Re-Engineering Australia Foundation

EMPOWERING FUTURE INNOVATORS. ADVANCING DIVERSITY AND ENGAGEMENT IN STEM

COMPREHENSIVE RESEARCH REPORT | MARCH 2024

TRANSFORMING STEM EDUCATION: A LONGITUDINAL ANALYSIS OF PROGRAM IMPACTS ON STUDENT ENGAGEMENT, DIVERSITY ENHANCEMENT, EDUCATIONAL ACHIEVEMENT, AND CAREER ASPIRATIONS

Authorised Agent

Dr Michael Myers OAM
BE, MBA, DBA, HonFIEAust, CPEng, EngExec, APEC Engineer, IntPE(Aus), FAICD
Executive Chairman
Re-Engineering Australia Foundation Ltd.
PO Box 136
Castle Hill NSW 1765
P: 61 2 9620 9944
E: contact@rea.org.au
W: www.rea.org.au

Copyright Notice

Reproduction

Date

February 2024

Cover Image: Team Argo-22: Wilderness School, South Australia – 2023 Development Class ROV National Champions

Executive Summary

Creating a workforce equipped for future challenges—marked by innovation, resilience, and global competitiveness—necessitates a paradigm shift in how we approach education, particularly in the fields of Science, Technology, Engineering, and Mathematics (STEM). Re-Engineering Australia Foundation Ltd (REA) has been implementing several STEM career intervention programs since 1998, including the F1 in Schools and SUBS in Schools programs, designed specifically as initiatives to bring about this shift in the approach we should take to education. These programs stand as beacons of STEM education excellence, recognised by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) for their innovative blend of theoretical learning with practical application. They enhance student engagement in STEM and play a crucial role in steering young minds towards potential career paths within these fields.

This report examined the capacity of these programs between 2019 & 2024 to impact students' engagement in STEM, diversity of engagement, educational achievement and change in career aspirations.

The Catalyst for Change: This research underscores a growing discrepancy between conventional academic metrics and the broader skill sets required in today's workforce. It advocates for re-evaluating our understanding of intelligence, emphasising the critical importance of soft skills such as creativity, adaptability, teamwork, and academic prowess.

Gender Engagement in STEM: The study dispels the myth of inherent gender biases towards STEM among students. It suggests that while interest in STEM does not differ significantly between boys and girls, the methods to initiate and maintain this interest vary. Acknowledging and addressing these differences is crucial for maximising the potential for gender diversity in STEM engagement.

Sustaining Australia's Leadership in STEM: Australia's success on the world stage, highlighted by REA's capacity to produce eight sets of world champions through its programs, underscores our country's potential to lead the world in STEM education. However, this position is at risk without continued funding from industry and government for programs that deliver long-term skills development in line with the industry's requirements.

Career Stereotypes: The research findings reveal a compelling narrative: 74% of parents hold a positive view of their children pursuing careers in the Defence industries, a sector that traditionally fought negative perceptual biases as it sought to attract new entrants. This statistic challenges prevailing stereotypes and underscores a shift in societal perceptions towards industry-based STEM careers and the perception of their positive role in society. In addition, over 50% of the participating students expressed an interest in pursuing careers in manufacturing, which is a very positive indicator for the industry.

Forward-Thinking Education System: This study confirms that the fundamental factors influencing children's career choices have remained unchanged since the initial research began in 2006. However, it identifies a critical need for enhanced collaboration among industry, educators, and policymakers to optimise students' engagement with STEM. Such collaboration is essential to nurture and support the career aspirations of the next generation, ensuring they are well equipped to contribute to a future defined by innovation and global competitiveness.

Nurturing Essential Traits: The research highlights the importance of the education system focusing on developing specific characteristics, such as conscientiousness, discipline, and leadership, within educational curricula. These traits, exemplified by students who excel in REA's programs, are identified as more predictive of career success than traditional measures of intelligence, such as IQ. While IQ can account for approximately 30% of the potential for career success, trait-conscientiousness—encompassing reliability, organisation, self-discipline, and responsibility (soft skills)— can play a more significant role in career success than IQ and can be enhanced and improved within the educational journey students undertake. STEM programs must evolve to foster these skills, as they are allowing students' innate intelligence to flourish, opening opportunities for success for all.

Rethinking Assessment Metrics: A pivotal recommendation calls for a departure from the Australian Tertiary Admission Rank (ATAR) as the primary metric for student performance. Instead, it advocates for recognising the innate skills and

capabilities that industries seek in new entrants. This shift necessitates adjusting the National Curriculum to acknowledge and value the engagement and outcomes produced by students participating in high-level longitudinal STEM programs.

Future Directions: The research outlines areas for further investigation, including a deeper exploration of parents' perspectives on their children's career aspirations and the role of social media as an influencer. This future research will build on the current findings, offering more nuanced insights into the complex interplay of factors that shape young people's career decisions in the STEM fields.

In summary, this study not only sheds light on the impact high-level STEM programs such as REA's initiatives can have in shaping students' engagement with STEM but also offers critical recommendations for reimagining the future of STEM education. By fostering essential skills, challenging outdated stereotypes, and promoting a more inclusive and equitable approach to STEM education, we can ensure that the workforce of tomorrow is diverse, motivated, and fully equipped to navigate the complexities of a globalised world.

Team INFINITUDE: A collaboration of students from Brighton Secondary School, S.A. and St Bedes College, Vic.
2nd F1 in schools World Final 2018 – Fastest Car & New World Record – Best Engineered Car

CONTENTS

About Re-Engineering Australia Foundation Ltd

Since its establishment in 1998, the Re-Engineering Australia Foundation Ltd (REA) an NFP-Charity, has revolutionised STEM education in Australia, bridging the gap between academic learning and the dynamic needs of the industry. Through pioneering initiatives like F1 in Schools and SUBS in Schools, REA has impacted over two million students, fostering experiential learning, and nurturing a passion for STEM careers. This innovative approach has propelled REA alums into global careers with industry leaders such as Airbus and Lockheed Martin, highlighting the international relevance of REA's programs.

REA's educational philosophy emphasises real-world applicability, transforming traditional educators into mentors who guide students in developing critical skills like problem-solving, creativity, and effective communication. This focus on essential, future-ready skills has led to significant academic achievements among participants, with many developing a strong interest in STEM fields. A substantial 84% of students report improvements in academic performance across various subjects due to their engagement with the programs, and an overwhelming 99% of teachers report gaining valuable knowledge and inspiration from their involvement in the programs, highlighting the reciprocal benefits of teacher learning and student inspiration.

Under REA's guidance, collaboration between educational institutions and industry offers students valuable insights into professional environments, aligning academic pursuits with potential career paths. These partnerships demystify career opportunities in the modern job market, ensuring students are ready to contribute meaningfully to the workforce of tomorrow.

Despite challenges such as the COVID-19 pandemic, REA's programs have demonstrated remarkable resilience, continuing to grow and adapt. The effectiveness of REA's approach is evident, with 81% of participants reporting an increased interest in STEM careers and over 50% showing an interest in manufacturing careers. Beyond fostering STEM engagement, REA aims to enhance employability, establish sustainable industry-education partnerships, and promote innovation across diverse communities.

Internationally, REA's success in achieving eight world championships has garnered recognition, inviting contributions to global STEM education in 26 countries. This international engagement underscores REA's role in developing an innovative, skilled, and diverse workforce.

The enduring success of REA's initiatives highlights the need for ongoing support from industry and government. The investment will expand these programs and signify a commitment to nurturing the next generation's talents and aspirations. By enhancing employability skills, making STEM appealing, and fostering collaborative innovation, REA sets a precedent for aligning education with industry needs.

Looking ahead, REA plans to introduce new programs and extend its reach to indigenous communities across Australia, reinforcing its commitment to inclusive and forward-thinking STEM education. This strategic expansion aims to ensure equitable access to quality STEM education, preparing all Australian students for the challenges and opportunities of a globalised economy.

In essence, the Re-Engineering Australia Foundation Ltd stands as a cornerstone in the evolution of STEM education, preparing a future workforce that is adaptable, innovative, and ready to meet global challenges. Through its commitment to real-world applicability and strategic industry-education partnerships, REA continues to set an international standard for STEM education excellence, inspiring future generations to pursue their passions in science, technology, engineering, and mathematics.

REA Programs

F1 in Schools AUSTRALIA

F1 in Schools™ is an engaging and multifaceted program that immerses students in the exciting world of STEM through the design and creation of miniature Formula 1® race cars. This dynamic and interdisciplinary program bridges the gap between theoretical learning and practical application, encouraging students to collaborate with industry experts in their project work.

Targeted at young minds aged 11 to 18, the program ignites a passion for Science, Technology, Engineering, and Mathematics. Through the lens of designing miniature F1® cars, students are exposed to a range of critical STEM principles, fostering skills such as problem-solving, teamwork, and creative thinking.

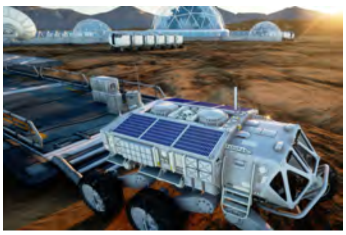
F1 in Schools™ offers a unique educational experience beyond the conventional classroom setting. It provides a platform for students to apply their learning in a challenging and exhilarating context, preparing them for future academic and career pursuits in STEM fields.

SUBS in Schools AUSTRALIA

SUBS in Schools represents a forward-thinking educational initiative strategically developed to prepare students for emerging industries from the Department of Defense's Nuclear Submarine Program. This comprehensive program is tailored to students in years 5 to 12, focusing on equipping them with the critical employability skills and in-depth knowledge necessary to thrive in these innovative sectors.

Aimed at fostering a deep understanding of advanced technologies and engineering principles, SUBS in Schools challenges students to engage directly with the concepts and processes integral to submarine design and construction. This hands-on approach enhances their technical understanding and nurtures essential skills such as critical thinking, teamwork, and problem-solving.

Through this program, students gain invaluable insights into the dynamic world of defence technology and its broader implications. SUBS in Schools is more than just an educational venture; it's a launchpad for the next generation of engineers, thinkers, and leaders who will shape the future of national defence and related industries.



SPACE in Schools AUSTRALIA

SPACE in Schools is an innovative program designed to immerse students in the captivating world of spatial design, leveraging advanced 3D design and virtual reality software tools.

At the core of SPACE in Schools is a unique and exhilarating challenge: students can conceptualize and design a living environment centered around human habitation and sustainability. This task not only sparks imagination and creativity but also requires the practical application of scientific and engineering principles in a context that transcends traditional boundaries.

Targeted at students in years 3 to 12, the program is structured to accommodate a wide range of ages and skill levels. It provides a platform for students to explore and develop skills in cutting-edge design technologies, environmental planning, and sustainable living solutions, all within the extraordinary context of extraterrestrial habitation.

Research Rationale

Introduction: What Shapes a Students' Career Choices?

The literature on the career decision-making processes of children underscores the significant impact of various environmental and sociological factors, differing markedly from those influencing adult motivations. Children's environments and attitudes are dynamic and complex, shaped by multiple influences that defy simple categorisation (Kegan, 1994). The interplay between student motivation and external forces such as culture, social context, and the expectations of parents and teachers is intricate and profound (Atkinson, 2000).

Research spanning decades highlights the critical importance of educational issues and vocational decisions during adolescence, revealing a broad consensus on the factors influencing teenage career expectations (Violato and Holden, 1988; Eme et al., 1979; and others). Farmer's extensive research on adolescent career and achievement motivation offers empirical support for this, identifying background variables (e.g., gender, ethnicity, socioeconomic status) and personal and environmental variables (e.g., ability attributions, intrinsic values, encouragement from significant others) as influential factors (Farmer, 1983; 1985; 1987; 1997).

Scholars such as Lent et al. (1994) emphasise the critical roles of ethnicity and gender in shaping the learning experiences and feedback individuals receive about careers. Herr (1996) broadens this perspective by proposing that individuals navigate their career paths within a complex ecological context comprising physical, social, political, and economic environments. These environments influence self-identity development and perceptions of the occupational world, including beliefs about occupational structures, job access requirements, and likely employment outcomes.

Paa (2000) further refines this understanding by suggesting that career choices stem from a mix of background, environmental, and personal factors, highlighting the significant impact of self-perceived abilities, perceived career barriers, and the influential roles of parents (especially mothers) and peer groups which aligns with the developmental career theories proposed by Super (1996), Ginzberg (1984), Gottfredson (1981), and others, who recognise adolescence as a pivotal period for developing interests, abilities perceptions, and occupational knowledge.

Cohen (2003) introduces an existential perspective to career decision-making, suggesting that individuals search for intrinsic motivation within a seemingly meaningless world, often developing extrinsic motivators as defence mechanisms against life-changing situations, such as career selection. Nauta (2002) supports a reciprocal relationship between career interests and self-efficacy, suggesting that both can influence each other over time.

The literature also acknowledges the profound influence of role models and critical figures in young people's environments on their career development, with theories such as Bandura's Social Learning Theory highlighting the role of successful role models in enhancing self-efficacy expectations for specific tasks or careers (Bandura, 1969; 1977; 1982; 1986).

In summary, the literature reveals a consensus on the complex, multifaceted influences on adolescent career choices, including intrinsic motivation, self-efficacy, the social environment, and inspirational heroes and role models. These factors, crucial to understanding and improving career decision-making processes in children, underscore the necessity of designing effective career interventions tailored to these varied influences.

Research Overview

This study delves deep into the factors influencing young students' career aspirations, focusing on the impact of REA's STEM (Science, Technology, Engineering, and Mathematics) initiatives. The 2024 report aims to explore how these programs can significantly shift students' motivations towards STEM disciplines, charting their progression from initial curiosity to a deep-seated interest and commitment to STEM studies and career paths.

This research critically examines a variety of determinants in career choice processes, including intrinsic motivation, self-efficacy, the effect of peer groups, and the motivational role played by industry leaders and role models. These factors are analysed within the framework of REA's programs to assess their influence on forming career aspirations and behaviours among different genders.

Emerging from a longitudinal study initiated at the University of South Australia in 2006, the scope of this research has broadened to evaluate the profound impact on teachers and educational institutions involved in REA's programs. Specifically, it assesses the program's effectiveness in the following ways:

i. Stimulating a strong interest in STEM careers among students.
ii. Enhancing academic achievements.
iii. Revealing new career pathways.
iv. Developing essential life and employability skills.

This analysis includes data from January 2019 to December 2023, providing a window into the robustness of these programs amidst varying conditions, including the disruption caused by the COVID-19 pandemic between 2020 and 2022.

At the heart of this investigation is the understanding of the complex interplay of factors that guide students' career decisions throughout their education, acknowledging the role played by various external influences. This study seeks to identify specific, measurable aspects that can inform the development of interventions to positively direct children's career choices.

The interaction with REA's programs may intersect with student motivations and perceptions of STEM careers. This research is particularly interested in capturing how student engagement with these initiatives evolves and influences their career motivations and preferences for STEM areas.

A distinctive feature of REA's programs is their emphasis on direct interaction with industry professionals, providing students with tangible role models and exposure to real-world challenges. This unique approach sets REA's initiatives apart from other educational programs and sparks students' intrinsic interest in STEM.

Through a comprehensive evaluation of these factors and the effectiveness of REA's programs, this study intends to illuminate effective strategies for boosting students' motivation and interest in STEM. The findings offer crucial insights for shaping future educational policies and practices.

Research Process

The research methodology emphasises capturing the shifts in students' self-perception regarding their career choices and the learning environment's influence. It focuses on identifying measurable aspects, their practical assessment, and the potential of these evaluations to refine and improve educational frameworks.

Conducted within Australia's culturally diverse backdrop, this study engages a broad array of stakeholders – students, educators, industry professionals, and families – ensuring a comprehensive understanding of motivational drivers from the students' perspective, unswayed by the predefined notions of other involved parties.

The question driving this research is: "How do REA's programs influence participants' motivation towards STEM-based careers?"

The methodology involves surveys targeting teachers and students, collecting quantitative and qualitative data to offer a multidimensional view of the programs' impacts.

Survey Reach

The study focuses on students and teachers actively involved in F1 in Schools and SUBS in Schools between February and December of 2019 2020, 2021, 2022 and 2023. In 2024 the research was expanded to include feedback from parents of those students involved. Over the years covered by this report, approximately 68,600 students engaged in the competition component of these programs, of which 2,223 students and 264 teachers from 250 schools and 114 parents of participants from across Australia provided feedback through questionnaires.

This research sought to gain feedback on a range of issues including:

- Demographics.
- Students' motivation in a range of areas.
- The programs' influence on academic selections and achievements.
- Levels of interaction with industry mentors.
- The impact of the programs within the schools and with the teachers.
- Parental attitudes toward their children's involvement with industry and more specifically defence industry.
- The impacts on STEM interest, student attitudes across disciplines, and the differential effects on boys and girls.

Methodology

By utilising a mix of quantitative and qualitative survey questions, the methodology aims for data triangulation, enhancing the reliability of the findings. This approach allows for a nuanced understanding of the programs' effects, informed by the direct experiences of those involved.

Participants, encompassing a wide age range and enrolled under varying educational settings, shared their experiences, ensuring a rich, diversified data pool. The involvement of teachers as survey coordinators underscored their integral role and commitment to this research endeavour.

This comprehensive methodological approach ensures that the study captures a holistic view of the impacts of REA's programs, paving the way for informed, strategic enhancements in STEM education and career motivation.

The student surveys collected the following data:

- Demographic information
- Students' motivation toward STEM
- Influence of the programs on engagement with STEM activities
- Impact of the programs on subject selection at schools, particularly in mathematics and science
- Level of interaction students had with industry professionals.
- Engagement with industry mentors
- Student interest in specific career directions
- Impact of Interaction with defence and defence industries mentors

The teacher surveys collected the following data:

- Demographic information
- Influence of each program within their school on increasing general interest in STEM
- Impact of each program on changing students' attitudes toward studying across all subject disciplines
- Impact of each program on Students
- Influence of Programs on boys versus girls
- Effect of Interaction with Defence and Defence Industries

The parent survey collected the following data:

- Demographic information.
- Familiarity with Defence Industries.
- Consideration of career options for their children in an Industry which supports Defence.
- Perceptions of career opportunities in Defence Industries.
- Perceptions of the skills they think are important for a career in Defence Industries.
- Concerns about their children child pursuing a career in Defence Industries.

These data provide insights into the influence and impact of the programs on both students, teachers and parents and examine the role of various factors, such as gender and industry interaction, in shaping students' experiences and perceptions.

The data collection methodology employed a questionnaire primarily consisting of quantitative measures, supplemented with several qualitative measures to provide data triangulation. Some qualitative questions serve a similar purpose as key quantitative questions, examining any potential impact of the questioning process on the student's responses.

Teachers, students and parents were given different questionnaires based on their involvement in the program, typically associated with events. The participating students varied in age, and their participation in the program could stem from different teaching circumstances. Some students competed as part of their Math and Science programs, some as part of a Design and Technology curriculum, and others as an extracurricular activity.

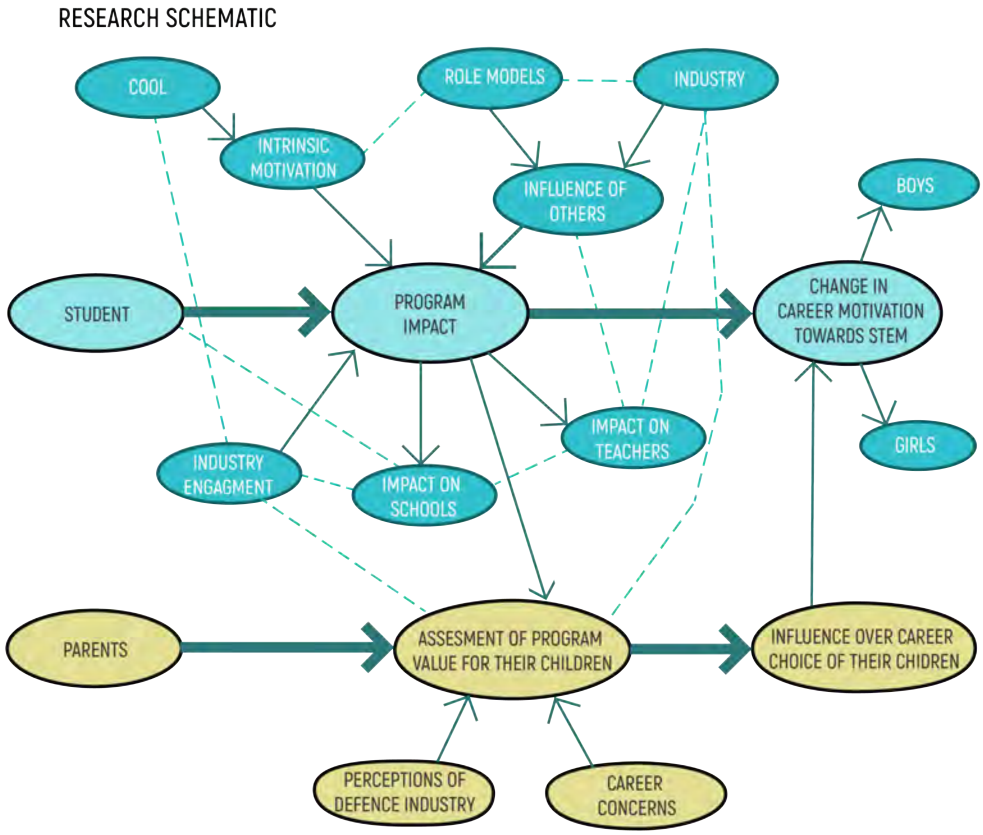
All students who completed the questionnaire participated in the program through to competing in a competition event, ensuring they had experienced all aspects of the program and had engaged in a wide range of interactions with industry professionals.

In most cases, the student teams comprised heterogeneous sets of students within the school, including individuals from separate peer groups and genders. This randomisation of the sample collection helped ensure diversity in the data.

The teachers responsible for managing the programs within their respective schools acted as liaisons and were responsible for distributing and collecting the student surveys. The enthusiasm of these teachers contributed to the high return rate achieved for the questionnaires, indicating their commitment and support for the research process.

Research Schematic

The research schematic appears in the following diagram.



Impact of COVID-19

The COVID-19 pandemic introduced unprecedented challenges to educational systems worldwide, including the disruption of extracurricular activities and the shift to virtual learning environments. This section of the 2024 report delves into the specific impact of the pandemic on REA's STEM programs, notably F1 in Schools and SUBS in Schools, while also reflecting on the broader implications for other initiatives like Space in Schools and 4x4 in Schools.

During the height of the pandemic in 2020 and 2021, the participation of schools in REA's programs faced significant hurdles due to school closures and the ensuing transition to online education. Although the engagement in F1 in Schools and SUBS in Schools remained relatively stable regarding student numbers, the delivery of Space in Schools and 4x4 in Schools was severely affected. These latter programs, which rely heavily on physical interaction, saw a temporary halt in events, reflecting the broader challenges of conducting hands-on educational activities during social distancing and lockdowns.

Starting in early 2023, there was a noticeable rebound in student and school engagement with F1 in Schools and SUBS in Schools. However, national competitions for Space in Schools and 4x4 in Schools were not reinstated in 2023. The resilience of F1 in Schools and SUBS in Schools during the pandemic is noteworthy, with several key observations emerging from the survey data comparing the pre-pandemic and pandemic periods:

- A reduction in extracurricular activities was observed across many schools as they focused on core academic competencies.
- The impossibility of industry site visits curtailed direct experiential learning opportunities.
- Virtual platforms became the primary medium for interaction between students and industry mentors.
- These programs facilitated a shift towards student-led learning, allowing for continued progress with minimal teacher intervention.
- Importantly, students' intrinsic motivation towards STEM and the perceived impact of the programs within schools did not show statistically significant changes, indicating the robustness of these programs in maintaining student engagement and motivation even in the face of substantial educational disruptions.

A novel addition to the 2024 report explores parental attitudes towards career pathways, their attitudes toward a career in defence-related industries, preconceptions about careers in defence industries and the program's influence on their children's skill sets. With responses from 114 parents, this analysis provides additional insights into the broader societal and familial impacts of these educational initiatives.

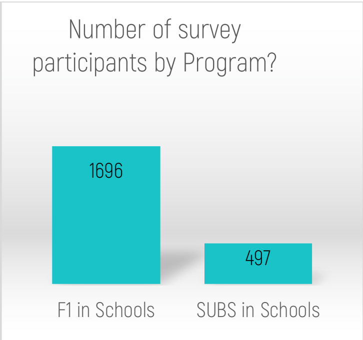
It's crucial to note the ethical considerations in involving children in research activities, including the anonymity of student responses, to ensure privacy and compliance with regulatory requirements. This approach precludes direct linkage of student and parent responses yet offers an indirect view into the socio-economic contexts influencing student participation and outcomes in these programs.

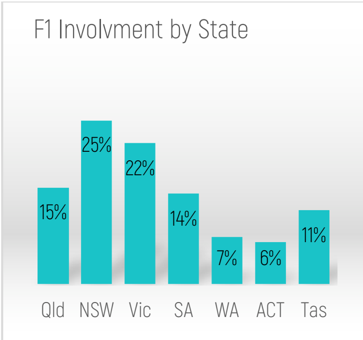
This examination of the pandemic's impact and the emerging trend in parental attitudes enriches our understanding of the resilience of educational programs in the face of adversity. It highlights the importance of flexible, adaptable learning environments that sustain student interest and motivation through uncertain times.

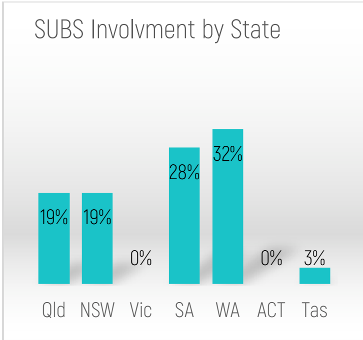
DEMOGRAPHICS

Research data comprised **1,640 student responses** and **245 teacher responses** from 170 schools.

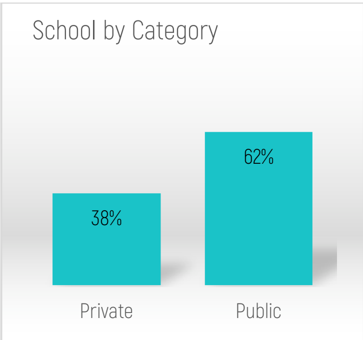
Program Demographics

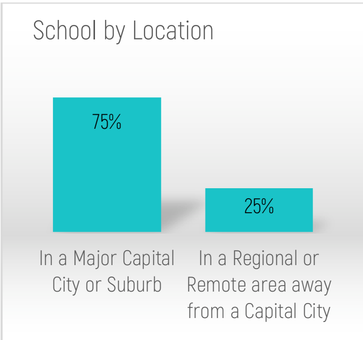




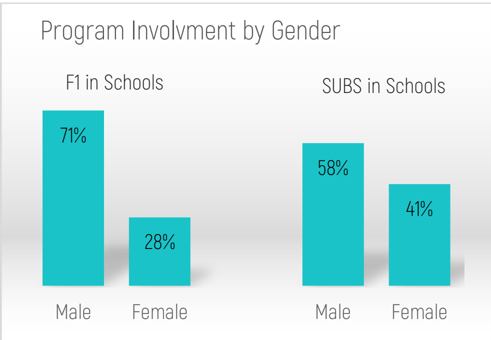


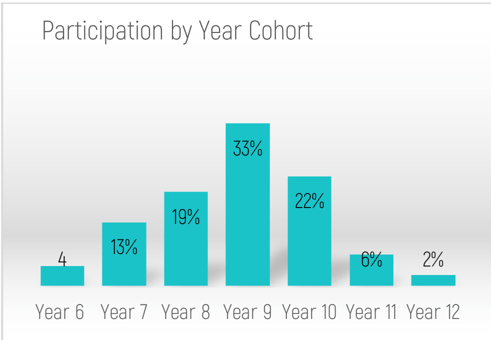
School Demographics

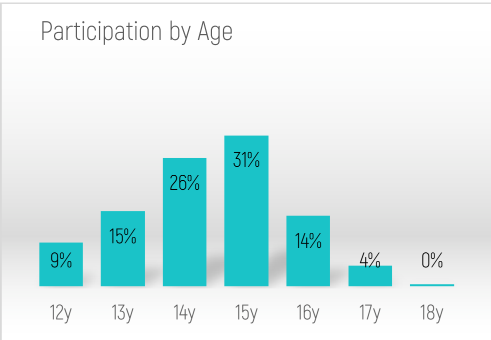


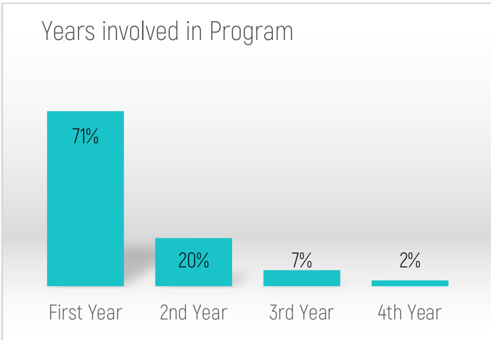


Student Demographics

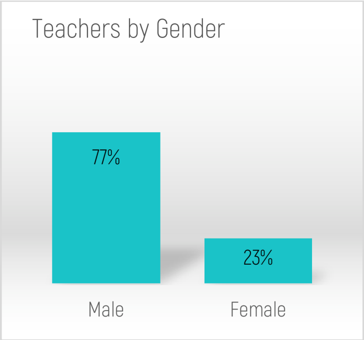


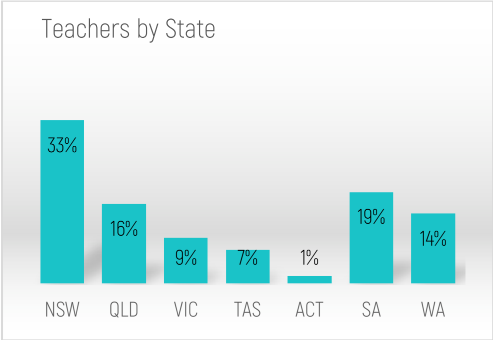


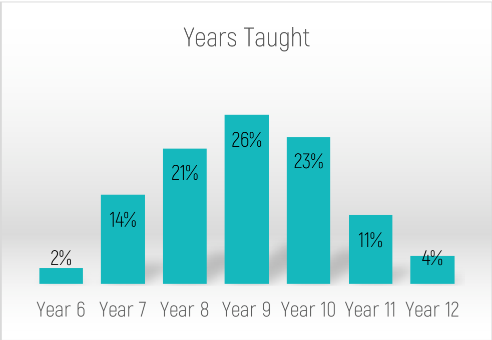


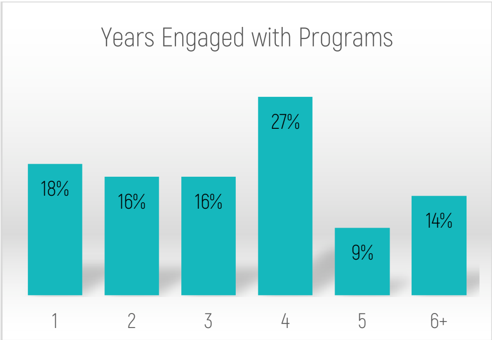


Teacher Demographics

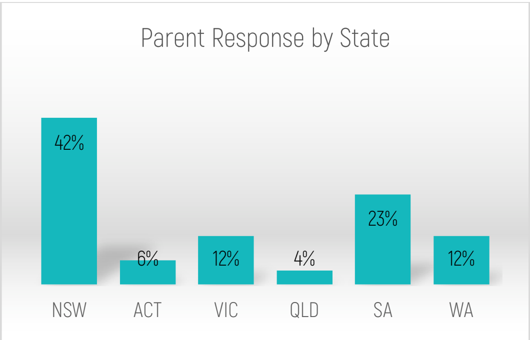


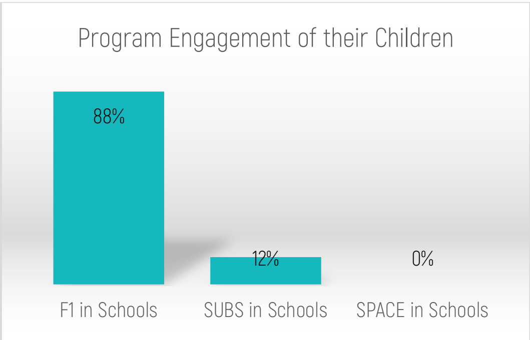






Parent Demographics





Student Motivation Towards STEM

Understanding intrinsic motivation's role in guiding students' career choices is crucial, as it significantly influences their engagement and persistence in activities, including educational pursuits and career pathways. Over the past few decades, research has extensively examined the intrinsic-extrinsic motivation dichotomy, highlighting intrinsic motivation as a critical driver of cognitive, physical, and social development (Ryan, 1999; Vallerand, 1997).

Self-determination theory (Deci and Ryan, 1985) posits that human behaviour is underpinned by different types of motivation, with intrinsic motivation being the most self-determined form. This type of motivation arises within an individual, driven by personal interest and enjoyment in the task rather than external rewards or pressures. In contrast, extrinsic motivation is impacted by external factors such as rewards or recognition. The theory suggests that fostering an environment that supports competency, autonomy, and relatedness can enhance intrinsic motivation, leading to more self-determined and fulfilling engagement in activities.

Intrinsic motivation is linked to positive outcomes, including persistence and satisfaction, and is considered vital for effective learning and development (Watt, 2004; Deci and Ryan, 1985). It is rooted in the natural human propensity to learn and assimilate, reflecting a true sense of choice and freedom in one's actions. Children are strongly inclined towards inherently exciting or enjoyable activities, indicating that intrinsic motivation is a significant factor in their early development and career exploration (Ryan, 2007).

Research also indicates that intrinsic motivation can decline with age, influenced by shifting focus towards extrinsic rewards and societal expectations. However, Organic Integration Theory suggests that individuals can internalise extrinsic motivations, transforming them into personal commitments through peer norms and role models (Ryan, 2007).

The role of parents and family is particularly noteworthy in shaping children's career choices. While adults are more aware of the environmental and societal influences on their career decisions, children are shielded from these realities. As such, family members can significantly impact children's career exploration and decision-making processes, underscoring the importance of nurturing intrinsic motivation from an early age.

Despite the recognised benefits of intrinsic motivation, the current educational system often emphasises extrinsic rewards, potentially hindering students' inherent interest and motivation. Acknowledging the complex interplay between intrinsic and extrinsic factors is essential for developing interventions that effectively support students' career motivations and choices, ensuring their pursuits align with their interests and inherent motivations (Song and Grabowski, 2006).

Research Process

Our research methodology examined the role of intrinsic motivation in students' career decision-making. We utilised the Situational Intrinsic Motivation Scale (SIMS), as developed by Deci and Ryan (1985) and later expanded by Guay et al. (2000). This instrument was chosen for its ability to capture various dimensions of motivation as they pertain to students' interests in STEM careers, specifically through the lens of self-determination theory.

The core inquiry guiding this segment of our questionnaire aimed at gauging students' interest in pursuing STEM careers is framed around the question, "Would you be interested in a STEM career?" The SIMS scale is structured to assess four distinct motivational orientations:

1. **Intrinsic Motivation:** Focuses on the degree to which students are driven by internal desires such as enjoyment, curiosity, and personal interest in STEM fields.
2. **Identified Regulation:** Measures students' recognition and acceptance of their career decision-making efficacy, reflecting a conscious valuing of a behavioural goal.
3. **External Regulation:** Evaluates the influence of external factors, including rewards or pressures from parents, teachers, and peers, on students' career choices.

4. **Amotivation:** Assesses the extent to which students feel disconnected or lack intentionality in their career decision-making, characterised by an absence of purpose.

These dimensions align with self-determination theory's premise that human behaviour is motivated by different types of motivation, each varying in their degree of self-determination. Self-determination is conceptualised as engaging in actions with a sense of volition and choice. According to the theory, intrinsic motivation and identified regulation represent more self-determined forms of motivation associated with positive educational outcomes and persistence. Conversely, amotivation signifies a lack of motivation, often leading to negative consequences, while external regulation occupies an intermediary position, potentially exerting both positive and negative effects on student motivation.

The SIMS scale's application in our study aimed to dissect these motivational constructs to understand their influence on students' STEM career interests. By evaluating levels of intrinsic motivation, the belief in one's ability to make career decisions (self-efficacy), and the perceived impact of social influences, we sought to capture a comprehensive picture of the motivational landscape guiding students' career paths.

Our analysis involved calculating average scores for each SIMS sub-scale, quantitatively measuring the prevailing motivational orientations among the student participants. These scores offer insights into the predominant motivational drivers and their potential implications for students' engagement with STEM careers, laying the groundwork for targeted interventions to enhance intrinsic motivation and support effective career decision-making among students.

The analysis of the SIMS scale results for the collected data is summarised in the graph below, which presents the average scores calculated for each of the four sub-scales for the group.

Observations

The findings provide valuable insights into the factors influencing students' interests in STEM careers, underscoring the significant role of intrinsic motivation and identified regulation in shaping their career aspirations. These observations are critical in the context of our research methodology, which employed the SIMS to quantify various motivational orientations among students. We aimed to understand how different types of motivation—ranging from self-driven interests to external pressures—impact students' inclination towards STEM fields.

Observations in Detail

1. **High Interest in STEM:** The analysis revealed that students exhibit a high interest in STEM, with intrinsic motivation and identified regulation scores surpassing the 3.5 threshold, indicating a robust and self-driven interest in STEM, suggesting that students are motivated by enjoyment, curiosity, and a sense of personal importance in these areas.

The methodology's focus on these dimensions allowed us to pinpoint the internal factors that encourage students to consider STEM careers, aligning with the research's aim to identify motivations that could be leveraged to enhance STEM engagement.

2. **Minimal Gender Differences:** The finding of negligible difference in STEM interest between boys and girls challenges common stereotypes and suggests that both genders are equally capable of and interested in pursuing STEM careers. This observation aligns with the research goal of understanding broad motivational trends and indicates that efforts to promote STEM should be inclusive, targeting all students irrespective of gender.
3. **Low Impact of External Factors:** The scores for external regulation and amotivation falling below 3.5 demonstrate that students' decisions to pursue STEM are less influenced by external rewards or pressures and not hindered by a lack of perceived control or direction. This finding supports the emphasis on fostering intrinsic motivation within educational programs. It suggests that creating environments that minimise extrinsic pressures could sustain students' interest in STEM more effectively.
4. **Positive Correlation with Program Participation:** The strong positive correlation between intrinsic motivation levels and increased interest in STEM following program participation underscores the effectiveness of engaging, hands-on STEM activities in enhancing students' inherent interest. This correlation, quantified at 0.65, highlights the critical role of practical, experiential learning in motivating students towards STEM careers. Our research methodology, which sought to assess the impact of specific educational interventions on student motivation, provides empirical support for the value of such programs.
5. **Impact on Career Decisions:** The observation that students with high intrinsic motivation who engage in STEM-related activities are more likely to pursue careers in these fields resonates with the research's overarching goal: to identify strategies that can positively influence students' career choices. By demonstrating that intrinsic motivation, augmented by relevant educational experiences, significantly affects career decisions, our study offers a blueprint for designing interventions that nurture students' interest and guide them towards fulfilling careers in STEM.

In Summary, these observations, derived from the research, offer compelling evidence of the power of intrinsic motivation in driving students' interest in STEM. They advocate for educational strategies prioritising personal interest and enjoyment, minimising external pressures, and providing enriching, hands-on experiences. Ultimately, the research underscores the potential of tailored educational programs to inspire students and guide them towards meaningful career paths in STEM.

Influence of Others - Peers and Role Models

Background

The concept of peer environments plays a crucial role in shaping students' behaviours, beliefs, and, ultimately, their career choices, acting like a complex, multi-layered onion with each layer intricately connected to the next. Bishop's (2007) analysis of the Neo-Darwinian Rational Choice Theory of Academic Engagement Norms delves into how secondary school environments foster the development of norms that influence student behaviour. This process underscores the social nature of humans, who seek to align with group norms to gain favourable attention, leading to a consensus on acceptable behaviours and enforcing conformity through social sanctions.

The enforcement of norms within peer groups is a self-organising process, with evidence suggesting a natural human inclination to punish norm violators. This act provides psychological satisfaction akin to the effects of stimulating substances. This enforcement mechanism, particularly in school settings, often manifests as exclusion, a powerful motivator for peer conformity.

Peer groups and the subcultures they create within schools are fundamental in providing emotional support and shaping behaviours. Bishop's further examination into the influence of peers and role models on educational involvement reveals that educational activities gain "cool" status through visibility and prominence, thus attracting positive peer attention. This visibility can transform the perception of academic interventions, suggesting that making such programs appealing and "cool" can mitigate negative peer pressures and enhance acceptance.

The time students spend with their peers influences their motivation to fit in, with behaviours and norms from respected students serving as models for acceptable conduct. These norms can positively or negatively influence attitudes towards education, with anti-teacher sentiments and the devaluation of academic effort often emerging from these group dynamics. Conversely, positive role models within peer groups can foster constructive attitudes towards learning and study.

Akerlof's (1983) discussion on loyalty filters within peer relationships highlights the complexity of social influences on students' beliefs and decisions, pointing to the willingness of children to adapt their loyalties based on social class identification. This adaptability underscores the importance of considering peer norms and social pressures when designing interventions to bolster self-efficacy, as proposed by Bandura (1977), who emphasises social persuasion as a critical factor in developing self-efficacy.

Designing effective intervention programs requires understanding the intricate web of social pressures and norms that influence students. Making interventions "cool" through strategic visibility and prominence, as Bishop (2003) suggests, can transcend negative peer influences, fostering a positive reception among students, parents, and the broader peer community. This approach aims to cut across social barriers, rendering the intervention attractive across multiple levels of the student's social environment, thereby enhancing its potential to positively impact students' self-efficacy and intrinsic motivation towards their career choices.

The Role of a Hero/Role Model

The role of heroes and role models in shaping individuals' aspirations, particularly in the context of career development, is a topic that has garnered significant attention in psychological and educational research. This exploration reveals the complex mechanisms through which individuals, notably students, draw inspiration and guidance from figures they admire, impacting their career choices and self-efficacy beliefs.

Role models and heroes play a pivotal role in individuals' lives by serving as benchmarks for success and sources of inspiration. Markus and Nurius (1986) suggest that being inspired by an outstanding individual involves envisioning an equally remarkable future self, implying that role models can significantly boost motivation and self-improvement efforts. Lockwood and Kunda (1997) further elaborate that role models' effectiveness depends on their achievements' perceived attainability, indicating that role models inspire by making desirable future selves seem achievable.

Bucher and Sterling (1977) classify role models into five types, ranging from partial role models, who provide a template for specific actions, to charismatic role models, who inspire others to emulate them; and negative role models, who serve as examples of what to avoid. This classification underscores how role models can influence individuals' behaviour and attitudes.

Several theoretical frameworks have been employed to understand how role models influence career development. Bandura's Social Learning Theory (Bandura, 1969, 1977, 1982, 1986) posits that individuals learn behaviours and skills by observing role models, suggesting that witnessing successful role models can enhance one's self-efficacy regarding specific tasks, such as pursuing higher education. Social Cognitive Career Theory (Lent et al., 1994) expands on this by highlighting how contextual factors, including relevant role models, indirectly influence career outcomes through their impact on interest, self-efficacy, and outcome expectations.

The influence of role models extends beyond personal development to shape educational environments. For instance, teachers who exhibit high motivation levels can become role models for their students, enhancing student motivation through establishing positive peer norms (Atkinson, 2000). Additionally, as defined by Erikson (1977) and others, heroes significantly influence cultural and peer norms, indicating that hero themes often guide societal role development.

White (1999) highlights a gap between students' perceptions of heroes and role models and those of educators, pointing to the need for more research into students' conceptualisations of these figures. Children's views of heroes evolve, often shifting from parental figures in younger years to representatives of broader societal ideals as they grow older. This evolution reflects self-perception and social environment changes, underscoring the importance of providing students with role models who demonstrate moral excellence and sustained leadership.

The exploration of the role of heroes and role models in career development underscores their significant impact on individuals' motivation, self-efficacy, and career choices. Theoretical and empirical studies highlight the importance of providing individuals with accessible and relatable role models to inspire and guide their career paths. As we consider the design of career motivation programs, incorporating experiential learning environments and engaging with industry to highlight essential skills becomes crucial. Understanding how different interventions resonate with boys and girls alike and tailoring these interventions to accommodate the varied influences on career motivation will be necessary to nurture the next generation's career aspirations effectively.

Influences Beyond the Formal Education Process

Exploring influences on learning and career decision-making beyond the formal education system unveils a rich tapestry of informal learning avenues that significantly shape occupational competencies and career paths. Overwien (2000) posits that a substantial portion of learning, estimated at 70%, occurs outside formal educational structures through informal apprenticeships and experiential learning, which are deeply ingrained in human behaviour and nearly impossible to replicate in traditional school settings. This perspective underscores the profound impact of mentors and role models in guiding young people's learning and career decisions.

Taylor (2005) further explores the transition from education to the workplace, noting that young individuals often possess soft skills aligned with industry expectations, acquired not within classrooms but from interactions with family members and community role models. This observation points to a knowledge and skill acquisition process that transcends the structured environments of schools, embedding essential soft skills such as communication, teamwork, and problem-solving in individuals from a young age.

However, Taylor also calls for more research to substantiate claims about the industry's role in nurturing skills outside the conventional educational realm. This includes examining how industries can contribute to identifying the necessary skills and competencies for future workers. The challenge of integrating employability skills into the curriculum has become a strategic concern for governments aiming to address both immediate and future industry needs and to foster the connections between education and the workforce.

Billett (2004) highlights a dilemma businesses face: balancing the development of specific, competency-based skills for immediate needs against anticipating future requirements for more generic employability skills. This balancing act involves weighing the need for technical expertise against the desire for broader capabilities like creativity, initiative, and self-management, which are increasingly prized in the modern workforce.

From an Australian perspective, the literature (AIG, 2006) emphasises the industry's critical role in defining its required skills and competencies. While industries demand a combination of hard and soft skills from new entrants, there is a particular emphasis on soft skills, which are deemed challenging to teach in a business context. The expectation is that the education system will prepare students with these foundational skills, allowing businesses to focus on imparting specific technical knowledge.

This evolving landscape blurs the traditional boundaries between educational content and workplace learning, with industries setting high expectations for new hires' "out-of-the-box" employability skills. Consequently, career intervention programs and academic institutions are tasked with bridging this divide, ensuring that learners are equipped with a comprehensive skill set that encompasses both the hard technical skills and the soft skills vital for success in the modern workforce.

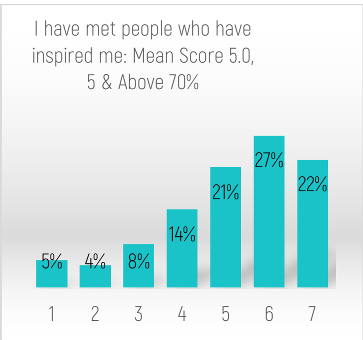
In conclusion, the influences on learning and career decision-making extend well beyond formal education, encompassing a wide array of informal learning experiences and interactions. Integrating soft skills development into educational and career planning is crucial, requiring a collaborative effort between academic institutions, industries, and communities to prepare individuals for the multifaceted demands of the contemporary workplace.

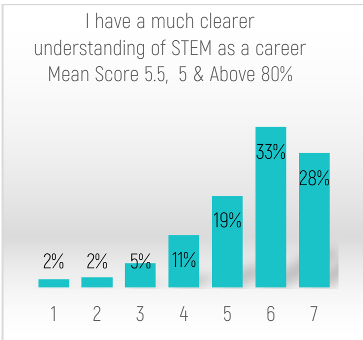
Research Process & Results

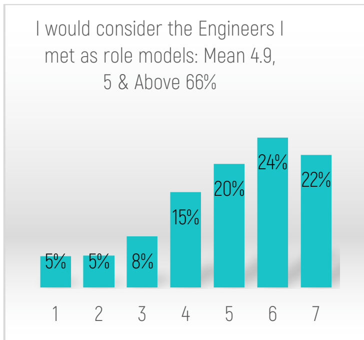
To gauge the impact of others within the students' environments, we utilised the "Influence of Others on Academic and Career Decisions Scale" **IOACDS** (Nauta and Kokaly, 2001). This scale aims at determining the dimensions of role model influence on academic and career decisions. The **IOACDS** scale consists of 14 two-stage questions containing a common primary factor and 14 secondary factors, e.g. "**When it comes to choosing a career**:" (primary element) "**There is someone who helps me consider my academic and career options**?" (secondary element).

*These 14 questions make up two consistency factors. These consistency factors and codification within the **IOACDS** scale are Scale 1 - Support and Guidance item: 1, 2, 3, 4(R)[1], 5, 6, 7, 8. Scale 2 - Inspirational Modelling item: 9, 10(R), 11, 12(R), 13, 14(R).*

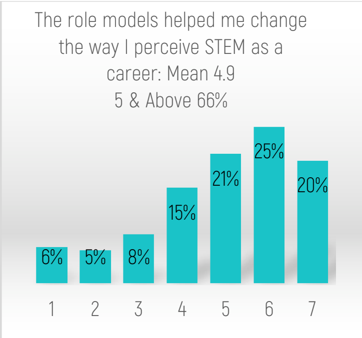
The following graphs highlight some of the results from the IOACDS portion of the students questionaire.

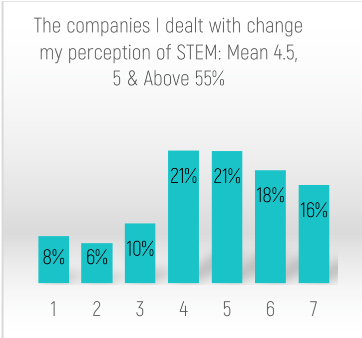


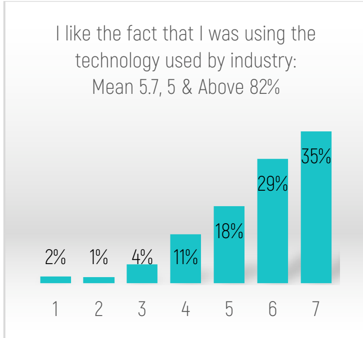


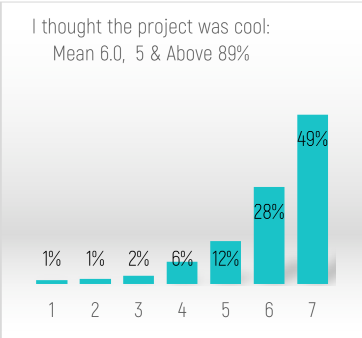


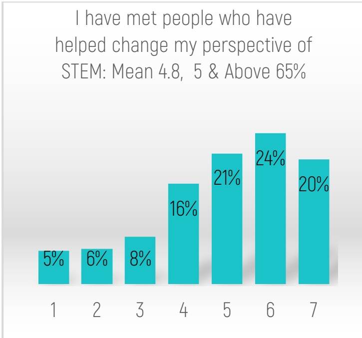
[1] (R) Indicates that the question was reverse scored i.e.. As these questions were asking for a response to a negative question rather than a response to a positive question the outcomes were reversed to allow a direct comparison of results to the positive questions. Score reversal was defined within the operating procedure as set for the use of this scale.

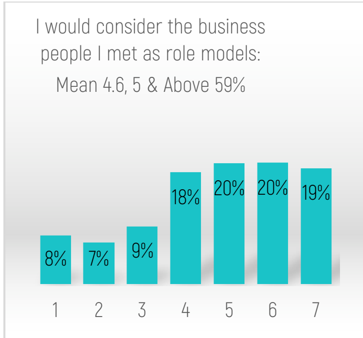


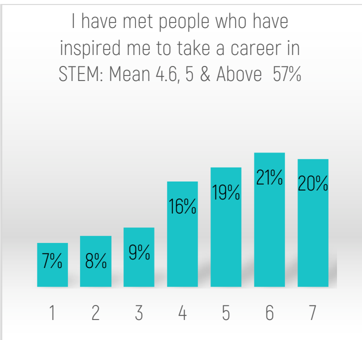


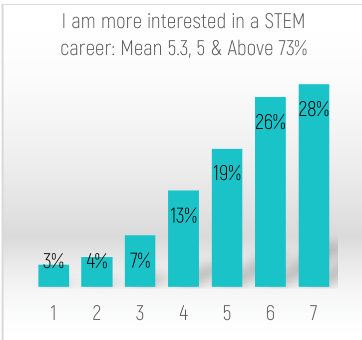




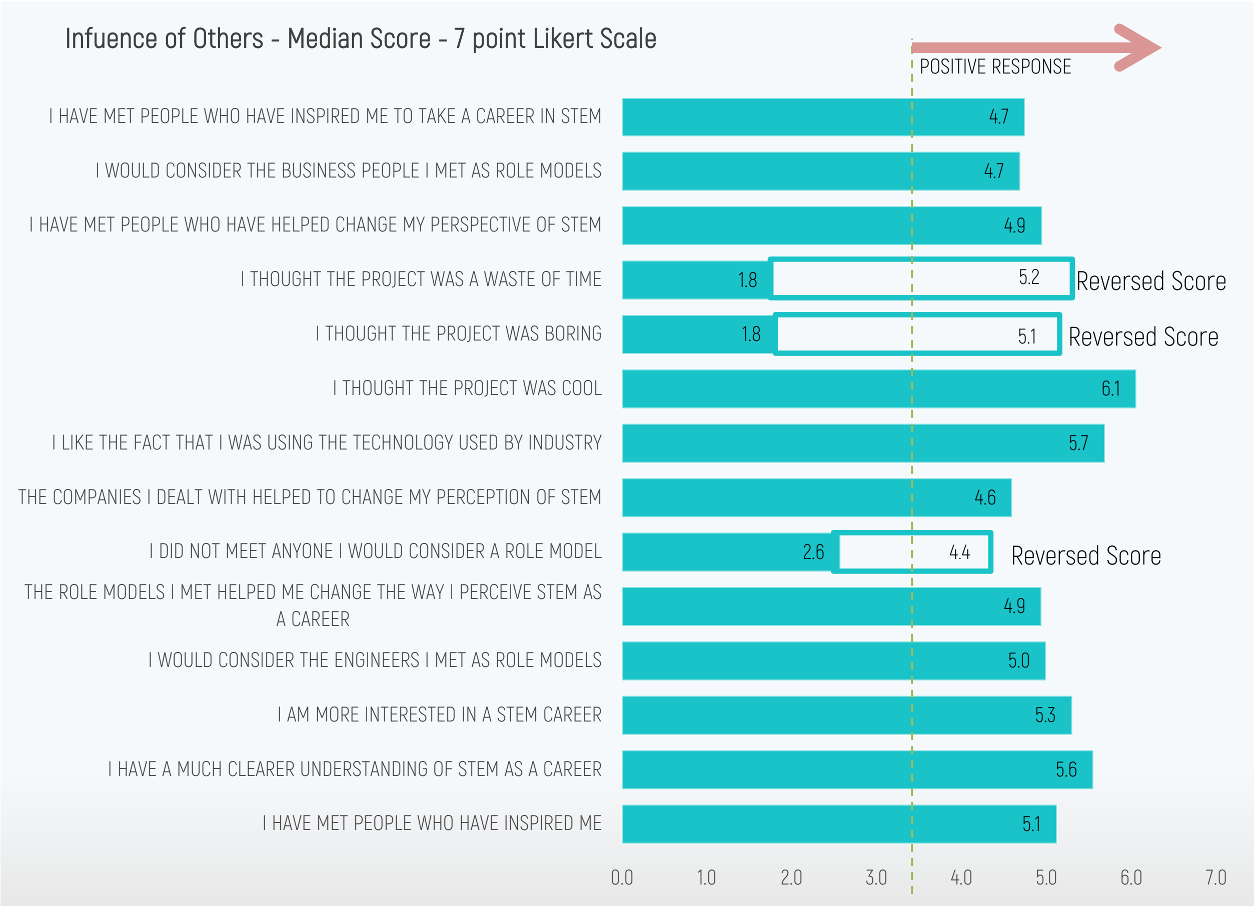








Trinity Grammar Schools Kew: Team Hadron – 2022 F1 in Schools World Champions with Daniel Ricciardo



Observations

The research sheds light on the nuanced role that diverse peer environments and exposure to role models play in shaping career choices among boys and girls, revealing the complexity of external influences on career decision-making processes. Role models influence both genders; however, notable differences emerge, particularly in how boys and girls perceive the impact of parental guidance on their career choices.

Statistically, girls showed a lower susceptibility to role models' influence than boys, a more pronounced disparity with increased exposure to STEM activities. Interestingly, regression analysis identified different sets of predictors influencing career decisions for boys and girls. For boys, significant factors included interactions with role models and a growing understanding of STEM careers. In contrast, for girls, the critical predictors centred on project engagement—specifically, their enjoyment of the technology used, autonomy over project components, and the excitement of the project itself.

These findings disrupt conventional stereotypes regarding gender and career preferences, particularly in technology and design fields. Contrary to the traditional belief that design and technology are domains predominantly suited to boys, girls demonstrated a strong interest in and enthusiasm for designing and building, underscoring the importance of challenging these outdated notions. Boys' inclination towards learning through hands-on experience and mentorship echoes prior studies on developing employability skills among male youths.

The research also suggests a shift in how girls value parental advice in their career decision-making. Initially, girls might lean heavily on their parents' counsel, but their reliance on parental guidance diminishes as they delve deeper into STEM fields and gain more confidence. They begin to place greater value on personal experiences within STEM, finding these activities enjoyable and engaging.

The observed gender differences in responsiveness to parental advice highlight a need for further investigation to uncover the reasons behind these divergent attitudes. This inquiry could provide deeper insights into how boys and girls navigate the complex influences shaping their career trajectories.

In summary, the findings underscore the significant impact that role models and project-based learning experiences have on influencing career choices among students, pointing to the necessity of adopting gender-sensitive approaches in career guidance. Tailoring interventions to accommodate the distinct preferences and perceptions of boys and girls—particularly regarding interpersonal interactions and project engagement—can enhance the effectiveness of programs designed to inspire young people towards future career paths in STEM and beyond.

Trade Display of Team INFINITUDE
A collaboration of students from Brighton Secondary School, S.A. and St Bedes College, Vic.
2nd F1 in schools World Final 2018 – Fastest Car & New World Record – Best Engineered Car

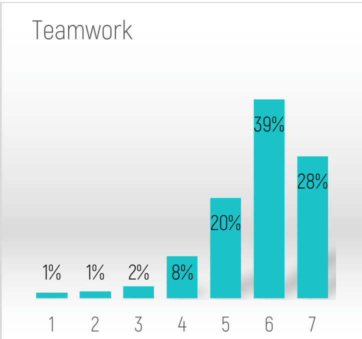
Program Impact on Student Motivation

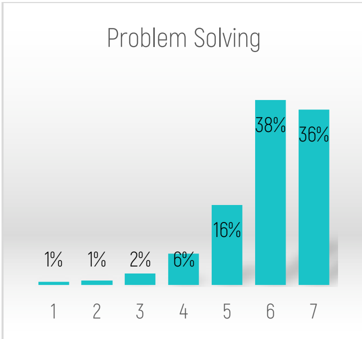
Students must have completed one of the programs through to a State or National level competition to be invited to participate in the questionnaire. Questions sought to determine the program's impact and elements influencing career motivation.

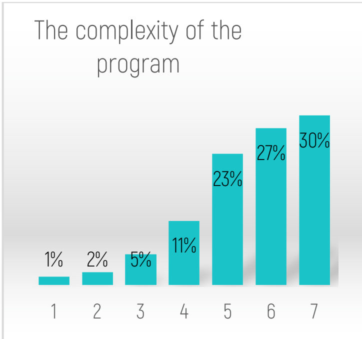
The primary question was: **"What are the things you liked about your involvement in this program".**

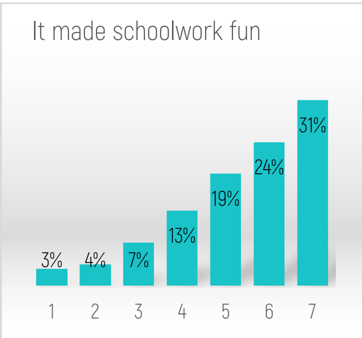
The responses were collected using a Likert scale with the following characteristics: 1: Corresponds not at all, 2: Corresponds very little, 3: Corresponds a little, 4: Corresponds moderately, 5: Corresponds enough, 6: Corresponds a lot, 7: Corresponds exactly.

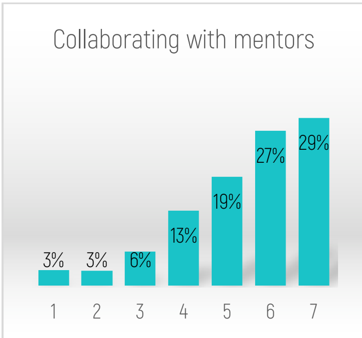
Responses on the Likert scale of 4 and above are considered positive.

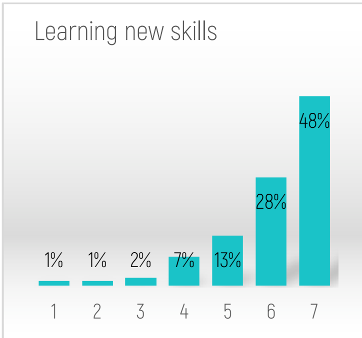


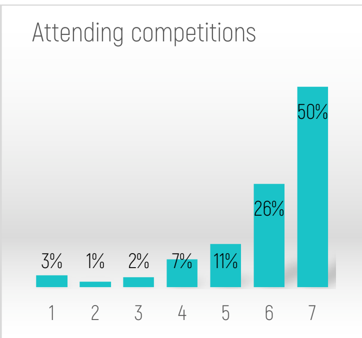


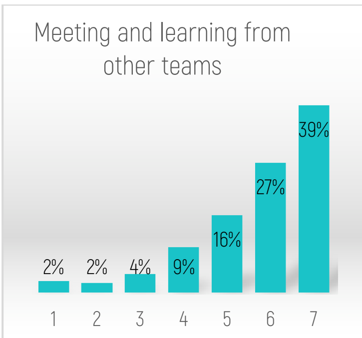


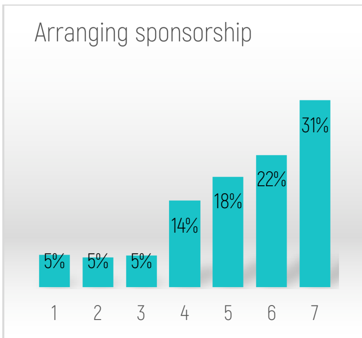


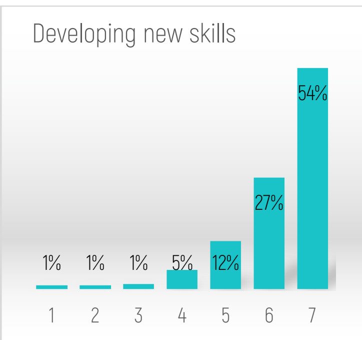


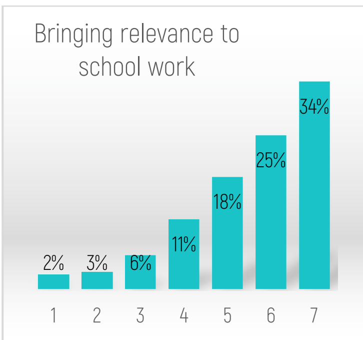


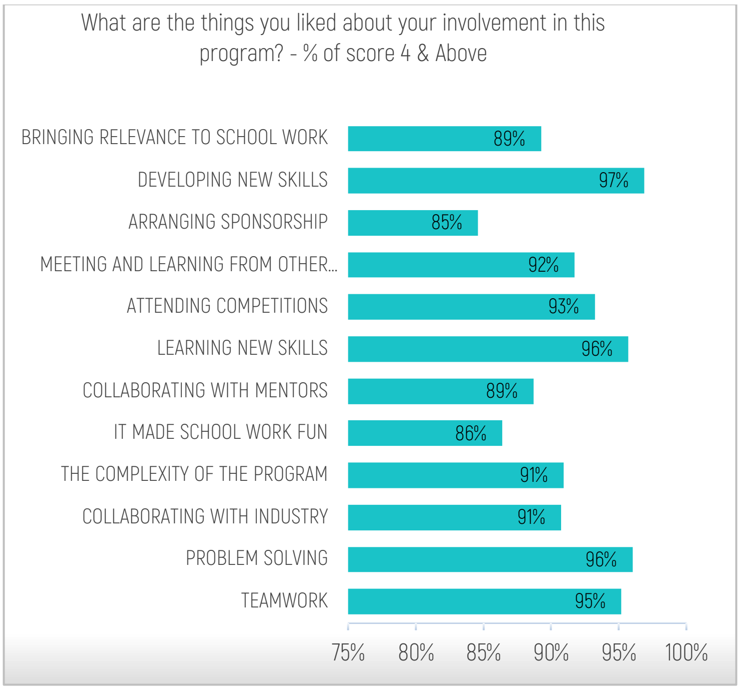


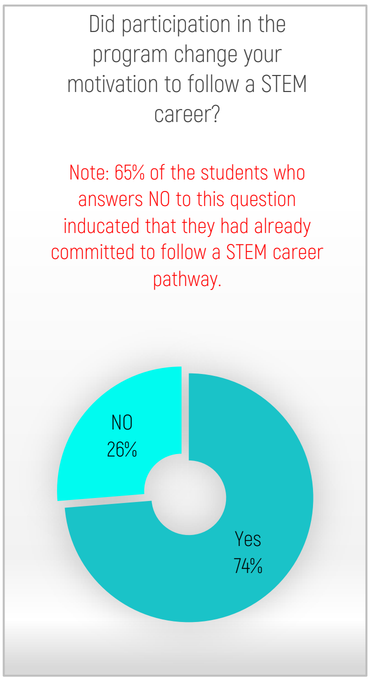


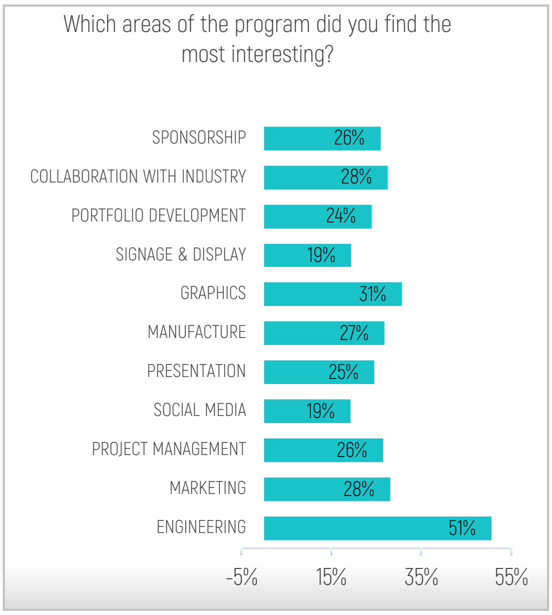


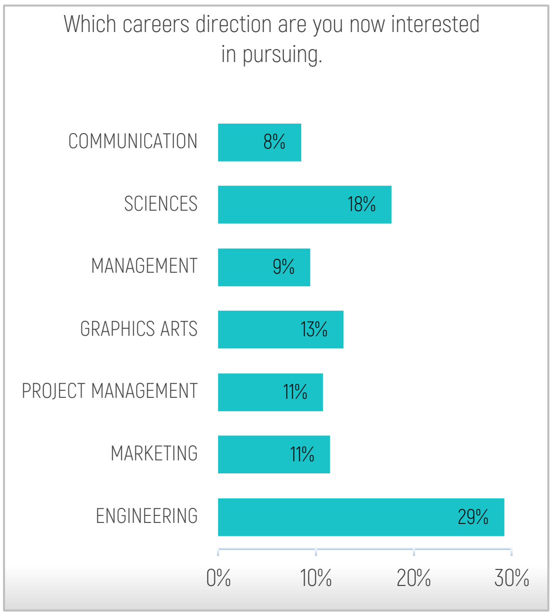












Observations

The research underscores the importance of fostering a broad acceptance and interest towards industry fields among students, emphasising the need for educational and intervention programs to enhance rather than control the environmental influences shaping students' career perceptions. Central to this is evaluating students' self-assessed ability to make informed career decisions, focusing on their confidence levels. Such confidence indicates these programs' potential efficacy in moulding students' career motivations and eventual choices.

A key finding from the study is the realisation among students that STEM projects and professions can be enjoyable and stimulating. This enthusiasm transcends gender boundaries, with girls and boys expressing a significant interest in engaging with industry-standard technologies. This interest is not just superficial but is recognised by students as a critical component of their educational journey, linking directly to potential future career paths. The allure of working with such technology underscores the need for program curriculums to incorporate hands-on, practical experiences that resonate with students' career aspirations.

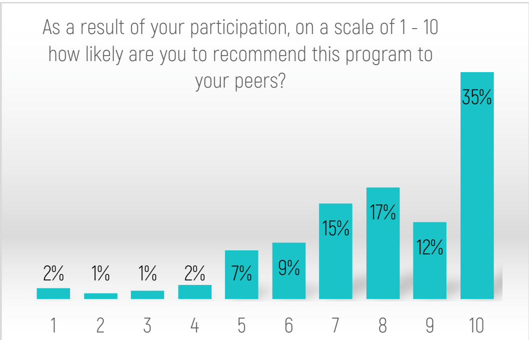
Moreover, the students' attraction to specific scientific fields, such as aerodynamics, despite its traditional classification as a science rather than technology, reveals a broader curiosity and openness to STEM subjects when presented in a contextually relevant manner. This suggests that even areas of STEM that might typically attract less interest can become focal points of student enthusiasm if aligned with practical applications and real-world relevance.

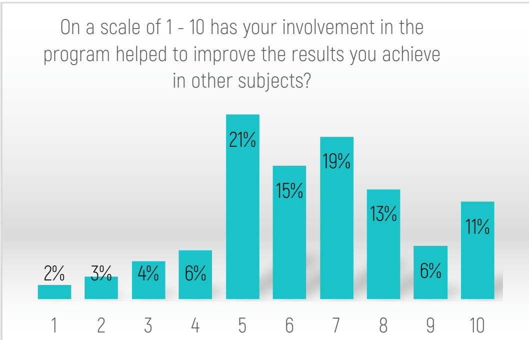
The requirement within these programs for students to compile a portfolio documenting their STEM learning journey, coupled with the opportunity to present their findings to industry professionals, is a powerful mechanism for students to consolidate their knowledge and envision themselves within a STEM career framework. Such activities reinforce the student's understanding and interest in STEM and enhance their communication skills, confidence, and ability to see the practical application of their studies.

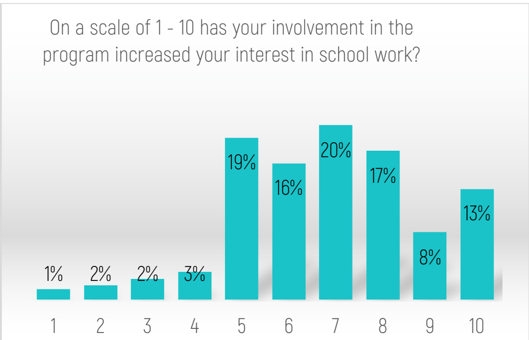
Real-world projects and direct engagement with industry role models within these programs are pivotal in influencing students' career orientations. These interactions provide tangible examples of career paths and professional identities within the STEM fields, making the abstract notion of a "STEM career" more accessible and appealing.

The timing of these interventions is critical. For maximum impact, program activities must be designed to coincide with students' developmental stages where they are most emotionally and cognitively open to absorbing new information and capable of integrating such insights into their evolving career aspirations.

In conclusion, the research suggests that intervention programs offering hands-on, real-world STEM experiences and exposure to industry professionals can profoundly influence students' career motivations. By demonstrating the relevance, excitement, and accessibility of STEM careers through contextualised learning experiences, such programs promise to alter students' perceptions and aspirations towards STEM fields significantly. This shift in perspective is essential for cultivating a future workforce that is both well-prepared and enthusiastic about embracing the challenges and opportunities of industries reliant on STEM competencies.







Differences in Motivation - Boys vs Girls

Extensive research has delved into the gender-based disparities in various educational experiences, encompassing achievement, motivation, literacy rates, attendance records, school completion rates, and disciplinary actions such as suspensions and expulsions. These investigations often determine whether observed differences between boys and girls represent variations in degree (quantitative differences) or kind (qualitative differences). Quantitative differences imply that boys and girls might score differently on specific metrics, such as motivation levels. In contrast, qualitative differences suggest fundamentally distinct approaches or attitudes towards motivation, including diverse underlying factors or distinct motivational profiles (Martin, 2004).

Martin (2004) analysed student motivation, evaluating mean differences and deeper structural aspects like factor structures and cluster profiles between genders. This analysis revealed that gender differences do indeed exist in student engagement and achievement, predominantly not favouring boys. Girls, on average, excel in a broader range of subjects and are more frequently found among the highest achievers (Collins et al., 2000).

However, while variations in the level of motivation between boys and girls were noted, the consistency in factor structures and cluster profiles across genders indicates a lack of fundamental qualitative differences. This finding is crucial for developing data analysis approaches and designing interventions to boost or maintain motivation levels across genders.

The widening achievement gap, marked by boys' distribution across the performance spectrum's extremes, prompted significant attention from educational policymakers. In Australia, for example, the Federal Minister for Education initiated an inquiry in June 2000 into the educational challenges facing boys, seeking insights into social, cultural, and academic factors impacting boys' education, especially regarding literacy and social skills in their early years. This inquiry aimed to identify effective strategies for addressing these challenges and explore opportunities for broader implementation or enhancement (Standing Committee on Employment, 2000).

Further discourse in the literature points to the differential response of boys and girls to motivational stimuli and debates the impact of maturity differences during early developmental stages on learning focus and processes (Carrington et al., 2008; Ringrose and Renold, 2010). These maturity differences, highly variable even within specific demographics, pose challenges in isolating the effects of individual variables on program outcomes. Recognizing maturity as one of many contextual factors, this study considers it alongside other influential factors such as ethnicity and socioeconomic background.

Understanding these gender-based differences is paramount for educators and program designers in creating interventions that resonate across diverse student populations. The goal is to design programs that inherently appeal to a wide range of students, fostering engagement, enjoyment, and learning irrespective of age, gender, ethnicity, or socioeconomic status.

In this complex landscape, industries looking to attract young talent must navigate these environmental influences without direct control. Instead, their efforts should be geared towards cultivating broad-based acceptance and interest among potential future professionals. This research aims to guide industry stakeholders, outlining strategies to thrive within this multifaceted context and effectively engage students in considering careers within their sectors.

Influence of Gender on Program Participation

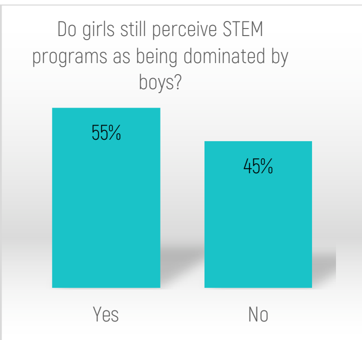
The imperative to assist students in uncovering the engaging and dynamic aspects of STEM and industry-related activities is evident. Creating educational environments that enhance understanding of STEM professions is vital for fostering informed career decision-making, particularly when considering the varied motivational influences on boys and girls. This study underscores the necessity of adapting the STEM narrative to cater distinctively to each gender, as their motivational triggers and responses to STEM exposure differ significantly.

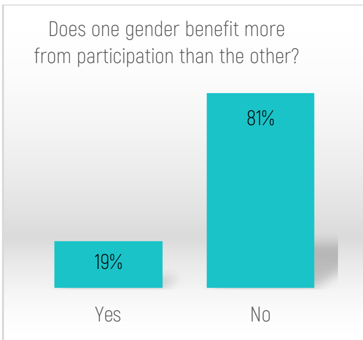
Motivation is notably heightened for boys through consistent interaction with role models and mentors. The apprenticeship model of learning—where boys engage directly with professionals in the field—proves especially effective. Boys are more inclined to commit to a career path after experiencing real-world applications of STEM, underpinned by the assurance of ongoing support and guidance from adults in these professions. Therefore, enhancing boys' opportunities for engagement with industry professionals can lead to a higher influx of male students pursuing STEM careers.

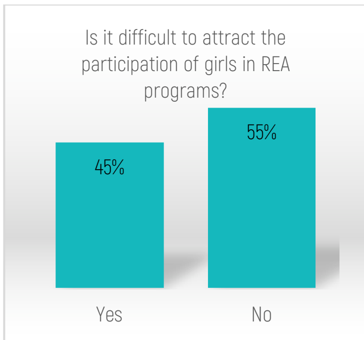
Conversely, girls are drawn to navigating complex scenarios within their learning environments. They are attracted to careers by understanding the detailed processes and the multifaceted nature of different roles, showing a keen interest in the project management and procedural aspects of careers. Girls need a comprehensive grasp of these processes before choosing a career path. This study reveals that interventions tailored to highlight these aspects can increase girls' interest in particular STEM fields.

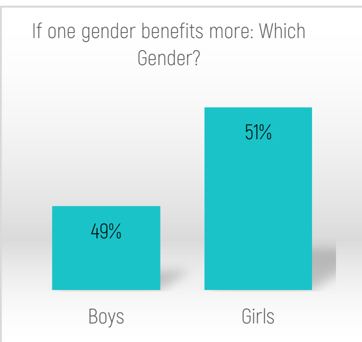
REA's Metamorphic Learning framework advocates for an inclusive approach to student engagement, eschewing segregation based on ethnicity, gender, diversity, age, or religious beliefs. It champions the principle of equality, focusing on helping each student identify and cultivate their passions and abilities, ensuring that career path selection remains uninfluenced by intersectional biases. It seeks not only to change the knowledge base of students and teachers but also to bring about a change in confidence, self-efficacy, motivation, and understanding that bringing about a change in the nation rests with them.

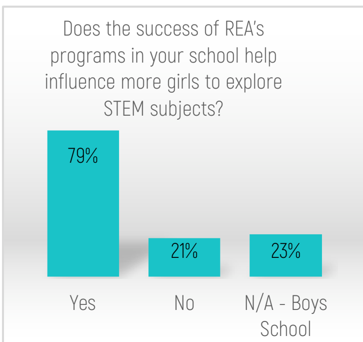
Despite prevailing stereotypes that suggest boys are more prevalent in STEM fields, this research illustrates that successful engagement with girls can be achieved by addressing their unique motivational drivers. This involves employing communication styles and methodologies that resonate distinctly with boys and girls, according to their specific motivational contexts. Feedback from educators involved in the study is telling; 79% of teachers observed that participation in the programs does not disproportionately benefit one gender over the other. Furthermore, 78% of teachers reported an increase in female students' interest in STEM, while 80% of boys and 76% of girls demonstrated improved attitudes towards their schoolwork following program participation. These outcomes underscore the effectiveness of well-designed interventions in fostering equitable engagement and enhancing attitudes towards STEM among boys and girls, highlighting the potential for such programs to balance gender representation in STEM fields.

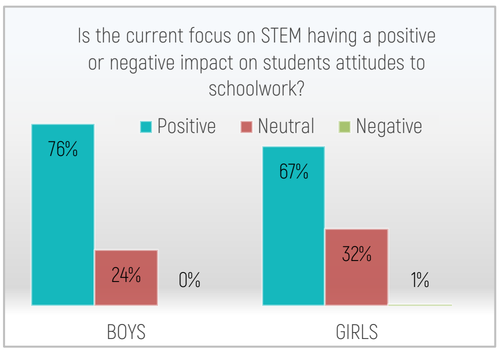












Analysis of the qualitative response of teachers to questions on the aspects of REA programs that girls are attracted to the most highlighted the following:

1. Project management.
2. Engineering
3. Innovation
4. Management
5. Teamwork
6. Developing relationships
7. Team management
8. Collaboration
9. Responsibility.
10. Design.
11. Leadership
12. Competition.
13. Marketing
14. Communication
15. Presentation
16. Artistic roles
17. Graphic Art

Team Horizon – Brighton Secondary Schools Adelaide – 2017 F1 in Schools World Champions

Impact of Programs on Learning Outcomes

The dichotomy between traditional academic learning approaches and those predicated on direct experience presents a unique challenge. De Jong (2006) asserts that learning approaches are inherently context-specific, suggesting that a one-size-fits-all approach to education—whether rooted in theoretical learning or experiential engagement—falls short of addressing students' diverse learning needs and preferences. This insight underscores the importance of developing educational strategies that are adaptable and responsive to the varied contexts in which learning occurs. Creating learning environments that resonate with the distinct motivational drivers of boys and girls is paramount in aiding students' navigation through their career decision-making processes, especially within STEM professions.

At the heart of the REA's educational initiatives is the Metamorphic Learning framework, a pioneering model that seamlessly integrates academic learning with experiential learning to underscore STEM careers' relevance. The goal is to bring about a change not only in the knowledge of students, teachers, and, where possible, parents but also to bring about a change in them. This framework is supported by substantial research into Action Learning and its myriad benefits, including promoting increased self-efficacy among learners. Action Learning, as a pedagogical approach, has been recognised for its efficacy not just in the context of student education but also in adult learning environments, offering valuable insights into the mechanics of effective learning across different age groups.

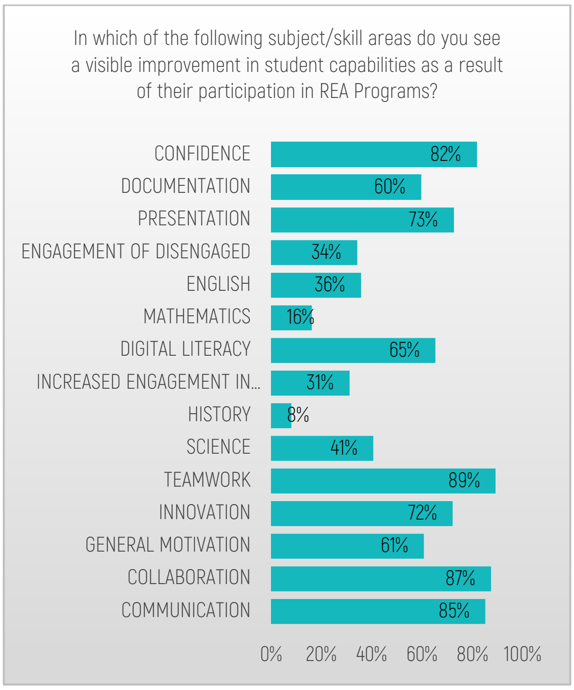
Blunsdon (2003) explores the pivotal role of experiential learning in crafting stimulating and engaging educational experiences for students, a theme that resonates deeply with the objectives of this research. Students' subject choices are often guided by their intrinsic interests and perceptions of what they find appealing. This challenges educators to ignite students' enthusiasm for learning while simultaneously meeting educational objectives without resorting to tactics that prioritise entertainment at the expense of substantive understanding and academic rigour.

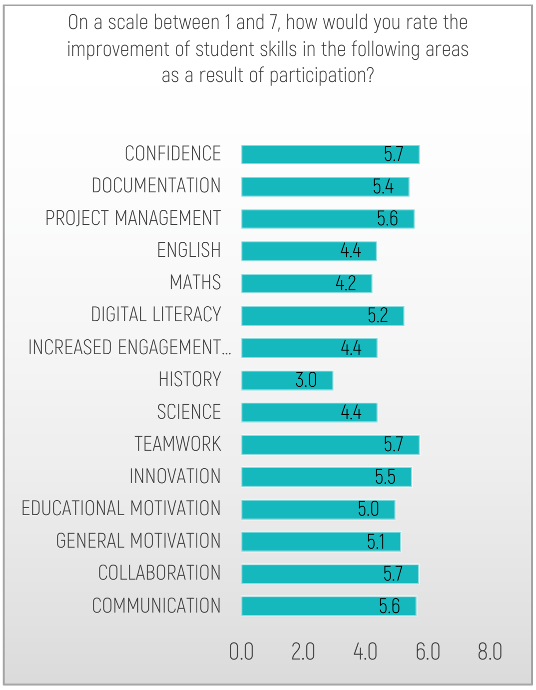
A prevalent issue within many school STEM programs is the tendency to emphasise entertainment value over educational substance and academic goals. This tendency stems from attempts to incorporate STEM education into pre-existing, often rigid educational curriculums, which can lead to compartmentalised and disjointed learning experiences. Such an approach detracts from the potential depth and richness of STEM education and risks diminishing the perceived relevance and applicability of STEM subjects in students' eyes.

This research advocates for a paradigm shift towards educational models that balance the need for engaging interest-driven learning experiences with the imperative of maintaining academic integrity and rigour. By leveraging the principles of the Metamorphic Learning framework and embracing the dual strengths of educational and experiential learning, educators can create more cohesive, comprehensive, and appealing STEM programs. These programs should foster a genuine understanding and appreciation of STEM disciplines, paving the way for students—regardless of gender—to explore and excel in STEM careers confidently and enthusiastically. Such an approach aligns with the overarching research goals of enhancing STEM education's appeal and effectiveness, encouraging a more diverse and well-prepared generation of future STEM professionals.

Incorporating these insights into the discussion on Metamorphic Learning environments underscores the transformative potential of these educational settings in enhancing STEM learning. Metamorphic Learning environments prioritize real-world problem-solving, urging students and teachers to explore varied approaches to attain learning objectives. This emphasis fosters a deep connection between student interest and engagement and bridges the gap between classroom learning and contemporary practices in the real world. The presence and involvement of expert practitioners from the STEM fields within these learning environments are instrumental, offering students firsthand insights and exposure to the applications and implications of STEM in real-world contexts.

Data provided by teachers on improvements in student capabilities following program participation.





The REA's Metamorphic Learning framework creates stimulating and effective STEM learning environments by capitalising on the principles of experiential learning. It nurtures students' intrinsic interests and connects classroom learning to actual practice in the STEM industry. By engaging students in activities that echo real-life tasks and challenges, the framework ensures that knowledge is relevant and compelling. Integrating ten fundamental activities–including collaboration in small groups, tackling real-life problems, reflective practice, and the synthesis of individual and collective efforts–deepens students' understanding and appreciation of STEM.

Moreover, these programs align with the four critical components of intrinsic motivation identified by Watt: self-determination, self-perceived competence, relatedness, and perceived relevance. This alignment underscores the importance of fostering a learning environment that empowers students, boosts their confidence in their abilities, promotes a sense of belonging and connection, and highlights the significance of their tasks.

Research by Song (2006) adds another layer of complexity to the discussion, revealing that heterogeneous groups tend to outperform their homogeneous counterparts in solving ill-structured problems. The diversity within these groups breaks down traditional peer norms, allowing each member to contribute unique perspectives and ideas. This disruption of established social structures enhances intrinsic motivation among group members and facilitates more effective problem-solving strategies.

By encouraging diversity in team composition, Metamorphic Learning environments capitalise on students' varied backgrounds and experiences to enrich the learning experience. This approach promotes a more inclusive learning environment and mirrors the collaborative and interdisciplinary nature of real-world STEM work. The ability of these programs to increase intrinsic motivation, exposure to practical STEM applications and the cultivation of soft skills like teamwork and problem-solving, positions students to navigate and succeed in the rapidly evolving STEM landscape.

In summary, the Metamorphic Learning framework represents a paradigm shift in STEM education that aligns closely with contemporary educational goals. By fostering an environment that encourages real-world engagement, embraces diversity, and nurtures intrinsic motivation, these programs offer a robust model for preparing students to meet the challenges and opportunities of future STEM careers.

Observations

Intervention programs that overlook the importance of developing employability skills struggle to engage students and fall short in inspiring them towards career paths in the intricate fields of STEM. Students place a high premium on the relevancy of their educational experiences, viewing these programs as pathways that offer insight into career opportunities while acknowledging their potential for learning and growth.

Feedback from educators highlights that learning outcomes in areas directly tied to employability skills are most significantly enhanced. These skills, which include confidence building, effective documentation practices, project management, presentation capabilities, digital literacy, teamwork, innovation, collaboration, and communication, are pivotal for students navigating the complexities of STEM professions. Therefore, these skill areas must be aligned with the Key Performance Indicators (KPIs) aimed at drawing students into STEM fields, bolstering their employability skills, making STEM subjects more attractive, and evidencing educational advancement.

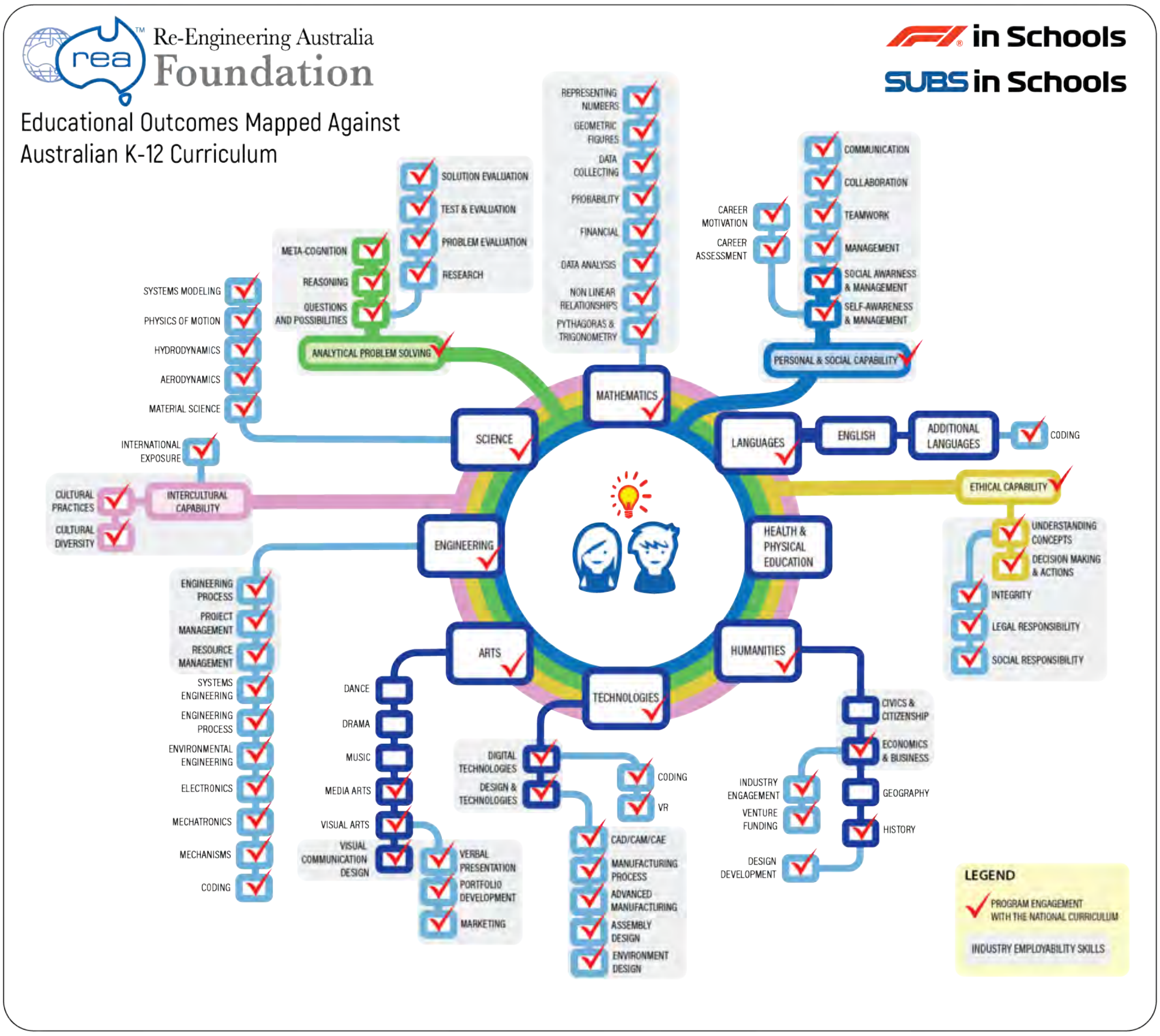
Students' enthusiasm towards utilising industry-standard technology underscores the importance of practical, hands-on experiences in educational programs. Data reveals a notably high positive response to integrating such technology, with 86% of boys and 71% of girls expressing favourable reactions. This disparity suggests that while technology remains a significant draw for all students, its role in attracting girls to STEM careers warrants particular attention, highlighting the need for strategies that amplify girls' engagement with technology.

The calibre of work produced by students in these programs reflects their grasp of research methods related to projects and careers and their eagerness to delve deeply into relevant information. These students exhibit a marked confidence in their abilities and a genuine interest in learning about the various aspects of STEM careers. This eagerness for knowledge is something the industry must acknowledge and respect when presenting career possibilities and employment insights. By providing comprehensive, age-appropriate information that respects students' intelligence and learning capacity, industries can more effectively appeal to young people's aspirations and help them make informed decisions about their futures in STEM.

To enhance student engagement in STEM and guide them towards fulfilling careers, it is essential to recognise the pivotal role of employability skills in student motivation and career choice. Programs must focus on these skills, integrating real-world technologies and practices to make STEM learning relevant and appealing. By doing so, educational interventions can improve learning outcomes and bridge the gap between academic knowledge and the practical demands of the STEM industry, ensuring students are well-prepared to meet the challenges of the future workforce.

Curriculum Mapping

The following chart maps the components of F1 in Schools and SUBS in Schools against the Australian National Curriculum.



Importance of Programs Being Cool

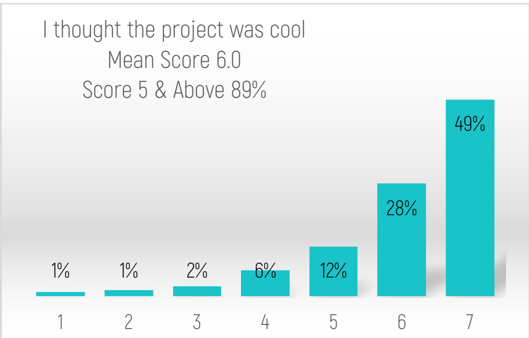
The concept of "Coolness" plays a pivotal role in shaping students' interest and self-efficacy, as highlighted by Bandura's Theory of Perceived Self-Efficacy. Emotional engagement, sparked by interest and anxiety mitigation, is essential in nurturing self-efficacy beliefs. However, the digital age, marked by the ubiquity of social media platforms such as Facebook, Instagram, and TikTok, has introduced a new dimension to maintaining the appeal of educational programs. While offering opportunities for connection and expression, these platforms also present distractions that can divert attention from academic content, making it more difficult for programs to be perceived as "Cool" and engaging.

The generational characteristics attributed to Generation Z, including a seemingly intrinsic motivation and a tendency towards engaging in activities "just because they're there" (Sheahan, 2005), suggest a unique approach to life and learning. This generation has been described as over-nurtured and allowed to remain socially younger for more extended periods, which could contribute to their strong intrinsic motivation. Despite these traits, the challenge of drawing students of all generational definitions' attention towards specific careers or intervention programs is exacerbated in a societal context flooded with appealing technological distractions.

In this study, 94% of students perceived the programs as "Cool," indicating their effectiveness in capturing student attention and aligning with their interests. Interestingly, for girls, the perception of the program's "Coolness" emerged as a prominent predictor of their positive response, underscoring the importance of aligning program characteristics with students' interests and cultural trends.

Furthermore, the research uncovered that students with higher intrinsic motivation levels were likelier to engage in programs that resonated with their interests. Therefore, the "Cool" factor is crucial in attracting students and fostering a connection to the subject matter. Programs like F1 in Schools, with its ties to the glamorous world of Formula One racing and opportunities for students to interact with racing heroes, utilize industry-standard tools, and engage with professionals on captivating projects, epitomize the kind of "Cool" that appeals to students. Similarly, the SUBS in Schools program benefits from the involvement of Navy personnel, whose uniforms convey authority, discipline, and success—qualities students admire in role models.

For industry stakeholders aiming to develop intervention programs that resonate with today's students, ensuring these initiatives meet the "Cool" criterion is essential. Without this appeal, programs struggle to break through the noise of daily distractions and genuinely engage students. Offering students access to a diverse array of mentors, role models, and heroes who embody the characteristics students find appealing is vital to crafting intervention programs that capture their interest and guide them through the complex landscape of career exploration. By prioritising "Coolness" in program design, educators and industry professionals can create more engaging, effective, and impactful learning experiences that align with contemporary students' motivational drivers and cultural zeitgeist.



2018 F1 in Schools World Champions
Team Hyperdrive – Trinity Grammar School, Kew Vic.

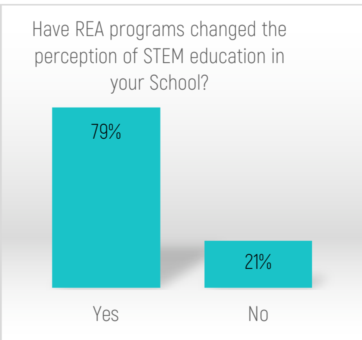
Program Influence on Schools and Teachers

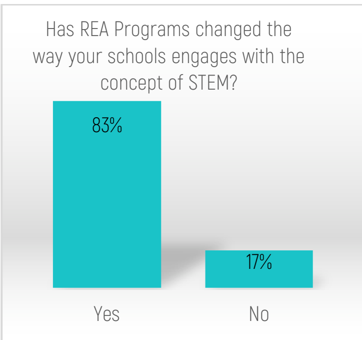
Introducing specialised programs to enhance STEM education and foster an interest in different industries among students has sparked significant interest among educators and researchers alike. These programs, designed to bridge theoretical knowledge with practical applications and industry insights, have the potential to not only inspire students but also to bring about transformative changes within educational institutions. As part of our research into the efficacy and impact of these initiatives, a particular focus has been placed on understanding how these programs have been received within schools and, more specifically, by the teachers who are instrumental in their implementation and success.

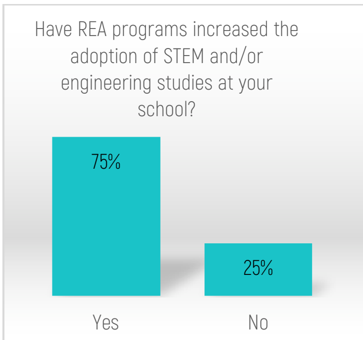
Teachers, as the primary facilitators of these programs, are uniquely positioned to observe and report on the changes and impacts these initiatives have on their schools and, by extension, their professional practices and attitudes towards STEM and industry education. Their insights are invaluable in assessing the value and effectiveness of these programs, providing a direct line of sight into the potential benefits, challenges, and transformative capacities of these educational interventions.

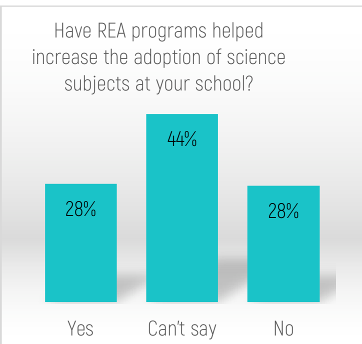
The feedback teachers provided regarding the impact of these programs in their schools and their attitudes towards the program's outcomes form a crucial part of our research. It serves not only as a testament to the programs' immediate effects but also as a gauge for the long-term implications of these initiatives on the educational landscape. This feedback encompasses a range of perspectives, from changes in student engagement and interest in STEM fields to alterations in teaching methodologies and curriculum development. It even shifts the school culture towards a more innovation-oriented and industry-linked approach to education.

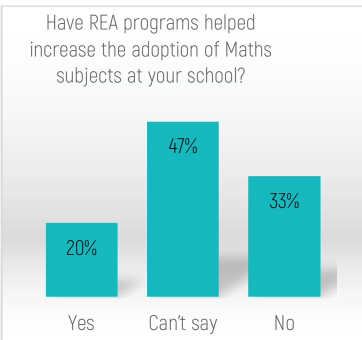
Understanding the influence of these programs on schools and teachers is essential to our research goals, which aim to evaluate the broader impacts of linking educational content with real-world applications and industry needs. By delving into the experiences and attitudes of teachers, our research seeks to uncover the multifaceted effects of these programs, not just on student outcomes but also on the educators who play a pivotal role in shaping the future workforce. Through this exploration, we aim to identify best practices, potential areas for improvement, and the overall significance of these programs in preparing students for careers in STEM and industry, thereby contributing to a more robust and relevant educational framework for the challenges of the 21st century.

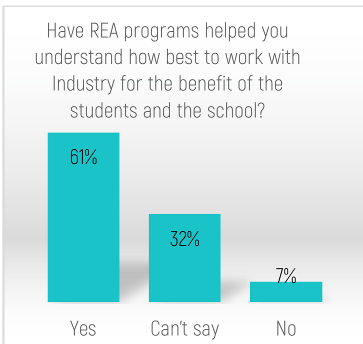


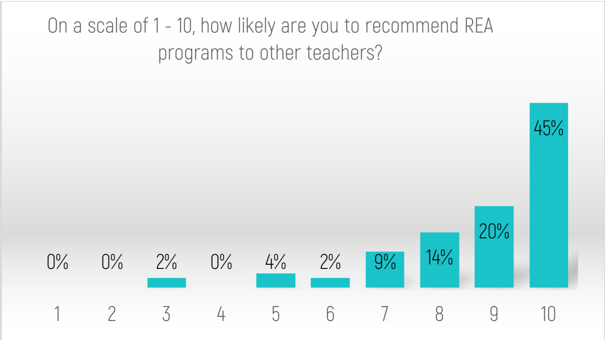


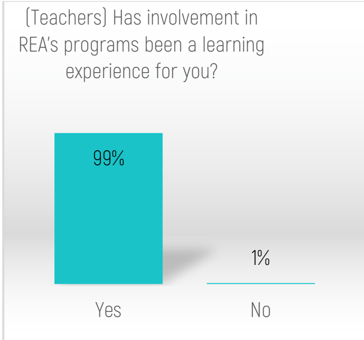












Observations

The research into the effects of educational programs on schools and students, as observed by teachers, provides invaluable insights into the dynamics of learning environments and the potential for transformative educational experiences. Teachers, being on the frontline of educational delivery, offer a unique perspective on how such programs influence student engagement, motivation, academic achievement, and the broader school culture.

Teachers observed that implementing the programs led to a noticeable increase in student engagement and enthusiasm for learning, particularly in STEM subjects. The hands-on, experiential learning approach advocated by these programs seemed to resonate deeply with students, sparking curiosity and an eagerness to explore complex concepts. This shift was evident in the students' attitudes towards specific subjects and reflected in their overall approach to learning and school participation.

Moreover, teachers reported improvements in students' collaborative skills and teamwork. The programs often required students to work in groups to solve real-world problems, mirroring the collaborative nature of the modern workplace. Through these activities, students developed more vital communication skills, learned to negotiate roles and responsibilities, and gained an appreciation for the value of diverse perspectives in problem-solving. These skills are essential for success in any career path, underscoring the programs' role in preparing students for future challenges.

The integration of these programs into the school curriculum also had a significant impact on teaching practices. Educators adopted more facilitative roles, guiding inquiry and exploration rather than delivering content in a traditional lecture format. This shift allowed for a more dynamic classroom environment and encouraged teachers to engage with the material in new and innovative ways, often leading to professional growth and a renewed passion for teaching.

From a school-wide perspective, the programs created a culture of innovation and continuous learning. Schools that successfully integrated these programs into their curricula often saw an uplift in their identity as a forward-thinking institution committed to providing students with the skills and knowledge needed to thrive in the 21st century. This, in turn, positively impacted the school's reputation and community perception, attracting more students and resources.

Teachers also highlighted the positive impact of the programs on students' career aspirations. Exposure to real-world applications of STEM and interactions with professionals in the field helped demystify these career paths, making them more accessible and attractive to students. This exposure is critical in broadening students' perspectives on potential career options and helping them make more informed choices about their futures.

In summary, the research from teachers' perspectives underscores the multifaceted impact of educational programs on students, educators, and schools. By fostering engagement, enhancing employability skills, and encouraging a culture of collaboration and innovation, these programs enrich students' educational experiences and equip them with the tools necessary for success beyond the classroom. The observations made by teachers are a testament to the potential of well-designed educational programs to transform learning environments and outcomes, highlighting the importance of continued investment in and support for innovative academic initiatives.

Teacher Feedback

The following is some of the qualitative data collected from teachers in response to the question: "What are the positive aspects of REA's programs that stand out for YOU as a teacher?"

- I love the program and love the rigour that is required to be successful. The feedback is excellent.
- Yes, this is the best experience for any student at a school! Thank you, REA.
- A very worthwhile educational initiative that applies knowledge and skills to relevant contexts for ambitious students.
- Been a tough few season,s one of the biggest buzzes is a live event where students see, hear, interact and form new friendships and a common understanding. As restrictions lift, bringing back students to experience the live event and rewarding them for their hard work with sideline events and expos or experiences adds to the value of their effort throughout the program. It's more than just a certificate or medal. Experiences are lifelong memories.
- I'm still loving this competition, although I may not be at Canberra High long enough to compete in the 2022 season. If I leave, I'm not sure if anyone will pick up the mantle. Many of the students who dropped out during the COVID lockdowns have already returned so I've got 13 students without even advertising the program and several Year 7s have expressed an interest.
- None thank you. I understand the benefits of running F1 in schools and Subs together for nationals this could also make it challenging for schools to be able to finance multiple teams to attend the event. The combination with the Australian F1 Grand prix is this going to make accommodation and flights more expensive to attend?
- Amazing program
- It was great having both the F1 in schools and subs in schools together. Our students got so much more out of this experience compared to past years.
- F1 in Schools is such a valuable program and has delivered amazing outcomes for our students. Their personal growth has been a delight to see!
- I am so grateful of the experience to mentor and support my students in Subs in School program. I also enjoy the discussions with the Mentors from SAAB and they have been helpful to the students. Keep up the good work.
- I love REA programs. F1 in Schools and now Space in Schools is having a hugely positive impact on our school, and our community. Students who started F1 in Schools in 2017 at Joseph Banks as Year 9's (a bumpy year as we established the program here) graduated from Year 12 and many of the students are now perusing Engineering, CAD and design at their universities next year. I have no doubt REA programs played a role in them perusing that as a career pathway. REA programs have given our current students at Joseph Banks a chance to excel and shine.
- Currently working on inviting 'sister' school to be involved with our boys in the F1 in Schools program. This is a fantastic program.
- The REA runs by far the greatest STEM challenges for school students in the World. Just great to be a part of it.
- Students are a bit overwhelmed with all the rules and regulations.
- This is a wonderful program and I look forward to expanding it at our school.
- We would like to thank the REA team for their ongoing support and wonderful programs offered to Australian students.
- Currently our small number of high-end students love the program, but many our students are below the state literacy and numeracy achievement levels. I believe the REA programs are fantastic, but the competition requirements can be quite high compared to our student academic level and this scares students away from wanting to compete. Being able to include older students in the F1 development class competitions could increase our team numbers entering the competition.
- Continuing to develop and refine the matrix for students. This will assist in the clarity of understanding and development of what is required within each of the criteria.
- Working as a team, developing "soft" skills - resilience, problem solving, collaboration
- Industry engagement, real life problem solving, nationally recognised competition.
- Chances to network, share, knowledge, develops workplace skills, exciting to race cars, feels very professional, plenty of opportunities offered through program.
- See student's confidence grow, see them become more resilient, see organisation and teamwork develop.
- Opportunity to compete against other schools and see what they've achieved.
- Engages students, STEM focused, a great mixture of cross-curricular.
- A program with clear goals and accountability in a competitive environment.
- Supports cross-curricular STEM projects in our classrooms.
- Holistic nature
- Pathways from primary, secondary, industry, STEM careers.
- A multidisciplinary approach, real life, people skills/confidence involved.
- Scaffold a project to aim towards competition as a reward and a goal.
- Seeing learning in a new way by working on "real world" projects. Soft skills
- Communication, collaboration, the buzz of the boys.
- Links in industry.
- Project-based learning. Learning to be self-directed learning
- A supportive, room for the students to grow in their work and different levels of competition.
- Bringing kids out of their shells.
- Friendly competition amongst schools. Teamwork, collaboration.
- REA makes some disengaged students happy to come to school. They look forward to learning.
- Diligence, fairness, engaging competitions.
- Structured, well-resourced, and documented. Well organised. Challenging but attainable.
- Competitive nature, real-world connections, goals
- Development of the student. They have improved employability and are better placed to cope with schoolwork.
- The non-competitive nature, you're competing to be your best, not competing to beat the other team.
- A larger proportion of girls than boys are involved. Students see what other students can do.
- Development of the student. They have improved employability and are better placed to cope with schoolwork.
- Competition and inter-school relations.
- Girls that have participated previously are now studying electronics and advanced design in Yr. 12
- For me, it's the teamwork connection to the industry and the establishment of 'their' brand.
- Although I feel the day was successful, and for the most part students gained many life-ready skills throughout the program. I really do feel the NSW state competition was great and to see this competitiveness and strive to be successful from the students was rewarding.
- Thank you. Your passion, enthusiasm, and commitment to the wide range of STEM programs and the corporate and government engagement you have and continue to secure to support this excellent program is fantastic. I appreciate the challenge the last few years have had on the program and wish it can continue and build whilst meeting the students where they are at and the challenges to re-enthuse students to undertake a compelling and life-changing STEM competition.
- Thank you so much for everything! F1 in Schools is a brilliant program for our school; as a small school, we can manage it.
- excellent work REA; thank you for providing exceptional ongoing opportunities for Australian students, and congratulations on 25 years of success.

- Our students and school, in general, have greatly enjoyed the F1 In Schools program, and due to limited participating numbers in our school, it is very hotly contested to participate.
- A program that has an authentic assessment that incorporates teamwork and collaboration.
- Allows students to experience working in a multi-disciplinary team to work together to solve engineering problems in a way that mimics real engineering.
- The Challenge of the program is to extend Collaboration and involvement with the 'outside' world - i.e., Industry.
- Confidence and real-world experiences are not possible in the classroom.
- Confidence to present to Industry professionals.
- Ability to work through difficult situations as a team.
- Ability to think on their feet and problem-solve on the run.
- Confidence, collaboration, seeking best practices in all disciplines involved.
- They are creating maturity in students. Building resilience and collaboration in students exposes them to skills outside of what the standard curriculum can offer.
- Developing teamwork and collaboration skills, Industry partnerships that encourage students and offer future pathways.
- Early adoption and development of CAD skills are lifelong assets for the next generation.
- They develop intrinsic solid motivation amongst students to extend their knowledge and skills in certain areas.
- It gives students experience with how projects run in the real world and an opportunity for students to utilise skills from many different disciplines.
- Hands-on, relevant to career opportunities, real-life deadlines, collaboration
- Having an opportunity to get to know the students better and work with them whilst they grow. I saw them start with soft skills and broad ideas and watch it unfold. Some students displayed potential, but they surpassed what I imagined when they had an opportunity to step up. In addition, the opportunity for students to learn about documenting, organising, and collaborating in this program gives them a unique opportunity to appreciate how being organised helps the team and the project in the long run. Finally, what brings other boys not entering? Showing up to support some of the newer members was impressive.
- High-level engagement in real-world, challenging environments.
- I love how the boys need to read deeply and be able to work together to articulate their vision for their team. They're growing up and maturing as they do this. I like that it is hard!
- I like the real-world aspects of the challenges, and those students must meet criteria given to them by an external provider instead of a teacher.
- The employability skills students are exposed to during the program.
- It makes the students read technical information closely, enhances responsibility and teamwork, and is FUN!
- It teaches soft skills and uses multiple disciplines of STEM (not biased to one subject)
- Large-scale project development and skills attained through the completion of it
- You are learning life skills that they can only learn by facing challenges.
- Learning the students achieve much more than in a typical curriculum. Creating life-long learners ready for 21st-century life!
- Most of the students that engage in Years 9 and 10 and stay with the competition go on and become student leaders in the senior school. The most tangible development of students occurs with their increased confidence in communicating with Industry leaders and politicians.
- Outcome-based learning. Hands-on learning and an emphasis on teamwork. Students must think about all aspects of their build for the documentation. Excellent mentoring from SAAB
- It was overcoming adversity. The teams hit every hurdle possible (not counting COVID) but still completed the project.
- Positive interactions within teams, between groups competing in the same category, mentoring new units, or among students who show difficulty within specific aspects of their role.
- Project management. Teaching and watching as the teams must plan their activities despite the many unknowns. The teams that understand planning last, while the others that are just there for the uniforms drop out quickly as they become overwhelmed.
- They are setting a rigid structure and professional thinking toward what the students are doing.
- Students are learning to communicate with Industry, increase in confidence, and real-world experiences.
- Teamwork & perseverance. It's a massive task to develop all the aspects of judging, especially as an extra-curricular.
- Teamwork, digital development of skills and knowledge, and students' confidence in their abilities.
- The ability to adopt a program in a school and have all the information needed to get it running.
- The alignment to real-world/Industry imperatives like the need for a plan, documenting work completed, distributing tasks among everyone in the team, managing the project, producing the required deliverables, and meeting deadlines.
- The communication between students and staff within your school and in collaborations. The visits from mentors to the school provide real-world Industry knowledge. Site visits also enable the students to see what happens in these industries. The teamwork and problem-solving skills that students develop.
- The extension of nature takes students outside their comfort zones and provides them with real-life experiences.
- The fact is that the students can innovate beyond their years. The adaptation of concepts into reality and their capacity to problem-solve. Their drive and willingness to take on such a massive challenge in an arena with students significantly older than them have been phenomenal. The power of the students to build relationships with mentors is profound. For example, watching Celestial 2020/21 World team members being mentored by members of the 2014 World team Gamma Ray-cing and now to see Fast Fusion being mentored by Celestial is an incredible legacy. The Macarthur Hub is going from strength to strength. All teams involved in this State level of competition were so supportive of each other - the F1 in Schools program has put students from Years 5 through to Year 12 in a high pressure, high stakes melting pot, and the outcome has been immense academic growth and exponential development of the 'soft skills'. Thank you, REA, for providing this opportunity for our students!
- The inclusive nature of REA's programs. F1 in Schools is a competition that ALL students can participate in no matter what their ability. It builds students' confidence and communication skills, preparing them and providing them with lifelong learning skills for their future.
- The organisation of final events, communication, support & following the rules & regulations for competitions. Make sure everyone is equal.
- The REA team and support. Dedication to the growth of young Australians. They are providing opportunities like no other STEM program.
- The student's confidence and application to schoolwork improve significantly.
- The Subs in School allows our students to accomplish a big project, work on a team and experience real-world connections with the industry (the sponsors).
- The whole f1 program is positive. Too many to mention. Exposing kids to all facets of STEM is great.

ENGAGEMENT WITH INDUSTRY

Students' Perspectives

Tackling the skills shortage within STEM fields necessitates a holistic and enduring approach, transcending mere economic incentives to enhance how students perceive and engage with STEM careers fundamentally. The reliance on traditional academic metrics fails to capture the essence of a candidate's potential, especially concerning skills highly regarded by employers, such as conscientiousness. Traits of conscientiousness, including diligence, reliability, and meticulousness, are invaluable in the workforce, underscoring the need for educational programs to foster these qualities, thereby smoothing students' transition into professional environments.

A distinctive element of the REA programs is their emphasis on meaningful student engagement with the industry through project-based learning. This hands-on approach demystifies the connection between academic pursuits and their practical applications in the workforce, offering students a glimpse into the real-world implications of their studies. By integrating industry collaboration and mentorship into the curriculum, REA programs facilitate technological literacy and career exploration and adopt a proactive strategy to draw students towards careers that resonate with their interests and competencies. This engagement deepened through competition criteria that encourage students to conduct and present career-focused research, thereby solidifying the link between their academic projects and future career paths.

Moreover, these programs equip students with personal and professional skills crucial for workplace success, including collaboration, strategic planning, and effective communication. Such skills are nurtured through direct interactions with industry professionals, who provide mentorship and real-world context to the theoretical knowledge acquired in the classroom.

The industry's role in fostering a robust pipeline of future STEM professionals is indispensable. While educational interventions lay the groundwork for student interest in STEM, the transformation into dedicated STEM career pathways hinges on active industry support. Engagement with industry professionals offers students access to role models and in-depth industry knowledge, which are pivotal in shaping students' career aspirations. Hands-on experiences with real-world projects, under the guidance of industry mentors, not only enhance students' understanding of professional environments but also forge emotional connections with careers outside the academic sphere.

A sustained and committed effort is required for the industry to effect meaningful change in student career orientation towards STEM and engineering. This includes adapting organisational practices to ensure ongoing program support and actively participating in initiatives that expose students to the myriad opportunities within STEM fields. Industry stakeholders must acknowledge their pivotal role in guiding student career decisions and dedicate resources to initiatives that inspire and empower students to embark on STEM careers.

In essence, the collaboration between educational programs and industry partners is crucial in bridging the gap between academic learning and professional practice. By fostering environments that encourage exploration, mentorship, and real-world application, we can inspire a new generation of students to pursue fulfilling and impactful careers in STEM and engineering, ensuring a well-equipped workforce for the future.

Defence & Industry Perspective

The involvement of the Defence Industry in supporting STEM programs is motivated by the altruistic desire to broadening the pool of individuals proficient in STEM, which will in the long term benefiting all sectors of Australian industry. Historically, the hierarchy of technological development has positioned space exploration at the apex, owing to its role in addressing non-existent challenges on Earth. This exploration has led to breakthroughs in materials and technologies such as carbon fibre, titanium, 3D printing, high-temperature insulation, and the advanced application of computers. These innovations initially served space exploration but gradually cascaded down to benefit Defence, aerospace, automotive industries, Formula One racing, and broader industrial applications, eventually permeating everyday life. This top-down dissemination of technology has been a critical force propelling societal innovation.

The race to the moon, ignited by President John F. Kennedy, exemplifies how high-stakes technological endeavours can capture the global imagination, offering a vision and mystique around what high technology can achieve. The moon landing was a pivotal moment, captivating children worldwide who were mesmerized by the astronauts and the sheer audacity of space exploration. This historical event linked heroes and role models to the aspirations of the youth, illustrating the profound impact that ambitious technological pursuits can have on motivating and inspiring the younger generation.

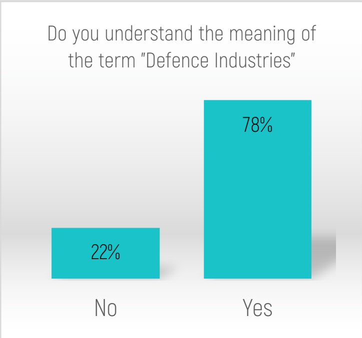
This enduring fascination with reaching for the stars and engaging with high-tech innovations underscores the importance of continuous industry engagement with students. By fostering interest in STEM careers, particularly those high technology careers offered by Defence Industry, we can cultivate a culture of innovation and forward-thinking that is crucial for the nation's future. The Defence Industry, with its rich history of driving technological advancements from the top down, possesses an intrinsic capability to inspire students. By exposing them to cutting-edge technologies and the challenges of modern defence needs, the industry can ignite a passion for innovation and problem-solving in young minds.

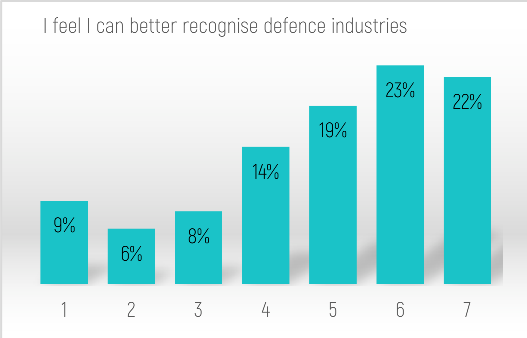
Engaging with the Defence Industry offers students unparalleled insight into the practical applications of STEM education, bridging the gap between theoretical learning and real-world application. This exposure not only motivates students by showing them the tangible outcomes of their studies but also provides them with role models and heroes in the form of engineers, scientists, and innovators who have contributed significantly to our technological progress.

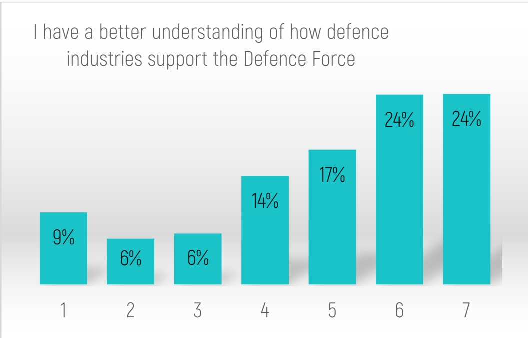
The strategic involvement of the Defence Industry and industry in general in STEM education initiatives is vital for inspiring the next generation of innovators and problem-solvers. By highlighting the exciting possibilities of a career in STEM and demonstrating the impact of technological advancements on society, industry plays a crucial role in shaping a future that continues to reach for the stars, driven by curiosity, innovation, and a desire to solve the grand challenges of our time.

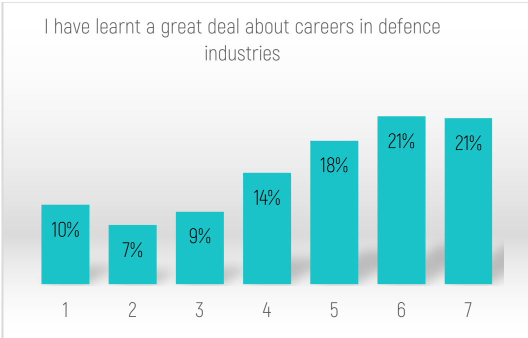
Student Interaction with Defence Industry

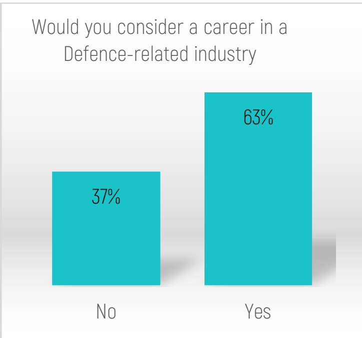
The following are students' responses to their involvement with Defence Industries.

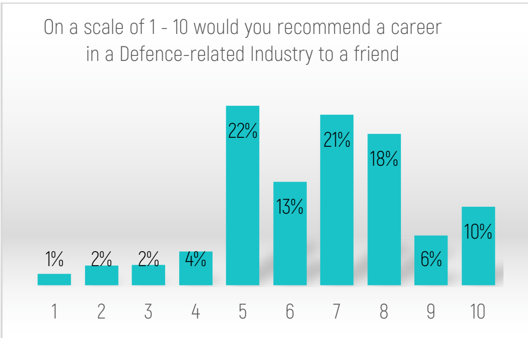




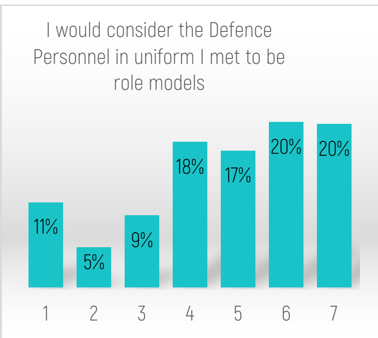


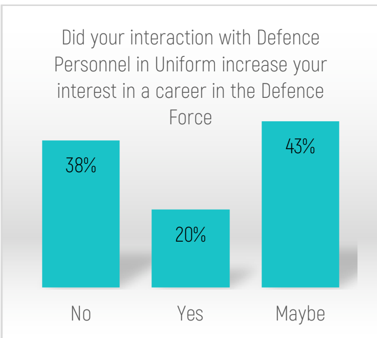


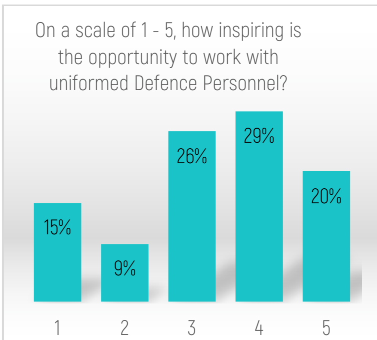




Student Interaction with Defence Personnel







Note: Due to COVID-19, students had minimal access to Defence personnel or Defence Industry mentors

Student Qualitative Feedback

The following is some of the qualitative data collected from students in response to the question: **"What interests you about a career in a Defence Industry?"** Some of the responses indicate that many students do not appear to separate Defence from Defence Industry. The students may not have a logical reason to separate the two in their perceptions.

- It allows different pathways as well as being a place where you can serve your country.
- The capability of what you can do and how to inspire others.
- The technology used in various defence Industry subdivisions.
- Knowing that I helped people achieve things.
- Designing and engineering in the Defence Industry
- That you have a chance to pursue what you love
- STEM is engaging, fun and widely used.
- I would be interested because I would be proud to represent the country.
- The diversity of the industry employees and all the different types of jobs available for all different skill sets.
- The ability to use advanced technology to help the defence force.
- The roles that support the ADF are essential, and as the Defence Industry supports the ADF, it is vital to involve a range of people and roles.
- The multiple aspects to it in enterprise/engineering
- The hands-on work, meeting new people, and having the chance to make a positive impact.
- The broadness of the topic and how it involves many companies and people.
- I am most interested in a career in the Defence Industry because of the ability to support people using my knowledge in STEM areas like aeronautical engineering.
- Aerospace engineering or any other defence Industry career which is related to engineering.
- The engineering of medical machines.
- Being able to use the technologies available to help protect the country.
- Helping people and marketing, as that is what I also specialise in F1 in Schools. Also, a lawyer for the Defence Industry.
- Sounds like a cool job. You're also well looked after by the government.
- The number of opportunities and flexibility with the sort of job
- While not my current first option, the idea of being able to contribute to a more significant project and support those across the country is a very appealing aspect of Defence Industry jobs.
- The wide range of things you can do and opportunities available; the challenges and work is interesting
- Being able to participate in such an important Industry sound like a cool opportunity.
- You can pursue many careers in the defence force–some of which are engineering and other related fields.
- Being able to work side by side with people who have the same goal and Interests as me
- Helping others and contributing to keeping the country safe
- I've always wanted to branch off into a career in medical sciences or to become a general practitioner; a career as a medic in the Navy provides just the challenge and adventure I've been looking for; I hope to explore this field someday further, and potentially offer services in the Australian Defence force.
- How you get to use different machines and get to learn about different materials
- F1 in schools has been super fun and interesting, as should the defence Industry.
- I want to help people; I want to be part of the Military, working with planes.
- Designing is something I'm very passionate about and having the opportunity to become a graphic designer is awesome.
- Being able to advance the technology we already have would be pretty cool.
- I would consider becoming an Engineering Officer; however, now I want to become an Infantry Officer
- Being able to advance the technology we already have would be cool.
- how you get to use different machines and get to learn about different materials
- I'm very passionate about design and having the opportunity to become a graphic designer is awesome.
- I've always wanted to branch off into a career in medical sciences or become a general practitioner, a career as a medic in the Navy provides just the challenge and adventure I've been looking for, I hope to explore this field someday further and potentially provide services in the Australian Defence force.
- Being able to work side by side with people who have the same goal and Interests as me
- There are many careers that you can pursue in the defence force. Some of which are engineering and other related fields.
- Being able to participate in such an important industry sounds like a cool opportunity.
- The wide range of things you can do and opportunities available; the challenges and work is interesting
- Aerospace engineering or any other defence industry career which are related to engineering.
- While not my current first option, the idea of being able to contribute to a bigger project and support those across the country is a very appealing aspect of Defence Industry jobs.
- I am most interested in a career in the Defence Industry because of the ability to support people using my knowledge in STEM areas like aeronautical engineering.
- The hands-on work and meeting new people. Having the chance to make a positive impact.
- The diversity of the industry employees and all the different types of jobs that are available for all different skill sets.
- I think that the roles that support the ADF are important, and as the Defence Industry supports the ADF, I think that it is important to have a range of people and roles involved with it.
- Things that interest me in a career in the defence industry are helping people achieve things I did to help them.
- Due to the pandemic, we didn't have the opportunity to engage with the Defence Industry, and therefore, I wasn't able to form an interest in it.
- that there are multiple different occupations in the Defence industry
- The engineering and designing perspective could interest me in a career.
- The defence industry interests me because after completing this course, I realised that there is 6 more opportunities within the defence industry
- I would take on a design engineer role in CEA.
- Helping those in need, if you design or make something for the defence industry, you know you are helping people, and that feels great.
- being good at STEM and the ability to make something helpful.
- That you get to see all the technology used in the world today by industries in the defence
- Engineering range of jobs available, selected universities and degrees paid for, and a possibility to travel to places I've never been before.
- Mechanical engineering, marine engineering, combat systems
- Just mainly the fact that being in the defence industry allows me a chance to feel like the work in which I would be doing is helping my entire country.
- Many of the careers utilise the skills of which I have learnt and really enjoy doing.
- Defence is an extremely important industry that is full of stem and opportunities. I think the engineering behind defence is fascinating.
- I would consider a career in the defence industry to further my experience towards reaching my goals.
- Be able to help people in an easier and more accessible way.

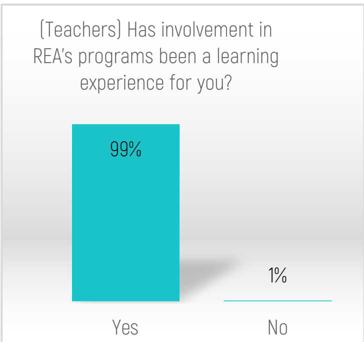
- The feeling of being part of a team. As we weren't allowed into any competition and I didn't meet anybody, I found it hard to answer some of these questions because I was never there.
- High-level company and jobs, but slow adoption of cutting-edge technology and slower hierarchy system
- An exciting and ever-changing workplace allows me to grow in knowledge and experience.
- That there are a variety of opportunities and jobs in the Defence Industry that will always be needed in our society, many of which are extremely interesting.
- I like the idea of working with a team and seeing the outcome of my work.
- Most likely a career as either a Field Medic or something like a Radar technician in the Navy.
- As an engineer whether it be mechanical or manufacturing. My dream job would be a design engineer for Loch heed Martin.
- Possibly the engineering aspect of the navy
- The wide range of interesting opportunities that you wouldn't have access to anywhere else.
- Being an engineer, creating strong bonds with people and working as a team.
- Repairing and designing products with relatively high job security
- It would be interesting to see what the defence industry can accomplish with all the new technology.
- I would like to be a part of the medical career within the defence industry.
- I think I'm still going to go to a coding industry but a defence industry would be the be the next thing because it definitely my second dream job after computer programming
- As I said, the career sounds very interesting and fun. It shows 6 of problem-solving and quick-thinking skills that I might enjoy participating in in the future.
- Exploring the many opportunities and learning new skills and topics.
- Helping to manufacture products that the military and Department of Defence is very interesting.
- It shows that you can have a job outside of the defence force but also be involved in the industry.
- You can have a job outside of the defence force but also help them.
- You get to build technology that may be used on the front lines.
- To create and design world-binding technology that could one day change the world.
- To improve people's lives by inventing new valuable technologies.
- the way they manufacture equipment for all of the defences which will be used to defend us
- It would be a great and rewarding experience to be able to get a career in the Defence industry.
- As mentioned prior, the range of skills and knowledges are both intriguing and interesting in which I believe would resonate with me. Additionally, a career in the defence industry would provide both many benefits and skills.
- It is fun, exciting and I could potentially make a big change towards the safety of our country and to being new technology to advance our defence industry.
- The Defence Industry would be interesting as you would be supporting the Defence Force and come in contact with a variety of people. The job availability would be very diverse.
- Defence industries are technical, decently paying jobs that relate to fields of study I am interested in.
- The fact that we are doing work that affects the way that others see Australia, and the responsibility it brings.
- I like engineering and this competition has shown me all the possibilities in the defence industry for engineering.
- The defence industry is appealing as I would be able to design and create products for the defence force.
- What interests me is that the Defence Industry involves many different fields of study, all of which can, are or will be used by the respective country's Defence Industry.
- I am interested in helping people in the defence force and helping peers in the defence industry.
- In Defence Industry you have a wide array of different opportunities where you are able to gain skills that aren't usually obtained.
- I would still be scared considering the risks, but the manufacturing process would interest me.
- Advancements in cybersecurity technology and innovative concepts to achieve better cybersecurity on land, air, and sea.
- I am most interested about the technology used by the defence industry.
- I like working with problem solving and working problems out. I like engineering and I know working in a defence industry will hely extend me in these areas.
- I find all of the opportunities to further develop my design skills, as well as make a meaningful impact on society quite interesting.
- There would be more of use for aerodynamics.
- The connections and collaboration with other industries
- Application of engineering concepts
- It would challenge me in certain areas and get me to think differently about our world.
- My main motivations for this stem from my love for engineering, especially found in the F1 in Schools competition. I would love to delve more into real-world applications.
- The different jobs are available for those industrials and the possible related skills.
- The different STEM careers and options cater towards ability and interests.

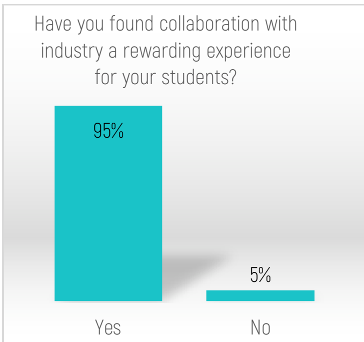
Impact of Industry Engagement on Teachers' Attitudes

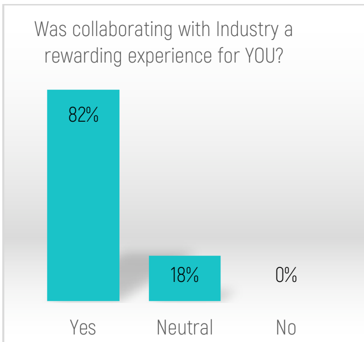
Throughout the research process, it became increasingly clear that teachers harboured reservations about their ability to facilitate STEM-based career interventions within their classrooms effectively. Many educators lacked confidence and proficiency in navigating experiential learning initiatives within the STEM disciplines. This apprehension is further compounded by a gap in understanding among some educators regarding the societal contributions of engineering and other STEM professions. While the primary focus of this study was to unearth the motivational drivers influencing students' career choices, these findings underscore the imperative need to bolster teacher support in this critical area.

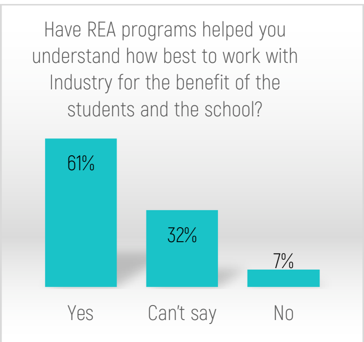
Teachers are instrumental in shaping students' educational journeys, frequently acting as the primary influencers and role models capable of broadening students' horizons beyond their immediate experiences and knowledge bases. To enhance teachers' effectiveness in orchestrating career-oriented interventions, it is essential to equip them with an arsenal of resources, targeted training, and opportunities for professional growth. This necessitates a concerted effort from the educational sector and industry stakeholders to furnish teachers with the requisite support, fostering a conducive environment for executing impactful career interventions. Such interventions should elevate teachers' self-assurance, competency, comprehension of STEM career pathways, and aptitude for leading experiential learning.

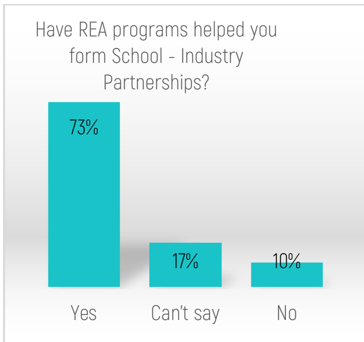
The synergy between the industrial sector and educational institutions is crucial in fortifying teacher support mechanisms. This collaborative Endeavor aims to mend the rift between academic learning and practical industry applications, ensuring educators are well-versed in the significance and applicability of STEM professions. By imparting educators with the necessary insights, tools, and pedagogical strategies, this partnership endeavours to cultivate a cadre of teachers who are knowledgeable about STEM fields and skilled in inspiring and guiding students towards meaningful career trajectories.











Investing in teachers' professional development is a strategic move that promises to amplify the efficacy of career intervention programs. Such investment acknowledges the central role that educators play in influencing students' career decisions and underscores the belief that well-supported teachers are pivotal to the successful implementation of career-oriented educational initiatives. The research sought to explore the effects of industry engagement on teachers' perceptions and understanding of career pathways, highlighting the transformative potential of industry-education collaboration in enriching teachers' career knowledge and instructional practices.

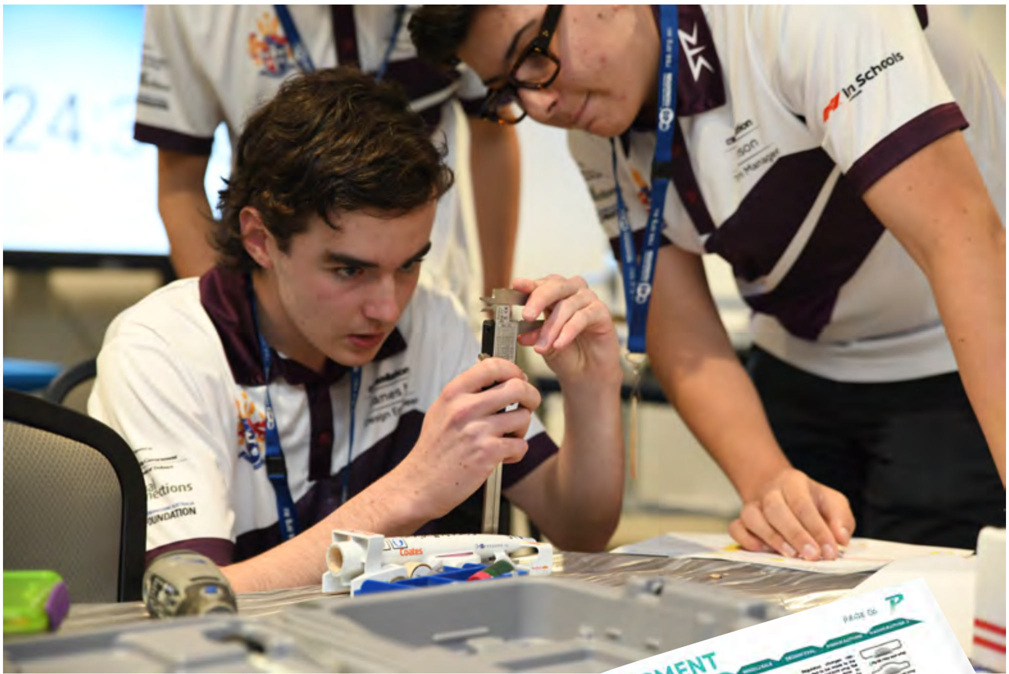
In summary, the research findings advocate for a more robust framework of support for teachers tasked with navigating the complexities of STEM education and career counselling. By bridging educational content with real-world industry practices, and by fostering a supportive network for teacher development, we can significantly enhance the quality and impact of STEM career interventions. This holistic approach not only benefits students by providing them with a clearer path to career readiness but also empowers teachers to become more effective educators and mentors in the rapidly evolving landscape of STEM professions.

Teacher Qualitative Feedback

The following is some qualitative data collected from students in response to the question: Are there any comments you would like to make?

- A program with clear goals and accountability in a competitive environment.
- Been a tough few years at school; one of the biggest buzzes is a live event where students see, hear, interact and form new friendships and a common understanding. As restrictions lift, bringing back students to experience the live event and rewarding them for their hard work with sideline events and expos or experiences adds to the value of their effort throughout the program. It's more than just a certificate or medal. Experiences are lifelong memories.
- Chances to network, share knowledge, develop workplace skills, exciting to race cars, and feel very professional, and plenty of opportunities offered through the program.
- Competition - students get to collaborate with other students from other schools.
- Continuing to develop and refine the matrix for students. This will assist in the clarity of understanding and development of what is required within each of the criteria.
- Our small number of high-end students currently love the program, but many our students are below the state literacy and numeracy achievement levels. I believe the REA programs are fantastic, but the competition requirements can be high compared to our student academic level, which scares students from wanting to compete. Including older students in the F1 development class competitions could increase our team numbers entering the competition.
- We are currently working on inviting a 'sister' school to be involved with our boys in the F1 in Schools program. This is a fantastic program.
- F1 in Schools is a valuable program and has delivered exceptional outcomes for our students. Their personal growth has been a delight to see!
- For me, it's the teamwork connection to Industry and the establishment of 'their' brand.
- A "Not applicable" response was needed for some questions as pursuing questions contradicted the previous response, hence an incorrect answer.
- Girls that have participated previously are now studying electronics, and advanced design in Yr. 12
- Great programs and outcomes for kids. Keep up the good work.
- I am so grateful for the experience of mentoring and supporting my students in the Subs in School program. I also enjoy the discussions with the Mentors from SAAB, and they have benefitted the students. Keep up the excellent work.
- I love REA programs. F1 in Schools and now Space in Schools have a hugely positive impact on our school and community. Students who started F1 in Schools in 2017 at Joseph Banks as Year 9s(a bumpy year as we established the program here) graduated from Year 12. Many of the students are now pursuing Engineering, CAD and design at their universities next year. I have no doubt REA programs played a role in pursuing that as a career pathway. REA programs have given our current students at Joseph Banks a chance to excel and shine.
- I love this competition, although I may not be at Canberra High long enough to compete in the 2022 season. I'm not sure if anyone will pick up the mantle if I leave. Many of the students who dropped out during the COVID lockdowns have already returned, so I've got 13 students without even advertising the program, and several Year 7s have expressed an interest.
- It is a rich program of skills and experiences that develop students for real life.
- It was great having both the F1 in schools and subs in schools together. Our students got much more out of this experience than in past years.
- Keep up the excellent work, and many thanks for running the program.
- A more significant proportion of girls than boys are involved. Students see what other students can do.
- Let's Say 2020 was a challenging year for all.
- I love the program and love the rigour required to be successful. The feedback is excellent.
- A multidisciplinary approach, real life, people skills/confidence involved.
- No, thank you. I understand the benefits of running F1 in schools and Subs together for nationals. This could also make it challenging for schools to be able to finance multiple teams to attend the event. Will the combination with the Australian F1 Grand Prix make accommodation and flights more expensive to participate in?
- Online competition due to COVID restrictions almost demolished the F1 in Schools program at the school. It takes the fun away, missing out on meeting other teams, and watching the races...
- Opportunities for the students, project-based learning.
- Opportunity to compete against other schools and see what they've achieved.
- Project-based learning. Learning to be self-directed learning
- REA makes some disengaged students happy to come to school. They look forward to learning.
- See student's confidence grow, see them become more resilient, and see the organisation and teamwork develop.
- Seeing learning in a new way by working on "real world" projects. Soft skills
- Some questions were difficult to answer and might not be valid for your survey as we had one student and his family bring this concept to the school. We weren't quite ready to get a whole team approach, so this motivated student went ahead on his own. I was just a liaison and mentor and helped with minor construction details.
- Structured, well-resourced, and documented. Well organised. Challenging but attainable.
- Teamwork and communication using all skills and concepts from STEM subjects in a project support transference of skills and knowledge.
- Teamwork, extending their competence at presenting.
- Thank you! Your dedication this year has been over and above. Your commitment has not gone unnoticed - Thank you!
- Thanks! The staff at REA are doing wonderful things. Michael Myers, for example, worked with one of my boys for hours at the state finals. He left with a massive smile, knowing that Michael cared for his learning. Subs in Schools NSW was a wonderful experience.
- The F1 model of education is fantastic. I love the integrated, cross-curricular approach.

- In the non-competitive nature, you are competing to be your best, not competing to beat the other team.
- The program forces students to work as a team and improve their collaboration. Their problem-solving skills have also been enhanced. This is an excellent cross-curricular program.
- The REA runs the most significant STEM challenges for school students in the World. Just great to be a part of it.
- This is a wonderful program, and I look forward to expanding it at our school.
- A very worthwhile educational initiative that applies knowledge and skills to relevant contexts for ambitious students
- We would like to thank the REA team for their ongoing support and wonderful programs offered to Australian students.
- Well done on getting it this far this year!
- Working as a team, developing "soft" skills - resilience, problem-solving, collaboration
- Yes, this is the best experience for any student at a school! Thank you, REA.



Influence of Parents

The existing literature on the impact of parental attitudes on students' career choices delineates a multifaceted network of influences that sculpt these pivotal decisions. While parental guidance undoubtedly plays a critical role in shaping the career trajectories of their children, the sway of peers and external factors becomes increasingly significant as students approach the threshold of the working world, typically around the age of 18 or older. This transition, especially pronounced in boys around the ages of 15 to 16, signifies a move towards seeking advice from peers and external sources over parents, aligning with the principles of the Neo-Darwinian Rational Choice Theory. This shift indicates a developmental stage where the influences of peers and external environments outweigh parental guidance in career decision-making processes.

For girls, this evolution towards autonomy in career decision-making occurs somewhat later. Research indicates that girls assert their independence in career choices after assimilating ample information from their social circles and the environments they navigate, including educational settings and industry interactions. This independence allows them to make career choices that resonate with their self-constructed social identity, crafted through peer interactions, rather than relying solely on parental input.

Participation in STEM programs elicits differing reactions from boys and girls, particularly concerning inspiration and role modelling. Boys show a marked increase in engagement with the inspiration/modelling aspect after involvement in STEM activities, suggesting a shift towards a more favourable view of STEM careers. Conversely, girls do not exhibit a similar change, pointing to a varied impact of STEM programs based on gender.

Further, the research uncovers significant variances in how boys and girls respond to influences such as parents, peers, and role models post-participation in STEM programs. Boys seem more open to parental advice on career decisions following the program, whereas a notable fraction of girls show a decreased tendency to heed their parents' career suggestions. This divergence highlights parental and role model guidance's different effects on each gender, with girls displaying a reduced receptiveness to role model counsel after engagement in STEM, suggesting a lesser influence of role models on girls compared to boys as they gain more exposure to the field.

In-depth regression analysis reveals contrasting impacts of role models on boys and girls. For boys, access to and interactions with role models are essential, with brief physical connections lasting influencing their career decision-making. Girls, however, view role models as sources of experiential knowledge necessary for navigating their current environment. While this advisory role is crucial, the connection to the role model diminishes shortly after the interaction, with girls valuing knowledge over personal connection.

This distinction extends to their receptiveness to parental career advice, with boys showing a slight increase in propensity to listen to parental suggestions following STEM program involvement. In contrast, girls demonstrate a significant decline, valuing the autonomy and knowledge gained from the program over parental input.

These findings emphasize the complex interplay between parental attitudes, peer influences, and educational programs in shaping students' career choices. The distinct responses of boys and girls to these factors underline the need for gender-specific strategies in career guidance and STEM education planning, ensuring that initiatives are designed to cater to all students' diverse needs and motivations.

Research Process

The research aimed to understand the influence of parents' perspectives on students' career choices in these programs and toward industry, particularly the Defence Industry. We encountered specific methodological challenges, primarily due to protocols around the anonymity and protection of children's data. To navigate these constraints, the research team employed a strategy that maintained the confidentiality of the students while still gathering insightful data from their parents.

The limitations imposed by research protocols, which prohibit the direct identification of children and, by extension, their parents, led the research team to devise a survey method that respects these boundaries. The surveys were anonymised to ensure no direct identification of the children, or their parents could occur. Instead, information was collected regarding the students and parents.

Survey administration was managed through the teachers, who acted as intermediaries between the research entity (REA) and the students—and, by extension, their parents. This approach ensured that the research team did not directly interact with the parents, thus maintaining compliance with ethical standards and privacy concerns. We did not interact with parents in a way that may influence or taint the data collected. The initial survey targeted specific areas of interest that were deemed valuable for understanding parents' perspectives on their children's involvement in the program and, in a broader context, the perspectives on the Defence industry. The survey questions aimed to gauge:

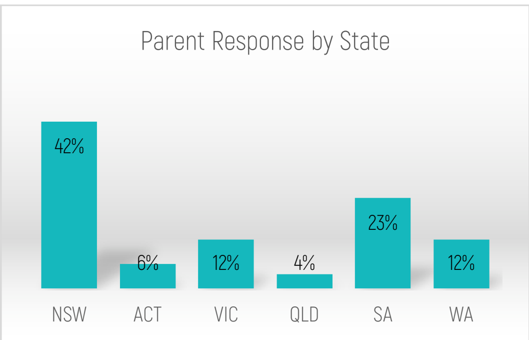
1. Parents' awareness of the program their children were participating in.
2. The extent of parents' knowledge about the Defence industries.
3. Their understanding of the Defence industries, considering the involvement of Defence Industry mentors and sponsors in the program.
4. Parents' perceptions of the Defence industries, with particular attention to any highly negative responses that could influence parental guidance on career choices.
5. Whether parents had considered a career in the Defence industries for their child.
6. Their understanding of the skills required for a career in the Defence industries.

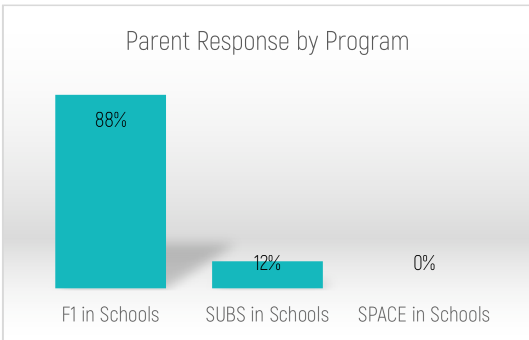
Results and Implications

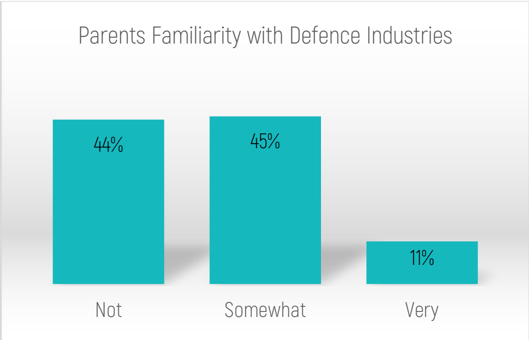
Focusing on these critical areas, the research uncovered how parental attitudes might influence children's career pathways, especially in sectors like Defence, with specific skills and knowledge requirements. This process collected responses from 114 parents in the initial survey round.

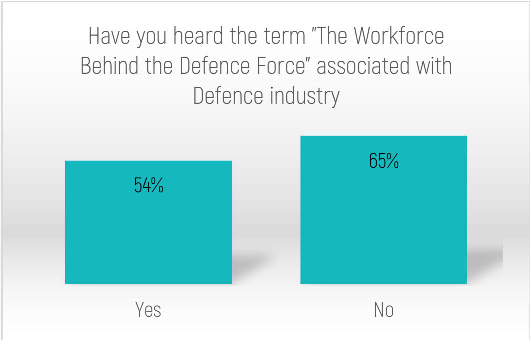
The results of these surveys are crucial for several reasons. They offer insights into the level of engagement and support students might receive from their parents' concerning careers in STEM and the Defence industry. Understanding parental awareness and perceptions can help educators and program designers tailor their outreach and engagement strategies to address misconceptions and highlight opportunities in these fields.

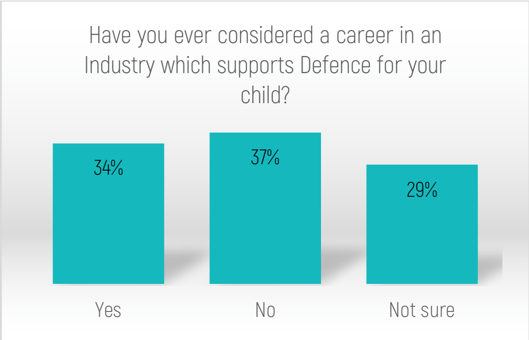
Moreover, the findings have implications for enhancing communication between programs and parents, ensuring that parents are well-informed and positively engaged in their child's educational and career exploration processes. This research underscores the importance of considering parental influence in the context of career guidance, especially in specialized fields like Defence, and highlights the need for strategies that effectively bridge information gaps between programs, students, and their families.

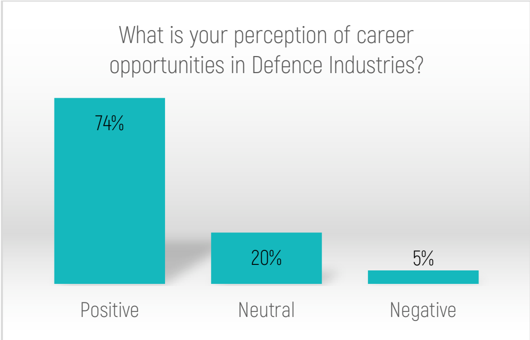


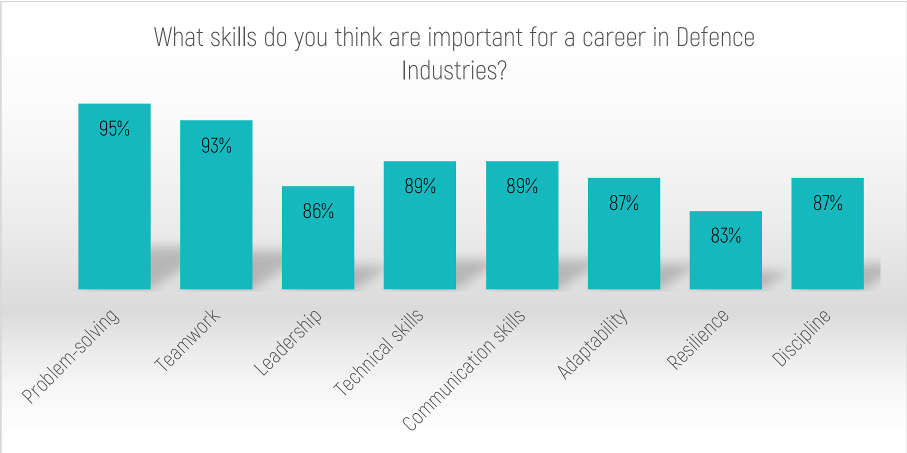



Parents Familiarity with Defence Industries
44%
45%
11%
Not
Somewhat
Very


Have you heard the term "The Workforce Behind the Defence Force" associated with Defence industry
54%
65%
Yes
No


Have you ever considered a career in an Industry which supports Defence for your child?
34%
37%
29%
Yes
No
Not sure


What is your perception of career opportunities in Defence Industries?
74%
20%
5%
Positive
Neutral
Negative


What skills do you think are important for a career in Defence Industries?
95%
93%
86%
89%
89%
87%
83%
87%
Problem-solving
Teamwork
Leadership
Technical skills
Communication skills
Adaptability
Resilience
Discipline

RECOMMENDATIONS

This research provides a nuanced understanding of the elements crucial for cultivating an interest in STEM among students and guiding them towards making informed career decisions. It underscores the significance of educational engagement, intrinsic motivation, the influence of parents and peers, and the critical role of industry collaboration in steering students towards STEM fields. Drawing from the findings, several key insights and recommendations emerge:

1. **Enhanced Collaboration:** The study reiterates the unchanged nature of factors influencing children's career choices since 2006, highlighting a paramount need for increased collaboration among industry professionals, educators, and policymakers. This united approach is essential to nurture and support the career aspirations of the next generation, preparing them for a future characterised by innovation and global competitiveness.
2. **Promoting Inclusive Participation in STEM**:
    a) It's essential to challenge gender stereotypes in STEM to enhance diversity and fairness. Research suggests that presenting STEM as a field without gender bias can help mitigate the negative impacts of gender-targeted promotion, leading to broader participation.
    b) Debunking the myth of natural gender inclinations towards STEM shows that interest levels in these fields are similar across genders. However, sustaining this interest requires different approaches for different genders. Developing tailored strategies to engage both boys and girls in STEM is key to achieving greater gender diversity.
    c) Expanding STEM career opportunities for girls is important, but the emphasis in media and governmental reports has predominantly been on encouraging girls, sometimes overlooking the importance of including boys. This imbalance negatively affects boys' participation and should be addressed.
    d) We should avoid projecting adult biases and historical gender assumptions onto students. The focus should be on creating an environment that welcomes all students. Evidence suggests that emphasising "Girls in STEM" may inadvertently deter boys from pursuing careers in fields they might naturally find appealing.
    e) The current emphasis on encouraging girls at the expense of boys should shift towards promoting STEM as a field that values contributions from everyone, regardless of gender.
3. **Development of Key Traits:** The importance of conscientiousness, discipline, and leadership within educational curricula is emphasised over traditional intelligence measures like IQ. Such traits indicate career success and should be integral to STEM programs to allow students' innate intelligence to thrive, ensuring equal opportunities for all.
4. **Redefining Academic Benchmarks:** In light of continuous technological advancements, traditional academic metrics are deemed insufficient for evaluating a candidate's suitability for modern workforce challenges. The study calls for a shift from relying on ATAR as the primary performance metric to recognising the value of practical engagement and outcomes in the National Curriculum, aligning more closely with industry needs.
5. **Parental Influence:** With 74% of parents viewing careers in the defence industry positively, this statistic challenges existing stereotypes and signals a shift in societal perceptions towards STEM careers. It suggests an opportunity for industries to increase their engagement with students, supported by the knowledge that most parental perspectives are favourable. In addition, over 50% of students indicated an interest in taking up manufacturing careers, which is a positive for the industry.
6. **Sustaining Australia's Leadership:** Highlighting Australia's achievement of producing eight sets of world champions through REA's programs, the research stresses the need for ongoing support from industry and government. Such support is vital to maintain Australia's leading position in STEM education and to build upon this success.

This study sheds light on the complex interplay of factors that foster a conducive environment for nurturing the next generation of STEM professionals. By embracing a multifaceted approach that includes motivational factors and mentorship roles and providing practical, real-world learning experiences, we can significantly enhance students' interest in STEM and guide them towards fulfilling careers. This comprehensive understanding paves the way for developing strategies that enhance STEM engagement and ensure students are well-prepared to meet the challenges of tomorrow's global workforce.

KEY INSIGHTS

This research delves into the intricate factors influencing students' commitment to STEM careers, underscoring the importance of societal validation, impactful personal experiences through STEM interventions, and the necessity for gender-specific messaging. These elements are crucial in shaping young individuals' perceptions and engagement with STEM professions, steering their motivation and career decision-making processes.

Societal validation stands out as a significant motivator. It suggests that the broader cultural and social endorsement of STEM careers—manifested through public recognition, the perceived prestige of STEM professionals, and the value society places on STEM contributions—significantly boosts students' attraction to these fields. The study highlights that students are more likely to pursue STEM paths when they perceive these careers as valued and respected by society.

Personal experiences gained from STEM-focused career interventions, such as specialised programs, mentorships, and hands-on project work, are pivotal in nurturing a genuine interest and comprehension of STEM disciplines. These interventions offer students practical insight into applying STEM knowledge, clarifying the routes into STEM careers and showcasing the vast array of opportunities. Direct exposure to the realities of STEM professions inspires students and arms them with the skills and confidence needed to embark on these career paths.

Additionally, the research stresses the importance of crafting messages that resonate distinctively with boys and girls, highlighting the necessity for tailored communication and engagement strategies. Recognising and addressing the unique interests, concerns, and motivational factors of each gender can significantly boost the impact of STEM career interventions. Such tailored approaches ensure a more inclusive appeal, encouraging a diverse range of students to consider and commit to STEM professions.

In conclusion, this research sheds light on the complex dynamics influencing students' orientation towards STEM careers. It points to the critical roles of societal endorsement, enriching personal experiences through targeted interventions, and the strategic differentiation of messaging to cater to gender-specific preferences. These insights underscore the need for a concerted effort from educators, policymakers, and industry leaders to forge more effective strategies that foster a diverse and capable future workforce in STEM. This multifaceted examination enriches academic discussions on STEM education and offers actionable guidance for designing more compelling and inclusive STEM career initiatives.

Expanding on Key Insights:

Societal Endorsement and Real-World Alignment in STEM:

Maintaining students' interest in STEM careers significantly depends on how society values these fields and how well intervention activities mirror real-life experiences. To make career interventions more impactful, it's crucial to update and refine how STEM and industry narratives are presented, ensuring they connect with young learners and accurately portray the evolving nature of these fields.

Customised Communication for Gender Engagement:

Our research highlights the importance of tailoring STEM conversations to meet the unique motivational needs of boys and girls:

- Boys are exceptionally responsive to direct interactions with role models and mentors. Mentorship experiences, practical involvement, and continuous professional encouragement greatly enhance their engagement and interest in STEM careers.
- Conversely, girls are attracted to the problem-solving and project management aspects of STEM careers. They prefer to fully understand the diverse challenges of these careers and how they can participate in control of their career environment before deciding on their professional pathways.

The "Cool" Factor vs. Role Model Influence:

Distinguishing between being seen as "cool" and being a role model is vital for engaging students. While "coolness" relates to the attractiveness and immediate appeal of a person or activity, role models are respected for their significant contributions to society and expertise. The challenge for the STEM industry is balancing these aspects to capture students' attention and inspire them towards meaningful contributions.

The Defence Sector as Inspirational Role Models:

The Defence sector stands out as a significant source of motivation for students due to its prominent societal role, especially during natural disasters. The exciting nature of high-tech projects, such as jet fighters and submarines, makes the Defence and Defence Industry " cool " and a powerful example for students aspiring to STEM careers.

Transformative Effects on Teachers and Engagement with the Industry:

Teacher feedback underscores the substantial influence of industry collaboration on their teaching approaches and perspectives, underscoring the potential of such partnerships to revolutionise education. Working together, educational institutions and industry partners can equip teachers with the necessary resources and insights to motivate and guide students more effectively.

Leveraging Student Creativity and Innovation:

The study points out the solid intrinsic motivation and potential for innovation among students, presenting a valuable opportunity for the industry. By recognising and engaging with these motivational factors, the industry can tap into a reservoir of creativity and innovation, crucial for technological progress and societal advancement.

Concluding Remarks:

Direct interactions with students and their work in STEM programs reveal remarkable talents and aspirations, highlighting a promising future for STEM fields, provided these potentials are effectively nurtured. This study underscores the critical need for targeted interventions, robust societal support, and industry engagement to cultivate a vibrant and resilient STEM workforce. Emphasising the unique motivations and untapped potential of young learners, alongside making STEM careers attractive and accessible, is essential for developing a skilled, innovative, and passionate cadre of professionals ready to tackle the challenges of a rapidly changing world.

The research calls for a united effort, urging educational bodies, industry stakeholders, and society to foster an environment that attracts students to STEM and supports them throughout their academic and career paths. Establishing a supportive ecosystem is vital to demystifying STEM careers, enhancing their appeal, and equipping students with the practical experiences, mentorship, and societal recognition necessary for success.

Furthermore, by adapting engagement strategies to meet the diverse needs and interests of students, including gender-specific approaches and the provision of role models, the STEM community can significantly boost its allure and impact. The Defence sector's active involvement demonstrates how industry collaborations can motivate students with advanced technologies and opportunities to make societal contributions, serving as a blueprint for other sectors.

Building a competent and driven STEM workforce requires our collective commitment to inspire, support, and empower the upcoming generation. With precise interventions, societal encouragement, and robust industry involvement, we can unlock the enormous potential of young minds, setting them on a path to become the pioneers and problem-solvers of tomorrow. The imperative is clear: we must act in a concerted and collaborative manner to ensure that STEM fields remain at the forefront of innovation and progress into the 21st century and beyond.

BIBLIOGRAPHY

AIG 2006. World Class Skills for World Class Industries. *In:* GROUP, T. A. C. (ed.) *Employers Perspective on Skills in Australia.* Australian Industry Group.

AKERLOF, G. A. 1983. Loyalty Filters. *The American Economic Review,* 73, 54-63.

ALMQUIST, M. & ANGRIST, S. S. 1971. Role model influences college women's career aspirations. *Merrill-Palmer Quarterly,* 17, 263-279.

ATKINSON, E. S. 2000. An investigation into the Relationship between Teacher Motivation and Pupil Motivation. *Educational Psychology Review,* 20, 45-57.

AUSTRALIA, B. C. O. 2011a. Lifting the quality of teaching and learning in higher education.: Business Council of Australia.

AUSTRALIA, C. O. 2011b. Realising Potential: Business Helping Schools to Develop Australia's Future. *In:* DEPARTMENT OF EDUCATION, E. A. W. R. (ed.). Canberra.

AUSTRALIAN-GOVERNMENT 2001. Backing Australia's Ability.

AUSTRALIAN COMMITTEE ON TECHNICAL AND FURTHER EDUCATION. & KANGAN, M. 1974. *TAFE in Australia: report on needs in technical and further education, April 1974,* Canberra, Australian Govt. Pub. Service.

BANDURA, A. 1969. Social learning theory of identification process., Chicago, Rand McNally.

BANDURA, A. 1977. Self-efficacy: Toward a unifying theory of behavioural change. *Psychological Review,* 84, 191-215.

BANDURA, A. 1982. Self-efficacy mechanisms in human agency. *American Psychologist,* 37, 122-147.

BANDURA, A. 1986. Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, NJ, Prentice-Hall.

BAWDEN, R. 1991. Toward Action Research Systems. *In:* ZUBER-SKERRITT (ed.) *Action Research for Change and Development.* Avebury, UK: Gower Publishing Co.

BETSY BLUNSDON, K. R., NICOLA MCNEIL, STEVEN MCEACHERN 2003. Experiential Learning in Social Science Theory: An investigation of the relationship between student enjoyment and learning. *Higher Education & Development,* 22, 43-56.

BETZ, N. E. 1994. Career counselling for young women in the sciences & engineering. *In:* WALSH, W. B. & OSIPOW, S. H. (eds.) *Career Counselling for Women.* Hillsdale, NJ: Erlbaum.

BETZ, N. E. 2000. Self-Efficacy Theory as a Basis for Career Assessment. *Journal of Career Assessment,* 8, 205.

BETZ, N. E. 2007. Career Self-Efficacy: Exemplar Recent Research and Emerging Directions. *Journal of Career Assessment,* 15, 403-422.

BETZ, N. E. & FITZGERALD, L., F. 1987. The Career Psychology of Women. *New York Academic Press.*

BETZ, N. E. & HACKETT, G. 1986. Applications of self-efficacy theory to understanding career choice behaviour. *Journal of Social & Clinical Psychology,* 4, 279-289.

BETZ, N. E., HAMMOND, M. S. & MULTON, K. D. 2005. Reliability and Validity of Five-Level Response Continua for the Career Decision Self-Efficacy Scale. *Journal of Career Assessment,* 13, 131-149.

BETZ, N. E. & KLEIN, K. L. 1996. Relationship among measures of career self-efficacy, generalised self-efficacy, and global self-esteem. *Journal of Career Assessment,* 4.

BETZ, N. E., KLEIN, K. L. & TAYLOR, K. M. 1996. Evaluation of a short form of the Career Decision-Making Self-Efficacy Scale. *Journal of Career Assessment,* 4, 47-57.

BIBBY, R. W. & POSTERSKY, D. 1985. *The Emerging Generation,* Toronto Canada, Collins & Harper.

BILLETT, S. 2004. From your business to our business: Industry and vocational education in Australia. Oxford Review of Education; Mar2004, Vol. 30 Issue 1, p13-35, 22.

BISHOP, J. H., BISHOP, M. & BISHOP, M. 2003. Make Middle-Schoolers COOL with School Success. *Education Digest,* 69, 51-53.

BISHOP, J. H. & BISHOP, M. M. 2007. A Neo-Darwinian Rational-Choice Theory of Academic Engagement Norms: The struggle for Popularity and Normative Hegemony in Secondary Schools.

BLUNSDON, B., REED, K., MCNEIL & MCEACHERN, S. 2003. Experiential Learning in Social Science Theory: An investigation of the relationship between student enjoyment and learning. *Higher Education & Development,* 22, 43-56.

BOURNER, T. 2011. Developing self-managed action learning (SMAL). *Action Learning: Research & Practice,* 8, 117-127.

BROWN, S. D. & LENT, R. W. 1996. A social cognitive framework for career choice counselling. *The Career Development Quarterly,* 44, 354-366.

BUCHER, R. & STERLING, J. G. 1977. *Becoming a Professional* Beverly Hills, CA., Sage.

CARRINGTON, B., TYMMS, P. & MERRELL, C. 2008. Role models, school improvement and the 'gender gap'—do men bring out the best in boys and women the best in girls? *British Educational Research Journal,* 34, 315-327.

CHECKLAND, P. 2000. Soft systems methodology: a thirty-year retrospective<FN>Reproduced from Soft Systems Methodology in Action, John Wiley & Sons, Ltd, Chichester, 1999. </FN>. *Systems Research & Behavioral Science,* 17, 11-S58.

CHENHALL, E. C. & CHERMACK, T. J. 2010. Models, definitions, and outcome variables of action learning. *Journal of European Industrial Training,* 34, 588-608.

CLARK, E. 2004a. Action learning with young careers. *Action Learning: Research & Practice,* 1, 0-116.

CLARK, E. 2004b. Action learning with young carers. *Action Learning: Research & Practice,* 1, 0-116.

CLEVLAND, W. S. 1993. *Visualising Data*, Hobart Press.

COHEN, B. N. 2003. Applying Existential Theory and Intervention to Career Decision-Making. *Journal of Career Development,* 29, 195.

COLLINS, C., KENWAY, J. & MCLEOD, J. 2000. Factors influencing the educational performance of males and females in school and their initial destinations after leaving school. *Department of Education, Training and Youth Affairs*. Canberra.

COLLINS, J. C. & HARPER, J. 1974. Problems of adolescents in Sydney. *Journal of Genetic Psychology,* 125, 189-194.

CONGDON, G. J. & CONGDON, S. 2011. Engaging students in a simulated collaborative action research project: an evaluation of a participatory approach to learning. *Journal of Further & Higher Education,* 35, 221-231.

CRITES, J. O. 1978. *Career Maturity Inventory,* Monterey, CA, CA: CTB/McGraw Hill.

DE JONG, J. A. S., WIERSTRA, R. F. A. & HERMANUSSEN, J. 2006. An exploration of the relationship between academic and experiential learning approaches in vocational education. *British Journal of Educational Psychology,* 76, 155-169.

DE QUERVIAN, D. J., FISCHBACK, U., TREYER, V., SCHELLHAMMER, M., SCHNYDER, U., BUCK, A. & FEHR, E. 2004. The neutral basis for altruistic punishment. *Science,* 305 (5668) 1246-7.

DECI, E. L. & RYAN, R. M. 1985. Intrinsic Motivation and Self-determination in human behaviour, New York, Plenum.

DEST 2005. Survey of Vocational and Technical Education (VET): Participation, Triggers, Perceptions and Aspirations. *Australian Government*.

DICK, B. 2011. Action research literature 2008—2010: Themes and trends. *Action Research,* 9, 122-143.

DONNENBERG, O. & DE LOO, I. 2004. Facilitating organizational development through action learning--some practical and theoretical considerations. *Action Learning: Research & Practice*, 1, 167-184.

DOTY, D. H. & GLICK, W. H. 1998. Common Methods Bias: Does Common Methods Variance Really Bias Results? *Organisational Research Methods*, 347.

DRAPER, N. R. & SMITH, H. 1980. Applied Regression Analysis Second Edition, New York.

EME, R., MAISIAK, R. & GOODALE, J. V. 1979. Seriousness of Adolescent Problems. *Adolescents,* 14, 93-194.

ENGINEERS-AUSTRALIA 2004. Encouraging Student Participation in the Enabling Sciences: Submission to House of Representatives Standing Committee on Science and Innovation.

ERIKSON, E. 1977. Toys and Reasons: stages in ritualisation of experience., New York, W. W. Norton & Company, Inc.

FARMER, H. S. 1983. Career and homemaking plans for high school youth. *Journal of Counseling & Psychology,* 30, 40-45.

FARMER, H. S. 1985. Model of career and achievement motivation for women and men. *Journal of Counseling & Psychology,* 33, 363-390.

FARMER, H. S. 1987. A multivariant model for explaining gender differences in career and achievement motivation. *Educational Researcher,* 16, 5-9.

FARMER, H. S. 1997. Women's motivation related to mastery, career salience, and career aspiration: A multivariant model focusing on the effects of sex-role socialisation. *Journal of Career Assessment,* 5, 355-374.

GEORGE, N. A. 2004. The action learning handbook. *British Journal of Educational Technology,* 35, 510-511.

GINZBERG, E. 1984. Career Development. *In:* BROOKS, D. B. L. (ed.) *Career Choice and Development; Applying contemporary theories to practice.* San Francisco: Jossey-Bass.

GOTTFREDSON, L. 1981. Circumspection and compromise: A developmental theory of occupational aspirations. *Journal of Counseling & Psychology,* 28, 545-579.

GOVERNMENT, A. 2001. Backing Australia's Ability.

GOVERNMENT, A. C. 2006. Making it Global: Advanced Manufacturing Action Agenda.

GUAY, F., VALLERAND, R. J. & BLANCHARD, C. 2000. On the Assessment of Situational Intrinsic and Extrinsic Motivation: The Situational Motivation Scale (SIMS). *Motivation & Emotion,* 24.

HACKETT, G. & BETZ, N. E. 1981a. A Self-Efficacy Approach to the Career Development of Women. *Journal of Vocational Behavior,* 18, 326-339.

HACKETT, G. & BETZ, N. E. 1981b. A self-efficacy approach to the career development of women. *Journal of Vocational Behavior,* 35, 164-180.

HACKETT, G. & BETZ, N. E. 1992. Gender, ethnicity, and social-cognitive factors predicting the academic achievement of students. *Journal of Counseling Psychology,* 39, 527.

HACKETT, G. & BYARS, A. M. 1996. Social cognitive theory and the career development of African American woman. *The Career Development Quarterly*, 322-340.

HACKETT, G., ESPOSITO, D. & O'HALLORAN, M. S. 1989. The Relationship of Role Model Influences to career Salience and Educational and Career Plans of Colledge Women. *Journal of Vocational Behavior,* 35, 164-180.

HAMPTON, N. Z. 2006. A psychometric evaluation of the Career Decision Self Efficacy Scale - Short Form in Chinese High School Students. *Journal of Career Development,* 33.

HAY, S. 2009. TRANSFORMING SOCIAL AND EDUCATIONAL GOVERNANCE: TRADE TRAINING CENTRES AND THE TRANSITION TO SOCIAL INVESTMENT POLITICS IN AUSTRALIA. *British Journal of Educational Studies,* 57, 285-304.

HERR, E. L. 1996. Perspectives of ecological context, social policy, and career guidance. *The Career Development Quarterly,* 45, 5-19.

HEYDT, G. T. V., T Jan/Feb 2003. Feeding our profession. *IEEE Power & Energy Magazine*.

INITIATIVE, A. G. 2001. Backing Australia's Ability.

JOLLIFE, I. T. 1986. *Principle Component Analysis,* New York.

JUNG, J. 1986. How useful is the concept of role model?: A critical analysis. *Journal of Social Behaviour and Personality,* 1, 525-536.

KEGAN, R. 1994. *In Over Our Heads*, Harvard University Press.

KING, R., DOWLING, D. & GODFREY, E. 2011. Pathways from VET Awards to Engineering Degrees: a higher education perspective. *In:* (ANET), T. A. N. E. T. (ed.).

KOLB, D. 1984. Experiential Learning: Experience as the source of learning and development, New Jersey, Prentis Hall Inc.

LENT, R. W., BROWN, S. D. & HACKETT, G. 1994. Toward a unifying cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior,* 45, 79-122.

LENT, R. W., BROWN, S. D., SCHMIDT, J., LYONS, H. & TREISTMAN, D. 2003. Relations of contextual supports and barriers to choice behaviour in engineering majors: Test of alternative social cognitive models. *Journal of Counseling Psychology,* 50, 458-465.

LEONARD, H. S. & MARQUARDT, M. J. 2010. The evidence for the effectiveness of action learning. *Action Learning: Research & Practice,* 7, 121-136.

LEWIS, P. E. T. & VELLA, F. G. M. 1885. Economic Factors Affecting the number of Engineering Graduates in Australia. *Bureau of Labour Market Research*.

LINNENBRINK, E. A. 2003. The dilemma of performance goals: Promoting students' motivation and learning in cooperative groups. 63, ProQuest Information & Learning.

LINNENBRINK, E. A. & PINTRICH, P. R. 2002. Motivation as an Enabler for Academic Success. *School Psychology Review,* 31, 313.

LINNENBRINK, E. A. & PINTRICH, P. R. 2003. The role of self-efficacy beliefs in student engagement and learning in the classroom. *Reading & Writing Quarterly,* 19, 119.

LIZZIO, A. & WILSON, K. 2004. Action Learning in Higher Education: an investigation of its potential to develop professional capability. *Studies in Higher Education,* 29, 469-488.

LOCKWOOD, P. & KUNDA, Z. 1997. Superstars and me: Predicting the impact of role models on the self. *Journal of Personality and Social Psychology,* 73, 91-103.

MACCANN, R. 1995. A longitudinal study of sex differences at the Higher School Certificate and School Certificate: Trends over the last decade. Sydney: *In* STUDIES, N. B. O. (ed.). Sydney.

MACQUARIE-UNIVERSITY 2005. Macquarie University Science, Engineering and Technology Study

MARGINSON, S. 1993. *Education and public policy in Australia,* Cambridge [England] ; New York, NY, USA, Cambridge University Press.

MARKUS, H. & NURIUS, P. 1986. Possible selves. *American Psychologist,* 41, 954-969.

MARSHALL, K. 2007. A Tradition of CAD/CAM and Competition. *Tech Directions,* 66, 18-18.

MARTIN, J. A. 2004. School motivation of boys and girls: Differences of degree, differences of kind, or both? *Australian Journal of Psychology,* 56, 133-146.

MARTIN, J. A. & LEBERMAN, I. S. 2005. Personal Learning of Prescribed Education Outcomes: a case study of the Outward Bound Experience. *Journal of Experiential Education,* 28, 44-59.

MCCARTHY, J. & RINER, P. 1996. The Accelerated Schools inquiry process: Teacher empowerment through action research. *Education,* 117, 223.

NAUTA, M. M., EPPERSON, D. L. & KAHN, J. H. 1998. A multiple groups analysis of predictors of career aspirations among women in science and engineering. *Journal of Counseling Psychology,* 45, 483-496.

NAUTA, M. M., KAHN, J. H., ANGELL, J. W. & CANTARELLI, E. A. 2002. Identifying the antecedent in the relation between career interests and self-efficacy: Is it one, the other, or both? *Journal of Counseling Psychology,* 49, 290-301.

NAUTA, M. M. & KOKALY, M. L. 2001. Assessing role model influences on students' academic and vocational decisions. *Journal of Career Assessment,* 9, 81-99.

NICHOLSON, S. I. & ANTILL, J. K. 1981. problems of adolescents and their relationship to peer acceptance and sex-role identity. *Journal of Youth and Adolescence,* 10, 309-325.

O'HARA, S., BOURNER, T. & WEBBER, T. 2004. The practice of self-managed action learning. *Action Learning: Research & Practice,* 1, 0-42.

OFIR, C. & KUHURI, A. 1986. Multicollinearity in marketing modles: Diagnosis and remedial measures. *International Journal in Marketing,* 3, 181-205.

OVERWIEN, B. 2000. Informal Learning and the Role of Social Movements. *International Review of Education,* 46, 621-640.

PAA, H. K. & MCWHIRTER, E. H. 2000. Perceived influences on High School Students' Current Career Expectations. *The Career Development Quarterly,* 49.

PAULSEN, A. M. & BETZ, N. E. 2004. Basic Confidence Predictors of Career Decision-Making Self-Efficacy. *Career Development Quarterly,* 52, 354.

PEARSON, K. 1901. On Lines and Planes of Closest Fit to Systems of Points in Space. *Philosophical Magazine,* 2, 559-572.

PEDLER, M., BURGOYNE, J. & BROOK, C. 2005. What has action learning learned to become? *Action Learning: Research & Practice,* 2, 49-68.

PETERSON, S. L. & DELMAS, R. C. 1998. The component structure of Career Decision-Making Self-Efficacy for underprepared college students. *Journal of Career Development,* 24, 209-225.

PLEISS, M. K. & FELDHUSEN, J. F. 1995. Mentors, Role Models and Heroes in the lives of Gifted Children. *Educational Psychologist,* 30, 159-169.

PUSEY, M. 1991. Economic rationalism in Canberra: a nation-building state changes its mind, Cambridge, England; Melbourne, Cambridge University Press.

RAISON, M. 2005. Macquarie University Science, Engineering and Technology Study

RINGROSE, J. & RENOLD, E. 2010. Normative cruelties and gender deviants: the performative effects of bully discourses for girls and boys in school. *British Educational Research Journal,* 36, 573-596.

ROBINSON, G. 2005. Action learning: developing critical competencies for knowledge era workers. *Action Learning: Research & Practice,* 2, 79-88.

RUTTER, M. 1980. *Changing youth in a changing society,* Cambridge, MA, Harvard University Press.

RYAN, R. M. 1999. Motivation for physical activity research on persistence, performance, and enjoyment in sport, exercise, and everyday life from a self-determination theory viewpoint. *Journal of Sport & Exercise Psychology,* Vol. 29, pS2-S2, 1/3p.

RYAN, R. M. 2007. Motivation of Physical activity research on persistence, performance and enjoyment in sport, exercise and everyday life from a self-determination theory viewpoint. *Journal of Sport & Exercise Psychology,* 29, 1-3.

RYAN, R. M. & DECI, E. L. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist,* 55, 68-78.

SEDDON, T. A., LAWRENCE 1999. Steering Futures: Practices and Possibilities of Institutional Redesign in Australian Education and Training. *Journal of Education Policy,* 14, 491-506.

SELIGMAN, L. 1991. Developmental Career Counselling and Assessment (2nd ed), Thousand Oaks, CA, Sage.

SHEAHAN, P. 2005. Generation Y Surviving with Generation Y at Work, Sydney.

SOFO, F., YEO, R. K. & VILLAFAÑE, J. 2010. Optimizing the Learning in Action Learning: Reflective Questions, Levels of Learning, and Coaching. *Advances in Developing Human Resources,* 12, 205-224.

SONG, H.-D. & GRABOWSKI, B. 2006, Stimulating Intrinsic Motivation for Problem Solving Using Goal-Oriented Contexts and Peer Group Composition. *Educational Technology Research & Development,* 54, p445-466.

STANDING COMMITTEE ON EMPLOYMENT, E. A. W. R. C. 2000. *In:* DEEWR (ed.).

SUPER, D. E. 1990. A life-space approach to career development. *In:* BROOKS, D. B. L. (ed.) *Career choice and development: Applying contemporary theories to practice.* San Francisco: Jossey-Bass.

SUPER, D. E. 1996. A life-space approach to career development. *In:* BROOKS, D. B. L. (ed.) *Career choice and development: Applying contemporary theories to practice.* San Francisco: Jossey-Bass.

TAYLOR, A. 2005. What employers look for: the skills debate and the fit with youth perceptions. *Journal of Education & Work,* 18, 201-218.

THORNTON, K. & YOONG, P. 2011. The role of the blended action learning facilitator: an enabler of learning and a trusted inquisitor. *Action Learning: Research & Practice,* 8, 129-146.

TYLER, R., SYMINGTON, D. & SMITH, C. 2009. A curriculum Innovation Framework for Science, Technology and Mathematics Education.

VALLERAND, R. J. 1997. Toward a hierarchical model of intrinsic and extrinsic motivation., New York, Academic Press.

VIOLATO, C. & HOLDEN, W. B. 1988. A confirmatory factor analysis of a four-factor model of adolescent concerns. *Journal of Youth and Adolescence,* 17, 101-112.

VONDRACEK, F. W., LERNER, R. M. & SCHULENBERG, J. E. 1986. *Career Development: A life-span developmental approach.,* NJ, Erlbaum.

WATSON, L. & MCINTYRE, J. 2011. Scaling Up: Building engineering capacity through education and training. *In:* DEPARTMENT OF EDUCATION, E. A. W. R. & TASKFORCE, A. N. E. (eds.). Canberra: University of Canberra.

WATT, H. M. G. 2004. Development of Adolescents' Self-Perceptions, Values, and Task Perceptions According to Gender and Domain in 7th- through 11th-Grade Australian Students. *Child Development,* 75, 1556-1574.

WATT, R. H., CASHWELL, C. S. & SCHWEIGER, W. K. 2004. Fostering Intrinsic Motivation in Children: A humanistic Counselling Process. *Journal of Humanistic Counselling, Education and Development,* 43, 16-24.

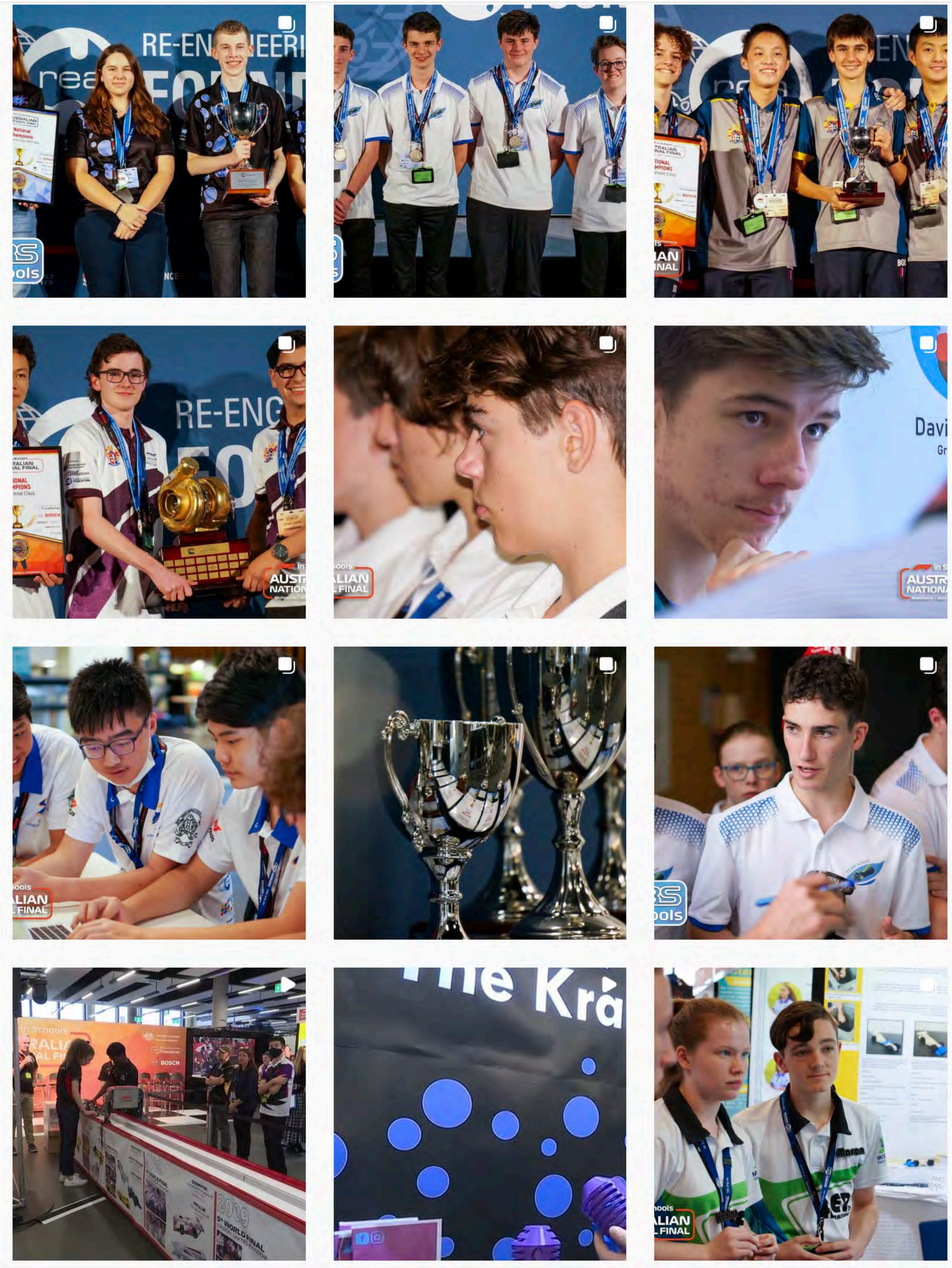
WHITE, S. H. & O'BRIEN, J. E. 1999. What is a Hero? An exploratory study of students' conceptions of heroes. *Journal of Moral Education,* 28, 81-95.

WILSON, K. & FOWLER, J. 2005. Assessing the impact of learning environments on students' approaches to learning: comparing conventional and action learning designs. *Assessment & Evaluation in Higher Education,* 30, 87-101.

WISE, S., SCHULTZ, H., HEALY, J. & FITZPATRICK, D. 2011. Engineering Skills Capacity in the Road & Rail Industries.

WURDINGER, S. D. & CARLSON, J. A. 2010. *Teaching for experiential learning: Five approaches that work.* Rowan & Littlefield Education.

WYNARCZYK, P. 2009. Providing the science, technology, engineering and mathematics skills of tomorrow. *New Technology, Work & Employment,* 24, 243-259.



Re-Engineering Australia
Foundation