STEM EDUCATIONAL OUTCOMES REPORT 2023

EVALUATING THE CAPACITY OF REA'S STEM PROGRAMS
TO IMPACT THE EDUCATIONAL AND CAREER MOTIVATIONS OF STUDENTS

Re-Engineering Australia Foundation

Authorised Agent

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Date

June 2023

EXECUTIVE SUMMARY

Addressing skills shortages in the long term requires a sustained and measured focus that goes beyond short-term economic considerations. While economic rationalism often drives industry decisions, solving the issue of career motivation among children cannot be achieved through quick-fix solutions. It requires a long-term commitment and strategic approach to improve student attitudes towards STEM careers.

From an industry standpoint, it is challenging to differentiate job applicants based on their educational credentials. Traditional school achievement measures, such as scores like ATAR, VCE, SASE, etc., do not accurately represent a person's potential for success in ways that align with the skills employers seek. This lack of alignment has resulted in intense competition across industries to find and attract talent.

Motivating students to pursue specific career pathways has become increasingly challenging due to various factors. The education landscape in Australia is undergoing significant changes due to the widespread availability of technology, easy access to knowledge, mobile computing, and the rapid growth of artificial intelligence. The education system, established over 70 years ago to increase community knowledge, has evolved into silos based on specific knowledge streams (such as math and science), which have become less relevant in today's environment. As a result, education's intended role and outcomes have blurred.

At an individual level, influencing students' career motivation involves navigating various influences and agendas, with complex connections between peers, teachers, parents, and the industry. Depending on their emotional developmental stage, these influences can significantly vary for each student. The concept of Science, Technology, Engineering & Mathematics (STEM) education, initially driven by the industry, aimed to create a cross-curricular educational environment that emulates the workplace and fosters the development of employability skills, such as communication, collaboration, teamwork, problem-solving, innovation, and entrepreneurship. These skills are not explicitly taught in schools, and despite Employability Skills Frameworks in most Australian states and territories, changing the educational system to enable STEM to deliver these employability skills effectively has proven challenging. The barriers between educational silos have become obstacles preventing the effective implementation of STEM, resulting in STEM being implemented in ways that provide little more than entertainment value for students, limiting STEM's academic potential.

It has become critical to equip teachers with new approaches that develop soft skills (or life skills) and employability skills, which will help students successfully transition into the workforce. Current social science research shows that long-term career success is linked to high levels of trait conscientiousness (life skills), which are just as crucial for career success as the intelligence quotient and form the foundation upon which employability skills development rests.

Conscientious individuals possess qualities such as thoroughness, responsibility, and reliability. They pay meticulous attention to detail, consistently follow through on commitments, and manage tasks responsibly and efficiently. With a strong work ethic and a sense of duty, they strive for excellence and reliably meet obligations and deadlines. The development of trait conscientiousness is directly linked to discipline and ownership, specifically ownership of the learning process and approaches that foster higher levels of discipline.

This research evaluates the effectiveness of two programs by Re-Engineering Australia Foundation Ltd (REA): F1 in Schools and SUBS in Schools. These programs have been operating since 2003 and 2015, respectively. They have shown to overcome the obstacles to implementing STEM, bridging the gap between formal education and the workplace, and motivating students to pursue STEM educational pathways aligned with their passions and skills. With the support of the industry and the Department of Defence, REA has created a platform that facilitates industry-related programs, exposing students to real-world career pathways.

The research analyses data collected from students and teachers involved in these programs over four years, from January 2019 to January 2023. The study assesses the effectiveness of these programs in influencing student career

motivation, explores the impact of interactions between students and industry mentors on career choices, and offers guidance to the industry on how to contribute to the development of employability skills.

These findings challenge stereotypes about gender preferences in career choices between boys and girls. Interestingly, there is little difference between boys and girls regarding their STEM interests. Both genders exhibit similar levels of intrinsic motivation and are equally driven by their interests rather than external influences. REA's programs encourage students to take ownership of their learning process which in turn cultivates leadership, discipline, and increased trait conscientiousness, crucial elements in eliminating cultural, social, and economic disadvantages.

The research findings underscore the importance of nurturing and supporting student motivation. Recognising the potential of these students, Industry must provide the necessary support for them to thrive, ultimately fostering a culture that propels our nation forward. By providing appropriate guidance, resources, and opportunities, Industry can help cultivate their innovative mindset and empower them to excel in STEM fields and beyond. This benefits individual students and holds broader implications for the growth and development of our nation. In a world that demands constant innovation and adaptation, the capabilities and motivation exhibited by this new generation of students offer a competitive edge. By harnessing their talents and encouraging their pursuit of STEM careers, the industry can position itself for success in a rapidly evolving global landscape.

CONTENTS

About Re-Engineering Australia Foundation Ltd

The Re-Engineering Australia Foundation Ltd (REA) is a non-profit charity founded in 1998 to ignite transformative change in Australia's educational landscape. REA has developed programs to address employability skills development and bridge the gap between industry and education, explicitly encouraging secondary students to pursue STEM education and careers. The focus programs for this research are F1 in Schools and SUBS in Schools.

REA's STEM-based school programs utilise Challenge-Based Learning, Action Learning, and Project-Based Learning within a transformative Metamorphic Learning™ framework. These programs create collaborative and experiential environments that involve schools, industry, TAFE, universities, and parents. Over one million Australian students have participated in these programs, showing an increased interest in STEM career pathways and notable improvements in educational attainment.

These programs enhance students' and teachers' knowledge, fundamentally transforming their ethos and approach to career pathways in a Socratic learning environment. Teachers transition from being sources of knowledge to educational coaches, while students enhance their communication and problem-solving capabilities, which are essential societal foundation skills. Students discover their capacity to innovate and solve problems at the intersection of human needs and challenges.

Despite the existence of Employability Skills Frameworks in most Australian states and territories, effecting changes to the educational system that effectively address industry employability skills needs has proven challenging. However, REA's programs yield measurable outcomes beyond mere knowledge acquisition. Students take ownership of the learning environment and develop discipline, passion, focus, conscientiousness, and leadership qualities. They understand career options that align with their skills, desires, and motivations.

While career interventions guide students towards opportunities, industry involvement is necessary for meaningful decision-making. REA works with hundreds of companies across Australia to build school-industry partnerships designed to connect students with industry mentors. Through the multifaceted nature of their programs and the use of industry mentors, they empower students to become catalysts of innovation, problem solvers, and pioneers of tomorrow's technological advancements.

The benefits of these programs extend to both the short and long term. Over one million students across Australia have participated, with 81% shifting their career motivations toward STEM and 85% experiencing increased educational attainment across various subjects.

REA's key performance indicators include enhancing the employability skills of participating students, increasing the appeal of STEM subjects and STEM career pathways, demonstrating measurable improvement in student educational attainment, and encouraging secondary students to pursue STEM education and career pathways to increase the future pool of skilled workers for industry recruitment, establishing sustainable partnerships between industries and schools, and promoting collaboration between urban and rural regions to foster innovation.

REA Programs

F1 in Schools™ is a multi-faceted and multi-disciplinary program based on the design of miniature F1® race cars. It facilitates students collaborating with Industry partners within their projects to learn STEM principles. The program focuses on students between years 5 to 12.

SUBS in Schools equips students with the employability skills and knowledge to allow them to take part in the new set of industries created because of the Department of Defence Future Submarine Program. SUBS in School focuses on students between years 5 to 12.

RESEARCH RATIONALE

Introduction

This research aimed to explore the relationships between various factors that affect career motivation and evaluate the influence of REA's STEM programs on school children's motivation to pursue STEM careers (Science, Technology, Engineering, and Mathematics). The study looked to understand how these programs can change participants' motivation levels towards STEM and the progression of their career choices from initial awareness to interest and commitment in STEM-related studies and pathways.

The research examined several factors identified in previous literature that influence career decision-making. These factors include intrinsic motivation, self-efficacy, the influence of peers, and the role of industry heroes and role models. Each of these factors operates within different aspects of the programs. Understanding the perceived impact of these factors on career expectations is crucial, as they are likely to affect behaviour, motivation, and the relationships between primary factors, specific program elements, and outcomes for both boys and girls.

This report is part of a longitudinal study initiated at the University of South Australia in 2006, investigating the motivational drivers of children's career decisions. The study has since been expanded to include the impact on teachers and schools involved in the programs. The report specifically examines the effects of the programs on the following aspects:

i. Shaping students' interest in STEM careers.
ii. The impact of the programs on enhanced academic achievement.
iii. Connecting students with previously unconsidered career pathways.
iv. Developing life and employability skills through the programs.

Data were collected from students and teachers participating in REA's programs between January 2019 and December 2022. The report also investigates the impact of the COVID-19 pandemic on the programs' ability to achieve desired outcomes in 2020 and 2021.

Research Overview

The primary objective of this research is to investigate the various factors that influence students' career decisions during their school years, recognising that multiple external factors play a role in shaping these choices. The aim is to understand which elements can be effectively measured and whether these measurements can guide the development of intervention activities that positively impact children's career decisions.

When students participate in REA's programs, they may already possess their motivations and perceptions regarding STEM as a career option. However, their reasons for participating may take time to become apparent to them, and the outcomes and benefits of their involvement may only become evident over time. The research aims to assess the impact of these programs on different aspects, including their ability to influence students' career motivations and specific interests in STEM careers.

One distinctive feature of REA's programs is the direct interaction with professionals from various industries, which allows students to engage with them as role models. Moreover, the programs incorporate real-world challenges that capture students' intrinsic interest, setting them apart from other STEM interventions.

By examining these factors and evaluating the effectiveness of REA's programs, the research intends to provide insights into how students' career motivations and interests in STEM can be effectively influenced and guided.

Research Process

The research process primarily focuses on measuring the changes that students perceive in themselves regarding their career choices and determining the influence of the learning environment on those choices. The emphasis is on understanding what aspects can be measured, how to measure them effectively, and whether these measurements can provide valuable insights for improving the underlying framework.

It is essential to acknowledge that this research was conducted within Australian culture, characterised by diverse ethnic backgrounds and social norms. The study involves various stakeholders, including researchers, students, teachers, industry professionals, and parents, who participate in the intervention processes to some extent. To ensure unbiased research outcomes, the emphasis was on understanding the motivational drivers from the student's perspective rather than being influenced solely by the mental models of other stakeholders involved in developing and managing the intervention program.

The primary research question for this study is: "What influence do REA programs have on the participants' motivation towards pursuing a STEM-based career?"

The research process involved administering survey questionnaires to both teachers and students. These surveys collected both quantitative and qualitative data. The qualitative questions aimed to explore the attitudes of teachers and students towards specific topics related to their involvement in the programs facilitate cross-referencing with the quantitative analysis.

Survey Reach

Participants for this research were selected based on their involvement in specific programs, namely F1 in Schools and SUBS in Schools. These events occurred between October and December in 2019, 2020, 2021, and 2022. According to teacher reports, approximately 38,600 students participated in the competition phase of these programs during the reporting period (2019-2022).

From 2019 to 2022, 1,730 students and 245 teachers from various locations across Australia completed the questionnaires. Teachers and students answered separate questionnaires. Of the responses received, 1,640 student and 245 teacher responses were considered valid, having completed all the questions. The research participants came from 150 schools in Australia, each with between 20 and 250 students involved in the programs.

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

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

Methodology

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 and students 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.

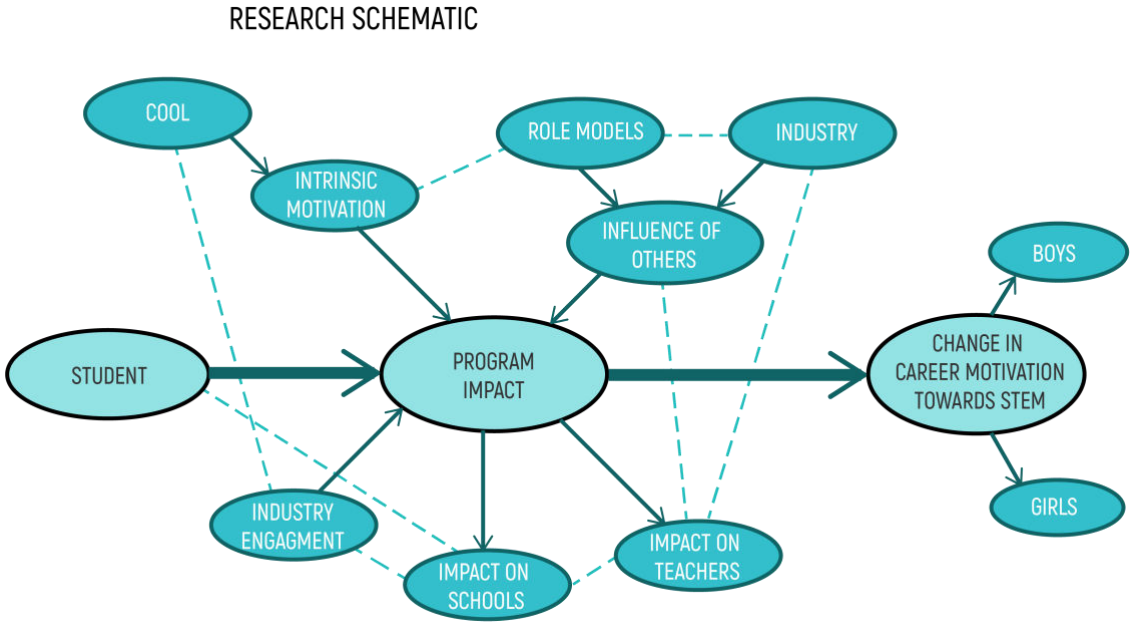
All students who completed the questionnaire participated in the program through to competing in a competition event, ensuring they had experienced all aspects of the program and had engaged in a wide range of interactions with industry professionals.

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

During the COVID-19 pandemic, the uncertainties surrounding school closures and the transition to virtual teaching impacted extracurricular activities and schools' participation in REA's programs. While the number of schools involved in the programs decreased during 2020 and 2021, the number of students involved in F1 in Schools and SUBS in Schools events remained unaffected. However, other programs previously run by REA, Space in Schools and 4x4 in Schools, were impacted, with no events held due to the pandemic. These programs heavily rely on in-person interaction, which was impossible during the period due to COVID-19 and the guidelines set by Education Departments in all states. As a result, no students from these programs participated in the research.

When comparing the survey results from the years before COVID-19 to those covered in this report, the following observations are noteworthy:

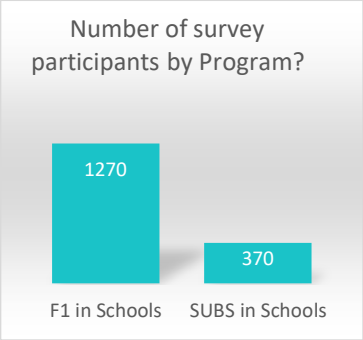
- Many schools reduced extracurricular activities during the lockdown period of COVID-19 to prioritise core competency development.
- Students were unable to undertake industry site visits.
- Students and industry mentors mostly interacted through virtual platforms such as Zoom.
- Due to the emphasis on student-led learning processes, many teachers reported that these programs allowed students to progress with minimal teacher support.
- There were no statistically significant changes in students' intrinsic motivation toward STEM or the programs.
- There were no statistically significant changes in the impact of the programs within schools.

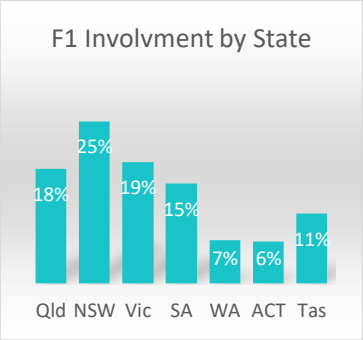
These findings highlight the adjustments and limitations imposed by the pandemic on implementing REA's programs. Still, they also indicate that the programs maintained their effectiveness and student motivation during this challenging period.

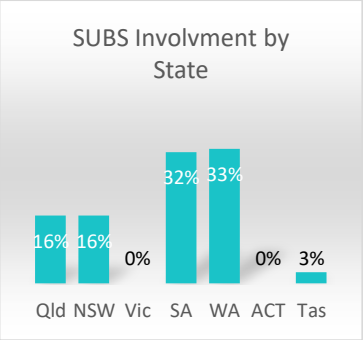
DEMOGRAPHICS

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

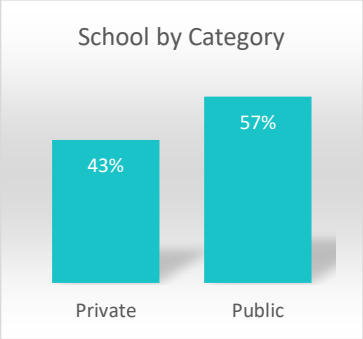
Program Demographics

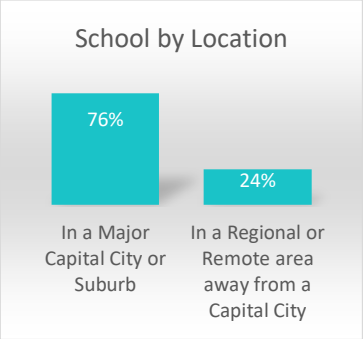




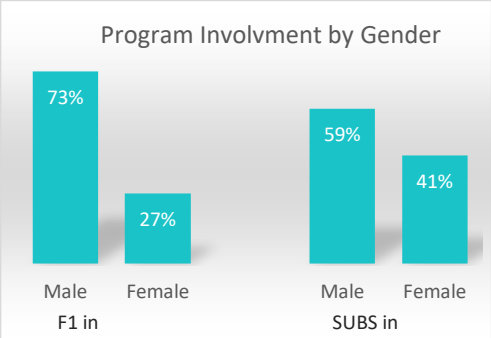


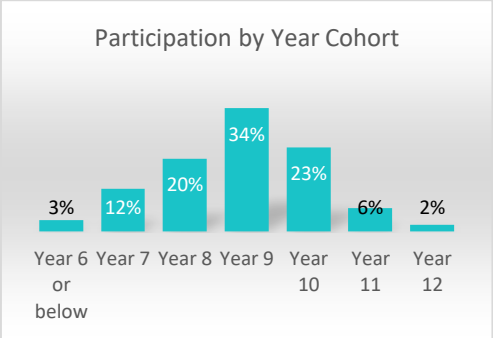
School Demographics

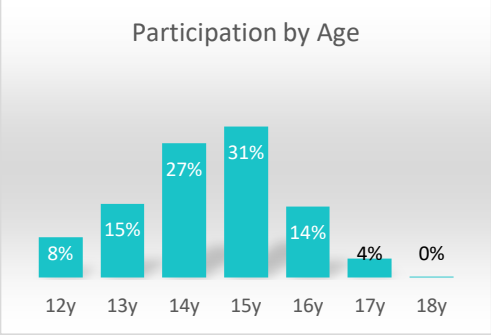


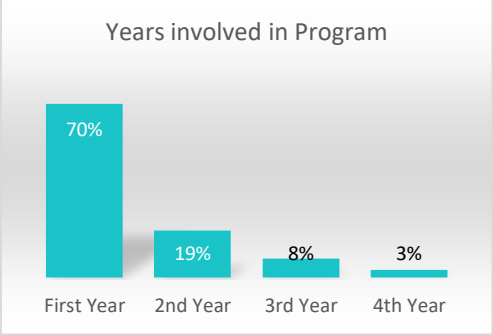


Student Demographics

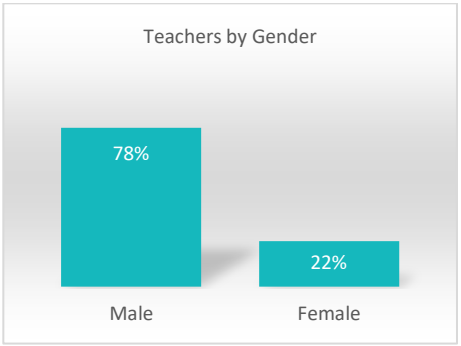


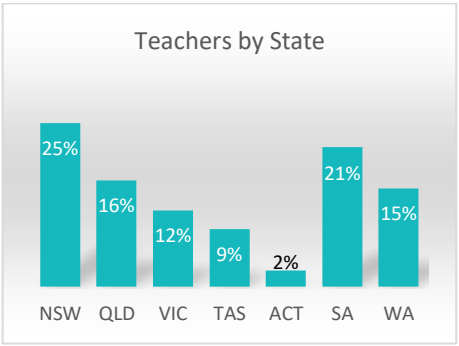


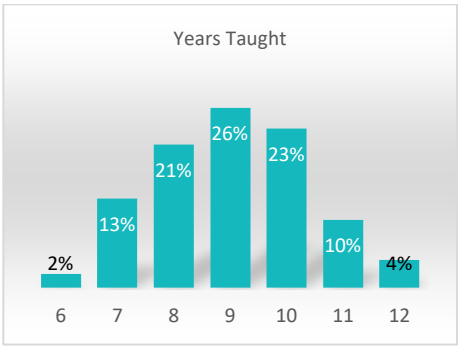


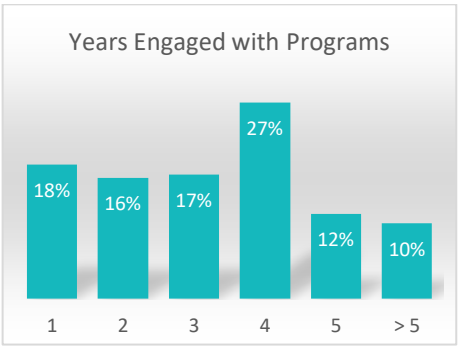


Teacher Demographics









STUDENT MOTIVATION TOWARDS STEM

Various factors influence career choice decisions and operate within an ecological context encompassing physical, social, political, and economic environments. These contexts are unique to each individual and interact to shape their identity, belief system, and life trajectory (Herr, 1996). However, children experience these contexts differently than adults. While adults have a clearer understanding of the environmental drivers and the impact of career choices on their social and economic well-being, children are shielded from many of these boundary conditions by their parents and family. As a result, children are more influenced by extrinsic social motivators that operate within their peer environments.

Paa (2000) examined the ecological contexts of children and proposed that career choices are influenced by background, environment, and personal factors. A student's self-perceived ability in a particular career direction and the perceived barriers to entry in that field significantly influence their career choices. Paa's research also highlighted the influence of parents, particularly mothers, and the role of peer group perceptions in the career decision-making process. Additionally, young children tend to base their early career choices on personal interests and intrinsic motivation.

Parents and families play a significant role in shaping children's career decisions, driven by their concern for their children's well-being. However, in the early stages of their development, students are more motivated by intrinsic interest in activities rather than responding to external motivators (Cohen, 2003).

Research Process

Understanding students' ability to make lasting career decisions requires examination of their belief in their control over their choices. A section of the research questionnaire utilised the Situational Intrinsic Motivation Scale (SIMS) (Deci and Ryan, 1985; Guay et al., 2000). The SIMS scale measures students' intrinsic situational motivation, a general factor influencing their interest in STEM careers. The primary question in this section is: "I would be interested in a STEM career?"

The SIMS scale consists of questions designed to assess intrinsic motivation, identified regulation, external regulation, and amotivation based on self-determination theories. It aims to measure three factors:

1. Levels of intrinsic motivation: This factor evaluates the extent to which students are motivated by internal factors such as enjoyment, curiosity, and personal interest.
2. Self-efficacy towards career decision-making: This factor assesses students' belief in their capability to make effective career decisions.
3. The influence of people in the student's environment: This factor examines the impact of individuals in the student's social context, such as parents, teachers, and peers, on their motivation and career choices.

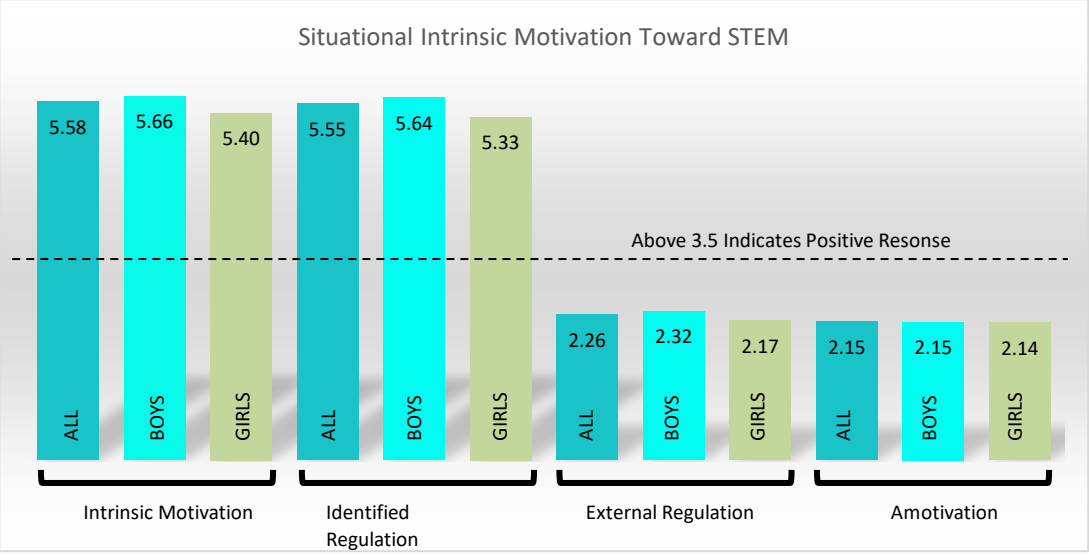
According to self-determination theory, different types of motivation underlie human behaviour. The theory emphasises the importance of the social context in fostering needs for competency, autonomy, and relatedness to promote self-determined motivations (Guay et al., 2000).

Different types of motivation vary in their level of self-determination. Self-determination involves genuine choice and freedom in one's actions (Guay et al., 2000). Intrinsic motivation is associated with positive outcomes, such as persistence, while identified regulation follows as a moderately self-determined motivation. On the other hand, amotivation is the least self-determined motivation and is linked to adverse outcomes, including depressive states. External regulation, which can have either a positive or negative influence, falls between identified regulation and amotivation (Deci and Ryan, 1985; Vallerand, 1997).

The SIMS scale consists of four factors that align with positions on the self-determination continuum:

1. Intrinsic Motivation: This factor relates to engaging in activities for their inherent enjoyment and satisfaction.
2. Identified Regulation: This factor pertains to behaviour valued and perceived as personally chosen.
3. External Regulation: This factor encompasses behaviour regulated by external rewards or punishments.
4. Amotivation: This factor represents a lack of perceived control and an absence of purpose or expectations of reward.

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

Based on the analysis, students' interest in STEM is remarkably high. The scores above 3.5 for Intrinsic Motivation and Identified Regulation indicate that students are motivated to pursue STEM based on their interests and choices. Conversely, the scores below 3.5 for External Regulation and Amotivation suggest that students' decisions to pursue STEM are not influenced by external factors or a lack of perceived control.

Interestingly, there is little difference between boys and girls regarding their STEM interests. Both genders exhibit similar levels of intrinsic motivation and are equally driven by their interests rather than external influences.

Furthermore, there is a strong positive correlation (correlation = 0.65) between the levels of intrinsic motivation in STEM careers and the students' reported increase in interest after participating in the program, indicating that engaging in STEM activities enhances students' inherent interest in those areas, which can have a significant impact on their career decisions.

When students already have a strong internal drive and motivation (intrinsic motivation) towards a specific direction, and when their interest is nurtured through relevant activities, it is likely that these activities will have a significant impact on their career choices within that field.

INFLUENCE OF OTHERS - PEERS AND ROLE MODELS

Background

Bishop's analysis of the Neo-Darwinian Rational Choice Theory of Academic Engagement Norms (2007) focuses on understanding the impact of norms within the secondary school environment and the influence of peer groups. According to Bishop, students form independent sub-cultures within the school, and these peer groups significantly shape their attitudes and behaviour. Bishop uses the metaphor of an "onion" with multiple layers to describe the peer environment, where each layer influences the next.

During the early stages of group formation, students establish their roles, like chickens determining their pecking order. Bishop emphasises the importance of visibility and prominence in shaping students' perceptions of what is considered "cool" within the school. For example, activities like school sports quickly gain popularity and status. Bishop suggests that intervention programs can be made "cool" through appropriate exposure, involving peers, showcasing success, and increasing visibility. These strategies can help change the acceptance dynamics and reduce negative peer pressure.

Students spend significant time with their peers, motivating them to fit in and conform to group norms. Bishop highlights that sixth graders learn school norms by observing and imitating behaviours that other students respect. These respected students become role models for the attitudes and standards children accept as the norm.

Bishop also discusses the influence of peer norms on attitudes towards teachers and studying. Negative attitudes, such as not "sucking up to teachers" or not studying too hard, can stem from group norms developed to maintain equality and prevent one member from outperforming others. On the other hand, positive attitudes towards learning and studying can also be influenced by role models within the peer group.

The phenomenon of bullying is also discussed, with peer control and manipulation playing a significant role in these processes. Bishop acknowledges the complexity of external influences, as highlighted by Paa and McWhirter (2000), in the decision-making process.

Bishop suggests that intervention programs must be able to navigate these social dynamics by making them attractive to students, parents, and other peer groups surrounding the students. Making the intervention process "cool" by increasing its visibility and prominence can help counteract negative peer influences and create a positive appeal at home and school levels.

The Role of a Hero/Role Model

The influence of role models and heroes on individuals, particularly children and adolescents, has been recognised by various scholars such as Akerlof (1983), Erikson (1977), Taylor (2005), and others. These role models provide guidance and inspiration, instilling the belief that individuals can attain similar heights with hard work. The education system also acknowledges the importance of heroes and role models in character development and moral leadership (DEST, 2005).

Bandura's Social Learning Theory (1969, 1977, 1982, 1986) suggests that individuals learn new skills and behaviours by observing and imitating role models. This theory has been extended to career development by Hackett and Betz (1981b), proposing that people learn to make career decisions by observing others. Role models can also influence self-efficacy expectations, particularly for tasks that individuals have limited direct experience with. They can expand the perceived range of possible careers, set norms, attitudes, and values, and demonstrate how different life roles can be negotiated (Almquist and Angrist, 1971; Nauta et al., 1998).

Jung (1986) proposed that role models go beyond teaching behavioural patterns and inspire individuals to act and assume specific roles, shaping culture and peer norms. According to Erikson (1977), heroes profoundly influence individuals and society, as hero themes play out in the development of roles.

Atkinson (2000) found a direct correlation between high levels of teacher motivation and increased student motivation. Teachers can serve as role models for students, influencing the peer norms within the students' environment. By becoming part of the peer group, teachers can create a heterogeneous environment that facilitates socialisation and changes peer norms through their presence. The challenge for motivators is to help students internalise and transform their engagement in extrinsic environments into intrinsic engagement.

White (1999) conducted a study on students' attitudes toward heroes and found that children perceive heroes as reflections of how they want to be perceived. Younger students often identify their parents as heroes, while older students see heroes as representatives of a larger culture. Heroes are viewed as individuals demonstrating moral excellence and sustained leadership. Children tend to identify heroes based on personal experiences with individuals who have exhibited sustained positive behaviours and have done well for others.

In summary, role models are individuals who exert influence or admiration and have an impact on others. They serve as sources of inspiration and guidance, shaping behaviours, attitudes, and career aspirations. Their power can extend beyond teaching specific behaviours to inspire individuals to take on certain roles and contribute to developing societal norms and values.

Influences Beyond the Formal Education Process

Examining influences on learning and career decision-making that extend beyond formal education is crucial in today's world. The traditional separation between what is taught in the education system and the skills expected in the workplace is no longer valid. Industries have high expectations for new entrants, requiring hard and soft skills (AIG, 2006). Bridging the gap between education and industry expectations is necessary for career intervention programs and the education system.

Overwien (2000) emphasises that life skills can be acquired outside formal education, with informal learning playing a significant role. Young people often develop a substantial portion of their occupational competencies through informal apprenticeships, which are challenging to replicate within the traditional education framework. In this context, the role of mentors and role models in learning and career decision-making becomes significant.

Taylor (2005) found that youth perceptions of their roles and responsibilities in the workplace align with the general expectations of the industry. Many of the required soft skills already exist within the youth, acquired from sources other than school, such as grandparents, uncles, and other role models. However, further research is needed to validate the assertions regarding the role industry should play in developing skills outside the traditional educational process, particularly in determining the required skills and competencies.

Billett (2004) highlights the challenge businesses face in developing competency-based skills to address short-term sectoral skilling needs while considering future requirements. Defining and implementing a curriculum that develops employability skills has become a strategic driver of government success, aiming to address both short-term and long-term needs and facilitate the linkages between education and industry. Balancing generic employability skills like communication, teamwork, problem-solving, and technical skills and competencies is crucial.

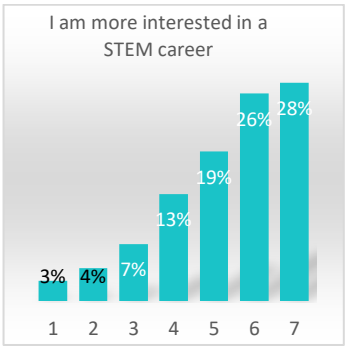
From an Australian perspective (AIG, 2006), industry plays a critical role in defining and developing the required skills of the workforce. However, it is essential to note that the industry desires hard and soft skills, with generic soft skills particularly sought after. These skills can be challenging to teach within a primarily extrinsically driven business environment. If students possess these soft skills, industries are more capable of providing the specific hard skills required within a profession. Thus, enterprises often prioritise recruiting for attitude and training for skills.

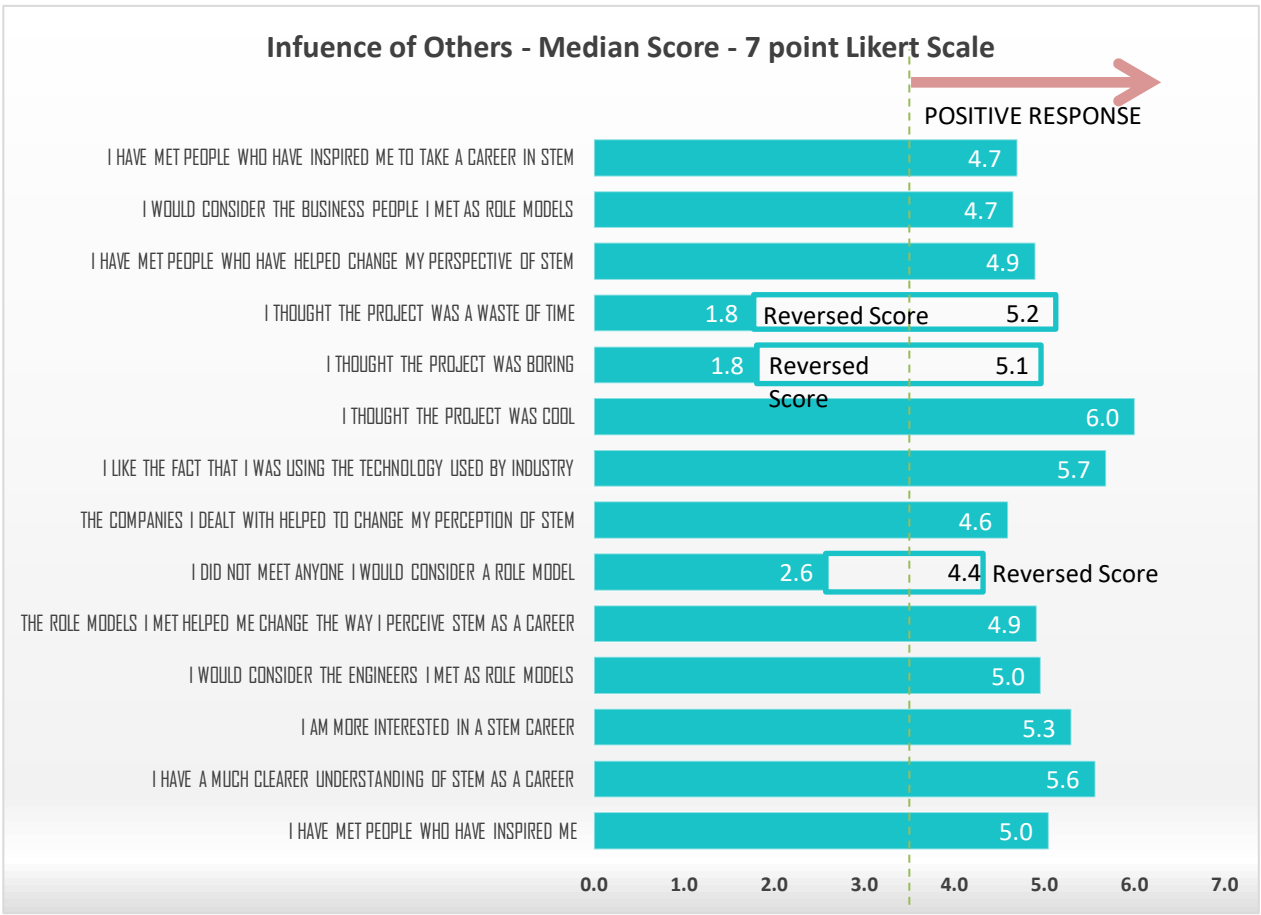
RESEARCH PROCESS

To gauge the impact of others within the environments of students, 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).*

[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.





Observations

The research indicates that participation in programs involving heterogeneous peer environments and interaction with role models has different effects on boys and girls in terms of their belief in the role of others in career decision-making. Both boys and girls respond to the influence of role models, but statistically significant differences were found, particularly regarding the impact of parents.

Girls appeared to be less responsive to role models' influence compared to boys, and this difference increased as girls became more exposed to STEM processes. However, the best subset regression analysis revealed distinct influence predictors for boys and girls. For boys, the predictors were related to their interaction with role models and an increased understanding of STEM as a career. On the other hand, for girls, the predictors were more associated with the project, such as liking the technology they got to use, control over the elements they were involved in and finding the project to be exciting.

These findings challenge stereotypes about gender preferences in career choices. Girls were interested in technology and enjoyed designing and making things, challenging the notion that design is primarily for boys. Boys' responses may be attributed to their innate capacity and desire to learn through experience and apprenticeship, aligning with previous research on employability skills in male youths.

Girls may have relied more on their parents' advice before participating in the program. Still, as they gained a clearer understanding of STEM careers, they became more confident in making their own decisions and may no longer seek parental advice. The qualitative data also highlighted that those girls valued developing their understanding of STEM activities and found STEM fun and exciting.

The unexpected differences in response between boys and girls regarding parental advice warrant further research to understand the underlying reasons for these perspectives.

Overall, the research findings emphasise that students are open to influence in their career choices and validate the use of role models. However, tailored approaches are needed to attract boys and girls to their respective career directions, considering their preferences for human interaction and their innate understanding of the environment and future vision.

PROGRAM IMPACT ON STUDENT MOTIVATION

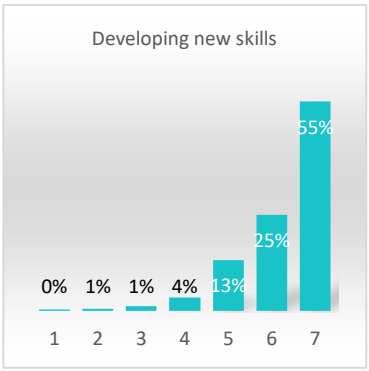
Students must have completed one of the programs to be invited to participate in the questionnaire. Questions sought to determine the program's impact and elements influencing career motivation.

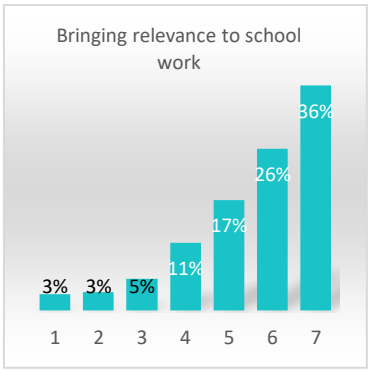
The primary question was:

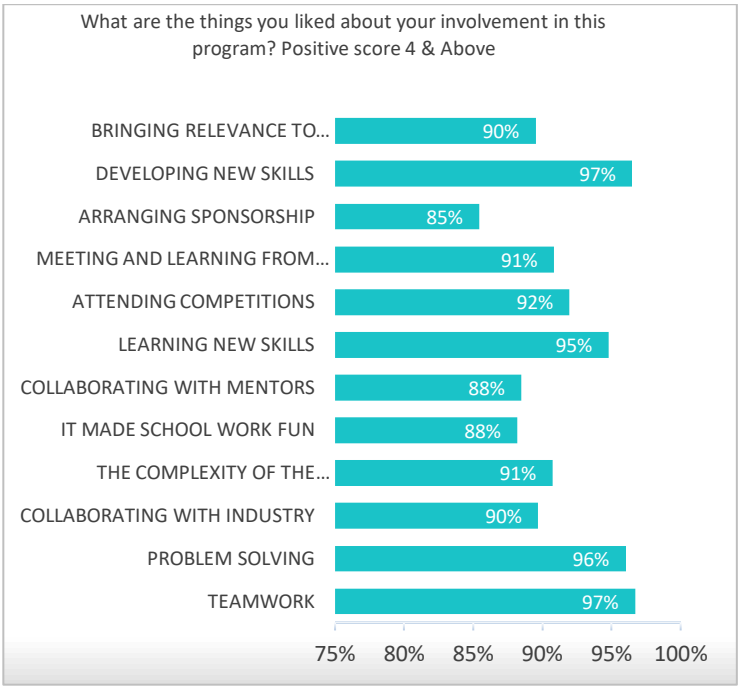
"What are the things you liked about your involvement in this program".

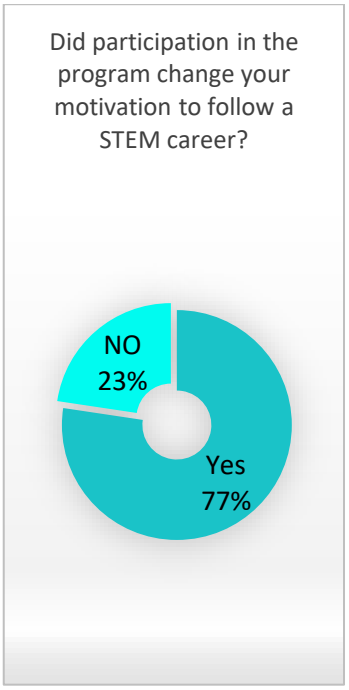
The responses were collected using a Likert scale with the following characteristics: 1: Corresponds not at all, 2: Corresponds very little, 3: Corresponds a little, 4: Corresponds moderately, 5: Corresponds enough, 6: Corresponds a lot, 7: Corresponds exactly.

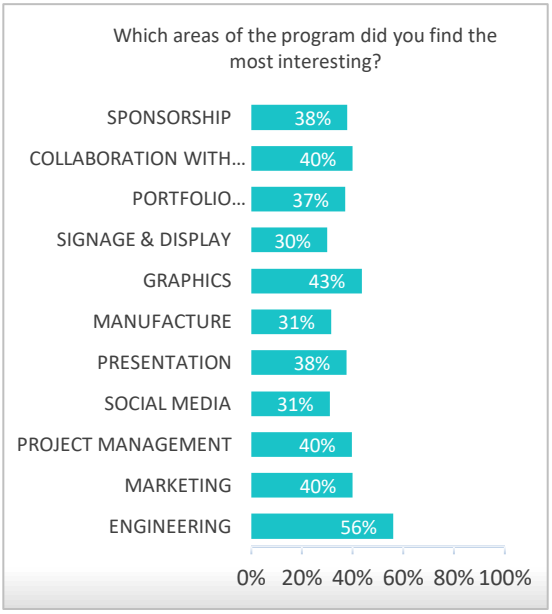
Responses on the Likert scale of 4 and above are considered positive.

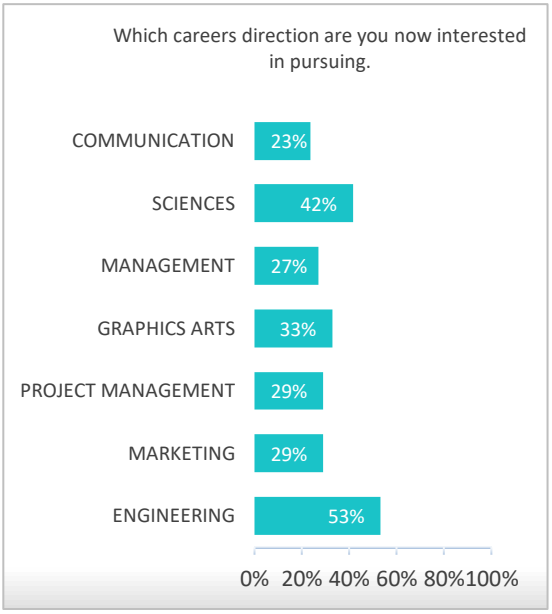

Developing new skills
0%
1%
1%
4%
13%
25%
55%
1
2
3
4
5
6
7


Bringing relevance to school work
3%
3%
5%
11%
17%
26%
36%
1
2
3
4
5
6
7


What are the things you liked about your involvement in this program? Positive score 4 & Above
BRINGING RELEVANCE TO...
90%
DEVELOPING NEW SKILLS
97%
ARRANGING SPONSORSHIP
85%
MEETING AND LEARNING FROM...
91%
ATTENDING COMPETITIONS
92%
LEARNING NEW SKILLS
95%
COLLABORATING WITH MENTORS
88%
IT MADE SCHOOL WORK FUN
88%
THE COMPLEXITY OF THE...
91%
COLLABORATING WITH INDUSTRY
90%
PROBLEM SOLVING
96%
TEAMWORK
97%
75%
80%
85%
90%
95%
100%


Did participation in the program change your motivation to follow a STEM career?
NO
23%
Yes
77%


Which areas of the program did you find the most interesting?
SPONSORSHIP
38%
COLLABORATION WITH...
40%
PORTFOLIO...
37%
SIGNAGE & DISPLAY
30%
GRAPHICS
43%
MANUFACTURE
31%
PRESENTATION
38%
SOCIAL MEDIA
31%
PROJECT MANAGEMENT
40%
MARKETING
40%
ENGINEERING
56%
0%
20%
40%
60%
80%
100%


Which careers direction are you now interested in pursuing.
COMMUNICATION
23%
SCIENCES
42%
MANAGEMENT
27%
GRAPHICS ARTS
33%
PROJECT MANAGEMENT
29%
MARKETING
29%
ENGINEERING
53%
0%
20%
40%
60%
80%
100%

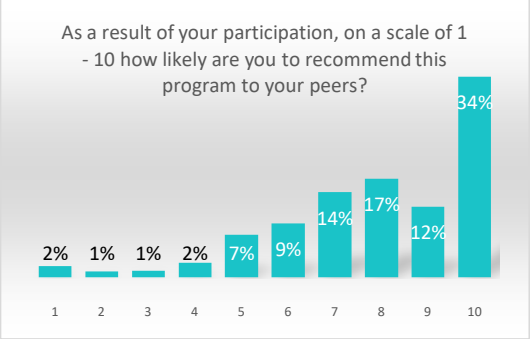
Observations

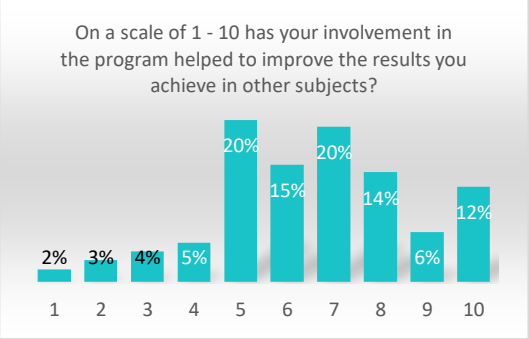
The research highlights that when the industry seeks to attract students towards their field, they should focus on generating a broad level of acceptance and interest rather than trying to control environmental influences surrounding the students. Assessing students' perception of their ability to make career decisions is crucial, as confidence in their decision-making abilities indicates the potential impact of intervention programs on their career motivations and choices.

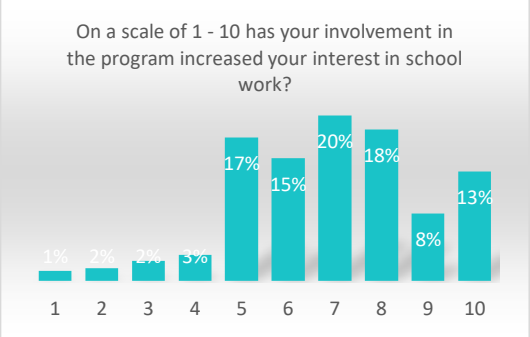
The findings reveal that developing an understanding that STEM projects and professions can be fun and exciting was a dominant theme in students' responses. Students, both girls and boys, showed significant interest in using industry-standard technology and considered it an essential learning outcome of the program. They found learning technology attractive and relevant to their future careers. Notably, students exhibited a high interest in aerodynamics, even though considered a science rather than a technology, suggesting that specific sciences can capture students' keen interest if presented with appropriate relevance.

The programs required students to document their understanding of STEM in a portfolio and deliver a verbal presentation to industry executives. This provided a platform for students to reaffirm their STEM knowledge and fit within a STEM career environment. By working on real-world projects, these programs amplified the impact of role models and interactions with industry in influencing and shaping students' career decisions. The timing of presenting the information to students is crucial, aligning with their emotional receptiveness to absorb and internalise the input.

These programs have the potential to significantly impact students' attitudes toward career choices by facilitating meaningful changes in their perspectives. By providing context, alignment, and relevance to students' perception of STEM careers in the real world, these programs can contribute to shifting normative understanding and shaping students' career aspirations.







DIFFERENCES IN MOTIVATION - BOYS VS GIRLS

The goals of career intervention programs should prioritise maximising intrinsic interest and fostering learning while also stimulating student enjoyment across diverse age groups, ethnicities, and socioeconomic backgrounds. Research has explored differences between boys and girls in various educational aspects, such as achievement, motivation, attendance, and disciplinary actions. However, there is still a need to clarify whether these differences reflect degree (magnitude) or kind (qualitative nature) differences. Additionally, the impact of the difference in maturity between boys and girls during early development on the learning process and student focus is an ongoing debate.

Differences of kind suggest that boys and girls are qualitatively different, with distinct perceptions of motivation. Studies have examined gender differences in motivational facets, engagement, and achievement. Girls often outperform boys in more subjects, and there is a higher representation of girls among high-achieving students. However, the data suggest that these differences are primarily degree differences rather than kind differences. The fundamental qualitative aspects of motivation, as revealed by factor structures, cluster profiles, and perceptual mapping, remain largely invariant across genders. This understanding has implications for data analysis and program interventions to enhance or sustain motivation in both boys and girls.

In the context of career intervention programs conducted by the REA, student teams consist of heterogeneous groups of students with diverse compositions, including students of different ages, maturity levels, genders, and social backgrounds. Isolating the impact of any one variable on the program becomes challenging within the scope of this research. The study acknowledges that while maturity is an essential factor, it is considered a general part of the study's context, along with other environmental influences such as ethnicity and socioeconomic background.

Influence of Gender on Program Participation

The need for significant support in helping students discover the fascinating aspects of STEM and industry activities is evident. To promote critical career decision-making processes, it is crucial to create learning environments that facilitate a deeper understanding of STEM professions, aligning with the different motivational drivers of boys and girls. The research conducted in this study emphasises the importance of tailoring the narrative surrounding STEM differently for boys and girls, as distinct patterns have been uncovered.

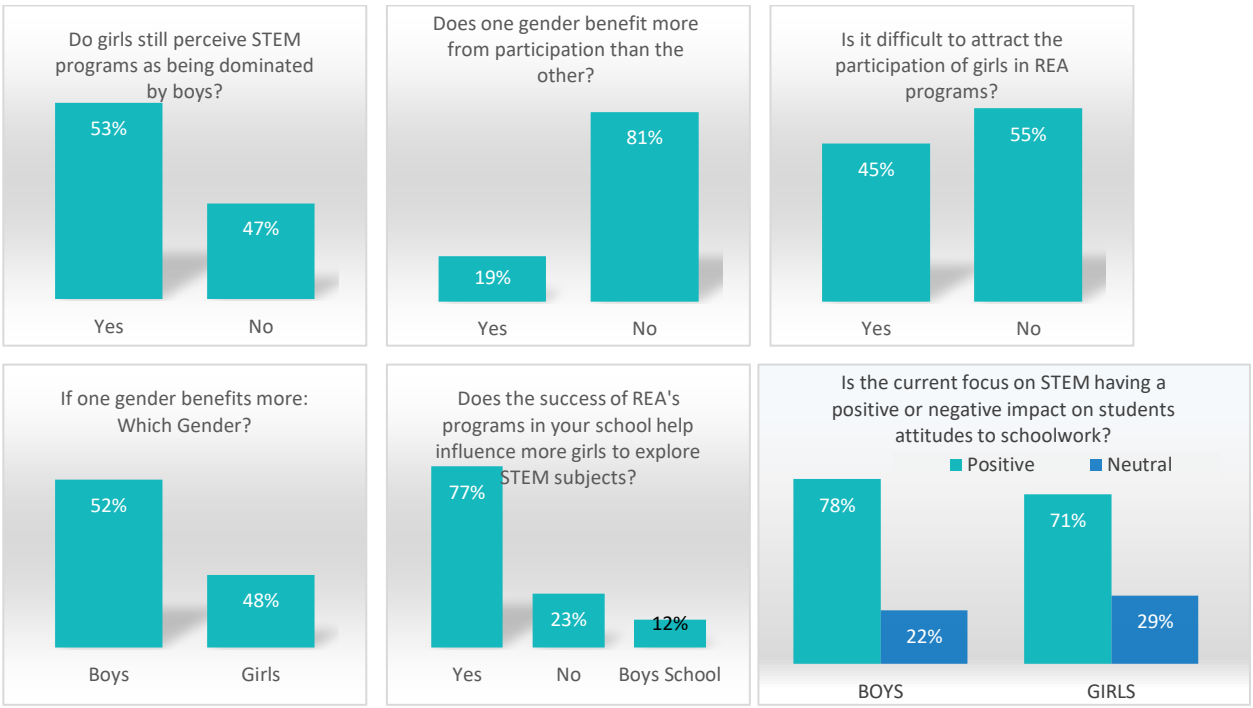
Boys' motivation increases through continuous human interaction, particularly with role models and mentors. They learn through apprenticeship and respond directly to the individuals they meet and engage with. Boys benefit from encountering real careers before emotionally committing to career engagement. The underlying message for them is that there will always be people around to support their learning and growth throughout their career journey. Facilitating increased interaction between students and adults in industry roles will contribute to a more significant movement of boys into STEM careers.

On the other hand, girls respond to the challenge of managing complexity in their environments. Highlighting the processes and intricacies involved in various career pathways attracts their interest and motivates them to become involved. Girls respond positively to the project management aspects of careers and must thoroughly understand the processes before making career choices. This research demonstrates that targeted interventions can significantly influence the number of girls interested in specific career pathways.

The REA's Metamorphic Learning framework emphasises equal engagement with students, avoiding any form of separation based on factors such as ethnicity, gender, diversity, age, or religion. All students are treated equally, with encouragement aimed at helping each student discover their unique passions and skills and then build upon them. No barriers are highlighted in career path selection based on intersectionality.

While there may still be a perception that boys dominate STEM activities, successful engagement with girls can be achieved by appealing to their different motivational drivers. This is accomplished using language and approaches

that resonate with each group, boys and girls, within their motivational framework. The responses from teachers in the study indicate that 79% of teachers believe that neither gender benefits more than the other from participation in these programs, 78% believe that these programs attract more girls to STEM, and 80% of boys and 76% of girls showed improvement in their attitude toward schoolwork. These findings highlight the positive impact of the programs and suggest that effective interventions can promote equal engagement and positive outcomes for both boys and girls in STEM education.



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 Arts

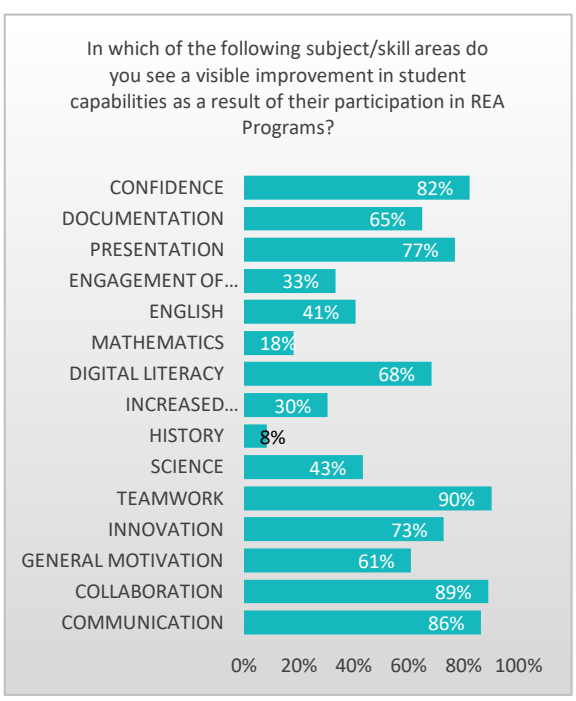
Impact of Programs on Learning Outcomes

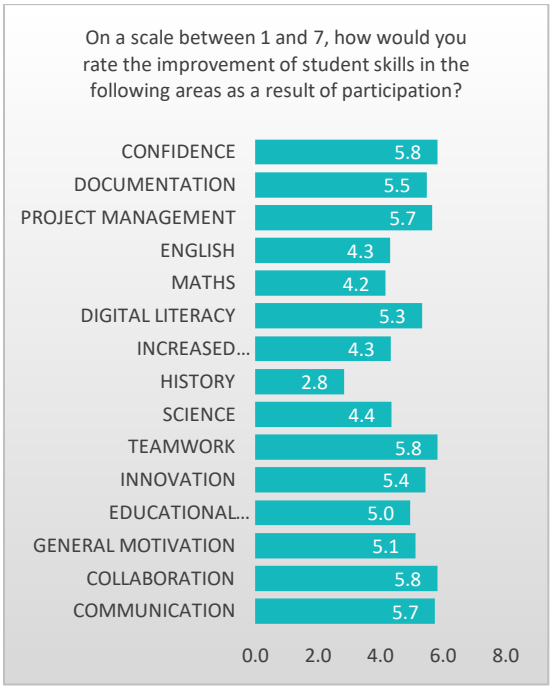
Learning environments that effectively cater to the different motivational drivers of boys and girls are essential in supporting students' critical career decision-making processes, particularly in STEM professions. A longitudinal research study examines the impact of gender on attraction to STEM in general and within STEM-based industries.

Research on individual learning approaches or styles recognises two traditions: one biased toward academic learning and the other toward learning from direct experience. De Jong (2006) concluded that learning approaches are context-specific, indicating that neither theoretical tradition nor experiential focus can claim universal applicability.

The programs developed by REA operate on the Metamorphic Learning framework, which combines academic and experiential learning to cultivate career relevance. Extensive research on Action Learning and its benefits, including increased self-efficacy, has demonstrated its effectiveness as a learning method for students and adults.

Blunsdon (2003) examined the role of experiential learning in creating engaging learning environments for students, which aligns with the findings of this research. Students tend to choose subjects based on their preferences and perceived interest, known as intrinsic interests. Educators struggle to stimulate student enjoyment while fostering learning and achieving educational goals without relying on unnecessary entertainment. Unfortunately, many school STEM programs prioritise entertainment over understanding and academic objectives. This issue arises from attempting to fit STEM into an existing, compartmentalised education curriculum.





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

Metamorphic Learning environments, which emphasise real-world problem-solving, encourage students and teachers to adopt different approaches to achieve learning outcomes. These programs connect student interest and engagement to exposure to contemporary real-world practices. Access to expert practitioners in STEM fields significantly impacts students.

The REA's Metamorphic Learning framework creates compelling and engaging STEM learning environments by leveraging experiential learning, fostering intrinsic interest, and providing exposure to real-world practice. The

programs encompass ten fundamentals students are encouraged to undertake, including working in small groups, engaging in real tasks or problems, reflecting on actions taken, and integrating individual and collective tasks/problems. The programs also align with the four components of intrinsic motivation proposed by Watt (self-determination, self-perceived confidence, relatedness, and perceived salience).

Song (2006) found that heterogeneous groups outperformed homogeneous groups when solving ill-structured problems. Heterogeneous groups, not bound by existing peer norms, looked to each group member as a source of inspiration. This lack of social peer structure increased intrinsic motivation and aided in problem-solving.

Observations

Intervention programs that neglect the significance of focusing on employability skills are unlikely to attract students and fail to provide the necessary motivation for career selection in complex STEM professions. Students highly value the relevance of their activities, as they perceive these programs as offering career relevance and recognising their learning capacity.

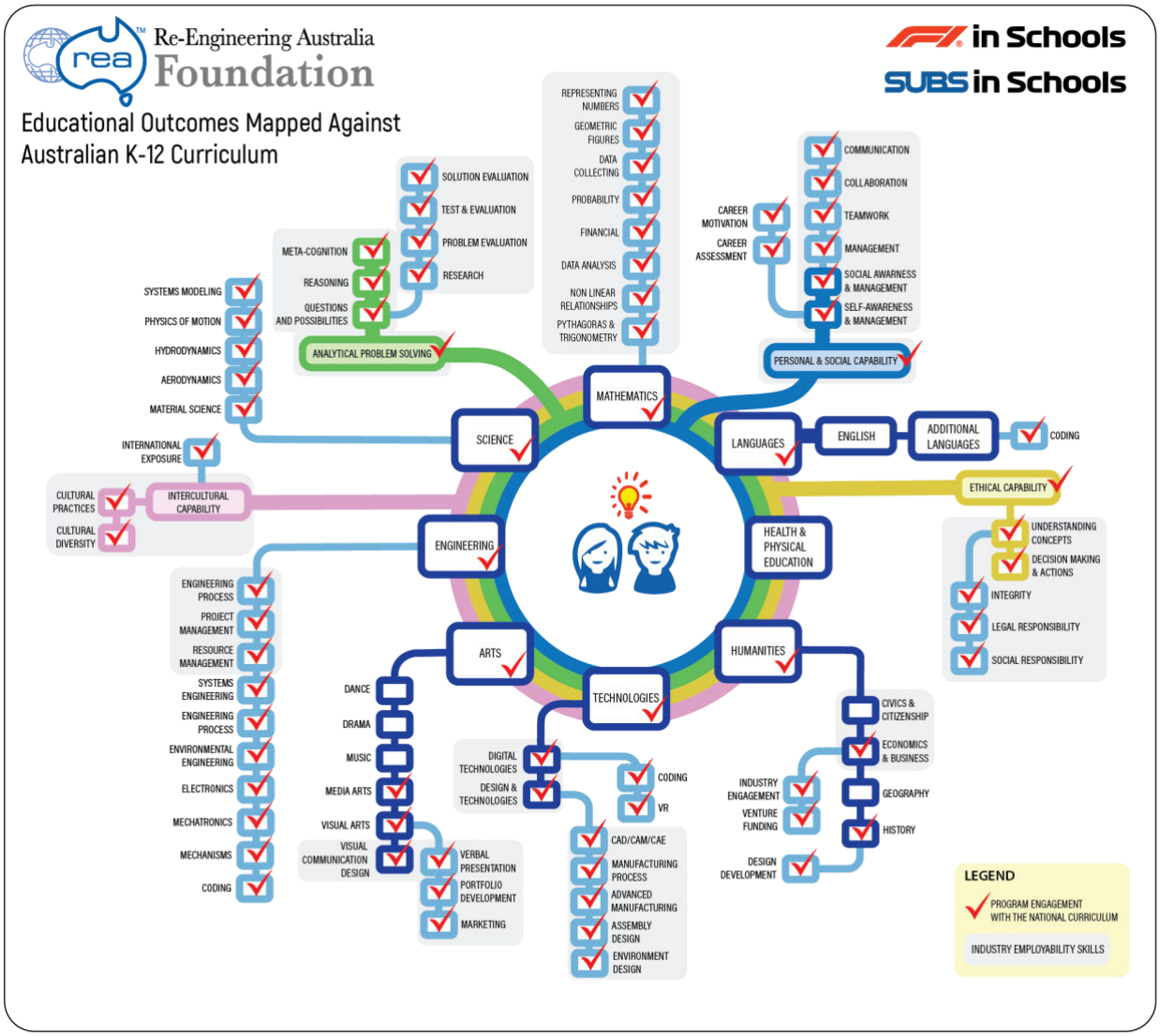
According to teachers, the areas directly related to employability skills showed the most substantial improvement in learning outcomes. These areas include confidence, documentation, project management, presentation skills, digital literacy, teamwork, innovation, collaboration, and communication. It is crucial to align these areas with the REA's Key Performance Indicators (KPIs), which include attracting students to participate, enhancing students' employability skills, increasing the appeal of STEM subjects, and demonstrating an improvement in educational attainment.

The student response to using industry technology was highly positive, supported by qualitative and quantitative data. Among boys, 86% responded positively to the utilisation of industry technology, while among girls, the percentage was 71%. Regression analysis indicated that technology was the most influential factor in predicting the students' response to the program, particularly for girls. Although girls' overall response to technology may not be as strong as that of boys, it remains a crucial determinant of their interest in pursuing a STEM career.

The quality of work students produce reflects their understanding of how to research projects and careers and their willingness to absorb and process substantial amounts of information. These students demonstrate confidence and a desire to learn about the benefits and processes associated with specific careers. This information is vital for the industry to develop resources that attract students to STEM careers. The industry must treat students respectfully when presenting career options and providing employment information, recognising their thirst for knowledge to make informed career decisions.

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

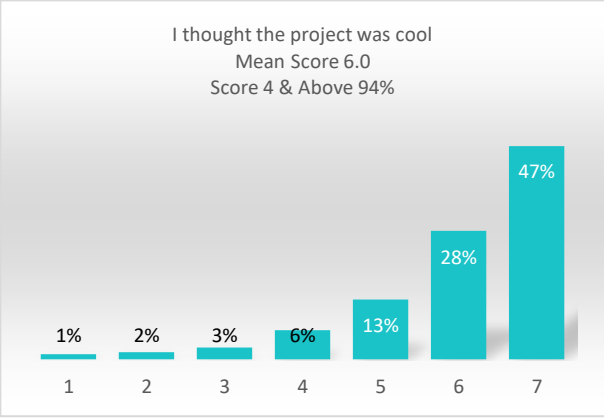
According to Bandura's Theory of Perceived Self-Efficacy, being perceived as "Cool" is a significant factor in generating interest and fostering self-efficacy. Emotional arousal, including the arousal of interest and the absence of anxiety, plays a crucial role in developing self-efficacy. However, in today's world filled with technologies like Facebook, Instagram and TikTok, being considered "Cool" poses a challenge, especially for those unaware of these technologies' distracting influence.

There is a widely held belief that the Z generation (and subsequent generations) possess an intrinsically driven attitude towards life, often described as "I do it because it's there" (Sheahan, 2005). Some argue that this mindset arises from being over-nurtured and growing up in an environment that allows them to remain socially younger for extended periods, leading to a stronger inclination towards intrinsic motivation. Despite these reasons, attracting students' inherent interest and modifying their motivations towards specific careers or intervention programs has become more challenging due to our society's abundance of "Cool" technological distractions.

In the research, 94% of the students regarded the programs as "Cool," indicating they successfully captured their attention and aligned with their intrinsic interests. Regression analysis showed that girls perceived the program as "Cool" as the second-highest predictor of their response to the program.

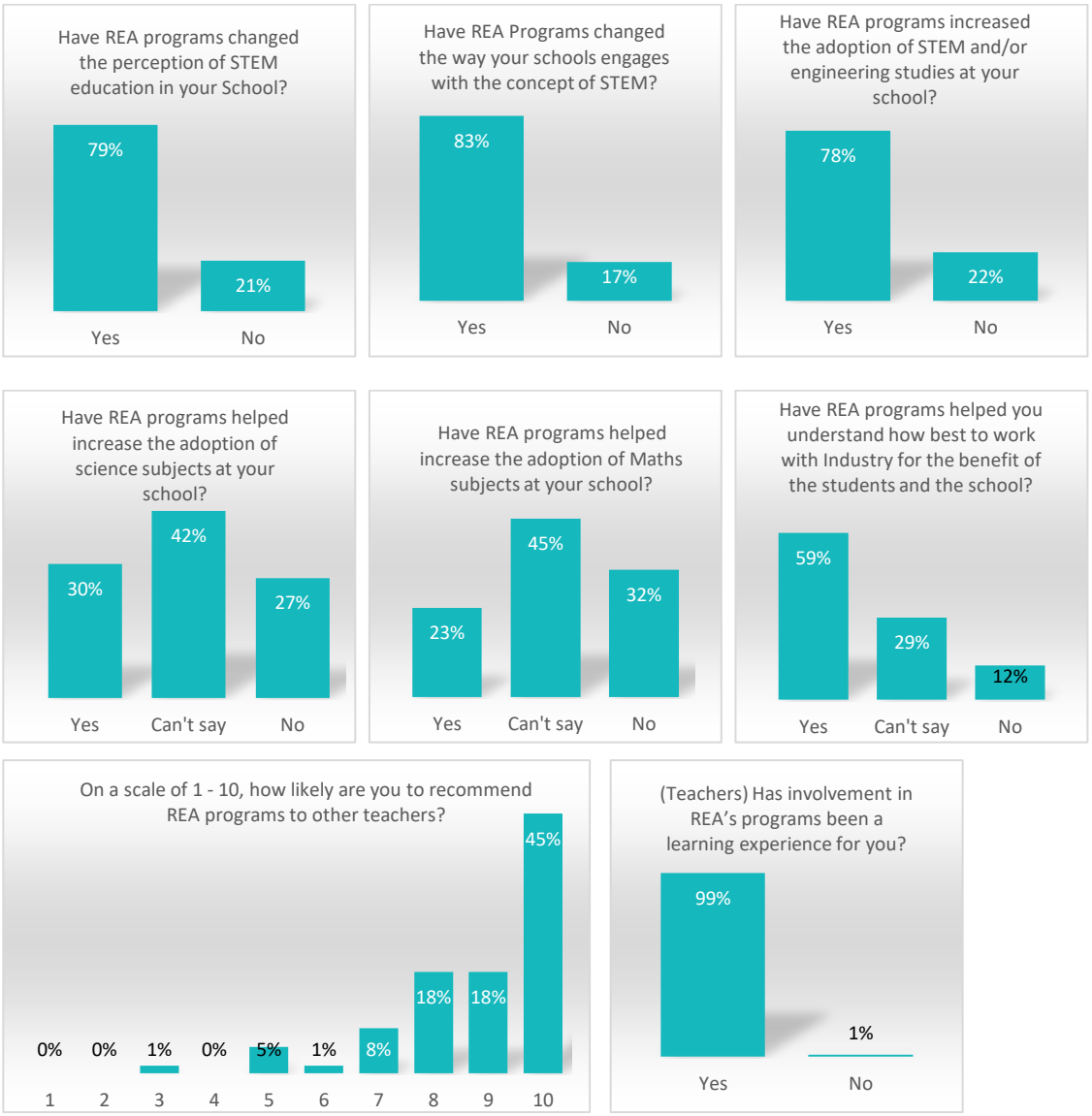
The analysis also revealed that students with higher levels of intrinsic motivation were more likely to be influenced by activities that appealed to their intrinsic interests. Being perceived as "Cool" appears to be a critical factor in attracting students' intrinsic interest. Programs like F1 in Schools, which provide associations with Formula One, the opportunity to meet racing heroes, the use of tools employed by companies like Airbus, or interactions with industry professionals working on exciting projects, were considered "Cool" by the students. Similarly, in the SUBS in Schools program, the presence of Navy personnel in uniforms had a significant impact on increasing students' interest, as uniforms project qualities such as authority, order, structure, and success that align with students' perceptions of role models.

If the industry aims to develop intervention programs that attract students in this age group, these programs must be sufficiently "Cool" to capture students' intrinsic interest. Without achieving this "Cool" status, it becomes challenging for any activity to break through and engage students. Providing access to a diverse range of mentors, role models, and heroes who can guide and support students in navigating the multitude of signals they receive is essential in designing effective career intervention programs.



PROGRAM INFLUENCE ON SCHOOLS AND TEACHERS

The following responses about the impact these programs had in their schools and their attitudes to the program's outcomes were provided by teachers.



Observations

Teachers who participate in the program find it enjoyable and perceive it as a valuable learning experience. An overwhelming 99% of teachers indicated that their participation in the program had been a learning experience, and 89% expressed their willingness to recommend these programs to their peers.

The level of work produced by the students and their access to industry-scale technology demonstrate that students are not afraid of technology and, to some extent, are more proficient in using it than adults. They can research projects and careers and are eager to absorb information. Traditionally, schools have only provided technology at a superficial level compared to what the industry uses. Teachers are aware that students can quickly grasp basic technology but become bored with it just as quickly. By integrating industry-standard tools into the program, the student's potential for learning is boundless and not constrained by any inherent limits. For example, the CAD/CAM technology used by the students in the classroom is the same as that used by leading industry

organisations such as Boeing, Toyota, and Ford. It became evident that students as young as 12 had no trouble handling industry-level technology.

The industry needs to be aware of the technological proficiency of students at a young age, as this information is crucial for developing resources that attract students to STEM careers. The industry must treat students respectfully when presenting career options and information about employment opportunities. Underestimating the level of knowledge that students seek to make informed career decisions would be a mistake.

Intervention programs that overlook the importance of providing technological relevance and fail to understand these dynamics will struggle to capture students' intrinsic interest. They will also fall short of providing the necessary motivation to encourage career selection in complex professions like engineering. The need for relevance in student activities is vital in targeting their interests. From the student's perspective, these programs offer career relevance and acknowledge their capacity to learn and excel.

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, 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.
- For some questions a "Not applicable" response was needed as pursing questions contradicted the previous response, hence inaccurate response.
- 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 a large number of 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 as a whole. 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

Addressing skills shortages in the long term requires a sustained and measured focus that goes beyond short-term economic considerations. While economic rationalism often drives industry decisions, solving the issue of career motivation among children cannot be achieved through quick-fix solutions. It requires a long-term commitment and strategic approach to improve student attitudes towards STEM careers.

From an industry standpoint, it is challenging to differentiate job applicants based on their educational credentials. Traditional school achievement measures, such as scores like ATAR, VCE, SASE, etc., do not accurately represent a person's potential for success in ways that align with the skills employers' value, like conscientiousness. Conscientious individuals possess qualities such as thoroughness, responsibility, and reliability. They pay meticulous attention to detail, consistently follow through on commitments, and manage tasks responsibly and efficiently. With a strong work ethic and a sense of duty, they strive for excellence and reliably meet obligations and deadlines. The development of trait conscientiousness is directly linked to discipline and ownership, specifically ownership of the learning process, and will help students successfully transition into the workforce.

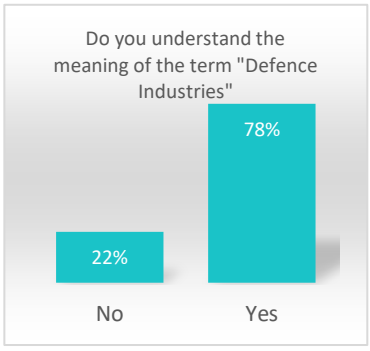
A key differentiating factor of the REA programs is the direct involvement of students with industry partners in their projects. This enables students to see a direct relevance between classroom activities they enjoy and real-world work. Collaboration and interaction with industry mentors are integral to all REA programs as students learn about technology and explore career options. REA adopts a pull strategy to enhance student engagement with industry career pathways, where students actively seek out information about careers aligned with their skills and motivations. The assessment criteria for each competition include a dedicated portion for students to highlight the career research they have undertaken, emphasizing the connection between their projects and potential career pathways. In addition to the immediate outcomes, students develop valuable personal and employability skills such as teamwork, goal setting, time management, resource management, and seeking industry support and mentorship.

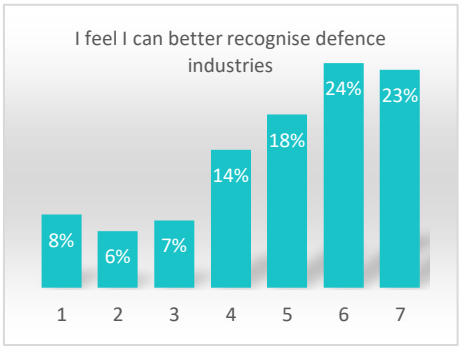
The industry has a critical role in encouraging students to pursue careers in STEM and engineering. While these career interventions can bring students to the doors of opportunity, the final step of transformation into a STEM career pathway requires industry support. Industry engagement is crucial in providing contact with role models and access to knowledge about the profession. Role models and knowledge play a critical role in shaping students' career choices, and the industry is well-positioned to provide both. Practical and purposeful interaction with the industry can emotionally connect students to the real world outside of the school environment. Providing students with opportunities to work on real-world projects and standing alongside them during their journey catalyses their ability to make informed decisions about their future work environments. Sustained efforts from the industry in nurturing students' intrinsic interest in engineering beyond the intervention activities will have the most significant impact.

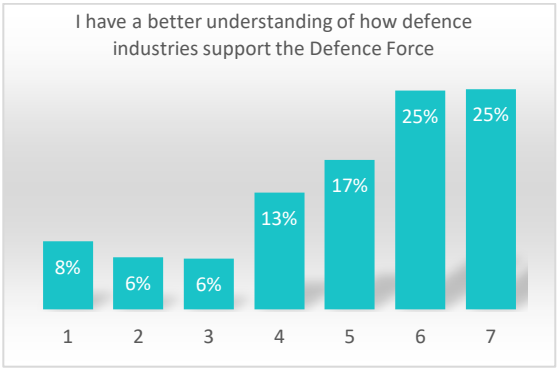
The challenge for the industry lies in maintaining focus on the problem and making necessary changes to organizational behaviours to ensure the continued support and sustainability of programs like these. It is crucial for industry stakeholders to recognize their role in developing student career choices and to commit to efforts that support and inspire students to pursue STEM and engineering careers.

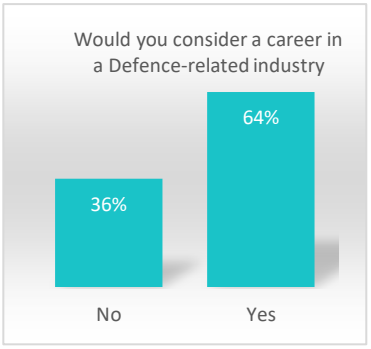
Student Interaction with Defence Industry

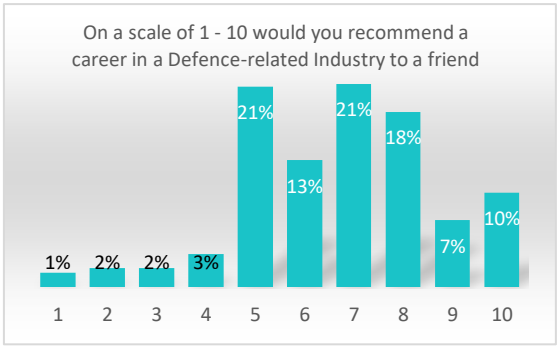
The following are students' responses to their involvement with Defence Industries.



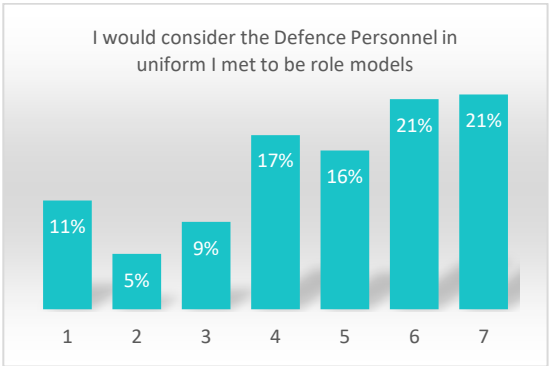


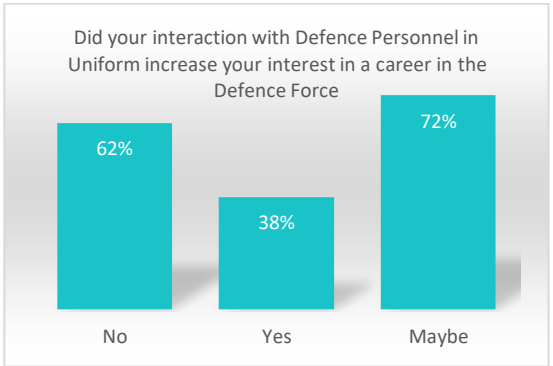


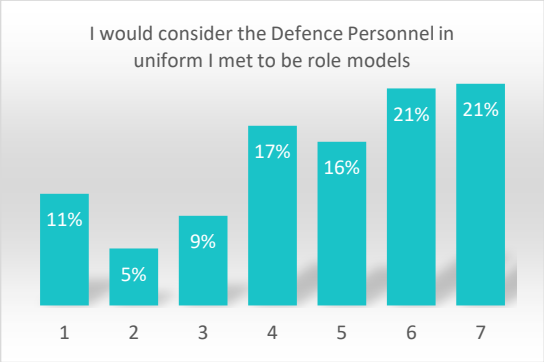


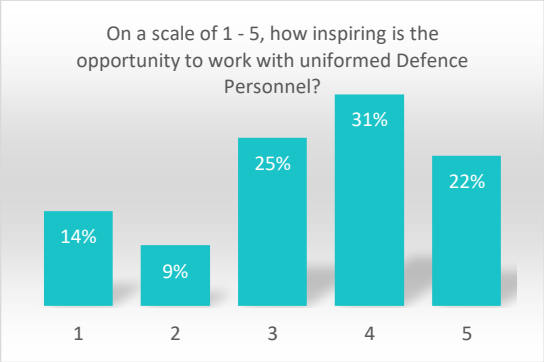


Student Interaction with Defence Personnel









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.

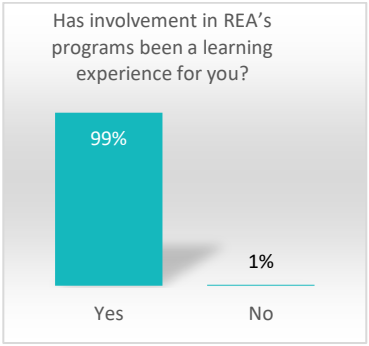
- My main motivations for this stem from my love for engineering, especially found in the F1 in Schools competition. I would love to delve more into real-world applications.
- The different jobs are available for those industrials and the possible related skills.
- The different STEM careers and options cater towards ability and interests.

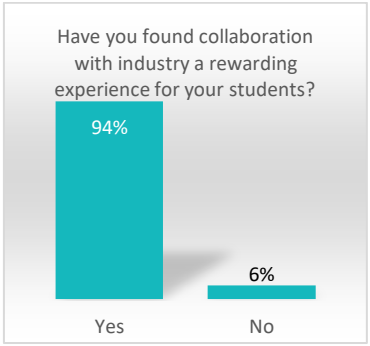
IMPACT OF INDUSTRY ENGAGEMENT ON TEACHERS' ATTITUDES

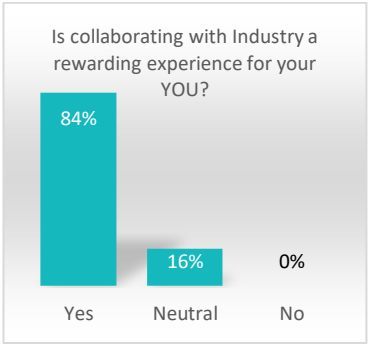
During the research process, teachers frequently expressed concerns about the support for implementing STEM-based career interventions. Many teachers lack the confidence and competence to explore experiential learning programs within the STEM field. Some teachers may not fully understand how engineering and other STEM professions contribute to societal needs. While this research focused on identifying students' motivational drivers, it is evident that significant efforts are needed to support teachers in this context.

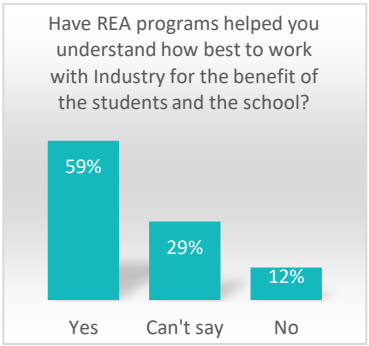
Teachers play a pivotal role in students' lives, often serving as the sole heroes and role models who can inspire and encourage them to engage in activities beyond the scope of their own experiences and knowledge. To empower teachers in implementing effective career interventions, providing them with the necessary resources, training, and professional development opportunities is crucial. In support of teachers it is critical that industry and the education system collaborate in providing ongoing guidance and support to teachers, encouraging them to implement effective career interventions that align with the outcomes sought by industry. This support should focus on enhancing teachers' confidence, competence, understanding of STEM careers, and ability to facilitate experiential learning programs.

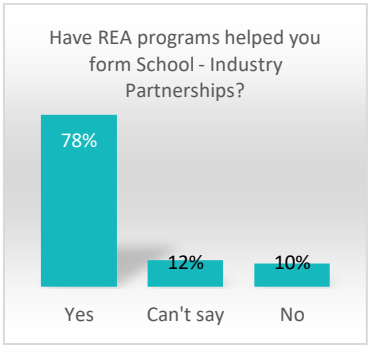
By working collaboratively, industry and the education system can provide the guidance and support needed to empower teachers in implementing impactful career interventions. This collaboration should bridge the gap between industry and education, helping teachers understand the relevance and importance of STEM professions and equipping them with the tools and knowledge to inspire and guide students effectively. Recognising the pivotal role of teachers and investing in their professional development will contribute to the success of career interventions and ultimately help students make informed choices about their future careers. The survey sought to determine the impact of interaction with Industry on teacher career knowledge.











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 pretty 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.

CONCLUSIONS

These findings highlight the role of sustained educational engagement, intrinsic motivation, peer influence, parental support, and industry collaboration in fostering interest in STEM education and career pathway choices in students.

Several key elements have emerged regarding the effectiveness of REA's STEM programs and the factors that influence student career choice:

1. **Metamorphic learning process:** The programs bring about a profound transformation in students' capabilities, fundamentally changing their knowledge base, maturity, self-efficacy towards career choices, personal drive, communication skills, self-confidence, and teamwork abilities.
2. **Self-driven Learning:** This program encourages students to pursue knowledge, especially related to their careers, actively, ultimately leading them to take responsibility for their learning. Extended trajectory self-driven learning has been shown to have a long-lasting effect on shaping career motivation.
3. **Educational conscientiousness**: is fostered through the competitive nature of the programs, which encourages students to take ownership of their learning process, cultivating leadership, discipline, and increased trait conscientiousness, crucial elements in eliminating cultural, social, and economic disadvantages.
4. **Intrinsic motivation:** Students display high levels of intrinsic motivation and respond to activities that capture their interest. The combination of high intrinsic motivation towards STEM and engaging activities has a significant impact, with 77% of students indicating a change in their career motivations towards STEM.
5. **Increase in employability skills:** Over 94% of students significantly improve their employability skills capabilities through program participation, as reported by teachers.
6. **Influence of peers and parents:** While students are influenced by their immediate peer environment and parents, the extent of this influence varies based on the people they interact with, the knowledge they gain, and the experiences they encounter in the intervention programs. Boys and girls respond differently to these influences. Boys more so to external role models (physical people), and girls to understand the complexity of the environment and the role they can play in managing it.
7. **Career decision-making self-efficacy:** Students exhibit high levels of self-efficacy in making career decisions, feeling confident in their abilities to choose a career path.
8. **Importance of "Cool" status:** Students are predisposed to respond to the influence of their peers in establishing a "Cool" status for processes or activities. Therefore, the industry needs to elevate the image of significant projects to attract students' interest.
9. **Fun and excitement of STEM:** Students' response to the programs is driven by learning about STEM careers and finding them fun and exciting.
10. **Interest in Manufacturing careers:** 50% of students are interested in employment in the manufacturing sector.
11. **Academic achievement improvement:** 84% of students report increased academic achievement across all subject areas due to their program participation.
12. **Teacher learning and inspiration:** 99% of teachers feel they have gained significant knowledge and inspiration through their participation, emphasising the impact of inspired teachers on creating inspired learners.
13. **Industry involvement:** The industry is crucial in attracting students' interest and facilitating their entry into specific career opportunities within companies.
14. **Tailored learning environments:** Learning environments that facilitate a better understanding of careers aligned with the different motivational drivers of boys and girls are essential for providing the guidance and understanding students seek when making critical career choices.

DISCUSSION

The long-term sustainability of students' career choice towards STEM is influenced by the societal reaffirmation they receive about STEM and how well it aligns with their experiences during STEM-focused career intervention activities. Ensuring the attraction and success of career interventions will require changing the messages delivered to students by both the industry and society regarding STEM are crucial.

It is essential to recognise that the story about STEM needs to be tailored differently for boys and girls. Here are some key considerations:

1. **Boys:** Boys benefit from continuous human interaction, particularly with role models and mentors, to perform at their best and develop career motivation. They learn through apprenticeship and role models influence. Engaging boys in STEM careers require hands-on experiences and emotional connections with the field. Highlighting the presence of professionals who will support their learning and growth throughout their career journey is essential. The elevator pitch for attracting boys to engineering/STEM careers could focus on the following points:
    - STEM careers offer opportunities to design cool things throughout your career.
    - You will work in great teams and continuously learn from experienced professionals.
    - Your career will be a journey of continuous discovery.
2. **Girls:** Girls respond well to managing complexity in environments. Emphasising the processes and complexity involved in STEM professions can attract them to the field. They are drawn to project management aspects and need a clear understanding of handling complex projects. The elevator pitch for attracting girls to STEM could emphasise the following points:
    - STEM professions require strong management skills to combine diverse skills, knowledge and processes needed to achieve outcomes and problem resolution.
    - Throughout your career, you will be responsible for managing and coordinating complex sets of tasks to bring projects to a successful conclusion.

By tailoring the messaging to address the specific motivations and interests of boys and girls, it is more likely to attract their attention and foster long-term engagement with STEM careers. This approach acknowledges boys' and girls' different learning styles, preferences, and career drivers, providing them with relevant and relatable information to make informed decisions about pursuing STEM pathways.

Cool vs Role Model

The term "Cool" has been consistently used throughout the document to describe something students find appealing and exciting. Students associate coolness with the level of exposure a person or activity attracts. However, it's essential to recognise that being cool does not necessarily mean being a role model. Students perceive these as distinct categories within society. In the context used by students, coolness is associated with gaining exposure. In other words, if someone gains exposure, they may be considered "cool." On the other hand, a role model is a label that students use to describe individuals, companies, or projects that positively contribute to society. Role models do not rely on exposure alone to earn student respect, whereas being cool does not automatically qualify someone as a role model. Students place a significant emphasis on competence rather than mere exposure when evaluating individuals or activities.

This presents a dilemma for the industry: should they focus on being cool and gaining visibility or being perceived as societal role models? Ideally, the industry should strive to achieve both. It should be cool enough to grab students' attention and pique their interest while also being a role model that students would aspire to work for. In general, students consider STEM fields to be cool, which helps attract their intrinsic interest. However, the industry needs to go beyond being cool to influence their career choice and increase the number of students pursuing STEM. It should demonstrate how STEM careers contribute to doing good in society in a way that resonates with

students. By presenting themselves as role models and showcasing their positive impact, the industry can change the norms around career choices and make STEM careers more appealing and acceptable to students.

In summary, the industry must lead how it presents itself to the next generation. By being cool and portraying itself as a societal role model, the industry can capture students' attention and make STEM careers more desirable options for them.

Defence & Defence Industry

Bandura's social cognitive theory emphasises the influence of well-regarded individuals on action and self-efficacy. In the context of the Defence and Defence Industry, their size and visibility offer a unique opportunity to impact students' understanding of the application of STEM. However, there is a dilemma surrounding the normative imagery associated with Defence in the community.

Traditionally, a role model is defined as someone who does good in society. The role of Defence in recent natural disasters, such as floods and fires, has strengthened its image as an entity that contributes positively to society. People in Defence, particularly those in uniform, align with the vision of positive role models, comparable to professions like doctors and nurses. Defence and its employees are seen as both cool and strong role models. This research examined the impact of interaction with the Defence Industry and Defence role models on student motivation towards STEM Industry career pathways.

Negative associations with Defence are more prevalent among the mature-aged (baby boomer) market. Students generally do not associate Defence with being "not good for society" for several reasons. The popularity of computer-based war games, which the younger generation finds enjoyable, promotes a mental model of Defence that doesn't discourage them from considering careers in Defence Industries or Defence. Additionally, it has been several decades since the last visible conflict (Vietnam), and the current generation of students and their parents may not strongly connect with negative images of war.

In attracting students to careers in Defence and Defence Industries, the current perception in society is positive. Projects such as jet fighters, submarines, and ships, in which Defence and Defence Industry are involved, are of intrinsic interest to students and are considered role model projects. From a student's perspective, these projects are undoubtedly cool.

Differentiating the impact of Defence personnel versus Defence role models on career motivation is complex. It would require a thorough multivariable analysis to determine the extent of difference in their influence on student motivation. However, qualitative responses indicated that students often do not differentiate between Defence and Defence Industry. To them, the two are intertwined. When asked if they would consider a career in Defence or Defence Industry, 64% expressed interest in Defence Industry, while 54% would consider Defence itself. Students also expressed a positive emotional connection with the roles of Defence and Defence Industry in society.

To significantly influence students' career motivation towards STEM, not limited to Defence or Defence Industry, merging the image between Defence and Defence Industry as a single marketing strategy could be impactful. By combining their positive attributes and emphasising their role in society, a unified vision can be harnessed to attract students to STEM careers.

Highlights

This research highlights the remarkable capabilities and enthusiasm of the current generation of students. Their high levels of intrinsic motivation and the strong correlation between intrinsic motivation, self-efficacy, and innovation indicate that these students possess immense innovation potential, which presents a significant opportunity for the industry and our nation as we navigate a competitive world.

Industry must recognise and value the capabilities of the next generation of students by tapping into a wellspring of innovation and creativity by understanding their motivations and harnessing their enthusiasm. These students hold

the potential to drive positive change, contribute to technological advancements, and make significant contributions across various sectors.

The research findings underscore the importance of nurturing and supporting these motivated students. By providing appropriate guidance, resources, and opportunities, the industry can help cultivate their innovative mindset and empower them to excel in STEM fields and beyond providing broader implications for the growth and development of our nation.

Once we recognise the potential of these students, the industry must provide the necessary support for them to thrive, ultimately fostering a culture that propels our nation forward. In a world that demands constant innovation and adaptation, the capabilities and motivation exhibited by this new generation of students offer a competitive edge. By harnessing their talents and encouraging their pursuit of STEM careers, the industry can position itself for success in a rapidly evolving global landscape.

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