of continuously reflecting on the outcome of the programme and making improvements.

Successful examples include coaches seeking feedback from students, coaches reflecting on their actions in briefings and debriefings and coaches following up on feedback from students. Challenges include delayed gathering of student feedback.

Coaching Alignment

Definition: Keeping coaching and feedback within the programme consistent, for instance through agreements, guidelines and training.

Successful examples include briefings and debriefings where coaches meet and discuss strategies, while observations reveal challenges of applying coherent coaching techniques.

4.3.2 Organisation and Structure

Organization and Structure encompasses the foundational elements that ensure smooth operation and effectiveness of a leadership development program, as well as establish the necessary prerequisites. All sub-categories in this area (figure 4.10) are strongly connected to the lower levels of *Maslow's Hierarchy of Needs* (see section 2.2.4), emphasising the importance and priority of their fulfilment to enable learning and for learners to reach their full potential (Bates, 2023). While *Securing Student Wellbeing* corresponds to the first level of the hierarchy, Physical Needs, the remaining three sub-categories correspond to the second level, Psychological Needs.

Figure 4.10: *Influencing factors related to Organisation and Structure.*

Communication of Information

Definition: Delivering practical information regarding the program, the organisation, key individuals and schedule, enabling students to grasp the context and have the right expectations of the programme.

Successful examples include deliverance of practical information in front of the whole cohort. On some occasions such information arrives late, which poses a challenge.

Planning and Scheduling

Definition: Well prepared schedule which is followed through on time. Timing of events to enable participation and undivided attention for all students and coaches.

Successful examples include a well-planned and organised programme with clear schedules. However, challenges in this category include timing of coaching modules to enable all students to participate and not leave sessions due to exams, and enabling coaches to be present and not focused on their regular job. Another challenge includes time management and an eagerness to share content resulting in sessions dragging out over time.

Securing Student Wellbeing

Definition: Actions for monitoring and securing physical as well as mental wellbeing through providing opportunities to refresh and recharge.

Successful examples include coaches checking in on students' well-being in the morning, reaching out to all students by digital tools or encouraging students to share their current mood with each other. An observed challenge is the lack of opportunities to take a mental break in between sessions during an intense week.

Set-up and Equipment

Definition: Adequate and functioning tools and equipment such as flipcharts, markers, note books, projectors and suitable furnituring. Also includes purposeful and functioning space and room for every activity with proper ventilation, lightning and acoustics.

Successful examples include well functioning rooms and equipment, though in other situations these areas constitute a challenge with bad acoustics, ventilation or bad quality on utilities like white board pens et.c.

4.3.3 Social Environment

The *Social Environment* encompasses the elements that foster a sense of belonging and collaboration within the cohort, enhancing the overall experience and effectiveness of a leadership development programme. All sub-categories in this area emphasise the creation of a supportive and cohesive environment (figure 4.11), promoting not only professional growth but also personal connections and well-being. They also strongly relate to *Maslow's Hierarchy of Needs* (see section 2.2.4), corresponding to the third level, *Affiliation*, as well as to the fourth, *Esteem* (Bates, 2023).

Figure 4.11: *Influencing factors related to Social Environment.*

In learning situations the third level means learners have a need for a sense of belonging, by feeling respected by peers as well as from teachers and coaches, and the fourth level, *Esteem*, means that learners have a need for self-belief and satisfaction and want to feel a sense of pride in their achievements (Bates, 2023). Thus, securing a safe social *climate* and building *relations*, as well as *Facilitating Interactions* between students are crucial factors in any kind of learning situation, enhancing *Fellowship and Friendship* as well as *Peer Learning*. The latter is facilitated through interactions, where shorter interactions ensure that misconceptions, gaps in understanding and incorrect understanding are identified and corrected (Johnson et al., 1991). This concept is hence something that influences learning positively and is also referred to as cooperative learning. A study on student performance on in-class concept questions indicates that peer discussion enhances understanding, even though none of the students in a discussion group initially knows the correct answer (Smith et al., 2009). In cases where any of the students actually knows the correct answer or are more experienced in an area, they are according to Vygotsky's Scaffolding Theory to be seen as *Most Knowledgeable Others* (MKOs) (Bates, 2023). They can then support their peers to reach their full potential in learning situations through what Vyggotsky described as the *Zone of Proximal Development* (ZPD), indicating the additional learning attainable by a learner in challenging situations with the support of MKOs. The major outcome of interactions stretched out over time is to develop positive relationships between peers, often carried out through group work. These strong relationships that occur over time are important for keeping students motivated to work together and for helping them grow socially, mentally, and physically (Johnson et al., 1991).

In upskilling and developing students in soft skills, thus changing behaviours, the social network and the culture have a strong influence. Addressing behavioural culture of a specific group, utilising elevated cultural values, is even suggested as a therapeutic method to achieve behavioural change (Evans, 2012). Besides the more apparent benefits of a *Professional Network*, such as business contacts and broadening career opportunities, the lifelong social and professional network provided in UNITECH, including continuous coaching opportunities, also acts as a safety net for students as they transition into the future workforce. Employees risk feeling abandoned when developing new skills and preparing for new jobs, which is why, in the ever-changing industrial environment, it becomes crucial to offer the employees opportunities to continuous reflect on impending issues in work situations, resulting learning needs, and possible paths to take (Shahlaei & Lundh Snis, 2023).

Establishing a Culture

Definition: Building a culture that creates pride and cohesion in the cohort. Includes talking about what it means to be an ambassador and acting it out.

Successful examples include encouragement of inclusion, community, professionality and personal development. This is also inspired by alumins presenting the alumni network during the coaching modules.

Professional Network

Definition: Life-long access to a social and professional network built up by students and alumni as well as Corporate Partners. Includes continuous coaching possibilities.

Successful examples are the opportunities to network with Corporate Partners in Module 2, as well as the access to enter an alumni network for UNITECH students.

Climate and Relations

Definition: Actions to secure a safe social climate built up by respectful and trustful relationships to and between the students. Includes establishing a positive atmosphere and building rapport with students.

Successful examples include sharing of personal experiences, activities that involve humour and interactions between peers and playing uplifting and cheerful music in the morning briefings. Observed challenges include instances where timeframes are not respected by coaches and where people are chatting while others are talking in the front.

Facilitation of Interactions

Definition: Actions to ensure students get to know, interact with and work with new peers often and effectively.

Successful examples include coaches continuously dividing students in new group constellations and students are encouraged to speak out their name prior talking in front of the group.

Fellowship and Friendship

Definition: Strong relations between students that contribute to a relaxed, supportive, and inclusive atmosphere. This includes forming new friendships as well as good team spirit.

Successful examples include the strong sense of community created during activities outside of scheduled sessions, both during weeks of coaching modules and between them, fostering friendships that endure beyond the time period of the programme.

Peer Learning

Definition: Learning and practice of skills that occur as a result of students working together, coaching each other or sharing learnings and experiences with each other.

Successful examples include students giving each other feedback on coaching and communication and students helping in explaining content for each other when not understood. Also, peer learning happens when students get to observe each other perform and act.

4.3.4 Teaching

The *Teaching* category encompasses a purely didactical perspective and is the most comprehensive category identified in this study. It is hierarchically structured with the highest number of sub-categories and has therefore been further subdivided into three intermediate categories: C*onditions for Learning, Delivering Learning,* and *Supporting Learning* (figure 4.12). The emphasis on the teaching category is justified by the teacher's role in effective learning, supported by the well-cited researcher John Hattie. In his meta study of influences and effect sizes on students' achievements, about 20 out of 30 factors are connected to the teacher's role (Visible Learning, 2018). The Teaching category is also, together with *Content* under *Programme Relevance*, the category strongest connected to *The Pursuit of Knowledge* as one of the four important purposes for engineering leadership programme developers to consider to ensure success for such programmes (Rottmann & Kendall, 2022).

Figure 4.12: *Influencing factors related to Teaching.*

4.3.4.1 Conditions for Learning

Conditions for Learning encompasses the foundational elements that facilitate effective learning experiences within the programme. These categories are arguably the most self-evident among the influencing factors identified, as they to a great extent are justified by observations of instances deemed to be obvious challenges or success factors. The examples from observations largely speak for themselves, but in addition, there are also some learning theories worth mentioning within this area.

In motivating learners, the belief in one's own potential to learn and achieve the results expected is a critical aspect identified in multiple various learning theories such as Vroom's Expectancy Theory (Bates, 2023) or Leslie Curzon's Fourteen points for motivation (Curzon & Tummons, 2013). This aspect emphasises the need of Adequate Preparations as well as motivating the student through encouraging them. Other crucial factors included in Curzon's 14 point list that relates to the main category Conditions for Learning are that:

a) effort and achievement should be acknowledged as often as possible
b) tasks set by the teacher should reflect the learners level of ability
c) short-term goals should be explained in relation to the learners desired long-term outcomes
d) lesson material and teaching ought to be meaningful and presented enthusiastically
e) learners should be able to understand what the teacher is telling them.

The first point even further emphasises the need to encourage the students, while the second underscores the *Adequate Preparations* in delivering tasks at the right level. The third and the fourth highlights the importance of illuminating relevance in *Motivating Learning*, while the fourth also emphasises the importance of making learning fun. The fifth point underscores the importance of *Clarity in Communication*. This sub-category is also emphasised by Sweller's *Cognitive Load Theory*, which differentiates cognitive load into three types (Bates, 2023). One of them is the *Extraneous Cognitive Load*, which refers to the way information or tasks are presented to a learner. Material presented in an unclear or unstructured manner can occupy unnecessary storage space in the students' working memory and thus hinder effective learning.

Motivating Learning

Definition: Illuminating relevance by explaining purpose and highlighting applicability, as well as encouraging students and making learning fun.

Successful examples include giving praise when students perform well, encouraging them when facing challenges, explaining the purpose of content and connecting it to research. On some occasions the purpose of content is not explained, forming a challenge in this category.

Maintaining Energy Level

Definition: Activities and building a structure aiming to maintain the physical and mental energy level to enable continuous focus and learning.

Successful examples include mental breaks with physical engagement during sessions, and lesson activities involving physical movements. Observed challenges include lack of such breaks, leading to students being fatigued during sessions and the lack of quiet places to recharge.

Clarity in Communication

Definition: Clarity in all forms of communication, including verbal, written, and visual.

Successful examples include power points without a redundant amount of information and clear instructions prior exercises. Challenges include lack of such instructions, not clear instructions or people speaking too fast or with a low voice.

Adequate Preparations

Definition: Measures to ensure that students are adequately prepared for tasks and exercises. Includes adequate amount of theory, instructions and guidelines as well as delivering tasks on the right level and secure opportunities to practice before performance.

Successful examples include coaches allowing students time to reflect prior answering questions or performing group work, as well as informing on schedule and what to expect. An observed challenge is students not always getting time to reflect or practice before performance.

4.3.4.2 Delivering Learning

Delivering Learning encompasses the effective execution of educational activities within the programme and includes five sub-categories, some of them more obvious influencing factors than others. Among these categories, *Lesson Planning* takes precedence as it is primarily considered before each session; ensuring its effectiveness enhances the remaining categories. While there is lots of literature emphasising the importance of lesson planning (Ashcraft, 2014; Bates, 2023; Fautley & Savage, 2014), it can also be captured with the well-known expression: “if you fail to plan, you are planning to fail”. Although the planning process itself is not directly observable during a session, the outcomes of effective or ineffective planning are. Included in the sub-category Lesson Planning is the variation of setups, teaching methods, and equipment, which is emphasised by another, not yet mentioned, point out of Curzon’s 14 points for motivation (Curzon & Tummons, 2013); that teaching and learning activities should be varied to prevent learners from becoming bored.

One crucial factor with proven efficiency in Delivering Learning is *Active Learning* (Bonwell, 1999), which can be defined as “a teaching approach that encompasses anything students might be called on to do in class besides watching and listening to an instructor and taking notes” (Felder & Brent, 2016). This fact strongly emphasises the need to keep students active by actions to *Enable and Ensure Participation*. In the process of delivering learning, a fundamental objective is to ensure the sustainability of learning outcomes. Consequently, *Reinforcement of Knowledge* emerges as a critical factor in achieving this aim. Supported by the well-known expression "repetition is the mother of learning," numerous studies highlight the *Spacing Effect*, standing out as one of the most robust and efficient methods for enhancing learning (Bjork Learning and Forgetting Lab, 2024). It denotes the observation that information presented repeatedly over spaced intervals is retained more effectively compared to information repeated without intervals. The importance of spacing is also emphasised along with three other crucial strategies in delivering learning, aiming to strengthen memory and fortify knowledge (McCabe, 2014):

- Deep processing - Putting new knowledge in a bigger context, visualising how to use it and relating it to previously known information.

- Self-reference effect - Relating new knowledge to personal experience.
- Testing - If not perceived as decisive to grades, and if highly controlled by students themselves, testing has been proved to be efficient to fortify knowledge.

Deep processing underscores the importance of contextualising the theory and illustrating concepts with demonstrations, aiming to *Create Understanding*. The second point, *Self-reference-effect*, corresponds to the linking of concepts into real-life examples in coaching, feedback and exercises, thus further emphasising the importance of Reinforcement of Knowledge. Finally, the third point *Testing*, relates to *Follow-up and Control* by ensuring that learning has occurred. Testing learning through frequent assessments is also an important factor raised for motivating learning (Curzon & Tummons, 2013) as well as for Reinforcement of Knowledge by making information more recallable in the future (Bjork Learning and Forgetting Lab, 2024). It also serves the important purpose of accountability and is therefore crucial in the process of delivering learning (Bates, 2023).

Lesson Planning

Definition: Structured and well prepared lessons, facilitating satisfactory time management and variation. This involves engaging introductions, smooth transitions, respecting time frames while allocating sufficient time for different elements, and varying setups, teaching methods, and equipment.

Successful examples include smooth transitions and variations in delivering content. Challenges include lack of overview on content and lessons, as well as time management during lessons.

Creating Understanding

Definition: Employing pedagogical techniques to foster understanding. This involves providing an overview to contextualise theory, utilising visual or mental models, illustrating concepts with examples and demonstrations, raising different perspectives, and summarising key messages.

Successful examples include explaining the relevance of content through working life examples or explaining theories through visual models and putting the context in a bigger perspective. Observed challenges include students not grasping content correctly while working with content in group work.

Enable and Ensure Participation

Definition: Utilising a variety of techniques and tools to enable and ensure the participation of all learners. This encompasses active and interactive teaching methodologies, strategic questioning techniques and distribution of speaking opportunities as well as ensuring adequate time for thoughtful responses. Additionally, it involves assigning tasks to all participants during exercises and leveraging various digital tools to enhance engagement.

Successful examples include reflective activities where students are individually engaged through, for example, writing, coaches directing questions towards the quieter students and coaches using digital tools to

receive input from all students. Challenges include sessions where students remain inactive, or where only the most talkative persons keep the conversations up with coaches and each other.

Reinforcement of Knowledge

Definition: Employing various didactic tools and techniques to reinforce knowledge. Involves summarising content and learnings, repetition of concepts by linking to previous content through questions, reminders, exercises, coaching and feedback. Also involves providing opportunities to practise skills related to the content. Strongly associated with Reflection and Metacognition (see section 4.3.5) through connecting and summarising learnings.

Successful examples include coaches summarising content delivered the day before, connecting new content to previous and summarising new content. Also, letting students practise new knowledge to develop skills is a successful example.

Follow-up and Control

Definition: Actions to ensure students' understanding of content, instructions, and tasks, as well as ensuring thorough compliance in task execution and activities. This also involves monitoring learning outcomes on a micro level to ensure that learning has occurred.

Successful examples include coaches asking students about their exercises, and following up with questions if they applied encouragements like following a framework in group work or engaging in Corporate Partners in coffee breaks. Challenges include the lack of these controls both through questions and observations, as well as the lack of controlling understanding.

4.3.4.3 Supporting Learning

Supporting Learning comprises the various measures and resources provided to assist students in their learning journey within the program. This involves maintaining an accessible presence, adapting to changing circumstances, and providing guidance and reminders to facilitate learning.

Similar as for Peer Learning, the importance of *Presence and Availability* is emphasised by Vygotsky's Scaffolding Theory, where coaches or teachers are the *Most Knowledgeable Others* (MKO), enhancing students' learning via the *Zone of Proximal Development* (ZPD) (Bates, 2023). *Responsiveness and Flexibility*, is inherent in the teachers professionality and this ability can be described by Schöns concept of *The Reflective Practitioner* (Schön, 1987). Schön suggested *Reflection-on-action* as well as *Reflection-in-action* as ways in which practitioners could become aware of their implicit knowledge, learn from their experience and improve. The latter, capturing the essence of *Responsiveness and Flexibility*, he argued, is the core of professionals' artistry in improvising and developing the talent to "think on their feet". The *Guidance and Reminders* category is justified mainly by observations deemed obvious, but it is also reinforced by its potential to provide support and supplement other sub-categories such as *Creating Understanding* (section 4.3.4.2), *Adequate Preparations* (section 4.3.4.1) as well as *Reflection and Metacognition* (section 4.3.5)

when they fall short. The connection to metacognition is further emphasised by the finding that metacognitive skills can be developed by letting students practise strategies both with and without guidance (Partanen, 2019).

Presence and Availability

Definition: The physical, mental, and social presence and availability of coaches for providing support, evenly distributed among students. It also involves actions by coaches to initiate conversations or make oneself accessible in other ways.

A successful example is coaches circulating and observing group work, though observed challenges are the minimal extent of time they stayed in the groups or an uneven distribution of coaches in different rooms during exercises.

Responsiveness and Flexibility

Definition: Involves observing, empathising, and adapting to current situations as well as to individual needs. This includes adjusting the environment, content, actions and demands based on the observations made.

Successful examples include coaches detecting difficulties in understanding, referring back to observations and giving feedback based on them. Challenges include not taking the cohort's energy level into account while delivering content.

Guidance and Reminders

Definition: Accessible written or oral guidance in exercises, tasks and reflections. Also includes reminders of instructions and responsibilities.

Successful examples include coaches repeating obligations, giving advice for successful group work and written instructions for reflections in groups. An observed challenge was guidance being dependent on coaches' presence and availability.

4.3.5 Fostering Growth

Fostering Growth encapsulates various strategies and approaches aimed at challenging students to reach their full potential, enhancing self-awareness, and promoting continuous personal development. This category strongly corresponds to one of the four purposes crucial for leadership programme developers to consider when educating engineering students in leadership, namely *Personal Growth* (Rottmann & Kendall, 2022). For this purpose, self-awareness and self-exploration is identified as critical aspects, potentially reached through methods such as personality or leadership style inventories, activities foregrounding interpersonal interactions, case study learning and guided reflections. By doing this, students' life-long learning potential is enhanced and it prepares them for the world beyond school and helps them build their confidence as social actors. The importance of Fostering Growth is also emphasised by corresponding to the first two of the seven strategies highlighted as crucial factors to make leadership development programmes succeed: *Focus on whole-person growth* as well as *Provide opportunities for self-reflection and meaning-making* (Yemiscigil et al., 2023). Sub-categories within Fostering Growth are shown in figure 4.13.

Figure 4.13: *Influencing factors related to Fostering Growth.*

Reflection in various formats is hence crucial for Fostering Growth. Except for being an important aspect for a teacher's professionality, the ability to reflect-in-action and to "think-on-your-feet", is a skill that should be enhanced in all professional educations (Schön, 1987), thus also in leadership development programmes. It prepares the students to handle complex and unpredictable problems with care and confidence. *Metacognition* refers to conscious thinking and the ability to steer and regulate one's actions to achieve learning and development (Partanen, 2019). Thus, practising and improving this skill is a booster for learning as well as for development and growth.

In addition to reflection, executive *coaching* and supervisory candid *feedback* are efficient tools for increasing self-awareness (Klimoski & Hu, 2011) and thus to foster growth. Research indicates that the former also can improve employees' emotional intelligence (Chapman, 2004) while the latter is highlighted as an additional important factor for motivating learning (Curzon & Tummons, 2013).

While *Challenge and Demand Accountability* may be commonly associated with aspects of personal growth, such as growing through stepping outside one's comfort zone or through growing with responsibilities,

research further emphasises their significance in development. Tackling unpleasant tasks is indeed considered essential, as stepping out of one's comfort zone is a prerequisite for learning and personal advancement (Molinsky, 2016). Similarly, taking responsibility for oneself, others, and the world is an inherent part of the personal growth process. As individuals become more autonomous in their actions and thoughts, they recognize their role in their own lives and society, becoming agents of change. Accepting this responsibility is a significant step toward maturity and growth (Maurer et al., 2023).

Challenge and Demand Accountability

Definition: Challenging students in their learning journey by setting high expectations, asking tough and thought-provoking questions, and pushing them beyond their comfort zone. This also involves assigning students responsibilities and holding them accountable for their actions.

Successful examples include coaches challenging students to engage in Corporate Partners, coaches questioning group work strategies and coaches putting expectations on students to be on time. Challenges include students attending sessions late and students performing final presentations in Module 3 with a low level of professionality.

Reflection och Metacognition

Definition: Actions promoting structured as well as spontaneous reflections, individually, in pairs, groups or in class, aiming to enhance self-awareness and foster long-term personal development. Also includes different levels of reflection such as preflection (reflection prior exercise), metacognition and metareflection (reflection on reflection). Encompasses reflecting on theory, tasks, exercises, expectations and learnings, as well as on processes, interactions, goals, feelings and one's own personality type.

Successful examples include coaching on learning progress, time for individual reflection before and after execution of exercises. One observed challenge is a lack of following-up on group reflections.

Coaching Techniques

Definition: Techniques and strategies employed in both individual and group coaching sessions, involving observing, sharing observations and addressing identified challenges. Includes employing open and challenging questions to open up different perspectives and guide individuals to their own solutions rather than offering direct advice.

Successful examples include asking questions rather than giving advice, giving feedback on processes rather than achievements and repeating what was observed before giving feedback. Challenges include occasions where coaches give advice and tell students the “right answer" instead of coaching through questions.

Feedback

Definition: Constructive, candid and sometimes tough feedback from coaches to students, either in groups or between two individuals. Includes feedback as part of, or separated from, a coaching session and encompasses feedback on processes and all kinds of interactions such as communication and behaviour.

Successful feedback includes coaches giving feedback on interactions in group work and giving feedback on voice and body language during presentations. A challenge within this category is that feedback sometimes might be a bit too harsh or critical.

4.3.5 Working Life Orientation

Working Life Orientation refers to the holistic approach and actions that focuses on preparing individuals for the professional world, by enriching teaching with practical examples, tools and providing real-world relevance and interactions. This category strongly corresponds to the third purpose, out of four identified purposes, critical to consider in engineering leadership development, *Professional Preparation* (Rottmann & Kendall, 2022). Readiness for working life also strongly relates to two, out of six, principles highlighted in Malcolm Knowles *Andragogy*, also known as *Adult Learning Theory*, on how to teach adults efficiently (Knowles et al., 2005). The first one, *Readiness to learn*, refers to life related and developmental tasks and means that adults typically become ready to learn when they experience a need to cope with a real life situation or perform a task. The second, *Orientation to learning* emphasises the need of a problem centred as well as contextual approach, saying that adults' orientation to learning is life-centred; education is a process of developing increased competency levels to achieve their full potential. Having this in mind, you nurture learning more effectively by sharing insights from working life as well as by preparing learners with tools and strategies applicable in working life. Additionally, UNITECH International's own purpose of enabling students to successfully manage future challenges in global industry (UNITECH international, 2024), also refers to equipping students with skills needed in working life. Sub-categories within Working Life Orientation are shown in figure 4.14.

Figure 4.14: *Influencing factors related to Working Life Orientation.*

Industry Engagement

Definition: Real-world relevance in interactions and collaboration with industry companies, such as through site visits, internships, and real-life case projects aimed at addressing actual customer needs.

Successful examples include opportunities to network with Corporate Partners during coffee breaks in Module 2 and a site visit to a chemistry company on day 1 during Module 2.

Supplying Professional Toolbox

Definition: Tools, models, and practical strategies, as well as usable tips and tricks, that are applicable and valuable for navigating future professional environments and addressing inherent challenges.

Successful examples include sharing and explaining well cited models within management and leadership.

Sharing Expertise

Definition: : Sharing insights from working life by sharing professional experiences, providing examples, and offering advice, in both coaching and teaching sessions.

Successful examples include coaches sharing practical tricks, recommendations and examples from their own careers during coaching or lessons.

5. DISCUSSION

This chapter is initiated with a discussion of the findings in relation to the research questions and previous studies, highlighting the contribution this thesis brings to the field and its practitioners. Additionally, the main areas of success and development specific to UNITECH are presented. Subsequently, the chosen methodology and methods are examined, discussing their impact on the validity of the study. Finally, future research directions and recommendations are provided.

5.1 Discussion of Results

This study aimed to identify the existing academia-industry gap within the engineering field and examine how a leadership development programme can effectively bridge this gap by answering the three research questions:

> RQ1. What is the perceived gap between the skills practised in engineering education and the industrial skill demand?
>
> RQ2. How effectively does the UNITECH leadership development programme bridge this gap today?
>
> RQ3. What are the influencing factors in the design of a leadership development programme to effectively bridge the skills gap?

5.1.1 RQ1

The first research question aimed at identifying the academia-industry gap within the engineering field. It was answered by the average rating of students' perception of the extent to which the top ten core skills (Di Battista et al., 2023) were practised during their engineering education. Previous research within the field is highlighting a lack of engineers capability in soft skills, related to personal as well as to social competence (Saniuk & Grabowska, 2022). Some of the non-technical skills that stood out were *devoting oneself to continuous learning, being creative by approaching a problem from different angles,* and *thinking in a solution-oriented way by favouring outcome over ego* (Groeneveld et al., 2021).

The results of this study reveal that four of the top ten skills, identified as core skills required by workers today (Di Battista et al., 2023), are practised to a moderate extent or less within engineering education. These skills include *Creative Thinking, Motivation and Self-awareness, Empathy and Active Listening,* as well as *Leadership and Social Influence.* All of them could arguably be considered as non-technical skills, not traditionally associated with the common perception of the engineering role (Cambridge Dictionary, n.d.). However, it is worth noting that Creative Thinking is closely linked to problem-solving skills, which are highly relevant in engineering contexts.

The findings of RQ1 are consistent with the background of this study, describing the core concern that prompted the founding of UNITECH in 2000 (Ward & Schwarz, 2023): *"Your students come to the company*

with an excellent knowledge. However, if the issue requires a solution that is not technical in nature, then they struggle to make an impact". The results, confirming a lack of practice of non-technical skills in engineering education, highlight the underlying reason for this perception of engineers' limited capacity to address the social aspects of their work.

As the results are in line with previous research, confirming a lack of engineers' lacking capability in soft skills, they are not surprising. The results from this study, as well as from previous research highlight Creative Thinking as one of the skills standing out in the academia-industry gap. Further on, the gap of "thinking in a solution-oriented way by favouring outcome over ego", found by previous research (Groeneveld et al., 2021), relates to the finding of this study through *Motivation and Self-awareness* (the ability to understand one's own desires and drive, and to maintain a positive and determined mindset to achieve goals) as well as through *Empathy and Active Listening* (the ability to understand and share others' feelings while actively listening to their perspectives and experiences).

Similarly, it is not surprising that *Analytical Thinking, Technological Literacy,* along with *Dependability* and *Attention to Detail*, are extensively practised in a technical engineering education at highly ranked universities. What is surprising, though, is that the lack of social skills among engineers seemed to be an apparent issue as early as the year 2000, and likely even earlier. Today, 24 years later, it appears that universities have not successfully addressed this gap. In line with the suggestion of previous studies to develop support programmes for academics to cultivate them with the skills necessary (Saniuk & Grabowska, 2022), this accentuates the importance of organisations like UNITECH, which are agile and adaptable, in bridging this gap to ensure a future workforce equipped for the demands of industry.

5.1.2 RQ2

The second research question aimed to understand how effectively the UNITECH leadership development programme bridges the academia-industry gap. The results comprise two main components. Firstly, the performance aspect, which involves students' perceptions of their performance before and after participating in the two coaching modules. Secondly, the practice aspect, which includes both researcher-observed and student-perceived practice during the coaching modules.

When comparing the self-ratings before Module 1 (August 2023) versus after Module 2 (March 2024), there was no significant difference in the students' perception of their own performance in any of the top ten core skills. This is somewhat surprising since all ten skills were practised to some extent, with some of them being practised significantly. However, a seven-month period with two weeks of training in coaching modules is relatively short for developing new skills, as skill acquisition is not an overnight process, typically taking at least six months (Hunt & Weintraub, 2016). Moreover, in the process of acquiring new knowledge and practising skills, there is likely an increase in understanding the deeper meaning of the areas practised. This understanding can lead to increased self-awareness regarding perceived performance and an elevated level of self-criticism. This phenomenon is described by the *Dunning-Kruger effect* (Kruger & Dunning, 1999), a cognitive bias related to self-assessment, which explains how people with limited competence in a particular domain tend to overestimate their abilities. With this in mind, it is possible that the students overestimated

their performance in the first survey, while having a more realistic or critical self-estimation in the second one. In addition, identifying skill gaps via self-assessment generally includes multiple reliability challenges, such as subjectivity and peer positivity bias, especially when examined through surveys (Rikala et al., 2024).

In terms of practice, the results reveal that for all four skills identified as part of the academia-industry gap under RQ1, UNITECH is bridging the gap to some extent, meaning that there was a significant difference in the average of students' perceived practice within at least one of the UNITECH coaching modules compared to their engineering education. Nonetheless, to effectively bridge the academia-industry gap, there appears to be room for improvement for *Creative Thinking*. A considerable number of students perceived that this skill had been trained only to a minimal or moderate extent within UNITECH, making it the skill for which the gap is least bridged. In general, the quantitative indications from observations supported the survey data of students' perceived practice very well. Particularly for Creative Thinking, the observation data highlights it as the skill, among the four identified as the industry-academia skills gap (RQ1), that was coded the least. Out of all the ten skills examined in this research, Creative Thinking is the third least coded, after *Technological Literacy* and *Analytical Thinking*, two skills that are extensively practised in engineering education and thus not aimed to be practised within UNITECH. The fact that Creative Thinking rates as the second most important of all the skills examined in the Future of Jobs report (Di Battista et al., 2023) even further underscores the urge for improvement.

While Creative Thinking emerges as the skill least bridged, *Motivation and Self-awareness*, as well as *Leadership and Social Influence*, emerge as the most extensively bridged. These two skills were identified as the least practised in engineering education and yet the most practised within the UNITECH coaching modules. Particularly noteworthy is the substantial amount of reflections, coaching, and feedback during coaching modules, contributing to the practising of Motivation and Self-awareness as a skill. For Leadership and Social Influence, the emphasis on group work, managing social and professional interactions, as well as communication and presentation, was particularly notable.

5.1.3 RQ3

Last but not least, the third research question aimed at mapping influencing factors for leadership development programmes to effectively bridge the academia-industry gap. The thematic analysis of the observation data resulted in 33 sub-categories that represent the influencing factors, organised into following six overarching categories; *Programme Relevance, Organisation and Structure*, *Teaching*, *Social Environment*, *Fostering Growth*, and *Working Life Orientation*.

A previous study on influencing factors in upskilling programmes for engineers include the following five themes: *Relevance, Organisation and structure, Working life competencies, Support from teachers* and *Collaboration with other learners* (Braun et al., 2023). Comparing the results of our study with the findings of the referred one, there seems to be three major differences. The first and most obvious difference is the level of detail, where our results point out new and more specific areas. The level of detail makes the results more applicable in programme development, making contribution for practitioners more intuitive, something that is further explained in 5.2.3.

The second major difference is the point of gravity being towards didactics, with twelve sub-categories relating to teaching, and even more categories fitting into the role of the teacher, compared with Braun et al.'s (2023) two sub-categories in this area; *Lecture style* and *Helpful in answering questions*. Nevertheless, this was a predictable result, since this study had didactics as an entry point to the subject. As researchers, our frame of reference was largely built on theories on learning. Equivalent to the findings of John Hattie's meta-analysis on effects on learning, one could argue that the teacher plays a major role in learning efficiency (Visible Learning, 2018).

Thirdly, Fostering Growth seems to be a new area of influencing factors in comparison with previously named study of influencing factors in upskilling programmes. However, this area is emphasised by previous research focusing on successful leadership development, both in general as well as specifically for engineers (Rottmann & Kendall, 2022; Yemiscigil et al., 2023). However, something worth highlighting in our findings, are sub-categories within Fostering Growth that motivate tough and challenging support from coaches; *Feedback, Coaching Techniques and Challenge* and *Demand Accountability*. These are sub-categories demanding proactive teachers or coaches in a programme, proposing that personal growth is not only a result of reflection, personality inventories and peer interactions. Once again, our result has the capacity to work more as a hands on tool for programme designers, as will be further explained in section 5.2.3.

One noteworthy outcome of the level of detail in the result of RQ3, is that solely one out of 33 sub-categories addresses the content of the programme. This could indeed be explained by the didactic focus in this study, but could also be seen as an argument for not diminishing the value of areas like *Social Environment* and *Fostering Growth*.

Looking at the resulting map of influencing factors, it seems to grasp all but one of four key purposes of engineering leadership education found by Rottmann and Kendall (2022). None of the influencing factors relates to the purpose of *Social Transformation.* This fourth purpose suggests that engineer leadership educations must integrate diversity, equity and inclusion into their ethical codes. If engineers are trained to only solve problems of interest to employers, they neglect their ethical responsibilities as professionals (Rottmann & Kendall, 2022). The reason why this purpose is not addressed by the influencing factors identified in this study is simply because these aspects have not been observed within the UNITECH Leadership Development programme, posing a threat to validity concerning undetected influencing factors, as further discussed in section 5.3.1. Further on, these aspects may not be addressed by the UNITECH Leadership Development programme due to various reasons, most likely related to the expectation that these aspects are part of engineering education and therefore not considered necessary skills to bridge within the programme. However, since such social transformation skills are not included in the list of the top ten core skills (WEF), this study cannot provide any insights on this matter. With a framework that includes skills related to social transformation, RQ1 could have identified a potential gap within these skills, and RQ2 could have explored potential opportunities for improvement in addressing the eventual gap. Further research should delve into this topic extensively and subsequently integrate this area into our existing map of influencing factors, as further discussed in section 5.4. Given that the WEF identifies the related topic of *Green skills* as one of the fastest-growing skills demanded by industry today (Di Battista et al., 2023), Social Transformation, as part of a leadership development program, is an aspect important to investigate further.

The category Fostering Growth is highly supported by three of the seven strategies for successful leadership development programmes found by Yemiscigil et al. (2023), *Focus on whole-person growth*, *Provide opportunities for self-reflection and meaning-making* and *Acknowledge and address psychological barriers to growth.* Three of the other strategies, *Offer targeted programmes to support leaders with acute or chronic stress, Don't underestimate short, intensive programmes* and *Embrace online learning,* relates to Organisation and Structure via *Securing Student Well-being*, as well as *Planning and Scheduling*, although the sub-categories within these themes are not as detailed as the strategies in their nature. The last strategy, *Ensure that short-term growth leads to sustained, long-term impact*, relates to our sub-categories *Reinforcement of Knowledge* and *Monitoring Output,* highlighting the importance of teaching techniques and assessments to ensure that learnings last over time. Additionally, learning theories supporting sub-categories within *Social Environment*, underline that good *Climate and Relations* contribute to both short term and long term learning (Johnson et al., 1991; Shahlaei & Lundh Snis, 2023).

Finally, a pattern discernible in our results is that different roles in an organisation delivering a leadership development programme, contributes to its efficiency and success. Some categories are executed by specific roles, whereas others relate to several roles, indicating that team work within an organisation is crucial. Moreover, the organisation itself is not responsible for all factors, since some of them, like *Fellowship and Friendship* and *Challenge and Demand Accountability*, are partly the responsibility of the participants. Also, the influencing factors are not solely responsibilities an organisation can plan and structure *ahead of* the programme, some factors depend on a responsiveness and flexibility *during* the execution of the programme, as well as organisational learning strategies *after* the programme is finished. In summary, this suggests that the final outcome of a programme is a result of great team work within the organisation, skilled staff executing the programme, and participants being willing to contribute to its success.

5.1.4 UNITECH's main areas of success

To support UNITECH International in further developing its programme and maintaining its success, this and the following section will summarise the main areas of success that should be preserved and the areas that could benefit from further development, both related to RQ3. To ensure consistency with the rest of the report and enhance clarity and visibility, these areas will be presented under the six overarching categories of influencing factors identified in this study.

Programme Relevance

For an organisation to stay successful in the rapidly changing world, it needs to equip itself with the ability to counter global changes whereas one of the most important tools for doing this is organisational learning (Saadat & Saadat, 2016). As an organisation aiming for bridging the academia-industry gap in the fast changing industry, organisational learning is an important influencing factor for UNITECH to consider to stay successful. A well cited model of individual and organisational learning is Argyris and Schön's model built up by three loops of learning (Bates, 2023). In this model, the *Single-loop learning* asks the question "Are we doing things right?" and focus on detecting and fixing errors while *Double-loop learning* asks the question "Are we doing the right things?" and focus on prevention of continuous errors. *Triple-loop learning* is the highest level of self-examination and asks the question "How can we be sure what's right is right?". It investigates and questions underlying assumptions and values.

In the UNITECH coaching modules, the coaches hold daily briefing meetings in the morning and evening. During these meetings, various topics related to the module sessions and their effectiveness are raised. In this forum, the coaching team has the opportunity to align, reflect, discuss, and decide on actions for improvements and continued effectiveness. Additionally, there are daily briefings (mornings) and debriefings (evenings) together with the students. These sessions provide opportunities to check in on well-being and to collect input from students on their perceptions, feelings, and feedback for improvements. Furthermore, UNITECH surveys the students on their perceptions and suggestions for improvements after each of the three coaching modules spread out during the programme. All these actions together allow for short-term day-to-day improvements as well as the gathering of input for future long-term development. They are highly related to organisational learning and mainly address the single-loop learning question, "Are we doing things right?".

The double-loop learning and triple-loop learning questions, "Are we doing the right things?" and "How can we be sure what's right is right?", are mainly addressed in forums higher up in the organisation, such as meetings with existing and potential Academic and Corporate Partners. These forums aim to ensure that the UNITECH programme has relevant content and delivers students with the required skills. The fact that UNITECH to some extent is bridging the gap for all the skills identified as the academia-industry gap by this study, is evidence of success in this area.

Organisation and Structure

Organization and Structure are strongly connected to the two lower levels of *Maslow's Hierarchy of Needs, Physical Needs* and *Psychological Needs* (see section 2.2.4). This emphasises the importance and priority of their fulfilment to enable learning and for learners to reach their full potential, as learning progress can take place only once the lower level needs are fulfilled (Bates, 2023).

Successful examples from observations related to this area include deliverance of essential and practical information regarding the programme, the organisation, key individuals and schedule, enabling students to grasp the context and have the right expectations of the programme. It also includes a well prepared and organised programme with clear and well planned schedules and coaches checking in on students' well-being during briefings.

Social Environment

The *Social Environment* strongly relates to *Maslow's Hierarchy of Needs* (see section 2.2.4), corresponding to the third level, *Affiliation*, as well as to the fourth, *Esteem* (Bates, 2023). In learning situations the third level means learners have a need for a sense of belonging, by feeling respected by peers as well as from teachers and coaches, and the fourth level, *Esteem*, means that learners have a need for self-belief and satisfaction and want to feel a sense of pride in their achievements (Bates, 2023). Thus, securing a safe social climate and building relations, as well as facilitating interactions between students are crucial factors in any kind of learning situation. In the UNITECH programme, such a climate is built by establishing a positive atmosphere and building rapport with students. This includes actions such as sharing personal experiences, engaging in activities that involve humour, encouraging peer interactions, and playing uplifting and motivating music during morning briefings. Facilitation of interactions is frequently achieved by constantly dividing students into new group constellations, ensuring that students get to know, interact with, and work with new peers often and effectively.

In the UNITECH programme there is a high amount of exercises, discussions and reflections conducted in pairs, groups or in the classroom. Students communicate through collaboration, giving each other feedback or coaching, sharing learnings and experiences and helping each other in explaining content when not understood. In addition to facilitating interactions, challenging the students to communicate and making learning more fun, this approach strongly enables peer learning, also referred to as cooperative learning, which is a concept that influences learning positively. Shorter peer interactions ensure that misconceptions, gaps in understanding and incorrect understanding are identified and corrected (Johnson et al., 1991). Additionally, a study on student performance on in-class concept questions indicates that peer discussion enhances understanding, even though none of the students in a discussion group initially knows the correct answer (Smith et al., 2009). In cases where any of the students actually knows the correct answer or are more experienced in an area, they are according to Vygotsky's Scaffolding Theory to be seen as *Most Knowledgeable Others* (Bates, 2023). They can then support their peers to reach their full potential in learning situations through what Vyggotsky described as the *Zone of Proximal Development*, indicating the additional learning attainable by a learner in challenging situations with the support of Most Knowledgeable Others. The major outcome of interactions stretched out over time is to develop positive relationships

between peers, often carried out through group work. These strong relationships that occur over time are important for keeping students motivated to work together and for helping them grow socially, mentally, and physically (Johnson et al., 1991).

In upskilling and developing students in soft skills, thus changing behaviours, the social network and the culture have a strong influence. Addressing behavioural culture of a specific group, utilising elevated cultural values, is even suggested as a therapeutic method to achieve behavioural change (Evans, 2012). In the UNITECH programme, numerous efforts are made to establish a culture that creates pride and cohesion in the cohort. Actions observed include talking about what it means to be an ambassador as well as encouragement of inclusion, professionality and personal development. The UNITECH Culture is also inspired by alumni presenting the alumni network during the coaching modules.

Besides the more apparent benefits of a professional network, such as business contacts and broadening career opportunities, the lifelong social and professional network provided in UNITECH, including continuous coaching opportunities, also acts as a safety net for students as they transition into the future workforce. Employees risk feeling abandoned when developing new skills and preparing for new jobs, which is why, in the ever-changing industrial environment, it becomes crucial to offer the employees opportunities to continuous reflect on impending issues in work situations, resulting learning needs, and possible paths to take (Shahlaei & Lundh Snis, 2023).

Teaching - Conditions for Learning

The emphasis on the Teaching category in this report is justified by the teacher's role in effective learning, supported by the well-cited researcher John Hattie. In his meta study of influences and effect sizes on students' achievements, about 20 out of 30 factors are connected to the teacher's role (Visible Learning, 2018).

The intermediate category Conditions for Learning identified in this study emphasises that teachers must facilitate the necessary preconditions for effective learning, including factors such as motivation, energy level, clear communication and adequate preparations. The belief in one's own potential to learn and achieve the results expected is a critical aspect related to motivation and adequate preparations, and is emphasised by multiple various learning theories such as Vroom's Expectancy Theory (Bates, 2023) or Leslie Curzon's Fourteen points for motivation (Curzon & Tummons, 2013). The latter also includes points that further highlight the need to encourage students, illuminating the relevance of learning and making learning fun. Coaches within UNITECH motivate students through praise when students perform well and provide encouragement when they face challenges. In addition to this, the learning is also made fun with a sense of humour. Successful examples from observations also include coaches allowing students time to reflect prior answering questions or performing group work, as well as informing on schedule and what to expect, ensuring that students are well-prepared for the content they will receive.

By clearly explaining the purpose and by highlighting the applicability of the content with examples from the professional world, coaches effectively illuminate the relevance of the concepts taught. For the clarity of communication, successful examples from observations include power points without a redundant amount

of information and clear instructions prior exercises. In the coaching modules, students also have the opportunity to engage in physical activities outside sessions, and some sessions are built up on lesson activities involving physical movements, enhancing the possibility to recharge and maintain a good energy level.

Teaching - Delivering Learning

Lots of literature emphasise the importance of lesson planning and implementing variation in lessons for example through variation in setup and equipment (Ashcraft, 2014; Bates, 2023; Curzon & Tummons, 2013; Fautley & Savage, 2014). Variation enhances motivation and prevents learners from being bored. Another crucial factor with proven efficiency in delivering learning is implementing *Active Learning* (Bonwell, 1999), which can be defined as "a teaching approach that encompasses anything students might be called on to do in class besides watching and listening to an instructor and taking notes" (Felder & Brent, 2016). UNITECH successfully implements engaging introductions, smooth transitions and various formats of peer interactions, such as group work, whole class discussions and walk-and-talk sessions in pairs. Sometimes, coaches direct questions towards quieter students or use digital tools to receive input from all students, thus activating the whole cohort.

Supported by the well-known expression "repetition is the mother of learning," numerous studies highlight the *Spacing Effect*, standing out as one of the most robust and efficient methods for enhancing learning (Bjork Learning and Forgetting Lab, 2024). In UNITECH, coaches frequently space and repeat important content and connect it to previous concepts through feedback, coaching and guidance in group work.

The importance of the spacing effect is further emphasised by its identification in a list of strategies effective for long term memory retention (McCabe, 2014). This list also includes the following strategies:

- Deep processing - Putting new knowledge in a bigger context, visualising how to use it and relating it to previously known information.
- Self-reference effect - Relating new knowledge to personal experience.

Coaches in UNITECH frequently contextualise the theory and illustrate concepts with demonstrations. This enhancement of Deep Processing is done through providing working life examples or explaining theories, using visual models and putting context in a bigger perspective. These working life examples clearly relate to students' professional career, meaning that coaches also contribute to the Self-reference effect in their teaching.

Teaching - Supporting Learning

Several factors regarding the teachers' role are crucial to support students in their learning journey. The importance of present and available teachers is emphasised by Vygotsky's Scaffolding Theory, where coaches or teachers are the *Most Knowledgeable Others*, enhancing students' learning via the *Zone of Proximal Development* (Bates, 2023).

Coaches at UNITECH are the students' Most Knowledgeable Others in their learning and professional development and they constantly encourage students to seek guidance and ask questions. During exercises, the coaches circulate and observe group work, identifying and addressing any difficulties in understanding. They provide feedback and coaching based on these observations and sometimes offer advice for successful collaboration.

Fostering Growth

Focusing on the holistic development of individuals, rather than solely professional competencies, has proven to be a key factor in effectively developing leaders (Rottmann & Kendall, 2022). Self-awareness and self-exploration is identified as critical aspects in leadership development, potentially achieved through methods such as personality or leadership style inventories, activities emphasising interpersonal interactions, case study learning and guided reflections - activities that are all recurring elements within the UNITECH programme. By integrating these practices, students' potential for life-long learning is enhanced, preparing them for life beyond academia and fostering their confidence as social actors.

The significance of fostering growth also aligns with the first two of the seven strategies identified as crucial for successful leadership development programmes: *Focus on whole-person growth* as well as *Provide opportunities for self-reflection and meaning-making* (Yemiscigil et al., 2023). Reflection, in its various formats, prepares the students to address complex and unpredictable problems with care and confidence, making it an essential aspect of professional education (Schön, 1987). Metacognition, or conscious thinking and the ability to regulate one's actions for learning and development, serves as a catalyst for both learning and growth (Partanen, 2019).

In the UNITECH programme, reflection and metacognition are regularly practised through opportunities to in class individually reflect on learnings and personal goals. Coaches promote structured as well as spontaneous reflections, both individually, in pairs, in groups and in the whole class. Reflections occur before and after exercises, encompassing various aspects such as theory, tasks, interactions, and personal goals.

In addition to reflection, executive coaching and candid supervisory feedback are efficient tools for enhancing self-awareness (Klimoski & Hu, 2011) and thus to foster growth. Research indicates that executive coaching can also improve employees' emotional intelligence (Chapman, 2004) while candid feedback is crucial for motivating learning (Curzon & Tummons, 2013). Coaches in UNITECH employ professional techniques and strategies such as observing, sharing observations, addressing identified challenges, asking challenging questions to open up different perspectives and guide individuals to their own solutions rather than offering direct advice towards solutions. Candid feedback in the UNITECH programme often targets processes and interactions in group work, or voice and body language during presentations.

Furthermore, personal growth is enhanced through challenging students and demanding accountability. Embracing discomfort and stepping out of one's comfort zone are prerequisites for learning and personal advancement (Molinsky, 2016). Similarly, taking responsibility for oneself, others, and the world is an

inherent part of the personal growth process. As individuals become more autonomous in their actions and thoughts, they recognize their role in their own lives and society, becoming agents of change. Accepting this responsibility is a significant step toward maturity and growth (Maurer et al., 2023). UNITECH coaches successfully challenge students in their learning journey by setting high expectations, asking tough and thought-provoking questions, and pushing them beyond their comfort zone. Coaches also assign students responsibilities and hold them accountable for their actions, constantly reminding them of their role and ownership in different situations.

Working Life Orientation

Rottmann and Kendall (2022), researchers on engineering leadership development programmes, argue that programmes should focus on *Professional Preparation* to fulfil its purpose. Readiness for working life also strongly relates to two, out of six, principles highlighted in Malcolm Knowles *Andragogy*, also known as *Adult Learning Theory*, on how to teach adults efficiently (Knowles et al., 2005). The first one, *Readiness to learn,* refers to life-related and developmental tasks. It means that adults typically become ready to learn when they experience a need to cope with a real life situation or perform a task. The second, *Orientation to Learnin*g emphasises the need of a problem centred as well as contextual approach, saying that adults' orientation to learning is life-centred; education is a process of developing increased competency levels to achieve their full potential. Having this in mind, you nurture learning more effectively by sharing insights from working life as well as by preparing learners with tools and strategies applicable in working life.

With experienced coaches from industry companies teaching in the UNITECH modules and a tight collaboration with the Corporate Partners in general, the programme has a clear working life orientation. Coaches frequently share professional experiences, practical tricks and provide examples in both coaching and teaching sessions. Students receive a professional toolbox consisting of managerial and leadership models and strategies, which is of great value when navigating future professional environments and addressing inherent challenges. Through case projects, delivered by Corporate Partners, The UNITECH students get the chance to practise applying these tools and interact with the industry themselves during the UNITECH year. Representatives from all Corporate Partners are invited to specific events in the coaching modules, enabling the students to interact with professionals from different fields of engineering. Apart from opportunities to interact with Corporate Partners and practising working life competencies during the coaching modules, a whole semester is allocated for internship at one of the Corporate Partners, meaning that all UNITECH students are placed in the right environment for professional preparation for a longer period. This is particularly important as skill acquisition is not an overnight process, typically taking at least six months (Hunt & Weintraub, 2016).

5.1.5 UNITECH's main areas of development

In this section, the main areas of development for UNITECH to consider in order to remain successful are presented. The recommendations are based on identified challenges from observations, as well as learning and leadership theories that highlight their importance, as detailed in chapter 4.3. To maintain consistency with the rest of the report and to enhance clarity and visibility, these areas will be presented under the six overarching categories comprising the influencing factors identified by this study. However, as no main challenges were found in Social Environment and Working Life Orientation, these categories are excluded.

Programme Relevance

In this category, the observed challenges are mainly related to Monitoring Output and Coaching Alignment. Both are influencing factors identified by this study that relate to organisational learning and specifically to the *Single-loop learning*, which asks the question, "Are we doing things right?" and focuses on detecting and fixing errors (Bates, 2023), see section 4.3.1.

The most protruding challenges within this category are the following:

- Assessment of participant progress at both macro or micro level. In the UNITECH programme, there are currently no structured short-term or long-term follow-ups or measurements of students' actual learning and development. On a macro level, such assessments are essential for the programme to track and evaluate its achievements in relation to its intended purpose and the needs of stakeholders, and to remain relevant. On a micro level, it is highly related to learning and accountability (see section *Teaching - delivering learning* below). These are deemed to be the most important factors identified among the areas for improvement.
- Keeping coaching and feedback within the programme consistent through agreements, guidelines, and training. Although the daily briefing meetings emphasise this aspect in the short term, observations suggest there are still improvements to be made in the consistency of providing coaching and feedback. According to observations, the quality of these activities was highly dependent on the coach performing them. The UNITECH programme would benefit from creating guidelines or a short training programme for the coaches, defining the UNITECH way of providing feedback and coaching.

Organisation and Structure

As previously mentioned, this category is strongly connected to the two lower levels of *Maslow's Hierarchy of Needs, Physical Needs* and *Psychological Needs* (see section 2.2.4 and 4.3.2). This emphasises the importance and priority of their fulfilment to enable learning and for learners to reach their full potential, as learning progress can take place only once the lower level needs are fulfilled (Bates, 2023).

Challenges frequently observed in this area include the following:

- Timing of events to ensure participation and undivided attention for all students and coaches. For some students, the coaching modules coincided with their exam periods, resulting in their absence from sessions and group work to study and write their exams.
- Time management related to the teaching sessions. Despite being done with good intentions to deliver relevant and important content and to enrich teaching, sharing experiences and spontaneously adding on to the topic often resulted in sessions dragging out over time.
- Securing physical as well as mental wellbeing through providing opportunities to refresh and recharge. Observed challenges include the lack of opportunities to take a mental break in between sessions during an intense week as well as accommodation circumstances making it difficult for students to recharge.
- Purposeful and functioning space and room for every activity with proper ventilation, lightning and acoustics. During Module 1, the premises were not optimal due to poor acoustics and ventilation negatively impacting learning opportunities.

Teaching - Conditions for Learning

As detailed in section 4.3.4.1, this category, in addition to being based on observations deemed obvious, mainly relates to Leslie Curzon's Fourteen points for motivation (Curzon & Tummons, 2013), Vroom's Expectancy Theory and Sweller's *Cognitive Load Theory* (Bates, 2023).

Challenges observed in this area include the following aspects:

- Maintaining energy level during teaching sessions. This is an obvious factor for ensuring that effective learning can take place and it involves implementing activities and structures aimed at sustaining continuous focus and engagement. Observed challenges include some sessions lacking mental breaks or activities that involve physical movements, leading to students being fatigued during sessions.
- Clarity in verbal communication related to individuals speaking too fast or with a low voice. Considering that many of the students are not accustomed to English, particularly in a business format, and factors like noisy ventilation, this is a critical aspect to consider.
- Adequate preparations in form of instructions, adequate amount of theory or practice, ensuring that students are adequately prepared for tasks and exercises. Observed challenges include students being insecure on goals and guidelines for tasks given as well as students not always getting time to think and reflect prior answering questions during teaching sessions.

Teaching - Delivering Learning

Varied, active and well planned lessons have proved to be crucial factors in delivering learning (Ashcraft, 2014; Bates, 2023; Bonwell, 1999; Curzon & Tummons, 2013; Fautley & Savage, 2014). This hinders lessons from being boring and keeps students activated. Learning as well as motivation is further enhanced through following up and testing that learning has occurred (Bjork Learning and Forgetting Lab, 2024;

Curzon & Tummons, 2013). Testing also serves the important purpose of accountability and is therefore crucial in the process of delivering learning (Bates, 2023).

Challenges UNITECH faces within this category includes:

- Variation and activation of all students in longer sessions filled with much new content. Some sessions included long presentations without any activation of participants, resulting in low engagement and lost focus among students.
- Follow-up and control of learning, understanding and execution of group exercises. Observations revealed that content was not always understood correctly in group work followed after lessons. Additionally, students' progression in learning was never mapped, tracked or tested through any structured or measurable method.

Teaching - Supporting Learning

Stated by Vygotsky and his Scaffolding Theory, where coaches or teachers are the *Most Knowledgeable Others*, students' learning is enhanced by good support (Bates, 2023). Additionally, flexibility and responsiveness, altered by the physical, mental, and social presence and availability of coaches, are important skills for teachers to possess (Schön, 1987).

Observed challenges in UNITECH includes:

- Physical and mental presence and availability in group work for providing support and detecting eventual misconceptions. Sometimes there was an uneven distribution of coaches in different rooms during exercises, or students worked for longer periods without the access of support and help in answering questions.
- Coaches not taking the cohort's energy level into account while delivering content. In addition to scheduling for mental and physical breaks in between and during sessions, it is also important to be responsive to the audience mood and act up on it.

Fostering Growth

Coaches in UNITECH frequently challenge students and demand accountability. In the coaching modules there are lots of initiatives and actions, like coaching and feedback, that foster growth. Nevertheless, there are a couple of challenges to tackle in order for UNITECH to strengthen factors in this category:

- Fostering students in taking the desirable responsibility. Observations include students attending sessions late, not taking notes during sessions and performing final presentations in Module 3 with a low level of professionality.
- Professional coaching is a significant aspect of the UNITECH programme. However, due to a lack of Coaching Alignment, coaching was sometimes delivered as advice or by providing "the right answer" instead of the more effective approach of asking questions.

5.2 Contribution

As the objective of this thesis was to offer valuable insights for education providers in designing or developing leadership development programmes, the intention for each of the three research questions was to contribute to this goal. Below, the theoretical as well as the practical contributions are presented for each of the three research questions.

5.2.1 RQ1

"What is the perceived gap between the skills practised in engineering education and the industrial skill demand?"

The aim of the first research question was to identify the existing academia-industry gap within the engineering field. While there are an extensive amount of studies measuring skill gaps (Rikala et al., 2024), not many focus on the academia-industry gap within the engineering field. Where they do, the focus is on skills grouped in overarching categories (Saniuk & Grabowska, 2022) or mainly on software engineers (Garousi et al., 2019; Groeneveld et al., 2021), leaving a question mark for the status of the engineering field as a whole. In this study, a comprehensive approach to engineers is adopted, and with a framework consisting of the top ten demanded core skills identified by WEF (Di Battista et al., 2023), the results are highly relevant.

Although the results of RQ1 originate from only one of the three actors playing a crucial role in addressing skill gaps (Braun, 2023), it encompasses all three perspectives, and the respondents are engineering students representing nine different leading universities in Europe and 13 different fields of study. Thus, the result from RQ1 provides an important insight into the current academia-industry gap within the engineering field.

This insight can serve as valuable input for designing engineering education and leadership development programmes aimed at bridging the academia-industry gap. The contribution for RQ1 lies within the 'What?' aspect, addressing the question of 'What skills should the programme aim to develop?' Moreover, the result can also be viewed as a pre-study, highlighting the importance of extending the time span over which a skills gap is measured, particularly when measured through differences in self-estimated performance over time.

5.2.2 RQ2

"How effectively does the UNITECH leadership development programme bridge this gap today?"

By addressing the second research question, significant support is provided for the further development of UNITECH International's leadership development programme. The answer to this question could assist in identifying specific areas for improvement, once again related to the 'What?' aspect. This includes identifying content areas that require enhancement, as well as those that may benefit from reduction. Beyond the contribution for UNITECH, the design of the method and the results also serve as an

inspiration for other programmes, constituting a study that could be replicated in their own programme. Additionally, the qualitative analysis that contributed to the result of RQ2 illustrates, with examples from UNITECH, the means by which a leadership development programme can ensure that trainers practice skills deemed necessary.

5.2.3 RQ3

"What are the influencing factors in the design of a leadership development programme to effectively bridge the skills gap?"

The aim of the third and final research question was to examine how a leadership development programme can effectively bridge the academia-industry gap, by mapping influencing factors in the design of a leadership development programme. Thus, addressing the 'How' aspect, as of 'How should the programme develop the skills determined?'. While there is thorough research in this area, including studies on the purposes that leadership programme developers must consider to ensure their programmes remain impactful, forward-thinking, and relevant (Rottmann & Kendall, 2022), and studies on strategies for programme designers to address to maximise the programme's long-term benefits for participants (Yemiscigil et al., 2023), the majority of them are presented at an overarching level and may not be easily and directly applicable.

The framework outlining challenges and success factors of an upskilling programme for engineers participating in the national programme Ingenjör4.0 (Braun et al., 2023) offers a detailed level of analysis, providing practical and directly applicable factors to consider when developing leadership development programmes. However, that framework is focused on online upskilling programmes, which in many aspects differ from the in-person leadership development programmes such as the one examined in this research, particularly in terms of teaching arrangements and opportunities for group exercises and other interactions among students. Despite this distinction, the results of RQ3 are not only contributing with valuable insights for in-person upskilling programmes but also for the online ones. In addition to the even further level of detail, the findings from RQ3 provide insights through a didactical perspective, essential for enhancing effective learning and development as well as additional factors not highlighted by the online upskilling programme framework, mainly included in the categories *Delivering Learning* and *Fostering Growth*. While some of these additional factors may not be applicable to an online programme, others are.

With the high level of detail provided in the results from RQ3, the map of influencing factors could also serve as a solid foundation for further development of models, toolboxes, or guidelines for programme developers and educators. This development could preferably be organisation specific while pinpointing ownership of responsibilities and considering time aspects related to each factor.

To summarise, the results from RQ3 contribute valuable insights to leadership development programmes, as well as other upskilling programmes. They highlight crucial factors to consider when designing and developing such programmes, presented in a detailed format that enhances applicability.

5.3 Discussion of Methodology

In this section, both methodology and methods are thoroughly discussed, highlighting potential threats to validity. These are also factors that should be considered in future research aiming to replicate a similar study.

5.3.1 Discussion of Approach and Research Design

To conduct this study, a case study was selected as the research design. As previously mentioned, while the purpose of case studies often lies in illustrating a more commonly occurring phenomenon, a common critique is the challenge of making empirical generalisations from them (Alvehus, 2019). Furthermore, conducting multiple case studies with multiple units of analysis, is arguably considered to provide higher validity compared to single-unit case studies (Yin, 2003). Thus, the generalizability of this study, conducted as a case study on a single leadership development programme, may be questioned, and there is a risk that the results, particularly for RQ3, could have differed if the study were conducted at another leadership development programme.

However, the choice of a single-unit case study was made consciously to not lose essential depth, considering the limited time and resources for the study. Such balancing of the number of cases against the available resources for data collection is highlighted as crucial (Alvehus, 2019). Studies of multiple cases, with limited resources available, will result in each case being studied more superficially, while the main strength of case studies lies in their depth of investigation. Moreover, with the observation data anchored in theories of learning and leadership, there is a great confidence that the result of RQ3 indeed represents influencing factors of a leadership development programme aimed at bridging skill gaps for industry. The risk to validity lies in the possibility of undetected data, including additional influencing factors that may be present in other leadership development programmes but were not identified in this research.

In addition to the always present risk for biases within research, where researchers unavoidably bring their theoretical backgrounds, assumptions, and expectations into the field, acting as a filter, particularly for observations (Christoffersen & Johannessen, 2012; Repstad, 2007), there may be an additional risk of bias inherent in the abductive approach employed for RQ3. We did enter the field with a load of theories in learning and leadership. Additionally, the observation protocol was created based on these theories, as well as on the five main categories identified as influencing factors in another upskilling programme for engineers, aimed at bridging skill gaps (Braun et al., 2023). Moreover, one of the main disadvantages of direct observations is indeed the risk of bias related validity issues (Esaiasson et al., 2017). Hence, there is arguably a risk of bias inherent in the design of this study. However, persistent efforts were made to remain objective throughout the study, working together and in parallel, constantly questioning and reminding ourselves and each other to stay open-minded and self-critical. Additionally, our passive participation approach during the observations enabled us to distance ourselves from the environment and the students, aiming to not "go native" and become a part of the phenomena investigated (Esaiasson et al., 2017). As a result, we are fairly confident that the risk of bias is at a reasonable level to maintain validity.

5.3.2 Discussion of Methods

Firstly, an aspect worth noting is the emphasis placed on RQ3 in this study, regarding the time allocated for literature review, data collection, and analysis. In addition to the fact that the theoretical framework utilised in analysing observations was derived from learning and leadership models studied over three semesters in the master's programme that encompasses this study, extensive time was also dedicated to both data collection and analysis. Approximately 80 observations were conducted during two weeks of coaching modules, resulting in an analysis of 433 coded data rows, yielding 756 unique codes for processing. This intensive process, involving data collection and analysis for RQ3, and to a lesser extent for RQ2, proved to be time-consuming. Consequently, due to the limitations of time available for the study, less attention was given to the first two research questions, leaving room for improvement in terms of validity, as will be further discussed later on in this chapter.

In aiming to identify the existing academia-industry gap within the engineering field, captured by RQ1, there are various approaches that can be undertaken (Rikala et al., 2024). The method of measuring the skills gap by examining perceived practice within engineer education could be questioned, and therefore also the formulation of the research question “What is the perceived gap between the skills practised in engineering education and the industrial skill demand?”. The word 'practised' could arguably be replaced by 'developed' since they are not necessarily equal. However, as identifying skill gaps via self-assessment includes multiple challenges, especially when examined through surveys (Rikala et al., 2024) as for RQ1, relying on the students' perceived practice within engineering education was deemed to yield a more objective perspective on the topic, than for instance self-perceived performance. These challenges were confirmed by the surprising results for RQ2, regarding the difference in perceived performance between the two coaching modules, as discussed in section 5.1.2.

Other threats to validity in this research include the timing of data collection relative to the UNITECH academic year. Due to this timing misalignment, we were only able to observe a portion of the programme, specifically Module 1 and Module 2 for the 2023/2024 cohort and Module 3 for the 2022/2023 cohort. For the same reason the questions surveyed on perceived practice within UNITECH only encompasses two of the three coaching modules. Further on, the discrepancy between the original timeframe for the thesis work (January 2024 to May 2024) and the timing of Module 1 and Module 2 coaching modules (August 2023 and January 2024, respectively) resulted in limited time available for observation preparations. With more time available for preparation, the observation protocol could have been further refined, incorporating additional theories as a foundation for its development. This could have increased the validity, since, apart from theories in learning and leadership, it was based on one single study of influencing factors in upskilling programmes for engineers. Another issue related to the timing of the surveys is that the students had not fully completed their engineering education when answering questions on perceived practice within it.

An additional validity risk related to the surveys is the selection of respondents for RQ1 and partly for RQ2, which, due to constraints of time and resources, was delimited to the UNITECH student cohort 2023/2024. In mapping the academia-industry gap within the engineering field, meaning the gap between industry expectations and student’s academic experience (Valstar, 2019), it’s reasonable to focus on skill gaps

among future employees (students), rather than the existing workforce. However, in approaching and defining the actual skills gap as closely as possible, data from education providers, employers, as well as from (future) employees need to be taken into consideration (Braun, 2023). Although the survey questions encompass all three perspectives, using the WEF's top ten core skills as framework for industry skill demand and surveying the students on their educational experience, the survey respondents only represent one of these groups. Despite this group representing eight different European universities and 13 different fields of study within engineering, inclusion of input from UNITECH alumni (RQ1 and RQ2), as well as from engineering students outside UNITECH and current working engineers (RQ1), would have added value to this research. This would have provided additional insights into the skills practised in engineering education and their relevance in professional settings, as well as the skills practised within the UNITECH program. In addition to this, perspectives other than learners' perceptions could have also been taken into consideration. For instance, by interviewing engineering programme managers, analysing the programme curriculum for courses included in engineering education, or by consulting the industry about the perceived skills gap. In fact, the ambition for this study was also to include representatives from the industry in identifying the academia-industry gap for RQ1. Therefore, a survey was sent out to UNITECH Corporate Partners where they were asked to estimate their perception of newly graduated students' performance in each of the top ten core skills. However, the results from this were excluded from this report due to deemed low validity. The main reason for this was a low response rate, along with post-insights regarding methodological and bias-related issues in how the questions were formulated and to whom they were addressed. This, despite all efforts and the employment of various measures to ensure quality in the formulation of questions and response options, as well as to achieve a high response rate. This underscores the fact that both formulation of questions and the response rate are significant and common challenges associated with designing surveys (Esaiasson et al., 2017). Nonetheless, for the surveys sent to the students, constituting the result for RQ1 and RQ2, a 55% response rate was reached, a percentage deemed to be acceptable for surveys (Esaiasson et al., 2017).

The delimitation to WEF's top ten core skills (Di Battista et al., 2023) as a reference for industry skill demand, is naturally another factor challenging the validity of the results through for instance excluding the fast emerging AI-related and Green skills (Di Battista et al., 2023; World Economic Forum, 2020) as well as skill frameworks identified by other organisations, such as the IDG Framework (Inner Development Goals, 2021). However, the one presented by WEF corresponds to the demand identified by the employers themself, one of the three actors playing a crucial role in addressing skill gaps (Braun, 2023).

Besides the validity issues related to bias that have already been discussed, there are other factors that challenge the results of the observations. One such factor is the placement during observations. While sitting at the back provided certain benefits for validity, such as maintaining distance from the students and facilitating diligent note-taking, it also resulted in a limited view of the students in some lecture rooms. This meant that we were not always able to see their faces or determine if, for instance, they were using their mobile phones during a session. Additionally, due to various reasons, primarily related to integrity or the risk of influencing the situation, we were unable to participate in some sessions or moments, such as individual coaching, focused group work, or feedback from the case advisor. Further on, as the observations were not followed up by interviews with students or surveys on perceived challenges and success factors, the result of

RQ3 does not capture either the students´ feelings or thoughts, nor their understanding of taught concepts and their future relevance.

While the surveys and thematic analysis were conducted according to well-established analysis methods, the method for coding of skills related to RQ2 may not have been conventional. However, the approach undertaken was highly structured, resulting in providing indications of how and to what extent a specific skill was practised. This structure allows for comparison and justifies the skill coding as a complement to the related surveys.

Significance level in the quantitative analysis was set to 5% which is a normal level in analysis (Monk & Munro, 2021). However, a small size sample in relation to the size of the population could be an argument to set a higher level of significance, allowing more skills to be included, both in the academia-industry gap (RQ1), and in differences in self-ranked performance (RQ2). With a small size sample, the results could be presented as a pre-study, motivating a higher level of significance. Further on, in analysing the skills gap, a reference level of 3.0 was chosen, representing the survey option *Moderately*. However, how to determine the appropriate level to indicate a lack of practice in engineering education could be argued and it requires further investigation for a more accurate assessment of the skills gap.

5.4 Future Research

In aiming to map the academia-industry gap in the engineering field more accurately, future research could replicate our study, with some minor adjustments to further improve validity and generalizability. Such adjustments include ensuring an even higher response rate and extending the selection of survey respondents. Alternatively, through other methods, incorporating input from academia and industry could be valuable, as they also play a crucial role in addressing skill gaps (Braun, 2023). More cases of leadership development programmes should be investigated to get a broader picture of the academia-industry gap and a more accurate answer to how such programmes can effectively develop sought skills. These case studies should also endure for at least the time frame of one programme, being a bit more than one year in the case of UNITECH International. Additionally, alternative methods for measuring skills developed could be considered, as self-assessment poses some identified challenges (Rikala et al., 2024).

This study has focused on short term effects of a leadership development program, why studies of long term effects is of interest to find how limited time of training can have a long term impact on performance and continuous development (Yemiscigil et al., 2023). Related to this is the need to investigate individual tracking of development, rather than average development of a cohort (Braun, 2023).

The findings from RQ3 provide valuable insights for future opportunities in designing models for the implementation of strategies in leadership development programmes, as well as other educational programmes. Such models can be adjusted to target different roles in an organisation and different timings of implementation. The map of influencing factors could also serve as a foundational framework for future research on effective collaborations between industry and academia. Research on strategies to adapt engineering education to meet industry skill demands more rapidly would also contribute significantly to bridging the skills gap, particularly since the pace in which technology develops continuously increases.

Further research should also explore what really are the right competencies for the future workforce and question to what extent skills contribute to a more sustainable future. For example, it would be of interest to analyse the top ten core skills identified by the WEF (Di Battista et al., 2023) and their relationship with the UN's Inner Development Goals Framework, which comprises 23 identified abilities categorised into 5 dimensions, recognized as critical for sustainable development and the achievement of the global goals (Inner Development Goals, 2021). This suggestion is also supported by Rottmann and Kendall's (2022) suggestion that *Social Transformation* is one of four purposes in leadership development programmes, emphasising that topics like social justice, diversity and equity should not be neglected in such programmes.

5.5 Recommendations and Way Forward

For UNITECH to maintain its success in bridging skill gaps for industry, several recommendations should be considered. Among the least practised skills in engineering education, *Creative Thinking* was identified as the least practised within UNITECH. Therefore, enhancing the development of creative thinking should be a priority. Furthermore, it is crucial for UNITECH to stay up-to-date with industry skill demand, including considering the rapid emergence of AI and Green skills (Di Battista et al., 2023; World Economic Forum, 2020). Evaluating and addressing any gaps in engineering education related to these areas is essential. Additionally, UNITECH should continue measuring the academia-industry gap (as addressed in RQ1) and their efficiency in bridging them (as identified in RQ2). This ongoing assessment will ensure an accurate understanding of the actual gap and progress in closing it.

Moreover, UNITECH, as well as leadership development programmes in general, could benefit from conducting evaluations based on the identified influencing factors from RQ3. Incorporating questions related to these factors can offer insights into where to prioritise efforts. Additionally, the main areas of development, presented in section 5.1.5, provide valuable insights into areas of improvement for UNITECH.

Finally, considering the *Teaching* category, which encompasses numerous sub-categories and represents a significant area of influence, leadership development programmes could benefit from developing a comprehensive teaching toolbox for coaches. This toolbox would aim to support coaches in their teaching endeavours and enhance the effectiveness of the educational process. By implementing these recommendations, UNITECH and other leadership development programmes can continue to enhance their effectiveness in preparing students for the demands of the industry and bridging the skills gap effectively.

6. CONCLUSION

With the emerging issue of industry's skill demand in mind, the aim of this study was to identify the existing academia-industry gap within the engineering field and examine how a leadership development programme can effectively bridge this gap. The three research questions that underpin this aim were addressed by conducting a case study at UNITECH International's leadership development programme for engineering students, using surveys and observations as data collection methods.

The results confirm the existence of an academia-industry gap, particularly noticeable in non-technical skills, encompassing four key skills: *Creative Thinking, Motivation and Self-awareness, Empathy and Active Listening*, and *Leadership and Social Influence*. Additionally, the study indicates that UNITECH International in general bridges this gap effectively, with the exception of Creative Thinking, which requires an increased focus. The bridging is done through the coaching modules of the programme, which challenge and develop students through coaching, feedback, case-oriented group work, professional as well as peer interactions, and instruction in leadership theories and models highly relevant for future professional life.

Additionally, the results outline influencing factors in the design of a leadership development programme to effectively bridge the academia-industry gap. These factors are represented by 33 different sub-categories, organised into six overarching categories: *Programme Relevance*, *Organisation and Structure*, *Social Environment*, *Teaching*, *Fostering Growth* and *Working Life Orientation*.

Findings can serve as an inspiration for further development of UNITECH International, as well as other educational programmes. Identified influencing factors of a leadership development programme can be utilised as a starting point in designing practically useful models for each role in programme organisations. Our suggestion for further research, apart from performing extended studies on our research topic to further increase validity and generalisability, is to investigate individual skills development and track long term effects of short term leadership development programmes. Furthermore, investigations into how industry and academia can collaborate more effectively to minimise and prevent skill gaps in the future would add even further value to our vision of ensuring a relevant and skilled future workforce.

REFERENCES

Adepoju, O. O., Aigbavboa, C. O. (2021). Assessing knowledge and skills gap for construction 4.0 in a developing economy. *Journal of Public Affairs*, *21* (3). https://doi.org/https://doi.org/10.1002/pa.2264

Akdur, D. (2021). Skills Gaps in the Industry: Opinions of Embedded Software Practitioners. *ACM Transactions on Embedded Computing Systems*, *20* (5), 1-39. https://doi.org/10.1145/3463340

Alvehus, J. (2019). *Skriva uppsats med kvalitativ metod: En handbok* (2nd ed.). Liber AB.

Ashcraft, N. (2014). *Lesson Planning*. TESOL Press.

Baartman, L. K. J., de Bruijn, E. (2011). Integrating knowledge, skills and attitudes: Conceptualising learning processes towards vocational competence. *Educational Research Review*, *6* (2), 125-134. https://doi.org/https://doi.org/10.1016/j.edurev.2011.03.001

Babic, M., Billey, A., Nager, M., Wuest, T. (2022). Status Quo of Smart Manufacturing Curricula offered by ABET accredited Industrial Engineering programs in the US. *Manufacturing Letters, 33*, 944–951. https://doi.org/10.1016/j.mfglet.2022.07.115

Bates, B. (2023). *Learning theories simplified : ...and how to apply them to teaching* (3rd ed.) SAGE.

Berner, B. (1999). Experiment som ingenjörsarbete. In *Perpetuum Mobile? : Teknikens utmaningar och historiens gång*. Arkiv förlag.

Bjork Learning and Forgetting Lab. (2024). *UCLA Bjork Learning and Forgetting Lab*. Retrieved 2024-04-27 from https://bjorklab.psych.ucla.edu/research/

Bonwell, C. C. (1999). Using Active Learning to Enhance Lectures. *Applied Economic Perspectives and Policy*, *21* (2), 542-550. https://doi.org/10.2307/1349897

Braun, G. (2023). *Towards bridging skill gaps for the future industrial workforce*. Licentiate Thesis. Department of Industrial and Materials Science, Chalmers University of Technology.

Braun, G., Stahre, J., Rosén, B. G., Bokinge, M. (2023). Ingenjör4.0 – A National Upskilling Programme to Bridge Industry's Skill Gap. *Procedia CIRP*, *120*, 1286-1291. https://doi.org/10.1016/j.procir.2023.09.164

Braun, V., Clarke, V. (2012). Thematic analysis. In (pp. 57-71).

Cambridge Dictionary. (n.d.). Engineer. In *Cambridge Dictionary*. Retrieved 2024 February 5, from https://dictionary.cambridge.org/dictionary/english/engineer

Chapman, D. D. (2004). Preparing Learners for e-Learning, edited by George M. Piskurich. San Francisco: Pfeiffer. *Human Resource Development Quarterly*, *15* (3), 351-357. https://doi.org/https://doi.org/10.1002/hrdq.1109

Christoffersen, L., Johannessen, A. (2012). *Forskningsmetoder för lärarstudenter* (1st ed.). Studentlitteratur.

Curzon, L. B., Tummons, J. (2013). *Teaching in Further Education: An Outline of Principles and Practice*. Bloomsbury Publishing.

Di Battista, A., Grayling, S., Hasselaar, E., Leopold, T., Li, R., Rayner, M., Zahidi, S. (2023). Future of jobs report 2023. Geneva: World Economic Forum.

Esaiasson, P., Gilljam, M., Oscarsson, H., Towns, A., Wängnerud, L. (2017). *Metodpraktikan - Konsten att studera samhälle, individ och marknad* (5th ed.): Wolters Kluwer.

European Commission. (2023). *DECISION (EU) 2023/936 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 10 May 2023 on a European Year of Skills*. Strasbourg: European Commission Retrieved from http://data.europa.eu/eli/dec/2023/936/oj

Evans, I. M. (2012). Culture as Behavior Change. In *How and Why People Change* (pp. 225–248). Oxford University Press.

Fautley, M., Savage, J. (2014). *Lesson Planning for Effective Learning*. McGraw-Hill Education.

Felder, R. M., Brent, R. (2016). *Teaching and learning STEM : a practical guide* (1st ed.). Jossey-Bass, a Wiley brand.

Garousi, V., Giray, G., Tüzün, E., Catal, C., Felderer, M. (2019). Aligning software engineering education with industrial needs: A meta-analysis. *Journal of Systems and Software*, *156*, 65-83. https://doi.org/https://doi.org/10.1016/j.jss.2019.06.044

Groeneveld, W., Vennekens, J., Aerts, K. (2021). Identifying Non-Technical Skill Gaps in Software Engineering Education: What Experts Expect But Students Don't Learn. *ACM Transactions on Computing Education*, *22* (1), 1-21. https://doi.org/10.1145/3464431

Hunt, J. M., Weintraub, J. R. (2016). *The Coaching Manager: Developing top talent in business.* SAGE Publications.

Inner Development Goals. (2021). *Inner Development Goals: Background, method and the IDG framework*. https://innerdevelopmentgoals.org/framework/

Jensen, T., Sandström, J. (2016). *Fallstudier*. Studentlitteratur AB.

Johnson, D. W., Association for the Study of Higher Education, ERIC Clearinghouse on Higher Education, George Washington Univ. (1991). Cooperative Learning: Increasing College Faculty Instructional Productivity. *ASHE-ERIC Higher Education Report number 4.* Jossey-Bass.

Kassie, S. A. (2023). Prevention before intervention: introducing mindfulness-based social-emotional learning in higher education institutions across the United Arab Emirates. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1281949

Kelly, J., Gielstra, D., J. Oberding, T., Bruno, J., Hadley, S. (2024). Uniting Academia and Industry to Bridge the Skills Gap: Incorporating Industry Advisory Councils in Curriculum-To-Careers Programmatic Mapping in Undergraduate Environmental Science Programs. *Industry and Higher Education*, *38* (2), 112-123. https://doi.org/10.1177/09504222231175413

Kirti, Saini, R. R. (2022). Bridging the Employability Skills Gap: A Review. *IUP Journal of Soft Skills*, *16* (3), 43-50.

Klimoski, R., Hu, X. (2011). Improving self-awareness and self-insight. In M. London (Ed.), *The Oxford Handbook of Lifelong Learning* (pp. 51–69). Oxford University Press.

Knowles, M. S., Holton III, E. F., Swanson, R. A. (2005). *The adult learner: The definitive classic in adult education and human resource development* (6th ed.). Society for Neuroscience.

Kruger, J., Dunning, D. (1999). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology, 77*(6), 1121–1134. https://doi.org/10.1037//0022-3514.77.6.1121

LibreTexts. (2021). *6.2: The Sampling Distribution of the Sample Mean*. Retrieved 2024 May 4 from https://stats.libretexts.org/Bookshelves/Introductory_Statistics/Introductory_Statistics_(Shafer_and_Zhang)/06%3A_Sampling_Distributions/6.02%3A_The_Sampling_Distribution_of_the_Sample_Mean

Maheso, N., Mpofu, K., Ramatsetse, B. (2019). A Learning Factory concept for skills enhancement in rail car manufacturing industries. *Procedia Manufacturing*, *31*, 187-193. https://doi.org/https://doi.org/10.1016/j.promfg.2019.03.030

Maurer, M. M., Maurer, J., Hoff, E., Daukantaitė, D. (2023). What is the process of personal growth? Introducing the Personal Growth Process Model. *New Ideas in Psychology*, *70*(101024). https://doi.org/10.1016/j.newideapsych.2023.101024

McCabe, J. (2014). Learning and memory strategy demonstrations for the psychology classroom. *Society for the Teaching of Psychology*. Goucher College.

Molinsky, A. (2016). If You're Not Outside Your Comfort Zone, You Won't Learn Anything. *Harvard Business Review Digital Articles,* 2-4.

Monk, P., Munro, L. J. (2021). *Maths for Chemistry - A Chemist's Toolkit of Calculations* (Vol. 3). Oxford University Press.

Napierala, M. A. (2012). What is the Bonferroni Correction? *Aaos Now*, 40-41.

Partanen, P. (2019). *Att utveckla förmågor på vetenskaplig grund - i skolan* (1st edition). Skolutvecklarna Sverige.

Pinch, T. (1993). "Testing - One, Two, Three... Testing!": Toward a Sociology of Testing. *Science, Technology, & Human Values*, *18* (1), 25-41.

Priya, A. (2021). Case Study Methodology of Qualitative Research: Key Attributes and Navigating the Conundrums in Its Application. *Sociological Bulletin*, *70* (1), 94-110. https://doi.org/10.1177/0038022920970318

Repstad, P. (2007). *Närhet och distans - Kvalitativa metoder i samhällsvetenskap* (4th ed.). Studentlitteratur.

Rikala, P., Braun, G., Järvinen, M., Stahre, J., Hämäläinen, R. (2024). Understanding and measuring skill gaps in Industry 4.0 — A review. *Technological Forecasting and Social Change*, *201*, 123206. https://doi.org/https://doi.org/10.1016/j.techfore.2024.123206

Rottmann, C., Kendall, M. R. (2022). Looking to the future: Four key purposes of engineering leadership education. *New Directions for Student Leadership*, *2022* (173), 149-155. https://doi.org/https://doi.org/10.1002/yd.20486

Saadat, V., Saadat, Z. (2016). Organizational learning as a key role of organizational success. *Procedia, Social and Behavioral Sciences, 230*, 219–225. https://doi.org/10.1016/j.sbspro.2016.09.028

Saniuk, S., Grabowska, S. (2022). Development of knowledge and skills of engineers and managers in the era of Industry 5.0 in the light of expert research. *Scientific Papers of Silesian University of Technology Organization and Management Series*, *2022* (158), 537-547. https://doi.org/10.29119/1641-3466.2022.158.35

Saniuk, S., Grabowska, S., Straka, M. (2022). Identification of Social and Economic Expectations: Contextual Reasons for the Transformation Process of Industry 4.0 into the Industry 5.0 Concept. *Sustainability*, *14*(3), 1391. https://doi.org/10.3390/su14031391

Schön, D. A. (1987). *Educating the reflective practitioner : toward a new design for teaching and learning in the professions* (1st ed.). Jossey-Bass.

Shahlaei, C. A., Lundh Snis, U. (2023). Conceptualizing industrial workplace learning: an information systems perspective. *Journal of Workplace Learning*, *35* (9), 1-21. https://doi.org/10.1108/JWL-04-2021-0048

Smith, M., Wood, W., Adams, W., Wieman, C., Knight, J., Guild, N., Su, T. (2009). Why Peer Discussion Improves Student Performance on In-Class Concept Questions. *Science (New York, N.Y.)*, *323* (5910), 122-124. https://doi.org/10.1126/science.1165919

Tavory, I., Timmermans, S. (2019). Abductive Analysis and Grounded Theory. In A. C. Bryant, Kathy (Ed.), *The SAGE Handbook of Current Developments in Grounded Theory* (pp. 532-546). SAGE Publications Ltd. https://doi.org/10.4135/9781526485656

UNITECH international. (2024). *UNITECH international*. Retrieved 2024 April 25 from https://www.unitech-international.org

Valstar, S. (2019). Closing the Academia-Industry Gap in Undergraduate CS. In *International Computing Education Research Conference (ICER '19), August 12–14, 2019*, Toronto, ON, Canada. https://doi.org/10.1145/3291279.3339440

Ward, D., Schwarz, A. (2023). *UNITECH Joint Modules Handbook: Developing Through Continuous and Effective Coaching*. Unpublished manuscript.

Williams, C. (2007). Research Methods. *Journal of Business & Economic Research*, *5*(3). https://doi.org/10.19030/jber.v5i3.2532

Visible Learning. (2018). *Hattie Ranking: 252 Influences And Effect Sizes Related To Student Achievement*. Retrieved 2024 May 7 from https://visible-learning.org/hattie-ranking-influences-effect-sizes-learning-achievement/

World Economic Forum. (2020). *Jobs of Tomorrow Mapping Opportunity in the New Economy*. W. E. Forum. https://www.weforum.org/publications/jobs-of-tomorrow-mapping-opportunity-in-the-new-economy/

Yemiscigil, A., Born, D., Ling, H. (2023). What Makes Leadership Development Programs Succeed? *Harvard Business Review*. https://nrs.harvard.edu/URN-3:HUL.INSTREPOS:37374468

Yin, R. K. (2003). *Case Study Research: Design and Methods* (3rd ed.). SAGE Publications.

DEPARTMENT OF COMMUNICATION AND
LEARNING IN SCIENCE
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2024
www.chalmers.se

CHALMERS
UNIVERSITY OF TECHNOLOGY