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Evaluation of a Work-Integrated Learning Program for Undergraduate STEM Outreach Instructors

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This paper describes and evaluates a comprehensive work-integrated learning program, developed and delivered by Actua, a Canadian National STEM organization. The program provides instructors with a variety of opportunities to improve their skills, career readiness, and their employer connections and networks. The program consisted of four sets of activities: (1) A set of skills-focused training modules to prepare participants for their more immediate STEM outreach work and longer-term work readiness; (2) Industry-Led Activities and Micro-experiences; (3) Short-term internships with industry partners; and (4) a Micro-Credentials pilot program in professional communications. The programs were evaluated using a comprehensive participant survey, alongside initiative-specific surveys and interviews to gather more precise feedback. Program evaluation demonstrated a strong positive impact on the professional skills, knowledge, confidence and workforce readiness of participating post-secondary students. This program provides a novel approach for work-integrated learning, in that it places more emphasis on the employment experience than is often the case in WIL programs - that is, it focuses as much on *providing learning that enhances the work experience* as it does on providing work experiences that enhance the learning experience. The paper draws from social cognitive career theory and identity trajectory theory to support the evaluation of work-integrated learning programming.

1. Introduction

This paper outlines efforts to provide undergraduate students, employed through a network of K-12 STEM outreach programs, with a work-integrated learning program. Actua was established nearly 30 years ago by a group of university students, and has grown to become Canada's largest STEM organization with the inclusion of 43 network members at universities and colleges. The Actua network delivers programming in 500 communities each year for youth aged 6-16 in every province and territory in Canada. In particular, the organization focuses on breaking down barriers towards youth engagement in STEM, with a focus on Indigenous youth, girls in STEM, at-risk youth, newcomers to Canada and/or other youth experiencing socio-economic challenges, with a goal of ensuring members of these groups can be full participants in, and fully benefit from, Canada's social and economic development.

Annually, Actua network programs employ approximately 800 college and university students who engage youth in a variety of programs, including week-long camps, year-round clubs, workshops and other programming models, designed to inspire students to build an interest in STEM. Many of the outreach programs are situated within engineering programs, and therefore attract a large number of undergraduate engineering students, who alongside other students from

STEM programs form the backbone of Actua's for-youth-by-youth model of inspiring youth to achieve their potential through engagement in STEM. Through their employment with Actua, instructors gain invaluable employability and leadership skills as they launch their careers in STEM. In addition to these instructors, hundreds of high school students are hired as junior instructors to assist in the delivery of STEM programs across Canada, who also benefit from the work experience that builds leadership and other employability skills, giving them a leg-up on their early career advancement.

Although the organization and the network members have a long history in training instructors for their educational outreach work, the organization has only recently started to explore a more in-depth Work-integrated Learning (WIL) program, with a focus on positioning STEM Outreach work in the broader employment trajectory, and educating students for the needs of their future employment. Working in STEM education offers a unique opportunity for undergraduate students to engage with their subject matter expertise with purpose. Furthermore, instructors build social and professional skills alongside disciplinary expertise, paving the way for many future job opportunities.

Previous program evaluation has established that the experience of working in STEM outreach is impactful. Although it varies from year to year and program to program, typically 1 in 3 instructors return for a second or more work term. Furthermore, previous work [1] described the development of skills in students delivering STEM outreach activities for youth, which, in combination with other skills inventories and literature review, resulted in a future skills framework to drive organizational learning. The future skills framework identifies 12 transferable employability skills grouped in three categories: (1) Delivering Results; (2) Working with Others and (3) Future Readiness. This previous work demonstrated that while instructors develop more confidence in a subset of skills, there was an opportunity for more fulsome connection between the STEM outreach work and skill development in service of career development, and a better awareness of the development of skills and their future application. We have subsequently focused on communicating these skills to instructors and other stakeholders within and outside of the context of member training.

Building on this previous work, and recognizing the critical role that work integrated learning plays in the science, technology and innovation ecosystem, Actua designed and delivered Actua's *Work Integrated Learning* (WIL) program for the university and college student instructors of its many STEM outreach programs. The program provided instructors with a variety of opportunities to improve their skills, career readiness, and their employer connections and networks. The program consisted of four sets of activities, alongside the STEM outreach work experience: (1) A set of skills-focused training modules to prepare them for their more immediate STEM outreach work and longer-term work readiness; (2) Industry-Led Activities

and Micro-experiences; (3) Short-term internships with industry partners; and (4) a Micro-Credentials pilot program in professional communications.

2. Theoretical background

In recent years, there has been a significant and growing interest in WIL programs within engineering, in an effort to draw connections between the learning that takes place in undergraduate or graduate studies, and the learning that takes place throughout one's career. WIL integrates academic learning with practical applications in a workplace, and can be offered within the requirements of an academic program, as a co-curricular program, or initiated by a student [2]. WIL provides students with a more immediate opportunity to apply what they've learned to a meaningful context, and build employment-relevant skills in the process.

We draw from three key areas from the literature in considering the construction and assessment of future skills and WIL programs. First, the development of Actua's future skills framework is explored. Then, Identity Trajectory Theory is used to explore the relationship between student identity development and WIL. Finally, Social Cognitive Career Theory is used to support an understanding of how career interests and choices emerge, and how this can be supported through the WIL.

2.1 Future Skills Framework

This work builds on previous work [1], which documented the development of a future skills framework. This framework includes a set of 12 skills that were thematically organized into three categories: delivering results, working with others and future readiness. This future skills framework was developed through instructor and program director surveys and interviews, employer interviews, and a literature review of competency and engagement frameworks used by employers and educational institutions. This included the Canadian Engineering Accreditation Board's Graduate Attributes, which represent key competencies that must be taught and assessed in undergraduate engineering programs in Canada [3] and is similar to the American ABET system. The competency and engagement frameworks reviewed were those linked to the University of Toronto Co-Curricular Record [4], The Canadian University Survey Consortium Survey of University Students [5], The National Survey of Student Engagement [6], the Memorial University Career Integrated Learning Initiative [7] and the National Association of Colleges and Employers (NACE) [8].

Table 1: Future Skills Framework

Delivering Results:	Working With Others:	Future Readiness:
1. Problem Solving 2. Critical Thinking & Analysis 3. Initiative 4. Commitment	5. Teamwork & Collaboration 6. Communication 7. Leadership 8. Social Intelligence (Social Perceptiveness)	9. Adaptability & Flexibility 10. Innovation & Creativity 11. Ability & Eagerness to Learn 12. Self-Awareness

The future skills framework also aligns with recent literature on the importance of lifelong learning. For example, work assessing the lifelong learning priorities of engineering program alumni prioritized skills that align with future readiness, including general curiosity and desire to learn; learning from others who have expertise in domains other than your own; innovation to develop creative and effective products, processes and services; and solving novel scientific or technical problems [9]. Lifelong learning skills like "ability & eagerness to learn" and "self awareness" align with the need to work through the complex sociotechnical challenges that engineers face today [10], and support students in navigating an evolving labour system [11]. Furthermore, the development of future skills through work integrated learning experiences has been documented in other research [12]-[15].

2.2 Identity Trajectory Theory

Identity theory has a strong presence in the scholarship on the education and development of engineering students, as practitioners attempt to understand the interplay between curricular, co-curricular and work experiences, and the development of students "as engineers" [16]-[18]. While Identity Trajectory Theory was initially developed as a theory to explain early career identity development in graduate students and new professors [19], Benedict et al [16] recently adapted this theory for use in a more predominantly undergraduate population. In this particular framing of identity; three interconnected strands are highlighted:

1. Intellectual: the relevance of developing and applying subject matter expertise to make some kind of a contribution; drawing on notions of ability, responsibility and recognition.
2. Institutional: education or work-based institution and its structures, responses and responsibilities that influence identity development, both as a student and in a future career.
3. Networking: framing the relationships and collaborations that support the development of identity.

Research by Castillo, McIntyre and Godwin [20] examined the connections between work integrated learning and identity trajectory theory, and found a number of important connection

points. For example, they discuss the relevance of institutional structures and resources to facilitate students' access to work-integrated learning experiences (WILs). They suggest that co-op and other work experience programs create space for these as "necessary and normal", and career services and organizations all provide important outlets to build future skills and career readiness. The use of student personal and professional networks were found to improve access to WILs; through interactions with faculty, advisors and mentors, opportunities emerged for work experience. Interestingly, the authors also found that WILs contributed positively towards self-efficacy; particularly when the participants had the opportunity to work independently on tasks and feel a sense of ownership. Students often felt validated about their career choice and more confident in the continuation of their studies.

Liu et al [21] constructed a framework to support understanding of WILs and their associated learning outcomes. This framework highlights, in particular, the relevance of student interactions with both their academic institution and the workplace; and that outcomes depend on the quality of relationship between all three. Furthermore, the authors, through a comprehensive literature review, defined a set of critical workplace affordances, including giving students the opportunities to apply knowledge and skills to practice, the importance of supportive mentors and supervisors, and treating students as junior colleagues rather than students. These themes build further on the interconnected strands of Identity Trajectory Theory as described above.

In considering the Actua work experience and the WIL activities, a number of the themes highlighted above are relevant. Instructors have the opportunity to engage with the resources, tools and structures within the national organization and their home institution, cementing opportunity for engagement and full participation. Participants engage the intellectual through the utilization and application of their STEM knowledge. Networking with their peers - both within their program and the national network - amplifies the experience and has the potential to contribute to future career development. Participants, in the work itself, are given the opportunity to take ownership in the development of curriculum development and classroom management, building potential for self-efficacy development. Finally, the three interconnected strands hold many connections to the Actua Future Skills Framework; "delivering results" requires intellectual development, "working with others" draws from networking skills and institutional knowledge; and future readiness draws from the three strands and makes connections to the participant's future career needs and opportunities.

2.3 Social Cognitive Career Theory

Social Cognitive Career Theory (SCCT) is a career theory rooted in general social cognitive theory, that aims to integrate three dimensions of career development: (1) how people become interested in particular careers or a particular academic path; (2) how people make decisions about that path; and (3) how success is or is not achieved in the chosen academic or career path.

SCCT is built on four main variables. The first variable is self-efficacy beliefs, or how a person perceives their ability to achieve goals. These beliefs are dynamic and can change over time. The second variable is outcome expectations, or the importance of whether an individual believes the outcome of a particular task or career will be positive; in the context of a career, it might be described as whether an individual can meet goals or values in choosing a particular path. Third, interests - subject-matter relevant or otherwise - impact career choice and persistence. Finally, personal goals drive people to pursue certain paths. These can be categorized as performance goals, learning goals or competency-based goals. In addition, there are institutional or environmental variables, including social support, expectations from others, and economic opportunities that influence career decisions [22]. Various reinforcing relationships exist between these variables in the SCCT model, and variables can have an impact whether they are real or perceived.

Within engineering, research has validated the relevance of these variables in understanding the career pursuits of engineering students [23]. Furthermore, research has also demonstrated that networking, building a number of quality professional connections, and observing others in the field to gain knowledge of the profession helps engineering students experiment with their own identity in service of building a professional identity [24]. The importance of institutional supports and contextual variables on self-efficacy, goal formation and outcome expectations in the engineering student population has also been documented [25]. More broadly, through the enhancement of SCCT-related variables, including self-efficacy and the fostering of positive and realistic outcome expectations, STEM career interest is built or reinforced [26]. These career interests are of critical importance to educational attainment and motivation, as well as professional identity development, and so the positive impacts are multiple.

Finally, the impact of WIL programming in engineering has been demonstrated to positively impact the variables included in SCCT, and also lifelong learning, professional skills and the attainment of other undergraduate engineering academic learning outcomes, which in turn support academic and occupational performance [27]. The evaluation of our WIL programming and our Future Skills Framework offer a strong focus on self-efficacy; and the work experience itself as part of a mission-driven organization connects to positive outcomes and personal goals. There is an opportunity to further situate the results of this work in understanding the career pathway development of the participants, and this paper is a first step towards this research goal.

3. Actua’s Work Integrated Learning program design

Actua’s Work Integrated Learning Program employs and trains undergraduate and graduate student instructors from across Canada each year, with the aim of not only preparing them for their STEM outreach work, but also increasing their employability skills, providing them with next-step career connections, and preparing them to enter the skilled workforce. After focusing

on the impact measurement of the work experience and the development of the future skills framework, as documented in previous work [1], we have focused on the development, implementation and testing of a series of new work-integrated learning experiences, focusing on four sets of activities, all of which were introduced in 2021 or 2022.

3.1 Training modules

First, after instructors are hired, they are offered a set of online skills-focused training modules to prepare them for their more immediate STEM outreach work while also preparing them for longer-term work readiness. These modules have been offered in different variations over time, depending on the member program needs and resources, but have only recently been standardized into a set of common modules for use across the organization. There are 15 modules in total, each offering focus on a specific topic. Each module has stated learning outcomes aligned with the program mission and the training needs of the STEM outreach programs. Each module also provides skill development under the Future Skills framework. Within the module, participants are provided with key information and theory, participate in short active learning activities, and are provided with reflection opportunities to self-assess on what they've learned. Modules topics are as follows:

1. Organizational Introduction
2. Anti-Racism in STEM
3. Classroom Management
4. Communicating with Parents
5. Conflict Resolution
6. Future Skills
7. Gender Equity
8. Inclusion and Accessibility
9. Indigenous Worldviews
10. Managing Stress/Mental Health
11. Mentorship 101
12. Online delivery of STEM programs
13. STEM Content Development
14. Training and Development (for member program leaders)
15. Feedback and Evaluation (for member program leaders)

3.2 Industry-led activities and Micro-experiences

A series of micro-experiences - such as topic-specific boot camps, hackathonsand thought leadership events - were designed, in collaboration with industry partners and other employers, to prepare students for the workforce and connect them with employers. While each event had unique objectives and focus, they had the common goal of helping to prepare students for the

workforce and increase their connections to employers. The short-term nature of micro-experiences afford the possibility of having participants engage in a number of experiences, building their network and connecting to a variety of possible employers and career pathways.

3.3 Micro internships

Among the most intensive of WIL experiences offered were the micro-internships which paired participants with industry employers to gain additional insight into and experience with the workforce. The structure and organization of micro-internships varied across organizations and participants. For most, the micro-internship operated mainly as an intensive job shadowing and mentorship experience with participants virtually embedded in the mentor's activities; for a few participants, the micro-internship also involved working on small projects and presenting and discussing results with mentor organization employees.

3.4 Micro-Credentials pilot program in professional communications

In 2022, Actua launched its first ever micro-credentialing program for instructors. The micro-credential was made up of 4 different badges:

- Classroom Management Badge - communicating and facilitating with youth
- Communicating With Parents Badge - communicating with parents/guardians
- Conflict Resolution Badge - interpersonal communication
- Future Skills Badge - communication with potential future employers

In order to successfully achieve the micro-credential, individuals had to first complete the corresponding training module and begin their work experience of engaging youth. They then submitted assessment forms (one for each badge) that were completed by themselves and their supervisors. The forms provided space to articulate how they have grown and developed skills through the work experience and training in order to earn each badge. Actua then reviewed the submitted forms for quality assurance and processed each badge. If an individual earned all 4 badges they received the micro-credential.

4. Evaluation Methods

The development of the work integrated learning experiences included a rigorous evaluation program, to assess the effectiveness of the training experiences and the program as a whole. A comprehensive online survey focusing on future skills development was given to all instructors who participated in an Actua summer work experience (and all of these participants completed at least some of the training modules, as described in 3.1). The survey asked instructors to report on the development of their future skills, and was deployed to participants at the beginning of their work experience, and for a second time within the last few weeks of their employment. The

survey was designed and administered with support from the RBC Foundation, which funds a number of related programs, and has participants in those programs complete a survey with core questions that match some of the questions posed to the Actua WIL program participants. Additional questions were added to the survey to meet organizational needs.

Activity-specific evaluation tools were also deployed, to measure the impact of the specific initiatives. To collect timely feedback on training modules, short post-activity surveys (6-8 questions) were developed and administered. For those who participated in the industry-led activities and micro-experiences, a survey was administered for each activity. Recognizing the unique and intensive nature of the micro-internship component, we conducted semi-structured, conversational interviews with a sample of participants to gather feedback on the quality and impact of the experience on their skills, knowledge, networks, and career opportunities. We conducted 10 interviews over the course of the micro-internship component of WIL. Further, feedback from 10 employers who hosted micro-internships was collected in the form of a short survey. Finally, we collected feedback from 14 participants who completed one or more micro-credential training modules, received the credential and completed a post-completion survey. We also received feedback from their supervisors. Additionally, the organization that facilitated the distribution of digital credentials collected information on how recipients were using them.

5. Results

Between February 2021 and September 2022, the WIL program engaged 835 post-secondary students in 1,337 experiences. All participants pursued at least one training experience, and served as a STEM outreach instructor. The participants also enrolled in industry-led experiences, including boot camps, hackathons, and thought leadership events. Overall, program evaluation demonstrated a strong positive impact on the professional skills, knowledge, confidence and workforce readiness of participating post-secondary students, confirming the value of practically-focused, work-integrated learning. Results from the comprehensive survey capture changes in participants' self-reported skills, knowledge, confidence, and career readiness over the course of the entire WIL program. For some, that means the impact of a suite of training modules and their experience as instructors. For others, it reflects the combined impact of training modules, instructor work experience, a micro-internship, and participation in special activities such as boot camps and hackathons.

This section will begin with a focus on the survey results, which represents participants across all of the WIL activities. Then, evaluation of each of the activities will be shared.

5.1.1 Pre and Post Participant Survey: Future Skill Development

634 complete surveys (388 pre-program and 246 post-program) were collected, and of these, a subset of 193 paired surveys were analyzed (i.e. from the same participants). 64 paired responses from “high intensity” WIL participants were also collected - i.e. those who completed 8 or more of the 16 training modules available to them. This allowed us to assess whether higher levels of participant engagement in the instructor training generated greater impact. The survey participants represent a diversity of academic programs and geographic locations across the country.

The main participant survey demonstrated that the WIL program had a significant positive impact on self-reported professional skills, knowledge and confidence of participants. Over the course of the program, participants’ confidence increased in 11 skills, including critical thinking, problem-solving, creativity, listening, leadership, presenting, cultural competence, certain technical and digital skills. Confidence remained statistically unchanged in 8 skills categories, and did not decline in any WIL skills category. In the following sections, survey results will be explored, first focusing on self-reported skill development, and then on a subset of other constructs measured in the survey.

The survey captured all program participants, but as noted, through analysis, high-intensity participants in the skill modules were identified, and the results demonstrate the growth in self-reported skill development between high-intensity participants, and the overall rate. For “high-intensity” WIL participants, improvements in confidence were often higher. High-intensity WIL participants’ confidence increased in 13 skills categories, with post-program confidence consistently higher than other WIL participants. Confidence remained unchanged in 6 skills categories, and did not decline in any WIL skills category. In Table 2 below, skills on which average confidence rose between 0.1 and 0.19 from the pre- to post-program surveys are shaded in light green, while those that saw a rise of 0.2 or more from pre- to post-program surveys are shaded in dark green. Changes of +/- 0.09 or less are considered unchanged. Participants were asked to report on each skill using a 10 point scale from which mean scores were calculated and used to complete the table below.

Table 2: Survey Assessment of Future Skills

WIL Skills	All Participants		High-Intensity	
	Pre-Program Confidence	Post-Program Confidence	Pre-Program Confidence	Post-Program Confidence
Critical-Thinking and Problem-Solving				
Thinking through and identifying causes of problems	8.14	8.35	8.20	8.46
Figuring out how different ideas fit together	7.90	8.23	8.09	8.25
Brainstorming ideas in a group	8.33	8.41	8.52	8.56
Thinking "outside the box" and developing unique ideas	7.76	7.78	7.82	8.05
Test and evaluate new ideas	8.01	8.13	8.15	8.39
Collaboration and Leadership				
Considering viewpoints that are different from your own	8.20	8.47	8.38	8.56
Considering pros & cons of different opinions, deciding which is best	8.04	8.28	8.23	8.53
Working cooperatively in groups	8.75	8.69	8.86	8.84
Considering other people's perspectives in a group	8.67	8.63	8.71	8.73
Contributing your ideas and suggestions to a group	8.34	8.41	8.45	8.52
Leading a group	8.27	8.55	8.43	8.72
Listening and Speaking				
Speaking or presenting in front of groups	7.56	7.93	7.89	8.22
Expressing your ideas and thoughts through writing	7.83	7.87	7.71	8.00
Listening to others to understand their point of view	8.84	8.77	8.89	8.91

Professional Skills				
Networking and building relationships in the work world	6.45	7.08	6.83	7.44
Articulating the skills and knowledge to employers	7.18	7.42	7.35	7.66
Equity, Diversity and Inclusion				
Fostering equity and inclusion in a group	8.69	8.81	8.83	8.88
Fostering inclusion and accessibility in STEM	8.42	8.65	8.60	8.78
Fostering anti-racist mindsets and behaviours in STEM	8.65	8.66	8.66	8.88

5.1.2 Pre and Post Participant Survey: Workforce Readiness

A central goal of work-integrated learning is to provide practical learning opportunities that will help equip participants with the professional skills and confidence needed to succeed in the workforce. The WIL program demonstrates significant impact in this regard. For example, 85% of WIL participants said they feel better prepared for the workforce as a result of their WIL experience. This includes 47% who "agree" and 38% who "strongly agree." Among "high-intensity" WIL participants, 88% report feeling better prepared for the workforce as a result of the program – including 36% who agree and 52% who strongly agree. In both cases, it is clear that the WIL program has had a substantial impact on participants' confidence in the readiness for work.

Other, more specific indicators reveal the factors that might be contributing to the high sense of work readiness among participants. For example, at the end of the program, 73% of participants said they are confident in their ability to articulate the skills and knowledge they have to employers (versus 66% at the start of the program). "High-intensity" WIL participants report a similarly high level of post-program confidence (73%) but start from a lower pre-program baseline (63%) thereby indicating a larger incremental impact from more intensive participation, albeit a similar final result.

5.1.3 Pre and Post Participant Survey: Professional Networking Skills

At the end of the program, 62% of all WIL participants said they are confident in their ability to network and build relationships with people and organizations in the work world (versus 50 percent at the start of the program). "High-intensity" WIL participants report a higher level of

post-program confidence in networking skills (67%) but also start from a higher pre-program baseline (60 percent) thereby indicating a smaller incremental impact, albeit higher final outcome.

WIL participants also reveal positive changes in certain knowledge and behaviours that contribute to career success. For example, the proportion of "high-intensity" WIL participants who agree or strongly agree that they know what skills they "need to develop to reach my career goals" increased from 82% to 89% over the course of the program. Other WIL participants reported little change, but a still high level of confidence (82% pre-program to 84% post-program). Further, the proportion of "high-intensity" WIL participants who agree or strongly agree that they have the skills to be successful in the workforce increased slightly from 85% to 89% over the course of the program. For other WIL participants, there was almost no change (87% pre-program to 88% post-program), although the post-program result was similar.

5.1.4 Pre and Post Participant Survey: Equity, Diversity and Inclusion in STEM

A key component of the WIL program is both the inclusion of a diverse cohort of participants in the program, and program content that address equity, diversity and inclusion issues. Using self-reported demographic data, the survey reveals a diverse participant cohort. 71 percent of participants identified as woman/female; 17 percent identified as a member of the LGBTQ2S+ community, while another 6 percent said they are "questioning" or "not sure"; 17 percent described themselves as a person with a disability; 5 percent identified as Indigenous; and 31 percent identified as a racialized minority, including South Asian (10 percent), Chinese (7 percent), Arab (3 percent), Black (3 percent), and Southeast Asian (3 percent).

The WIL program also had an important impact on participants' confidence in their ability to participate in, advocate for, and foster a more diverse STEM ecosystem. 89% of participants said that the program prepared them to be better advocates for diversity in STEM. This was slightly higher among those who completed an WIL training module on inclusion and accessibility (91%) or anti-racism in STEM (91%) than among those who did not (87%). 94% said they are confident in their ability to foster inclusion and accessibility in STEM. This was slightly higher among those who completed the inclusion and accessibility module (95%) than among those who did not (92%). 92% said they are confident in their ability to foster anti-racist mindsets and behaviours in STEM. This was slightly higher among those who completed the anti-racism in STEM module (95%) than those who did not (92%). Those who completed the anti-racism in STEM module were also more likely to select 9 or 10 on the 10-point confidence scale (63 percent) than those who did not complete the module (52 percent).

5.1.5 Pre and Post Participant Survey: Future Intentions

In most cases, WIL participants already know their education and career intentions before they participate in the program. In that case, the impact of the program on those intentions is usually a

matter of reinforcing, rather than redirecting, the paths that students are already on. Results from the comprehensive survey appear to confirm this. 89% of WIL participants agreed or strongly agreed that, after the WIL program, they plan to work in their field of study – a small increase from the 85% who agreed or strongly agreed prior to the program. The proportion who "strongly agreed" rose from 49 to 56%. Among "high-intensity" WIL participants, 88% agreed or strongly agreed – which marked an increase of five percentage points from the 83% who agreed or strongly agreed prior to the program. 86% of WIL participants agreed or strongly agreed that after participating in the WIL program, they are optimistic about attaining the career or job path they want in the future. While this is equal to the share who were optimistic prior to the program (86%), it is an encouragingly high post-program result nonetheless. Finally, among "high-intensity" WIL participants, the proportion who are optimistic about attaining the career or job path they want in the future rose substantially from 82% at the beginning of the program to 92% by the end – a larger gain and higher end-result than other WIL participants.

In short, the WIL program appears to reinforce education and career plans and optimism, especially among those who participated in more training modules and activities.

5.1.6 Post Participant Survey: Overall Preparation for Future Career Goals and Plans

In the post-program survey, participants were asked "how has your work experience with this program prepared you for your future career goals and plans?" This provided some further understanding of how participants viewed the WIL program in the context of their broader career plans. A total of 159 participants responded to this question. A very small minority (7 survey respondents) noted that the WIL program didn't have an impact on their career preparation. A larger minority (n=35) described the relevance to their future goals as a teacher or child psychologist/healthcare worker in terms of working with kids ("I plan to work with kids in the future and this program has given me experience and good tactics for dealing with kids"), activity prep (" It allowed me to learn how to prep for activities learn how to deliver material and learn how to use new tech"), institutional knowledge ("(I) better understand how to use classroom knowledge and skills in my daily practice. It also enhanced and improved my understanding of Ontario curriculum expectation to youth learners.") and the teaching of STEM topics specifically ("I have improved my ability to explain technical concepts in a simple manner and understand how to tailor my actions as a teacher to the specific class I'm teaching").

However, the majority of participants (n=115) connected their experience with competencies that are applicable to a broader set of careers. Many of the participants cited multiple examples of skills developed. A summary of commonly cited skills is as follows:

- Networking: "It has made me realize about the importance of networking and soft skills apart from giving me technical skills"
- Teamwork: "I feel prepared to work in a team where I both need to manage up to my superiors and manage down to the people I am in charge of organizing"

- Creative thinking: “It has improved my communication and creative thinking which will play a vital role in my future as my future career involves research”
- Communication: “This program has allowed me to learn how to communicate effectively with co-workers as well as become confident with my projecting my voice”
- Leadership: “This work experience has allowed me to develop leadership skills which will be helpful in my future career”
- Equity in STEM: “This opportunity has provided me with a more thorough understanding of what equity in STEM truly looks like”
- Use of technology: “I have learned valuable technological skills that will assist me in the growing tech world for healthcare”
- General knowledge of the working world: “This experience gave me a good insight into the working world. It also provided me with a great community and wonderful opportunities to talk to those further into their careers and gain insight into the work force as well as tips and advice.”
- Self-advocacy: “I learned a lot about advocating for myself and how to articulate my technical and soft skills better to potential employers”
- Self-awareness: “It has made me familiar with my strengths and weaknesses. It has made me realize my potential and given me a real world work experience in the field related to my academics which is something I want to do after graduating”

All told, the participants were able to connect the WIL experience to a variety of career-focused skills and competencies, demonstrating a sense of self-efficacy drawing from their own skill development, and articulating a connection to career goals.

5.2 Evaluation of Training Modules

While insights on the impact of the training modules on participants’ skills, knowledge, and career readiness were generated from participants’ comprehensive survey responses, further feedback was elicited from post-instruction training module surveys. We received 672 surveys across all modules. The number of responses varied by training module - from a low of 7 to a high of 105 - providing rich insights for many, but not all, modules. Participants were asked to rate their experience on each training module they participated in, on a scale of 1 to 5, on the basis of (1) overall satisfaction; (2) increase in knowledge relevant to the training module; (3) preparation to lead STEM outreach activities and (4) Preparedness for the workforce. Overall, WIL participants tended to be highly satisfied with the training modules and indicated positive impacts on their knowledge, readiness to lead STEM activities, and readiness for the workforce. Although there is room to improve the training modules, on balance they appear to have had substantial positive impacts on participants’ job and career readiness.

A summary of responses is found in Table 3. Scores highlighted in green are the top average responses in each question category, while responses shaded in amber are the bottom average responses in each question category. The overall satisfaction question asked "Overall, how satisfied were you with this training activity?" and provided a scale from 1 (not at all satisfied) to 5 (extremely satisfied). The other questions used a scale that ranged from 1 (not at all) to 5 (very much) and asked "How much did this training activity *increase your knowledge* in the topic(s) addressed?", "How much did this training *prepare you for leading STEM activities*?", and "How much did this training activity *prepare you for searching for, acquiring, and succeeding in jobs and careers generally*?"

Table 3: Summary Analysis of Training Module Survey Responses

Module	Number of Respondents	Overall Satisfaction (Average)	Increase in Knowledge (Average)	Prepared to Lead STEM Activities (Average)	Prepared for Workforce (Average)
All Training Modules	***672***	***4.1***	***3.7***	***3.6***	***3.5***
Organizational Introduction	75	4.1	3.9	3.5	3.2
Anti-Racism in STEM	83	4.3	3.9	3.9	3.7
Classroom Management	105	4.0	3.6	3.5	3.4
Communicating With Parents	39	4.2	3.7	3.5	3.5
Conflict Resolution	67	4.0	3.5	3.4	3.6
Future Skills	18	3.8	3.2	3.1	3.4
Gender Equity	65	4.3	3.7	3.9	3.7
Inclusion and Accessibility	61	4.0	3.6	3.8	3.4
Indigenous Worldviews	76	4.1	3.7	3.5	3.4
Managing Stress/ Mental Health	71	4.2	3.4	3.5	3.7

5.2.1 Training Modules: Overall Satisfaction and Knowledge Improvement

On a scale ranging from 1 (not at all satisfied) to 5 (extremely satisfied), the average satisfaction score was 4.1 – indicating "very satisfied." The modules with the highest satisfaction scores included Anti-Racism in STEM (4.3), Gender Equity (4.3) and Managing Stress/Mental Health (4.2), and Modules with the lowest (but still generally high) satisfaction scores included Classroom Management (4.0), Conflict Resolution (4.0) and Future Skills (3.8).

On average, across all training modules, participants reported improvements in their knowledge of the topics addressed in training activities. On a scale ranging from 1 (not at all) to 5 (very much), the average increase in knowledge score was 3.7 – indicating "somewhat" to "a lot" of improvement. The modules with the highest scores for increased knowledge included the Organizational Introduction (3.9) Anti-Racism in STEM (3.9), and Gender Equity (3.7). Modules with the lowest (but still generally high) knowledge scores included Conflict Resolution (3.5), Managing Stress/Mental Health (3.4), and Future Skills (3.2).

5.2.2 Training Modules: Readiness to lead STEM activities

On average, across all training modules, participants reported increased readiness to lead STEM activities. On a scale ranging from 1 (not at all) to 5 (very much), the average readiness score was 3.6 – which indicates that training left participants "somewhat" to "a lot" more prepared. The modules with the highest scores included Anti-Racism in STEM (3.9), Gender Equity (3.9) and Inclusion and Accessibility (3.8). Modules with the lowest (but still generally high) scores included Conflict Resolution (3.4) and Future Skills (3.1).

5.2.3 Training Modules: Readiness for the workforce

Finally, on average, across all training modules, participants reported increased preparedness to search for, acquire, and succeed in jobs and careers as a result of training activities. On a scale ranging from 1 (not at all) to 5 (very much), the average score was 3.5 – which indicates that training better prepared participants "somewhat" to "a lot."The modules with the highest scores included Anti-Racism in STEM (3.7), Gender Equity (3.7) and Managing Stress/Mental Health (3.7). Modules with the lowest scores included Classroom Management (3.4), Indigenous Worldviews (3.4) and (redacted) 101 (3.2).

5.2.4 Training Modules: Qualitative Feedback

Qualitative feedback from participants across all training modules indicated a generally high level of satisfaction and appreciation for the training, and an especially strong appreciation for the practical elements embedded in training. Participants were most impressed when training material allowed them to work through real or hypothetical scenarios – whatever the topic – and when it provided them with knowledge and skills that they could apply directly in education and careers. In open-ended responses, there was a clear trend of participants indicating strong preferences for even more practical strategies, tools, and techniques to apply in classrooms and careers, as well as more scenarios and examples as part of the learning.

5.3 Industry-led Activities and Micro-experiences

The WIL program offered participants opportunities to attend boot camps, hackathons, and other activities each designed to contribute to the development of one or more skills, knowledge areas, or professional networks. In considering these different activities, there were 428 unique participations. Evaluation of impact was based on short post-activity surveys (n=75). The number of responses varied by activity - from a low of 1 to a high of 37. While the number of responses is too low to generate insights for individual activities, the total sample provides good insights about the activities and experiences overall.

The activities were short in duration, so expectations about any substantial impact on skills and knowledge were kept to a minimum. With respect to more technical skills and knowledge, this expectation was well-founded. By contrast, the reported impact on professional skills was high – including, networking, articulating skills to employers, and gaining experience that would help in the workplace. Many participants agreed or strongly agreed that certain professional skills improved as a result of participating in one of the career and skills development activities. More specifically, 77% agreed or strongly agreed that the experience contributed to their professional network (e.g., of employers, mentors, peers, students). 72% agreed or strongly agreed that they gained experience that will help them in the workplace after they graduate. 69% agreed or strongly agreed that, as a result of the experience, they are better prepared to articulate skills and knowledge to prospective employers.

In terms of specific skill development (see Table 4 for full summary of results), nearly half of participants in career and skills development activities agreed or strongly agreed that the experience improved their critical thinking skills (45%), problem-solving skills (44%), and oral communication skills (43%). Fewer participants (but still a significant number) agreed or strongly agreed that the activity improved their written communication (39%), teamwork (33%), and time management (27%) skills. That many participants felt they improved one or more skills over the course of a short activity speaks to the value of activities intentionally focused on bridging education and skills for the workforce. When asked what improvements they would suggest for future iterations, a number of participants said they would like to see more practical applications or concrete examples of the skills and strategies shared during the activities. As with other WIL activities, participants' desire for concrete tools and techniques they can apply in their education and careers was clear.

Table 4: Impact of Career and Skills Development Activities on Skill Acquisition

Skill	**Impact of Experience** (% "agree" or "strongly agree") n=75
Professional Skills	
The experience contributed to my professional network	77
I gained experience that will help me in the workplace after I graduate	72
I am better prepared to articulate skills and knowledge to prospective employers	69
I feel better prepared to find a job in my chosen field after I graduate	48
Critical Thinking and Problem-Solving	
My critical thinking skills improved	45
My problem-solving skills improved	44
Communication	
My written communication skills improved	39
My oral communication skills improved	43
Time Management	
My time management skills improved	27
Teamwork	
My teamwork skills improved	33

5.4 Micro-Internships

As a pilot activity, the micro-internships were offered to a small number (17) of WIL participants, giving them an opportunity for experience with an industry partner. Feedback received was generated by a survey and interview completed by 9 individuals, and focused on future work and networking with employers. Feedback from participants across all experiences was overwhelmingly positive. In follow-up interviews, most micro-internship participants

indicated that they had opportunities to develop or reinforce some professional skills, with some participants suggesting they also gained some new technical skills. Key benefits were grouped into three main themes: (1) Professional skill development; (2) Technical skills and (3) Professional Network Development.

Examining professional skills of the participants interviewed indicated that the internship contributed to their professional skills development and/or provided them with real-world illustrations of the importance of certain skills. Participants mentioned that they had opportunities to improve communications and presentation skills, teamwork skills, critical thinking and project management. Arguably more important for many was seeing how these skills were used by people at their internship companies and talking about their use and importance with their mentors. Some participants also had opportunities to talk with their mentors about work life more generally – including deadlines, mental health issues, and managing conflict – and learn about strategies for managing these experiences. Finally, many participants indicated that they were given advice and guidance on the job search process – including resume-writing, interview skills, and communications during recruitment.

In looking at technical skills, some micro-internship participants also had opportunities to develop new technical skills. A number of participants said that they were included in projects that involved learning new software, data analysis, programming/coding, and database management. Both these and other participants also noted that the micro-internship gave them opportunities to see how certain technical skills were used in the context of industry projects and during teamwork and team meetings. As with professional skills, even if opportunities to develop skills were few, many participants were impressed with how the experience showed them the relevance and practical application of certain skills and knowledge.

Finally, nearly all of the WIL micro-internship participants interviewed said that the experience helped to expand their professional network and give them more confidence and optimism about their future job prospects. Participants were almost always invited to stay in touch with their mentors; many were introduced to and provided contact information for other employees at their partner companies; and, in a few cases, were offered assistance with their career plans, including making additional contacts outside of the partner organization.

While nearly all participants were very satisfied with their experience, participants made some useful suggestions about directions forward. Some participants thought that the process of matching them with companies could have been more rigorous or more tailored to their specific career interests and aspirations. That said, even those who felt that had a less-than-ideal match noted that the experience was valuable. Participants were about equally divided on the pros and cons of the virtual nature of the micro-internships. Roughly half were happy that the virtual format allowed for more flexibility in timing, no commuting and a wider geographic range from which companies could be selected. The other half thought that while the experience was good, an in-person format might have contributed to better connections and a more applied experience

overall. Finally, a few participants suggested that the internships have a longer duration to allow for better relationship development and to open the possibility for more hands-on, project-oriented experiences that align with company activities and timelines.

Formal feedback from employers involved in the micro-internships was limited but positive. Four partner organizations completed a post-internship survey with closed and open-ended questions. All were satisfied or very satisfied with the experience, and indicated that they thought it was valuable both for them and the interns. Specifically, the employers said that they benefited by having access to the creativity, knowledge and skills of post-secondary students; an opportunity to promote their business to students; and opportunity to build stronger connections with education institutions; and appreciation for the chance to provide a social good. Like many of the interns, a few employers indicated that they would like to see a more rigorous matching process at the outset and some consideration to changing the duration of the internship and frequency of meetings to allow for better connections and project planning.

5.5 Micro-Credential Offering

In total, 64 individuals received Actua's Professional Communications Micro-credential. Participation included individuals from 5 different network members as well as Actua's outreach team. Feedback from the micro-credential participants about the training was limited, but generally positive. 14 of 14 participants who completed surveys rated the training experience "good" or "very good," while 9 of 11 who participated in the professional communications micro-credential course and completed a survey said they felt more or much more prepared in professional communications. When asked about the value of the micro-credentials they received, however, feedback was more mixed. 5 of 14 said the micro-credential had "high value" for them personally, while 6 said it had "moderate value" and 3 said it had "low" or "no" personal value. More specifically, 4 of 14 said they expect employers will see "high value" in the micro-credential, while 7 said they expect employers to see "moderate value" and 3 said they expect employers to see "low" or "no" value. 13 of 14 nevertheless indicated that they will use the micro-credential in one or more ways (e.g., adding it to their resume, LinkedIn profile, teaching dossier and/or mentioning it to employers). Follow-up data collected by Badgr, the organization that issued the digital badges, demonstrates that nearly half of micro-credential recipients have shared their badge on one or more social media platforms, with LinkedIn being the most prominent. Overall, it appears there may be room for improvement in the micro-credential experience - mainly to ensure that it is designed to have greater value in the eyes of employers, and therefore more value in participants' career paths. As a pilot, the micro-credential initiative shows clear promise, but could use some further reflection.

6. Discussion and Future Work

The goal of this WIL program was to pair meaningful work experience with work-integrated learning experiences that not only prepared participants for their work in STEM outreach activities, but also provided them with scaffolding to help make connections to their future career goals, and better articulate skill development. The program provides a novel approach for work-integrated learning, in that it places more emphasis on the employment experience than is often the case in WIL programs - that is, it focuses as much on *providing learning that enhances the work experience* as it does on providing work experiences that enhance the learning experience; and working from the perspective of the employer rather than an educational institution (although the employer, in this case, is highly connected to the educational institution, which offers some strong institutional synergies). Furthermore, participants wear three hats: as student, through participation in training modules and micro-credentials; as instructor, doing the outreach work (and applying what they've learned, learning skills for the future) and as a "future employee," through participation in a career focused activity. Through this, participation in the WIL program provides an opportunity to transverse these overlapping identities, shifting between learner, instructor and future employee while exploring the relevance of future skills. Finally, STEM outreach work offers unique opportunities to connect human-focused future skills (such as "working with others" in the future skills framework) with the application of STEM knowledge, and connect meaningful purpose to their STEM expertise.

An example of the unique nature of the Actua experience that affords strong integration between learner, instructor and future employee is reflected in the EDI focus of the work. As noted, participants demonstrated strong gains in their confidence to participate, advocate for and foster a more diverse STEM ecosystem. While this was integrated into the learning experiences assessed in this paper, the instructors are also embedded in the environment where these skills are put to use immediately. This is reinforced by the relevance of mission-driven work, as indicated through institutional structures and responsibilities. Drawing from SCCT, these gains in advocating for diversity may also improve outcome expectations in the participants, which in turn contributes positively to professional identity development.

Participants in the WIL programming demonstrated gains in several of the future skills articulated in the Actua Future Skills Framework, and in perceptions of career-readiness. As noted, the programming reflects the key pillars of identity development - opportunities for application of expertise (intellectual), importance of institutional factors and structures, and the importance of building relationships and collaborations through networking [16]. Participants take advantage of a highly collaborative work and learning environment and opportunities to engage with work and education-related institutions as they consider their own career trajectory. As noted, the strength of these identity-forming strands correlates positively to self efficacy [20] which in turn supports motivation towards academics and career planning [13]. Furthermore, the training programs serve as examples of institutional supports, which further support professional identity and career development according to both Identity Trajectory Theory and SCCT.

Most of the participants reported that they felt more prepared for the workforce as a result of their experience with the Actua WIL program. However, it is noteworthy that the high-intensity WIL participants had a substantial increase in optimism about attaining the career or job path they want, suggesting the impact of a more comprehensive participation in the WIL training opportunities on self-efficacy and outcome expectations. Encouraging participants toward more fulsome participation is recommended based on these results. Examining a more specific area of career-readiness, networking, we see some opportunity for improvement; while the participant surveys demonstrated improvement in networking, only 62% (or 67% for high-intensity participants) of participants reported feeling confident in their ability to network and build relationships in the work world. Given the importance of networking in professional identity development and career readiness, this should be an area of priority for further training and development.

Building on the work of Liu et al [21], we also believe there is an opportunity to further explore potential connections between universities and colleges, and work of STEM outreach instruction, and Actua. Although our WIL programming takes advantage of institutional structures and resources, given the embeddedness of our STEM programming in colleges and universities, there may be further opportunities to connect with institutional work integrated learning programs and determine opportunities to share resources or otherwise maximize impact.

Given the success of the WIL program, Actua plans to continue to grow this program over the coming years and beyond. We are working on leveraging its strengths to deepen the impact among postsecondary students and increase the opportunities offered to high school student interns. As noted in the previous section, some program components, particularly the micro-credentials, will be reviewed to consider possible improvements. While we believe these “micro” experiences offer a flexible and “stackable” mechanism of work integrated learning, in which participants have the opportunity to connect with different possible employers and build a broader network, there is a balance to be struck between flexibility and impact of an individual experience.

Finally, additional program components under consideration include a more robust instructor and program awards program, to elevate the profile of the WIL program and the incredible work of program instructor and staff. Finally, engaging alumni instructors, who number in the thousands and are working in a variety of career spaces, would elevate opportunities for networking.

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References

[1] T. Ross and L. Romkey, “Post-secondary Work Integrated Learning Through STEM Outreach”, *ASEE Annual Conference Proceedings, 2021.*

[2] Murdoch University. “What is WIL: Work Integrated Learning” Accessed on: February 1 2023 [Online]. Available murdoch.edu.au.

[3] Engineers Canada.“Canadian Engineering Accreditation Board 2019 Accreditation Criteria and Procedures.” Engineers Canada, Ottawa, Ont., Canada, Dec. 2019. Accessed on: February 3 2023. [Online] Available https://engineerscanada.ca/sites/default/files/accreditation/Accreditation-Criteria-Procedures-2019.pdf

[4] University of Toronto Career & Co-Curricular Learning Network, ‘U of T Co-Curricular Record’, 2019. Accessed on February 3 2023 [Online]. Available: https://clnx.utoronto.ca/ccr/overview.htm

[5] Prairie Research Associates and Canadian University Survey Consortium. “2013 First-year University Student Survey Master Report.” 2013. Accessed on: February 3 2023 [Online]. Available : https://cusc-ccreu.ca/?page_id=32&lang=en

[6] National Survey of Student Engagement. “NSSE 2016 Survey Instrument (Canadian English).” Indiana University, Bloomington, Indiana. 2016. Accessed on: February 3 2023 [Online]. Available https://nsse.indiana.edu/nsse/reports-data/nsse-overview-2016.html

[7] Memorial University of Newfoundland and Labrador. “Career Integrated Learning: A grassroots approach to creating awareness of graduating student competencies”. Presentation at Canadian Association of Career Educators and Employers meeting, May 27, 2014. St. John’s, NL. Accessed on: February 3 2023 [Online] Available: https://www.mi.mun.ca/media/marineinstitutewwwmimunca/mi/careerintegratedlearning/files/IAEVGpresentationJune2014.pdf

[8] National Association of Colleges and Employers. “Job Outlook 2020.” National Association of Colleges and Employers. Bethlehem , PA. Accessed on February 3 2023 [online]. Available: https://in.nau.edu/wp-content/uploads/sites/204/2020-nace-job-outlook.pdf

[9] N. Dawe, L. Romkey, and A. Bilton, “Survey Results: How Does Lifelong Learning Enable Alumni Careers?”, *PCEEA*, Nov. 2022.

[10] C. Rottmann, D. Reeve, S. Kovalchuk, M. Klassen, M. Maljkovic and E.L. Moore, “Counting Past Two: Engineers’ Leadership Learning Trajectories”, *PCEEA*, Jun. 2019.

[11] J.N. Magarian and W.P. Seering, “Characterizing Engineering Work in a Changing World: Synthesis of a Typology for Engineering Students' Occupational Outcomes”. *Journal of Engineering Education*, vol 110, pp. 458-500, 2021.

[12] N. M. Ramirez, J. B. Main, T. L. Fletcher and M. W. Ohland, "Academic predictors of cooperative education participation," *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, Madrid, Spain, 2014, pp. 1-6.

[13] W.J. Schell & B.E. Hughes, “Developing an engineering leadership identity”, In M. R. Kendall & C. Rottmann (Eds.). *New Directions for Student Leadership: No. 173. Student leadership development in engineering* (pp. 129– 137). Wiley, 2022.

[14] B. Khampirat, C. Pop, & S. Bandaranaike, “The effectiveness of work-integrated learning in developing student work skills: A case study of Thailand”. *International Journal of Work-Integrated Learning*, vol 20, 127-146, 2019.

[15] C. McCall, L.D. McNair, & D.R. Simmons, “Advancing from outsider to insider: A grounded theory of professional identity negotiation in undergraduate engineering”. Journal of Engineering Education, vol 110, 393– 413, 2021.

[16] B. Benedict *et al*., "An Early Adaptation of Identity Trajectory to Understand the Identities of Undergraduate Engineering Students," *2019 IEEE Frontiers in Education Conference (FIE)*, Covington, KY, USA, 2019, pp. 1-5.

[17] J.M. Case & G. Light, “Emerging Research Methodologies in Engineering Education Research”. Journal of Engineering Education, Vol 100: 186-210, 2011.

[18] J.P. Gee, “Identity as an Analytic Lens for Research in Education.” *Review of Research in Education, Vol* 25: 99–125, 2000.

[19] L. McAlpine and C. Amundsen, *Identity-Trajectories of Early Career Researchers Unpacking the Post-PhD Experience*, 1st ed. 2018. London: Palgrave Macmillan UK, 2018.

[20] A. Castillo, B. McIntyre, & A. Godwin, “Understanding the Influence of Work-Integrated Learning Experiences on Students’ Identity Formation in Engineering”, *ASEE Annual Conference Proceedings*, 2022.

[21] Q. Liu, S. Kovalchuk, C. Rottmann, and D. Reeve, “Engineering Co-op and Internship Experiences: The Roles of Workplaces, Academic Institutions and Students”, *PCEEA*, Dec. 2018.

[22] R. W. Lent, S. D. Brown, and G. Hackett, “Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice, and Performance,” *Journal of vocational behavior*, vol. 45, no. 1, pp. 79–122, 1994.

[23] R. W. Lent, D. Singley, H.-B. Sheu, J. A. Schmidt, and L. C. Schmidt, “Relation of social-cognitive factors to academic satisfaction in engineering students,” Journal of Career Assessment, vol. 15, no. 1, pp. 87–97, 2007.

[24] S. D. Burleson, D. A. Major, X. Hu, and K. J. Shryock, “Linking undergraduate professional identity development in engineering to major embeddedness and persistence,” *Journal of vocational behavior*, vol. 128, p. 103590–, 2021.

[25] J.-V. Peña-Calvo, M. Inda-Caro, C. Rodríguez-Menéndez, and C.-M. Fernández-García, “Perceived Supports and Barriers for Career Development for Second-Year STEM Students,” *Journal of engineering education (Washington, D.C.)*, vol. 105, no. 2, pp. 341–365, 2016.

[26] W.-C. J. Mau, S.-J. Chen, and C.-C. Lin, “Social cognitive factors of science, technology, engineering, and mathematics career interests,” *International journal for educational and vocational guidance*, vol. 21, no. 1, pp. 47–60, 2021.

[27] B. Khampirat, “The Impact of Work-Integrated Learning and Learning Strategies on Engineering Students’ Learning Outcomes in Thailand: A Multiple Mediation Model of Learning Experiences and Psychological Factors,” *IEEE access*, vol. 9, pp. 111390–111406, 2021.