Research Report

STEM EDUCATIONAL OUTCOMES REPORT 2022

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

Re-Engineering Australia
Foundation

Authorised Agent

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EXECUTIVE SUMMARY

If nothing else, Industry must take from this research that the capabilities and enthusiasm of our children are profound. Given the high levels of intrinsic motivation and the strong linkage in the literature between intrinsic motivation, self-efficacy, and innovation, it is reasonable to assume that this new generation of students given the right opportunity and the right development they could be highly innovative. Capitalising on this opportunity will place our Industry and our nation in an excellent position in a competitive world.

The industry has high expectations of the out of the box capabilities it expects from new entrants regarding employability skills (AIG, 2006). The once clear separation between what the education system teaches and what is learned at work no longer exists. The career intervention programs examined by this research provide an educational bridge between the traditional pillars of education and delivery of the hard and soft skills that Industry seeks.

Science, Technology, Engineering & Mathematics (STEM) education, an industry-led initiative intended to promote the importance of employability skills, first introduced around 2015 as a catalyst for the transformation of skills development, has, unfortunately, been reverse engineered to work within academic structures devised and created over 70 years ago, significantly diluted the educational value STEM has the potential to deliver. Most STEM programs today comply with few of the guiding principles of STEM and have become little more than amusement value for students.

To meet the requirements of an ever-changing educational environment, it has become crucial to provide approaches to help teachers offer education in the classroom in new ways that aid the development of skills that will facilitate student transition to the world of work. This research examines the capacity of several Re-Engineering Australia Foundation Ltd (REA) programs, developed using a Metamorphic Learning framework, to impact students' educational and career motivations.

REA has been implementing STEM-based programs since 1998, based on a Metamorphic Learning framework that draws on concepts from Challenge Based Learning, Action Learning and Project-Based Learning. These programs deliver outcomes that create a transition in student (and teacher) capabilities so profound that they don't just change a person's knowledge base; they change them fundamentally.

These programs link Schools, Industry, TAFE, Universities, and parents in a collaborative and experiential environment that has demonstrated a capacity to instil innovative capability in students very early in their years at school. Over 1 million students across Australia have participated in these programs. The vast majority significantly improved educational attainment across many subjects and increased interest in STEM career pathways.

This research examines data collected between 2019 & 2021 from students and teachers across Australia. The students who participated exhibit the ability to make the linkage between Industry, career opportunities that fit with their skills and passions, and the roles they can play in their future. Without the support of Industry, however, the final link in the transition from school to a career will not happen in any structured or controlled way. While career interventions can bring students to the doors of opportunity, without Industry playing a role in the students' journey of discovery and being there to open career doorway when the students are making the final choice, control over the process will not happen. Industry needs to make a sustained effort to provide contact between students and role models and provide access to knowledge about careers to have a lasting impact on the next generation.

Because of the size and visibility of its projects, Defence and Defence Industry is in a unique position to be able to have a significant impact students' understanding of the application of STEM. A component of this research examines the impact the Industry involved in Defence projects can have in influencing students' motivation toward STEM career pathways and why careers in these industries can be attractive career doorway for students to enter (Note: The defence Industry, via the Department of Defence, supports REA programs).

CONTENTS

BACKGROUND

REA delivers several programs specifically to address employability skills development and bridge the gap between Industry and education. This research looks at the effectiveness of these programs in achieving these goals.

The forces and agendas that influence students' career choice decisions are many, with complex linkages between the stakeholders (students, teachers, parents & Industry). For the students who participate in STEM programs, the outcomes and benefits being "sold" to them by the differing influencers may not be particularly evident in their eyes due to their stage of social and physiological development. The benefits for each of the stakeholders can also be very different.

Today's education environment is significantly different from that most of us experienced growing up. General educational levels are much higher than 30 years ago. Students have access to vast amounts of knowledge, and more students, with higher levels of education are vying for the same opportunities.

From an industry perspective, the educational requirements required in new entrants have advanced significantly. Higher competency levels in the 3Rs are assumed, and the benchmark for the required skills has increased considerably. The competition between industries within the market to attract new entrants into specific career directions is also very intense.

Industry is looking for what they have called employability skills that include communication, collaboration, teamwork, problem-solving, innovation and entrepreneurship. Skills that are not explicitly taught in school, and to no small extent, are not readily visible in the general population. While most States and Territories in Australia have produced documents defining Employability Skills Frameworks, the leap from propositioning the need to delivering a change in the education system has not resulted. It has thus become crucial to provide approaches to help teachers offer education in the classroom in new ways that aid the development of life skills that will facilitate students' transition to the world of work.

Science, Technology, Engineering & Mathematics (STEM) education is an industry lead initiative intended to promote the development of the skills industry requires in new entrants. It was designed as a catalyst to break down the educational silos invented in an education system devised and created over 70 years ago. Unfortunately, since its first introduction, the concept of STEM has been reverse engineered to work within existing frameworks, significantly diluting the educational value STEM has the potential to deliver.

To survive and flourish in Industry rolls, students must become skilled at communication and problem-solving, and to help them acgieve these goals teachers must become coaches of expertise rather than the source of knowledge.

About Re-Engineering Australia Foundation Ltd

Created in 1998, the Re-Engineering Australian Foundation Ltd is a not-for-profit charity created to implement career intervention programs[1] based on STEM concepts. These interventions build employability skills and encourage students to follow STEM-based career pathways; REA's programs include F1 in Schools, SUBS in Schools and SPACE in Schools. The F1 in Schools program inks with the international F1-in-Schools challenge, which now runs in 50 countries and has over 17,000 schools participating each year worldwide.

REA's programs are offered to high schools across Australia, initially aimed at students in years 7 through 10 but often extended downward to years 5-6 and upward to years 11-12. These programs focus on developing the creativity and

[1] Career intervention programs are activities explicitly developed to raise awareness of specific careers, disciplines or subjects to attract students to undertake those activities and the prerequisites needed to participate in those careers, disciplines or topics.

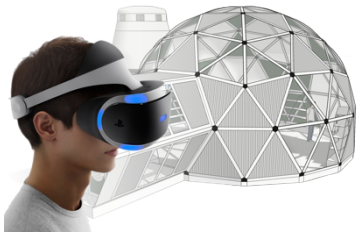
innovation of students very early in their school years. Each program links Schools, Industry, TAFE, Universities and parents in a collaborative and experiential environment focused on changing the metaphor of the education process.

Students from schools all over Australia, in both city and regional communities, participate in the programs. Schools are linked through technology into hubs, focusing on developing collaboration skills. Over the school year, both in their own time and in class with the supervision of dedicated teaching staff, students follow the Design, Appraise, Make and Test learning steps. The program curriculum tests their problem-solving skills and encourages innovative and imaginative thinking within design constraints. They also fosters an environment of team competition to prepare students for participation in the competitive global work environment.

A fundamental differentiator is a requirement for students to work directly with industry in their projects which results in students seeing a direct relevance between classroom activities they enjoy and the world of work. Through this legislated requirement to interact with industry mentors to solve real-world problems, the programs provide environments that have demonstrated a capacity to instil innovative capability in students very early in their years at school. They build career relevance and the employability skills industry seeks, successfully influence the change in students' career decisions. Another difference is the provision of the latest technologies that enable teachers, students, and industry to collaborate efficiently in "smart" environments.

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 Defense Future Submarine Program. SUBS in School focuses on students between years 5 to 12.



SPACE in Schools is to expose students to the world of spatial design, utilising 3D design and virtual reality software tools to design for human habitation. SPACE in Schools allows students to develop a human environment on Mars. SPACE in Schools focuses on students between years 3 to 12.

Each program utilises an underlying Metamorphic Learning framework that draws on concepts from Challenge-based learning, Action Learning, and Project-Based Learning. The metamorphic transition in student (and teacher) capabilities is so profound that they don't just change a person's knowledge base; they change them fundamentally. The benefits of this Metamorphic Learning approach to education in both the short and long term are immense. Over 1 million students across Australia have participated in these programs, with 77% of students changing their career motivation to be STEM and 85% of students increasing their educational attainment across most learning areas.

REA's Key Performance Indicators (KPIs) for these programs include:

1. The structure should be such that they attract students to participate.
2. The programs must improve the employability skills of the students taking part.
3. The program must increase the attractiveness of STEM subjects.
4. The programs demonstrate an increase in student educational attainment.

In addition, REA has additional targeted outcomes it seeks to achieve:

1. Forming sustainable partnerships between industries and schools.
2. Promoting collaboration between our cities and country regions in support of innovation.
3. Developing the skills of our children to ensure their opportunities for the future.
4. Raising the level of innovation, engineering and manufacturing undertaken in Australia.
5. Supplying students direct to the industry who can understand and work with advanced technology.
6. Creating in our students an understanding of Australia's potential to take a world leadership role in areas of design and manufacture.

RESEARCH RATIONALE

The research aimed to measure the impact of REA's Metamorphic Learning programs have on the motivation of school children towards a career based in STEM and investigate the relationships with a range of potential factors that impact career motivation. More specifically, what influence do the programs have on changing participants' motivation toward STEM? The impact of the hierarchy in the career decision choice process, e.g. moving from being unaware to having some awareness, having some interest, to higher levels of commitment such as undertaking prerequisite STEM studies, is also of interest.

Of the factors highlighted by a previous literature review as having a possible impact on career decision choice, the ones of specific interest to this research are intrinsic motivation, self-efficacy, peer environments and the effects of heroes and role models (industry). Each of these plays out within the different facets of the programs. Developing an understanding of the perceived influence of these factors on career expectations is essential because such perceptions are likely to influence behaviour and motivation, as do the relationships between these primary factors and specific elements of the programs and between these factors and outcomes for Boys vs Girls.

This report examines data collected as part of a longitudinal study into "The Motivational Drivers of Children's Career Decision Choices" that began at the University of South Australia in 2006 and subsequently expanded to include the impact on teachers and the schools involved in the programs. This report seeks to examine the effect of these programs on the following:

i. The capacity to influence change in the students' interest in STEM careers.
ii. The impact on delivering new approaches to education that improve academic attainment.
iii. The effect on connecting students to career pathways options they may never have considered.
iv. The impact of virtual events on student motivation and academic achievement.
v. The capacity of the programs to build life and employability skills.

The data for this research was collected over three years, from 2019 to 2021. Each year was part or substantially impacted by the COVID-19 Pandemic. The report thus also seeks to determine any impact caused by the COVID-19 Pandemic on the program's capacity to deliver the desired results.

Research Overview

Career choice decisions are just one of the many socially implied extrinsic drivers a student is faced with handling while they travel through their school years. Within this research environment, it is essential to understand what can be measured, how it is measured and whether these measurements can provide helpful guidance for the development of other intervention activities capable of influencing the career decision choices of children.

The students who come to these programs are not sterile regarding their motivation toward STEM as a career option. Each student brings their perceptions and incentives for participation in the program, and we have little influence over their starting point. From the student's perspective, the reasons for their participation may not be evident to them. Given the experiential nature of the programs, the outcomes and benefits the students receive from their participation may also not become apparent to them until sometime after they have completed their involvement. The goal is to determine the impact of these programs on a range of topics, including the capacity to influence students' career motivations and specific interest in STEM-based careers.

The primary difference between REA's programs and other STEM interventions is the requirement for students to interact with industry directly, an overt focus on using heroes and role models, and real-world challenges that can attract students' intrinsic interest.

Research Process

The challenge is to measure the change students see in themselves concerning their career choice and whether the learning environment had a specific influence on those choices. Within this environment, it is crucial to understand what can be measured, how it is measured, and whether these measurements can provide helpful guidance for improving the underlying framework.

While Australia is very diverse ethnically, this research was carried out within Australia and within the context of Australian culture's social norms and attitudes. Within this research environment, we are dealing with researchers, students, teachers, industry, and parents, all of whom are, to some extent, participants in the intervention processes. Within this mix, it is essential that we focus the research outcomes on understanding the motivational drivers from the students' perspective and do not allow influence by the mental models of others involved in developing, managing, or assisting with the intervention program.

The baseline for this report is data collected from a more extensive longitudinal study into "The Motivational Drivers of Children's Career Decision Choices" begun at the University of South Australia in 2006.

The following statement of the primary research question for this study:

"What influence do REA programs have on the participants' motivation towards a STEM-based career? "[2]

The research process involved different survey questionnaires completed by both teachers and students. The surveys collected both quantitative and qualitative data. The qualitative questions sought to examine the teachers' and students' attitudes to specific topics relating to their involvement in the programs in a way that allowed for cross-referencing against the quantitative analysis.

Survey Reach

Participants were selected based on their participation in the State Final events of either F1 in Schools, SUBS in Schools or 4x4 in Schools. Events run between October and December in 2019, 2020 & 2021. Teams that participate in State and National Final must win their way through these events via schools and regional finals. The number of students involved in the competition phase of the programs during the reporting period (2019-2021) was approximately 27,800 (as reported by teachers).

Over the three years (2019 – 2021), **1,300 students and 185 teachers** from across Australia completed the questionnaires. Teachers and students received different questionnaires, with **1,243 student responses** and **185 teacher responses** considered valid, having most questions completed. The research participants came from 150 schools located across Australia. Each school has between 20 and 250 students involved in the programs.

Student surveys collected the following data:

- Demographics,
- Students' Motivation toward STEM,
- Influence of the programs on engagement with STEM activities,

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[2] Ethical Constraints

As this research involves students, the ethical constraints on the research process and the issues influencing the selection and involvement of students in the research process were quite complex. We sought participation from schools from every state with a combination of city and regional schools. The ethical constraints on undertaking research on school students vary from state to state. Guidelines set down by the State Governments controlled how we could carry out this research. These guidelines included how the researchers could interact with the schools and students and prevented tracking or identifying any individual student. Data on the age and gender of students was allowed if not connected to a particular student.

- The impact of the program on subject selection at schools, mainly maths and science,
- The level of interaction the students had with Industry,
- Engagement with Industry Mentors,
- Student interest in Careers in specific career directions,
- Impact of interaction with Defence and Defence Industries.

Teacher surveys collected the following data:

- Demographics,
- The influence each of the programs had within their school on increasing the general interest in STEM,
- The impact each of the programs had in changing attitudes of students toward study across all subject disciplines,
- The impact each of the programs had on students,
- Impact of programs on Boys vs Girls,
- The influence of gender in influencing the involvement of students,
- Effect of interaction with Defence and Defence Industries.

Methodology

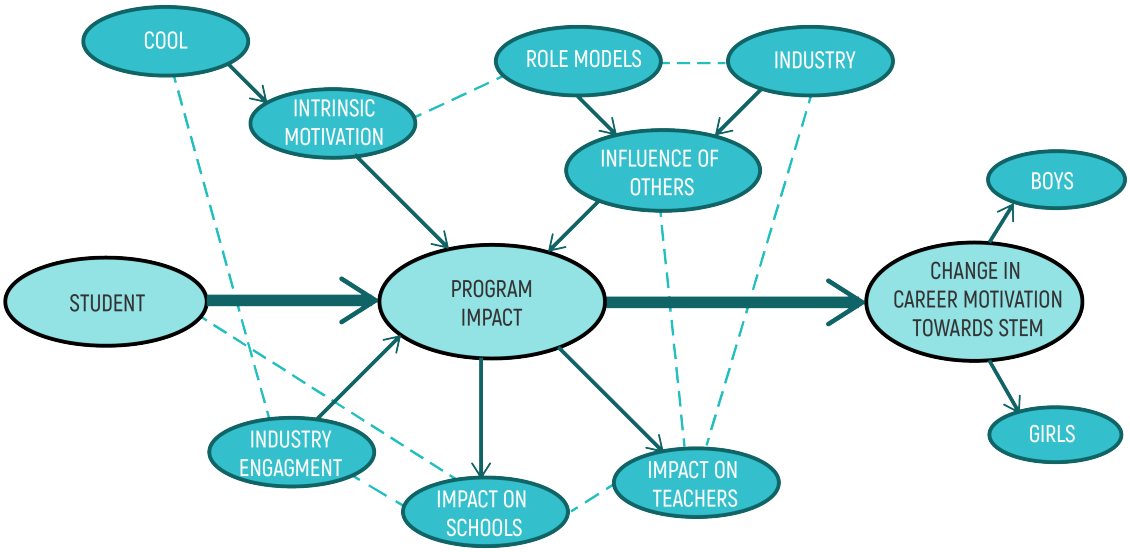
The general methodology for collecting data was a questionnaire consisting of quantitative measures, with several qualitative measures included to provide a level of triangulation with the quantitative data. Several of the qualitative questions were similar in structure and purpose to several key quantitative questions–the responses to these similar questions determined if the questioning process impacted the students' responses.

- Teachers and students answered different questionnaires following their involvement in the program–usually linked to a State or National Final event.
- Students who participated were of varying ages. Their participation in a program could have resulted from different teaching circumstances, i.e. some students competed as part of their Maths and Science programs, some as part of a Design and Technology curriculum and others as an extracurricular activity.
- All students who completed the questionnaire made it through to the program finals events held in each state. Completion through to this level ensured the students experienced all aspects of the program and had had a wide range of interactions with industry.
- In most instances, the student teams were composed of heterogeneous sets of students within the school, i.e. from separate peer groups and genders, randomising the collection sample.
- The teacher responsible for managing the programs within each school was the liaison person responsible for distributing and collecting student surveys. The enthusiasm of these teachers ensured the high return rate achieved for the questionnaires.

Research Schematic

The research schematic appears in the following diagram.

RESEARCH SCHEMATIC



Impact of COVID-19

During the COVID-19 pandemic, uncertainties surrounding schools' closures and the switch to virtual teaching required teachers to focus on core skills development. This refocusing impacted extracurricular activities and the number of schools. Overall, the number of schools involved in REA's programs dropped during 2020/21 but did not impact the number of students involved in finals events for F1 in Schools or SUBS in Schools. It did impact the number of students involved in the Space in Schools and 4x4 in Schools programs as no final's events were held for these programs. SPACE in Schools and 4x4 in Schools events are heavily dependent on in-person interaction, which was not impossible during 2020-21 due to COVID-19 and Education Department guidelines in all states and thus no students from these programs participated in the research.

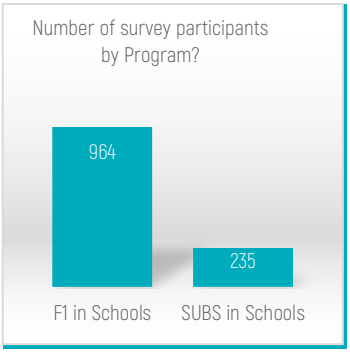
When comparing survey results for the years before COVID-19 with those covered in this report, the following comments are relevant:

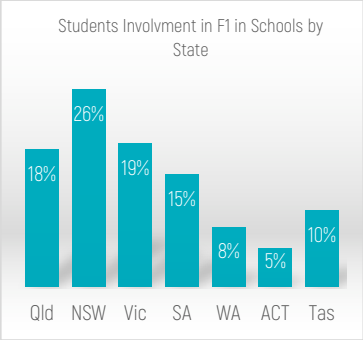
- Many schools reduced extracurricular activities during COVID-19 lockdown period to allow increased teaching efforts focus on core competencies.
- Students were prevented from undertaking industry site visits.
- Interaction between students and industry mentors was, for the most part, limited to virtual interactions via Zoom type tools.
- Due to the focus on the students leading the learning process, many teachers reported that these programs allowed the students to progress with minimal teacher support.
- There was no statistically significant impact on students' intrinsic motivation toward STEM or the programs.
- There was no statistically significant change in the impact of the programs within schools.

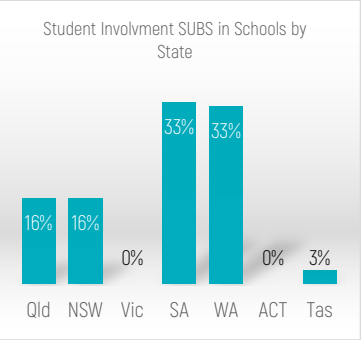
DEMOGRAPHICS

Research data consisted of **1,243 student responses** and **185 teacher responses** from 170 schools.

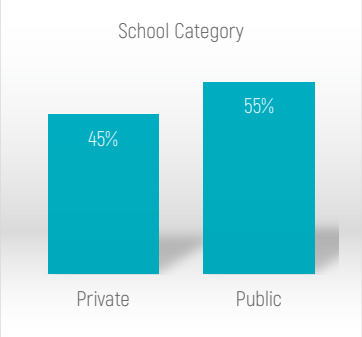
Program Demographics

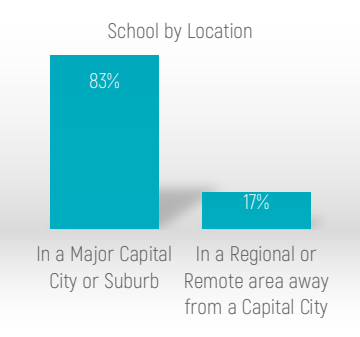




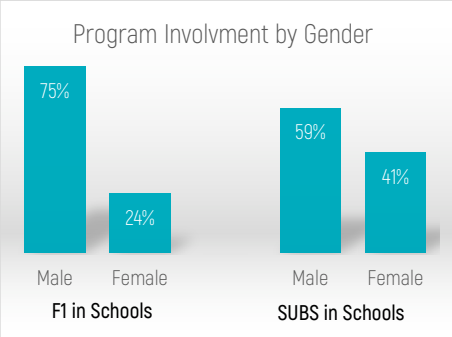


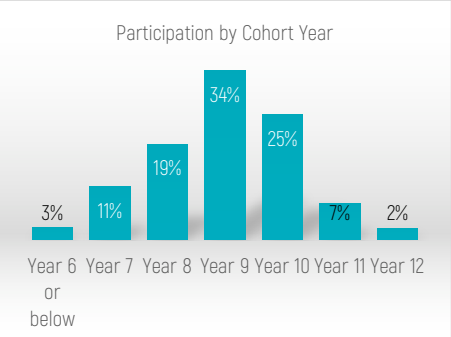
School Demographics

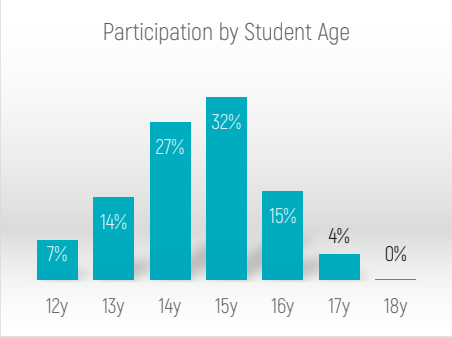


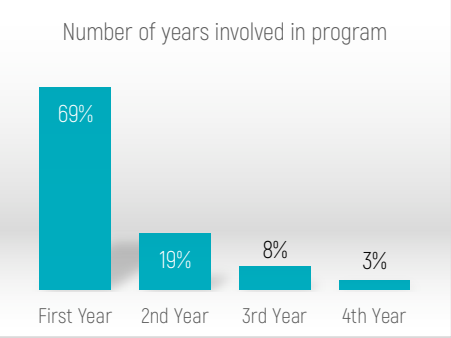


Student Demographics

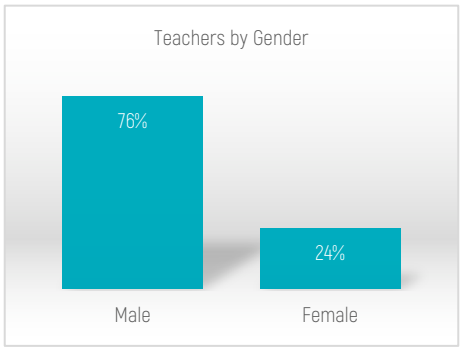


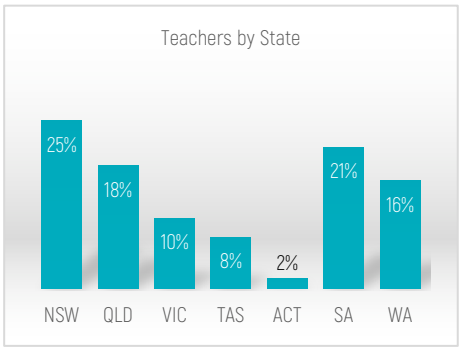


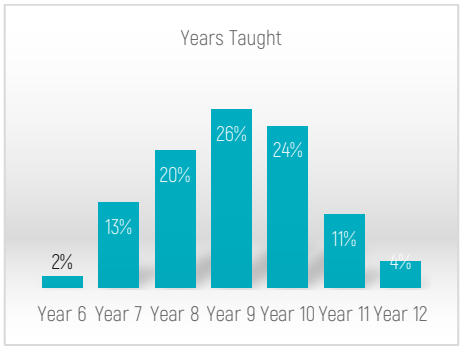


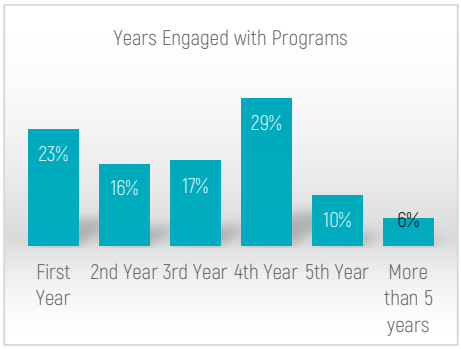


Teacher Demographics









STUDENT MOTIVATION TOWARDS STEM

Career choice decisions are just one of the many socially implied extrinsic drivers a student is faced with handling while they travel through their school years. Herr (1996) proposes that individuals operate within an ecological context that includes "the combination of physical, social, political, and economic environments that persons occupy and combine to create the circumstances in which each person negotiated his or her identity, belief system and life course". These contexts vary from person to person and represent interacting influences rather than static concepts.

To a much greater extent, adults clearly understand the environmental drivers that influence their lives. Adults also understand how career choices will impact their short and long term social and economic well-being. For children, however, these realities have not yet become boundary conditions. They are shielded from direct contact with most career boundary conditions by their parents and family and hence, they can be more reactive to the extrinsic social motivators that operate at the boundaries of their peer environments.

Paa'sPaa's (2000) examination of these ecological contexts in terms of children proposes that career choice is made based on influences derived from background, environment, and the personal issues surrounding the children. Indeed, the self-perceived ability of a student in a particular career direction is a significant influence on career choice, as are the perceived barriers that exist to participate in that specific career. Paa's research highlighted the impact on the career decision process by parents, particularly mothers, and the role of peer group perceptions. It also examined how these play out against the inherent tendency of young children to have their early career choices revolve around personal interests and intrinsic motivation.

Parents and families play a prominent position in influencing children's career decisions, with their motivations to do so affected by their desire for the well-being of their children. Yet while parents have their children's well-being at the forefront of their considerations, the students' motivations early in their adult development are much more focused on participation based on intrinsic interest in activities rather than responding to extrinsic motivation (Cohen, 2003)

Research Process

In understanding students' capacity to make lasting career decisions, we need to understand the ability of students to believe they are in control of their choices. A section of the research questionnaire used the Situational Intrinsic Motivation Scale SIMS scale (Deci and Ryan, 1985, Guay et al., 2000), which examines students' intrinsic situational motivation as a general factor influencing student interest in STEM careers with the primary question being:

"I would be interested in a STEM career?"

The SIMS is a set of scaled questions focused on assessing the constructs of intrinsic motivation, identified regulation, external regulation, and amotivation based on self-determination theories.

The scale seeks to measure three factors:

1. Levels of intrinsic motivation:
2. Self-efficacy towards career decision-making:
3. The influence of people in the student's environment.

According to self-determination theory, different motivation types underline human behaviour. Self-determination theory considers that the social context should foster needs for competency, autonomy, and relatedness to produce self-determining motivations (Guay et al., 2000).

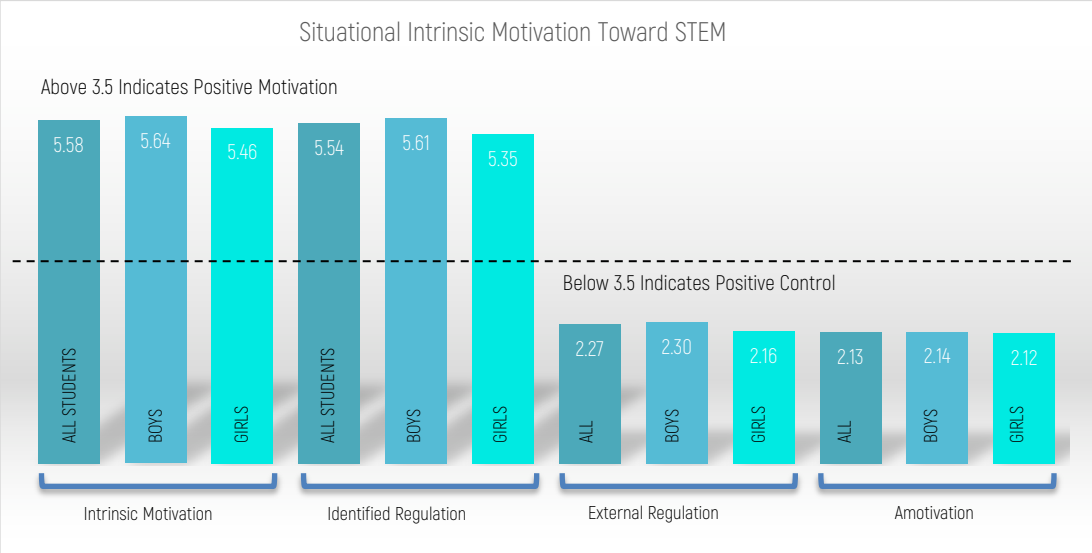
These types of motivation differ in their inherent levels of self-determination.

- Self-determination involves a real sense of choice and feeling free in doing what one has chosen to do (Guay et al., 2000).
- Intrinsic motivation is associated with positive outcomes (e.g., persistence) followed by identified regulation. In contrast, the most negative (e.g., depressive states) will stem from amotivation followed by external regulation (Deci and Ryan, 1985, Vallerand, 1997).
- Extrinsic motivation (which can have either a positive or negative influence), and amotivation, which is the least self-determinate motivation because there is no sense of purpose and no expectations of reward or possibility of changing the course of events.

The SIMS scale contains four internal consistency factors that align with positions on the self-determination scale.

- Intrinsic Motivation: engaging activities for their own sake.
- Identified Regulation: behaviour valued and perceived as being chosen by oneself.
- External Regulation: behaviour regulated by rewards or negative consequences.
- Amotivation: lack of perceived control.

The SIMS analysis results for this data appear in the Graph below, which summarizes the average scores calculated for each of the four sub-scales for the group.



Observations

The general conclusion from the analysis is that student interest in STEM is exceptionally high. Scores above 3.5 for both Intrinsic Motivation and Identified Regulation indicate that the students are motivated toward STEM. Scores below 3.5 for External Regulation & Amotivation suggest that students' decisions toward STEM are driven by intrinsic interest rather than because someone told them. The data shows little difference between boys and girls.

A strong connection is exhibited between the levels of intrinsic motivation in careers and reported that they were more interested in careers in STEM because they participated in the program (correlation =0.65). After experiencing STEM activities, their intrinsic interest in those activities increased.

For students who show high levels of intrinsic motivation in a particular direction and whose interest is fueled by activities that align with those interests, there is a propensity for those activities to influence career decisions.

INFLUENCE OF OTHERS - PEERS AND ROLE MODELS

Background

Bishop (2007), in his analysis of Neo-Darwinian Rational Choice Theory of Academic Engagement Norms, examined the impact of the development of norms within the secondary school environment. The construct of peer environments is like an onion, multi-layered, with each layer interfacing with the next. As soon as you uncover the intricacies of one layer, there is another and another.

Students form groups with strong independent sub-cultures in a school environment to facilitate these needs. In the early stages of these peer groups coming together, acting like groups of chickens determining their pecking order as they decipher the most appropriate groups and the most appropriate ways to operate within the group. Bishop (2003) examined the involvement and influence of peers and role models on educational involvement by highlighting that education becomes "Cool" when it receives visibility and prominence. This prominence and visibility can create popularity, starting on day one of their school life. School sports exposure is an example of an activity that quickly obtains "Cool" status. Bishop proposes that making intervention programs "Cool" with the appropriate exposure, including the use of peers, success and visibility, can change the dynamic of acceptance and reduce negative peer pressure.

As students spend a great deal of time with their peers, there is a solid motivation to fit in, and Bishop highlights that sixth-graders learn school norms and copy students' behaviour respected by other students. These respected students become role models for the attitudes and standards that the children accept as "The way it is".

Bishop also notes that anti-teacher attitudes like "Don't suck up to teachers" come from school-based norms inherited from previous years. Attitudes like "Don't study too hard" are derived from internal group norms developed to keep members from making it hard for others in the group to compete. This is similar to the phenomenon known as the "tall poppy syndrome" in Australian culture. Inner group norms can also positively impact the group if the role models have a positive attitude to issues such as learning and study. Within a school environment, peer control and manipulation play out in the processes behind bullying.

George Akerlof (1983) proposes that while, for the most part, children repeat their parents' beliefs and loyalties, they are willing to disassemble these beliefs if they feel it appropriate to identify with others in their social class. It does highlight the complexity of the role that some of the external influences highlighted by Paa and McWhirter (2000) can play in the decision process.

While it would be impossible to understand every potential social pressure, intervention program such as these needs to be able to cut across these social fundamentals in a way that makes them attractive to the students, the parents and the others within the peer groups, which surround the students. Bishop (2003) highlighted that one way of doing this is to make the intervention process "Cool" by giving it the appropriate visibility and prominence, which can cut across the issues of negative peer influence and create favourable attraction at multiple levels, both home and school.

The Role of a Hero/Role Model

As highlighted by Ackalof (1983), Erikson (1977), Taylor (2005) and others, the influence of role models and heroes can be profound. When society fails to provide these, we fail to provide the guidance our children need. The increased motivation and self-enhancement provoked by a role model stems from the belief that "I, too, can attain similar heights if I work hard enough".

The education system (DEST, 2005) sees heroes and role models as people being able to offer character development and moral leadership.

Nauta (2001) has highlighted several attempts to explain how role models influence career development. Bandura's Social Learning Theory (1969, 1977, 1982, 1986) suggests that a person learns new skills and behaviours by observing and

coding appropriate role model behaviour, reproducing them if they continue to be reinforced. Hackett and Betz (1981b) extended this theory to career development, suggesting that people learn to make career decisions and engage in career behaviours by observing others. In addition, Bandura (1977, 1982, 1986) and Hackett and Betz (1981b) suggest that the observation of relevant and successful role models may increase a person's self-efficacy expectations for a task (e.g. enrolling in a University course) with which they have had little or no direct experience. Other theorists have suggested that role models may expand the range of careers a person perceives as possible by setting norms, attitudes, and values (Almquist and Angrist, 1971) and by demonstrating how multiple life roles, such as those of parents and workers, maybe negotiated (Nauta et al., 1998).

Jung (1986) postulated that role models might go beyond simply teaching people how to behave by inspiring others to act in specific ways or assume certain roles. Erikson (1977) highlighted those heroes exert a profound influence over individuals, culture and peer norms as people play out hero themes. These themes lead to the development of roles in society. Atkinson (2000), in studies on the relationship between teacher and student motivation, confirmed an increase in student motivation as a direct result of high levels of teacher motivation. In this case, the teachers become role models for the students, influencing the peer norms within the students' environment. The teacher becomes part of the peer group and can make the environment heterogeneous to facilitate socialisation and change peer norms by their presence. The task of the motivator then is to develop strategies that help students internalise and transform their involvement in extrinsic environments into one of intrinsic engagement.

White (1999) studied the attitude of 590 K-12 students to determine their attitude toward heroes. His findings highlighted that children see heroes as a reflection of how they want to be perceived, and this self-perception changes over time with changes in the social environment.

Younger students often identify their parents as heroes, while older students see heroes as representatives of a larger culture.

Students perceive heroes as people demonstrating moral excellence and sustained leadership. Many parents have a perceived mental model that hero status resides in the domain of the sporting world. Most children, on the contrary, identify their heroes as people they have had direct personal experience with, who have shown sustained behaviour and who do good for others.

What seems to be a common theme across these definitions is that role models are other persons who, either by exerting some influence or simply by being admired in one or more ways, have an impact on another (Nauta and Kokaly, 2001).

Influences Beyond the Formal Education Process

There is much to learn from examining influences on learning and career decision making, which would usually be outside the formal education process.

The clear separation between what the education system teaches and what is expected to be learned in the work environment no longer exists. The industry has high expectations of the out of the box capabilities it expects from new entrants regarding employability skills (AIG, 2006). Career intervention programs and the education system now must span these traditionally separate pillars and bridge the skills divide to provide both hard and soft skills that Industry is seeking.

Overwien (2000) highlights that one can acquire life skills outside formal education. Informal learning can comprise 70% of all wisdom. Thus, young people develop a significant component of their occupational competencies through an informal apprenticeship that is nearly impossible to simulate within the traditional framework of the education system, with informal apprenticeships being a platform for acquiring a high portion of our occupational competencies. In that case, the role of mentors and role models in learning, and career decision choice, is likely to be considerable.

Taylor (2005) found that youth perceptions of their roles and responsibilities in the workplace are "very traditional and in line with the broad expectations of industry" and proposed that most of the soft skills required already existed within the youth investigated. These originate from and are honed by sources other than at school, e.g. grandparents, uncles and other role models.

Taylor also highlighted that many areas require significant additional research to validate the assertions that have been put forward in terms of the role industry should play in the development of skills outside the traditional educational process. The industry's role in determining the required skills and competencies is of particular interest.

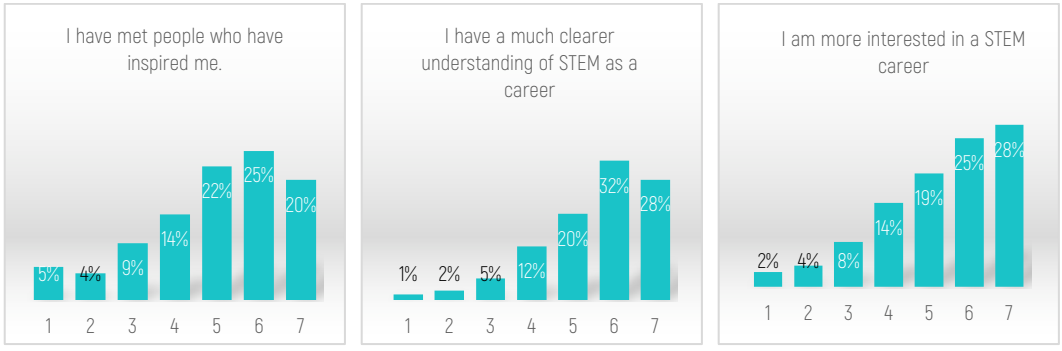
Billett (2004) highlights the dilemma faced by business that needs to develop competency-based skills to solve specific short-term sectoral skilling issues against consideration of the skills and capabilities they will require in the future. The difficulty of defining and implementing a curriculum that develops employability skills has grown into a strategic driver of success for governments. They seek to solve both the short term and long-term requirements and facilitate the numerous linkages and interrelationships between education and Industry. Within this dilemma is the need to rationalise the balance between the requirement for highly generic employability skills and abilities such as communication, teamwork, problem-solving, planning, organisation, technology, learning, self-management and initiative against technical skills and competencies.

From an Australian perspective (AIG, 2006), the critical role industry should play in defining and developing the required skills of the people it seeks to attract. However, it is a fundamental truth that Industry wants it all, both hard and soft skills, yet when pressed, it is those generic soft skills described above that it is seeking from the education process. These are skills that Industry finds hard to teach within a generally extrinsically driven business environment. If students come to them with these skills, the Industry is internally capable of providing the specific hard skills required within a profession: recruit for attitude and train for skill.

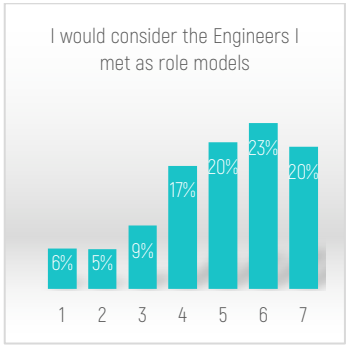
Research Process

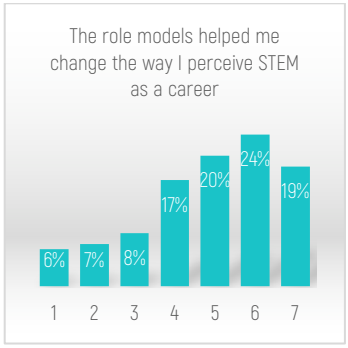
To gauge the impact of others within the environments of students, we utilised the "Influence of Others on Academic and Career Decisions Scale" **IOACDS** (Nauta and Kokaly, 2001). This scale aims at determining the dimensions of role model influence on academic and career decisions. The **IOACDS** scale 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).

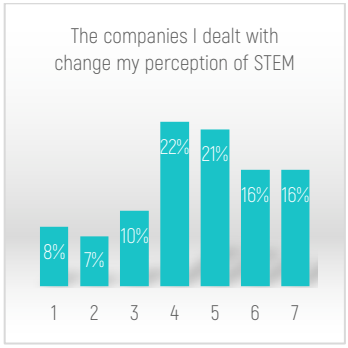
*These 14 questions make up two consistency factors. These consistency factors and codification within the **IOACDS** scale are Scale 1 - Support and Guidance item: 1, 2, 3, 4(R)[3], 5, 6, 7, 8. Scale 2 - Inspirational Modelling item: 9, 10(R), 11, 12(R), 13, 14(R).*

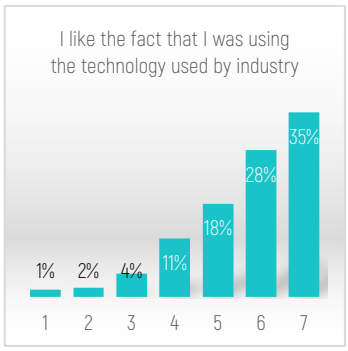


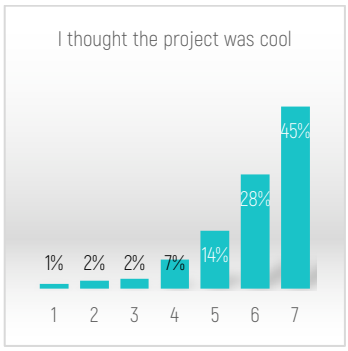
[3] (R) Indicates that the question was reverse-scored ie. As these questions were asking for a response to a negative question rather than a response to a positive question the outcomes were reversed to allow a direct comparison of results to the positive questions. Score reversal was defined within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

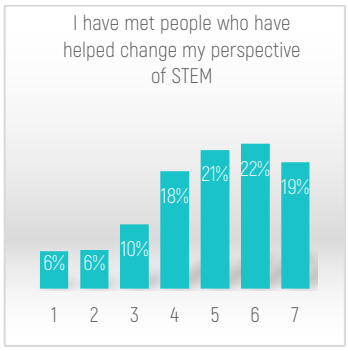

I would consider the Engineers I met as role models
6%
5%
9%
17%
20%
23%
20%
1 2 3 4 5 6 7

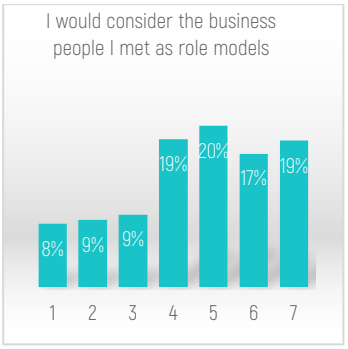

The role models helped me change the way I perceive STEM as a career
6%
7%
8%
17%
20%
24%
19%
1 2 3 4 5 6 7

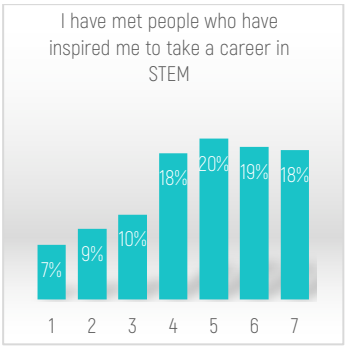

The companies I dealt with change my perception of STEM
8%
7%
10%
22%
21%
16%
16%
1 2 3 4 5 6 7

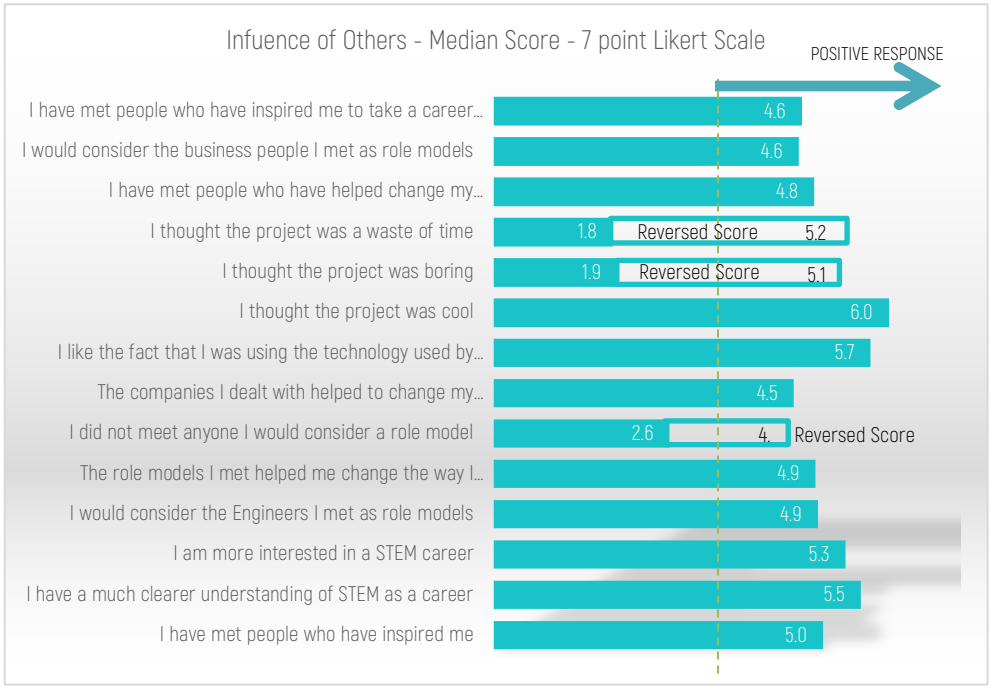

I like the fact that I was using the technology used by industry
1%
2%
4%
11%
18%
28%
35%
1 2 3 4 5 6 7


I thought the project was cool
1%
2%
2%
7%
14%
28%
45%
1 2 3 4 5 6 7


I have met people who have helped change my perspective of STEM
6%
6%
10%
18%
21%
22%
19%
1 2 3 4 5 6 7


I would consider the business people I met as role models
8%
9%
9%
19%
20%
17%
19%
1 2 3 4 5 6 7


I have met people who have inspired me to take a career in STEM
7%
9%
10%
18%
20%
19%
18%
1 2 3 4 5 6 7


Infuence of Others - Median Score - 7 point Likert Scale
POSITIVE RESPONSE
I have met people who have inspired me to take a career...
4.6
I would consider the business people I met as role models
4.6
I have met people who have helped change my...
4.8
I thought the project was a waste of time
1.8
Reversed Score
5.2
I thought the project was boring
1.9
Reversed Score
5.1
I thought the project was cool
6.0
I like the fact that I was using the technology used by...
5.7
The companies I dealt with helped to change my...
4.5
I did not meet anyone I would consider a role model
2.6
4.
Reversed Score
The role models I met helped me change the way I...
4.9
I would consider the Engineers I met as role models
4.9
I am more interested in a STEM career
5.3
I have a much clearer understanding of STEM as a career
5.5
I have met people who have inspired me
5.0

Observations

As part of these programs, students work outside their homes and in heterogeneous peer environments, interacting with role models in a complex business process. Participation in the program has facilitated different changes in Boys compared to Girls in terms of their belief in the role others play in the career decision process.

The IOACDS scale measures two dimensions of the impact of role models on academic and career decisions: inspiration/modelling and support/guidance. The results suggest that we are dealing with a group of students who respond to the influence of others. The sub-scale scores for inspiration/modelling and the sub-scale scores for Support/Guidance for both Boys and Girls were above 4.2, which is a moderate to high response to those influences.

As recorded in previously collected data, there was some evidence that the Boys and Girls responded differently because of their involvement in the program regarding the inspiration/modelling sub-scale. There was statistically significant evidence of a difference in the program's impact on the responses of the Boys and Girls, particularly concerning the influence of parents.

We examined the influence of parents, mates, and people they met during the program and considered role models. The most remarkable differences between the Boys and the Girls were recorded against the impact of parents and role models on career choices. These data appear to support the argument that Girls respond less to the influence of role models than do Boys, with the difference between Boys and Girls increasing the more the Girls became exposed to the processes involved in STEM.

The best subset regression analysis highlighted a difference between the predictors of influence in terms of others between the Boys and Girls. This analysis showed that for the Boys, the best predictors of the overall response to the program were the following three items:

1. I have met people who have inspired me to take a career in STEM.
2. I would consider the engineers I have met role models.
3. I have a much clearer understanding of STEM as a career.

The analysis of Girls' responses showed quite a different pattern, with the best predictors of their response to the program being:

1. I liked the fact that I used technology used by Industry
2. I thought the project was Cool
3. I have a much clearer understanding of STEM as a career

For the Boys, there was an overt focus on the influence of the role models they had met and an increased understanding of STEM. For Girls, there was an overt focus on the technology, an improved understanding of the career and an acceptance that STEM was "Cool," i.e. socially acceptable for them.

The first two of these predictors are associated much more with the project itself for the Girls. In contrast, for the Boys, the first two predictors were related to their interaction with people they considered to be role models. This appears to contradict the generally held concept that Girls are attracted to people issues while Boys are attracted to technology. The responses to the qualitative data also supported this hypothesis, with a surprisingly more significant proportion of the Girls (40%) compared to the Boys (29%) acknowledging that they liked designing and making things. Anecdotally design has been considered a boy thing.

The boys' response might be explained as them responding to an innate capability and desire to learn by experience and apprenticeship. This result links with the findings of Taylor (Taylor, 2005), who found that employability skills in male youths in Western Australia had been honed by interactions with grandparents, uncles and other role models. An increased movement of Boys, more so that Girls, into STEM careers will be achieved by facilitating an increase in interaction between students and adult STEM role models and increasing opportunities to learn by apprenticeship from older adults.

In contrast to the Boys, Girls may have been more prepared to look to their parents for advice on career choice before their involvement in the program, which changed after involvement. We may be seeing that the experience has provided the Girls with a significantly improved understanding of the processes involved in STEM careers, thus giving them a clearer understanding of STEM and their abilities to handle the complexity of STEM roles. This new knowledge about STEM careers may now be sufficient for them to feel they have the confidence to make their own career decisions, and thus they feel less compelled to take their parents' advice. They now understand the processes of STEM to the extent that they think that they can make clear career decisions for or against a STEM career direction. In support of this, the qualitative data highlighted that the most significant outcome from participation for the Girls revolved around those items which developed their understanding of the activities and complexity involved in STEM and that STEM is fun and exciting.

The differences in response between the Boys and Girls regarding their propensity to accept their parent's advice were unexpected when the research started. The research tools did not provide a direct method of determining, in more detail, the reasons behind the difference in perspective between Boys and Girls—a significant finding and an area worthy of much further research.

The fact that the students are open to influence by others in terms of career choice adds to the validity of the research outcomes. If the students were showing low levels of response to influence by others, the possibility of influencing their career choices with the use of role models would be limited. What has become evident is the difference in the extent to which the Boys and Girls respond to role models vs a developed understanding of the processes involved in a STEM career, a point not perceived as relevant when the research began yet has become a critical ongoing finding of the longitudinal analysis.

The Boys seek out human interaction, particularly with mentors and role models. In contrast, Girls appear to seek out an innate understanding of the complexity of the environment and how that environment fits with their vision for their future direction. For the Industry to be successful at influencing the career decision of students, it will require the development of a different set of selling messages if they are to attract Boys as compared to Girls in their direction.

PROGRAM IMPACT ON STUDENT MOTIVATION

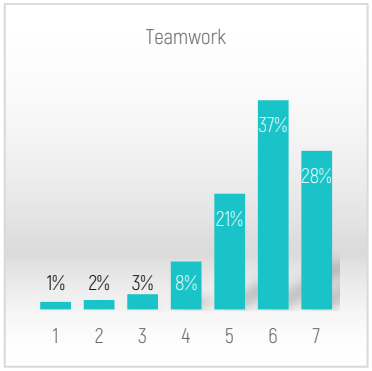
To be invited to participate in the questionnaire, students must have completed one of the programs. Questions sought to determine the program's impact and elements that influenced career motivation.

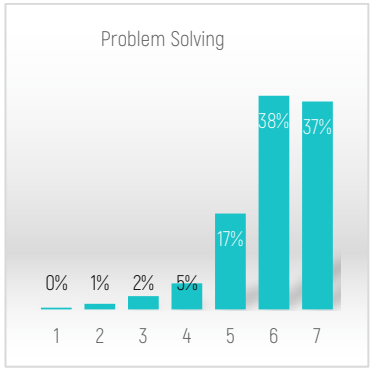
The primary question was:

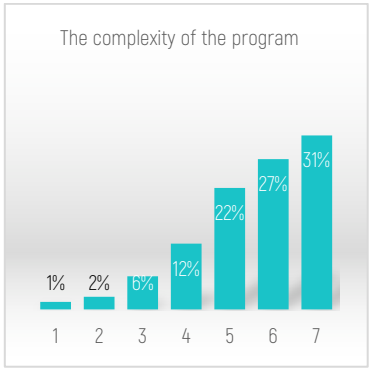
"What are the things you liked about your involvement in this program".

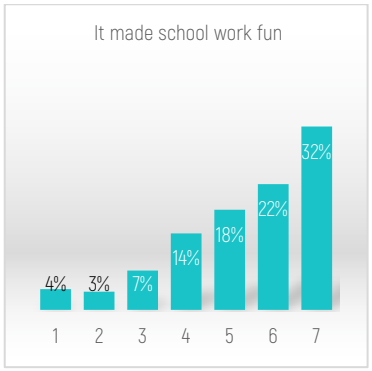
The responses were collected using a Likert scale with the following characteristics: 1: Corresponds not at all, 2: Corresponds a very little, 3: Corresponds a little, 4: Corresponds moderately, 5: Corresponds enough, 6: Corresponds a lot, 7: Corresponds exactly.

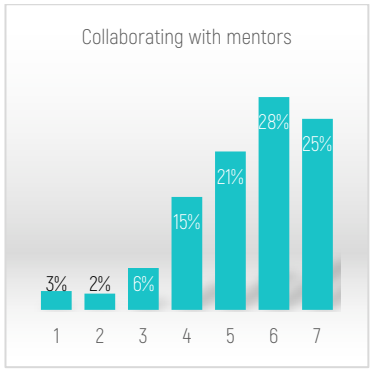
Responses on the Likert scale of 4 and above are considered positive.

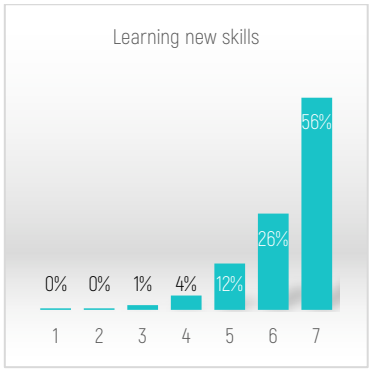


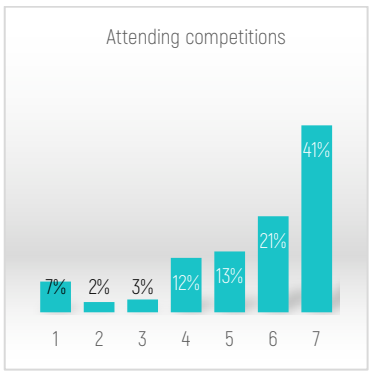


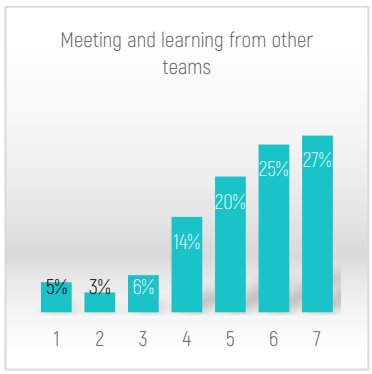


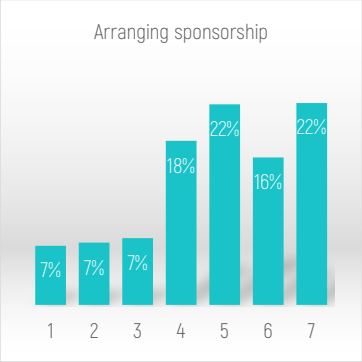


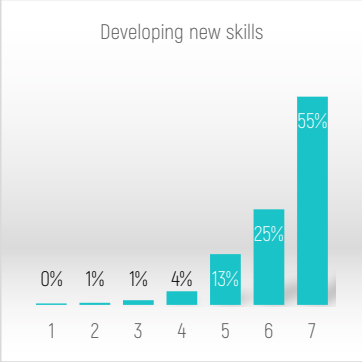


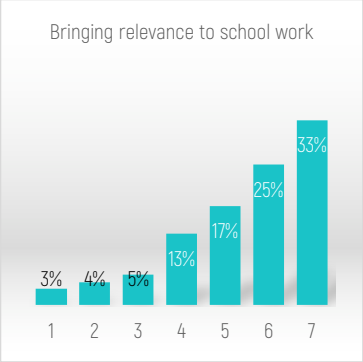




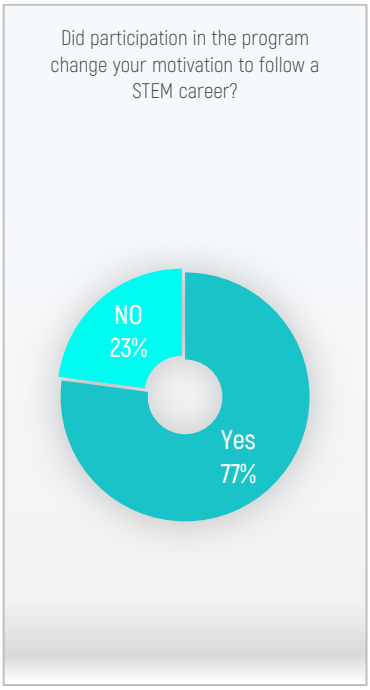


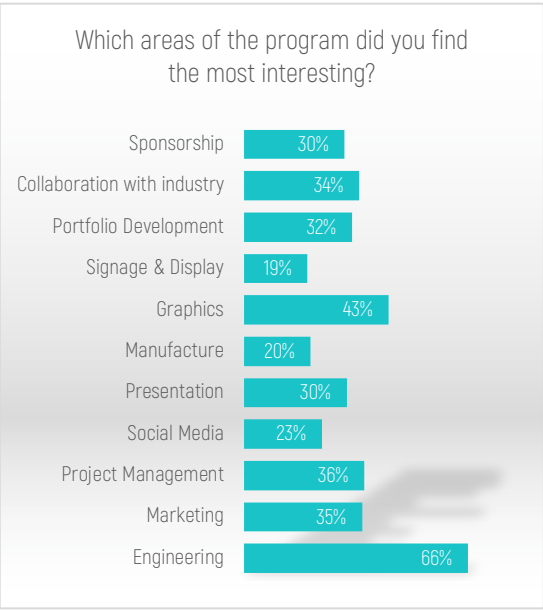

Arranging sponsorship
7%
7%
7%
18%
22%
16%
22%
1 2 3 4 5 6 7

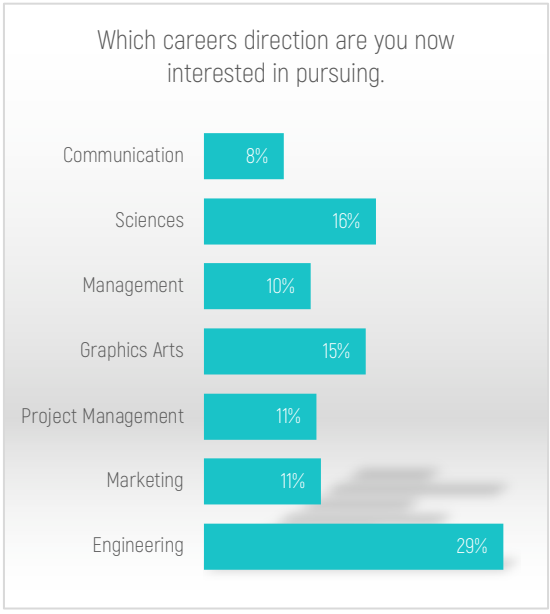

Developing new skills
0%
1%
1%
4%
13%
25%
55%
1 2 3 4 5 6 7


Bringing relevance to school work
3%
4%
5%
13%
17%
25%
33%
1 2 3 4 5 6 7


What are the things you liked about your involvement in this program? (% of students recording scores of 4 & above which is considered positive)
Bringing relevance to school work 88%
Developing new skills 98%
Arranging sponsorship 79%
Meeting and learning from other teams 87%
Attending competitions 88%
Learning new skills 98%
Collaborating with mentors 90%
It made school work fun 86%
The complexity of the program 91%
Collaborating with Industry 89%
Problem Solving 96%
Teamwork 94%


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 30%
Collaboration with industry 34%
Portfolio Development 32%
Signage & Display 19%
Graphics 43%
Manufacture 20%
Presentation 30%
Social Media 23%
Project Management 36%
Marketing 35%
Engineering 66%


Which careers direction are you now interested in pursuing.
Communication 8%
Sciences 16%
Management 10%
Graphics Arts 15%
Project Management 11%
Marketing 11%
Engineering 29%

Observations

When seeking to attract students in their direction, Industry has no control over the environmental influences. It must focus its efforts on generating a broad level of acceptance and interest. Within the scope of this research, it was essential to determine if the students who participated had an underlying strength or weakness in terms of their perceived ability to make career decisions. When students show confidence in their career decision abilities, we can be more confident that any observed positive impact of the program on their career motivations may flow through into a decision to pursue a career in STEM. A lack of perceived ability to make career decisions would question the assumption that any intervention program can, in fact, influence career decision choice.

Developing an understanding that STEM projects and professions can be fun and exciting dominated the students' responses. There was also significant interest in using the technology and technology used by Industry. 71% of girls and 86% of boys highlighted the opportunity to use Industry-standard technology as an essential learning outcome of the program. They saw learning technology as attractive and bringing career relevance to the program. An interest in aerodynamics was rated highly in the students' qualitative responses. Aerodynamics could be considered a science rather than a technology. Yet, it appeared to attract the interest of many students and would indicate that if given the appropriate relevance, specific sciences are of keen interest to students.

Each program requires the students to document their understanding of STEM in the 20-page portfolio and make a verbal presentation to industry executives about their project, their engagement with science and engineering and their involvement with Industry. This platform allows the students to reaffirm their understanding of STEM and further understand how they see themselves fitting within a STEM career environment. The programs bring context, alignment and relevance to their sense of STEM careers within their perceptions of what exists in the real world. Working on real-world projects provides a catalyst to magnify the impact role models, and interactions with Industry can have in influencing and changing career decision choices. It is essential to place the information the students seek in front of them at a critical point when their emotional willingness to accept information is tuned to the subject so they can absorb that input.

This ability to change normative understanding has the most significant potential to impact long-term change in student attitudes toward career choice.

DIFFERENCES IN MOTIVATION - BOYS VS GIRLS

The goals of the career intervention and hence their design must be to maximise intrinsic interest across age groups, ethnicity and socioeconomic backgrounds while at the same time stimulating student enjoyment and fostering learning.

There has been much research exploring differences between Boys and Girls on various elements of their educational experience, such as achievement, motivation, literacy, attendance, school completion, and suspension and expulsion. A lack of clarity exists about how these differences reflect differences of degree on these dimensions or differences of kind. There is also significant debate about the impact the difference in maturity between boys and girls during the early development years has on the learning process and student focus (Hackett and Betz, 1992). This difference in maturity between Boys and Girls, even within specific demographics, is highly variable.

Differences of a kind would suggest that Boys and Girls are qualitatively different. For instance, Boys perceive vital aspects of motivation in fundamentally different ways than girls or cluster into motivational profiles that do not match the profiles of Girls (Martin, 2004).

Martin (2004) explored issues concerning student motivation by examining mean differences between Boys and Girls on critical facets of inspiration. In addition, he looked at Boys' and Girls' respective factor structures, cluster profiles, and perceptual mapping of these facets of motivation. He found compelling evidence that there are gender differences in students' engagement and achievement. For the most part, these differences are not in the boys' favour. On average, Girls outperform Boys in more subjects, and there are more Girls among the higher achieving students (Collins et al., 2000). Martin's data suggest that there are also differences in the degree to which Boys and Girls are motivated. However, invariance in factor structure, cluster profiles, and perceptual mapping suggests no fundamental differences of kind. Implications for data analysis and programmatic intervention aimed at enhancing (or sustaining) Boys' and Girls' motivation.

Within the scope of the REA's programs, both homogeneous and heterogeneous groups of students form teams of varying age groups, maturity, gender and social background. Within the scope of this research, it is difficult to examine the impact on the program of any one of these variables in isolation. We accept that maturity, whilst a critical variable, would be considered a general part of the context of this study, along with other environmental impacts such as ethnicity and socioeconomic upbringing.

Influence of Gender on Program Participation

Students currently need significant support to discover just how interesting and exciting STEM and the activities of Industry can be. Learning environments that facilitate an increased understanding of STEM professions involved in a way that fits the different motivational drivers of Boys and Girls go a long way to promoting students' critical career decision processes. The research has highlighted that the story about STEM needs to be delivered differently to Boys than to Girls. As part of the longitudinal research, we examine the impact of gender on attraction to STEM in general and to industries that classify as being STEM-based.

We found that boys' motivation rises with continuous human interaction, particularly with role models and mentors. Boys appear to learn by apprenticeship and respond directly to the people they meet and interact with. They need to encounter careers before making an emotional decision about career engagement. The underlying message is that there will always be people around them during their career journey who will help them learn and grow. For Boys, careers are a continual learning environment. The movement of Boys into careers will increase when we can facilitate an increasing interaction between students and adults in industry roles.

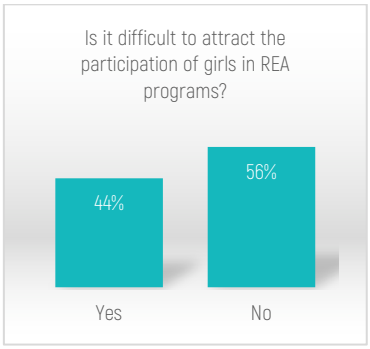
Girls, on the other hand, respond to managing complexity in environments. Highlighting the processes and complexity involved in career pathways will attract them and lift their motivation to become involved. Girls react positively to the project management aspects of careers and need to understand the processes involved in a career before choosing

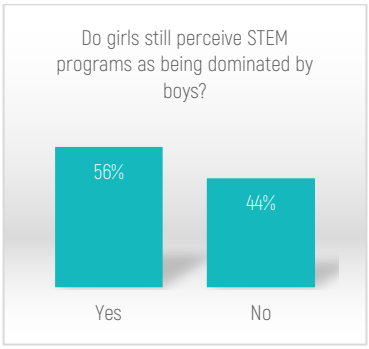
that direction. This research has shown that correctly targeted interventions can dramatically change the number of girls interested in specific career pathways.

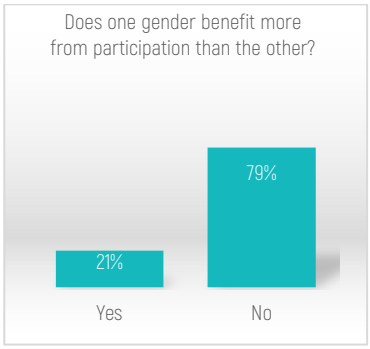
A key component of REA's Metamorphic Learning framework is to engage with students without creating a level of separation based on issues of ethnicity, gender, diversity, age, or religion. All students are treated equally with encouragement directed at each student discovering their unique passions and skills and then building on these. There are no reasons to highlight blockages to career path selection based on any level of intersectionality.

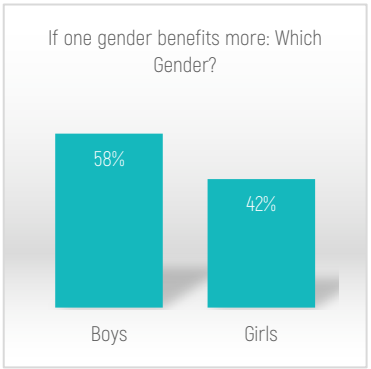
While there still exists a perception that boys dominate STEM activities, we can successfully engage with girls as we do boys if we appeal to their different motivational drivers. We do this by utilising the appropriate language, which brings the programs within motivation that the students, boys vs girls, can relate to. The following graphs highlight responses from teachers to questions about gender. Key responses include:

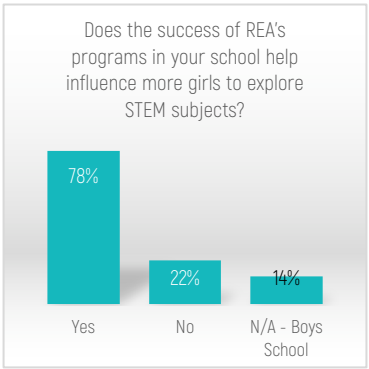
- 79% of teachers believe that one gender does not benefit from participation more than another,
- 78% believe that these programs attract more girls to STEM,
- 80% of boys and 76% of girls improved their attitude toward schoolwork.

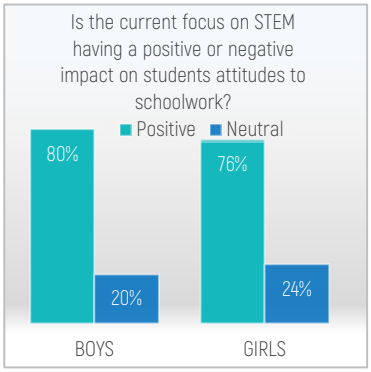












Analysis of the qualitative response of teachers to questions on the aspects of REA programs that girls are attracted to the most highlighted the following:

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

IMPACT OF PROGRAM ON LEARNING OUTCOMES

Learning environments that facilitate an increased understanding of STEM professions involved in a way that fits the different motivational drivers of Boys and Girls go a long way to promoting students' critical career decision processes. As part of the longitudinal research, we examine the impact of gender on attraction to STEM in general and to industries that classify as being STEM-based.

Research on individual learning approaches or learning styles has two traditions, one of which is biased towards academic learning and the other towards learning from direct experience. De Jong (2006) concluded that learning approaches are relatively context-specific, implying that neither theoretical tradition nor experiential focus can claim general applicability.

REA's programs operate on a framework of Metamorphic Learning which delivers a learning environment based on both academic and experiential learning to develop career relevance. There exists extensive research into Action Learning and its benefits, particularly in terms of its ability to increase self-efficacy, which has highlighted its effectiveness as a learning method both in student and adult environments (Clark, 2004b, Lizzio and Wilson, 2004, Wilson and Fowler, 2005, Wurdinger and Carlson, 2010, Bourner, 2011, Thornton and Yoong, 2011, Congdon and Congdon, 2011, Dick, 2011, Sofo et al., 2010, Leonard and Marquardt, 2010, Chenhall and Chermack, 2010).

Blunsdon (2003) examined the role experiential learning plays in creating learning environments that are attractive to students, and these same impacts are highlighted in this research. Students tend to select subjects to study based on preferences or perceived perception of interest in a particular topic: intrinsic interest. The educator's challenge is stimulating student enjoyment avoiding unnecessary entertainment while still fostering learning and achieving educational goals. Unfortunately, most STEM programs currently implemented in schools are heavily focused on entertainment to showcase STEM rather than promoting understanding and achieving academic goals–an issue resulting from reverse engineering STEM into an existing siloed education curriculum.

The link to real-world problem-solving provided by Metamorphic Learning environments drives students and teachers to implement different approaches to generating learning outcomes due to the processes within this environment. In these programs, student interest and engagement vision links to exposure to contemporary real-world practice. For many, this implied access to expert practitioners of science, technology, engineering and mathematics has a significant impact.

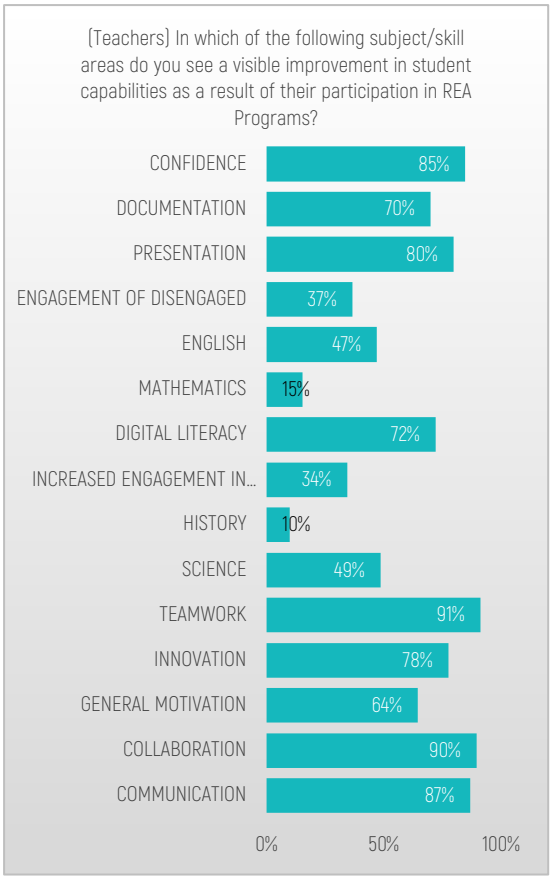
The following fundamentals are visible within the scope of these programs, and students are encouraged to undertake them:

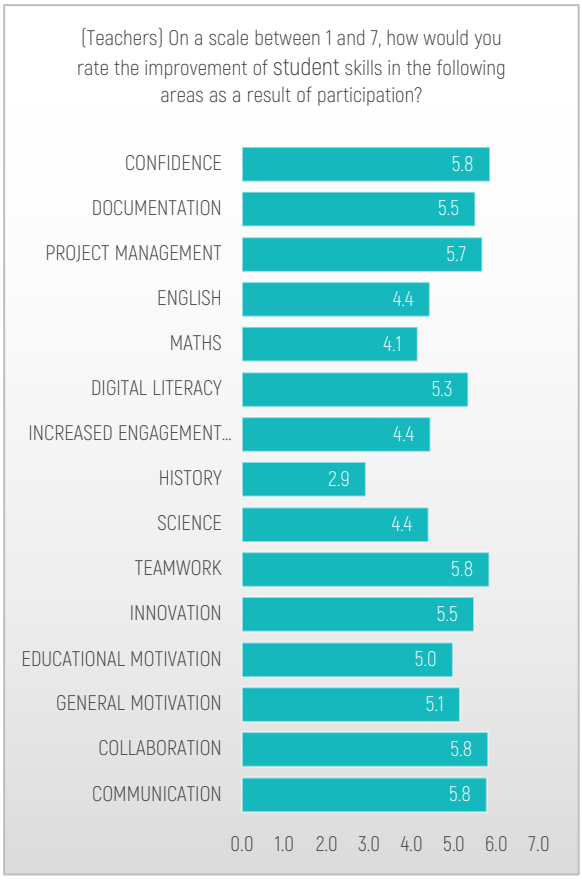
1. Structured around sets of 6 people,
2. Action on real tasks or problems at work,
3. Learning is from reflection on actions taken,
4. Tasks/problems are both individual and collective,
5. Tasks/problems are chosen independently by individuals,
6. Questioning is the primary way to help participants proceed with their tasks/problems,
7. Mapped to existing curriculum,
8. Facilitators are used,
9. Taught elements are included,
10. Linked to a qualification.

These ten steps also align well with the four components of intrinsic motivation proposed by Watt (self-determination, self-perceived confidence, relatedness, and perceived salience).

Song [2006] also found that when you brought groups of students together to solve ill-structured problems, the groups selected from heterogeneous peer groups outperformed homogeneous peer groups. Heterogeneous groups were not constrained by existing peer norms and looked to each group member as a source of inspiration. This lack of social peer structure allowed them to be more highly intrinsically motivated, which helped with problem-solving.

The following graphs highlight data provided by teachers on their perspective of the subject/skill areas they see a visible improvement in student capabilities following participation. One looks at performance, the other teachers rating on importance. In the second graph, a ranking score above a mean of 3.5 is considered high.





Observations

Overly simplistic intervention programs that do not understand the importance of focusing on employability skills will struggle to attract the students and will fail to provide the motivational fuel to promote career selection toward complex STEM professions. The need for relevance in the activities undertaken by students appears critical in targeting their interests. The students see these programs as providing career relevance and recognising their learning capacity.

From the teachers' perspective, the areas which provided the most significant increase in learning outcomes were those areas that link to the definition of employability skills: confidence, documentation, project management, presentation, digital literacy, teamwork, innovation, collaboration, and communication with responses between 72% and 91%. Aligning directly with the REA's Key Performance Indicators (KPIs):

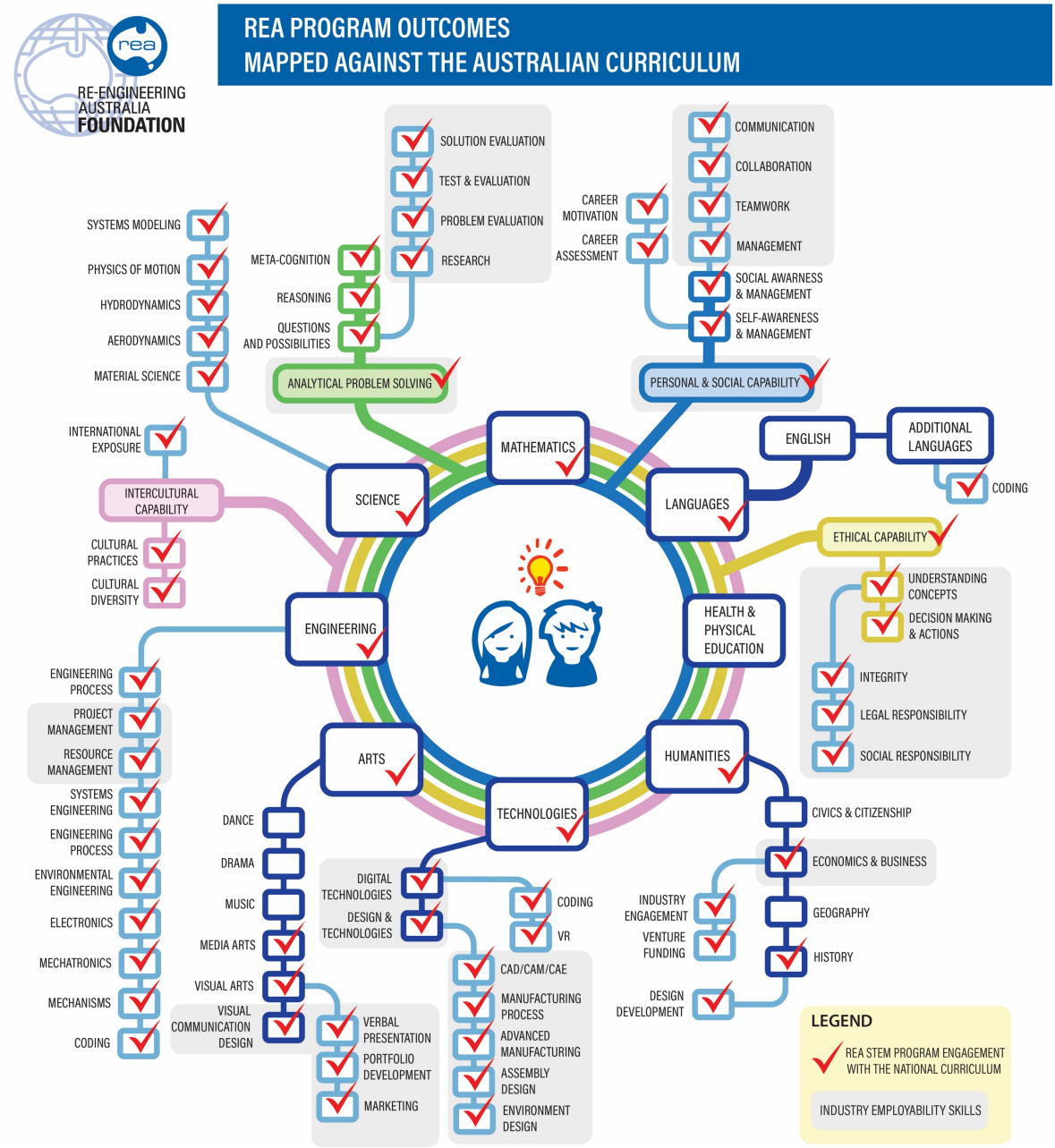
1. The programs should be such that they attract students to participate.
2. **The programs must improve the employability skills of the students taking part.**
3. The program must increase the attractiveness of STEM subjects.
4. The programs should be able to demonstrate an increase in educational attainment.

The students showed a very positive response in both the qualitative and qualitative data to the use of industry technology. Within the quantitative data, 86% of the Boys and 71% of the Girls responded positively to the use of industry

technology. Regression analysis highlighted that for the Girls, the use of technology was the highest predictor of their response to the program. Whilst the girls' response overall towards the technology was not as strong as it was for the Boys, this factor is one of the essential separators for whether Girls are likely to be interested in a STEM career.

The level of work produced by the students is a clear indication that the students understand how to research projects and careers and are willing to accept and absorb high levels of information. These students are confident and are keen to learn about the benefits and processes involved in specific careers–critical information for Industry in terms of developing resources needed to attract students to careers in STEM. Industry must treat students with great respect when offering career options and providing students with employment information. It should not underestimate the level of knowledge students seek to help them make career decisions.

Mapping Against Curriculum



IMPORTANCE OF PROGRAMS BEING COOL

Being "Cool" is all about being of interest. Bandura's (Bandura 1977) Theory of Perceived Self-Efficacy includes emotional arousal (arousal of interest and lack of anxiety in connection with the behaviour) as one of the critical elements in the development of self-efficacy. Being "Cool" fits with this concept. Within a world of Wii's, Twitter, Facebook and Playstation, being sufficiently "Cool" is a battle in itself that cannot be fought by those who do not understand the distractive influence of this technology.

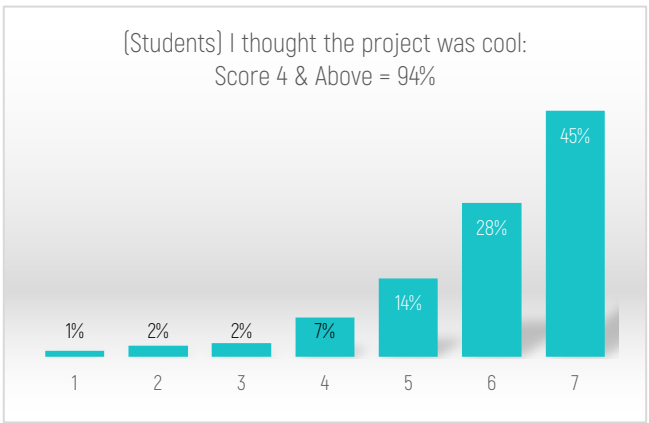
Indeed, modern-day mythology (Sheahan, 2005) has the Y generation associated with the "I do it because it's there" intrinsically driven attitude to life. There is much popular conjecture why the Y generation and the generations that follow are more inclined in this way than previous generations. Some argue (Sheahan, 2005) that the Y generation has just been over nurtured and spoilt, growing up in an environment that allows them to stay socially younger longer and, thus, perhaps driven more by intrinsic motivation. It may result from growing up in an encouraging environment that promotes inherent motivation development. Whatever the reason, attracting students' intrinsic interest to modify their motivations toward a specific career or career intervention program has become much more difficult given the success of our society is creating a plethora of "Cool" technological distractions.

In this research, 94% of the students felt that the programs were "Cool", confirming that the program could break through to the students and place itself in the target range of the students' intrinsic interests. In a regression analysis, Girls put the fact that they felt the program was Cool as the second-highest predictor of their response to the program.

The analysis of the relationship between the measure of intrinsic motivation and the program's impact showed that the students with higher levels of intrinsic motivation were more likely to be further influenced by activities that can attract their intrinsic interest.

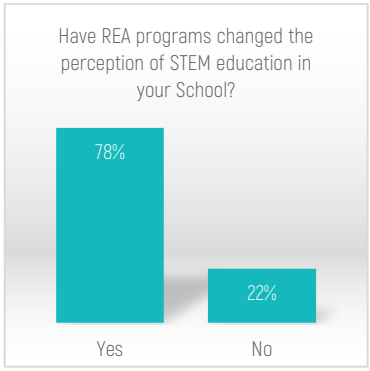
Being Cool appears to be a key to the doorway of intrinsic interest. The F1 in Schools program has several elements which the students find "Cool". The association with the Formula One, being able to meet heroes such as Lewis Hamilton, Daniel Ricciardo, or Sebastian Vettel (Formula One Drivers), being able to use the same tools used by Airbus to design the A380 or interacting with people from Industry who they feel build "Cool stuff". Within the SUBS in Schools program, students highlighted their impact with Navy personnel in uniforms as having a significant effect on increasing their interest in the program, particularly people in Uniforms. "Uniforms" projects a set of qualities including authority, order, structure and success, all of which fit with students' definition of role models: people who do good in society.

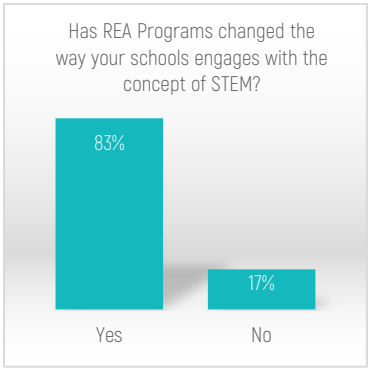
If Industry is to develop intervention programs to attract students of this age, those intervention programs need to be sufficiently "Cool" to gain the students' intrinsic interest. Without this "Cool" status, it becomes difficult for any activity to break through to students. Providing access to a diverse range of mentors, role models, and heroes who can guide and assist them in resolving the priority of the many signals they are receiving is an essential aspect of the design of career intervention programs.

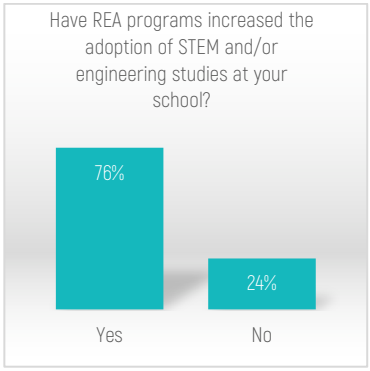


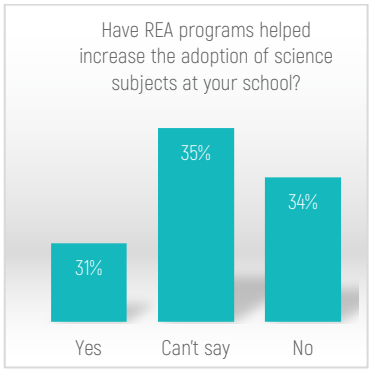
PROGRAM INFLUENCE ON SCHOOLS AND TEACHERS

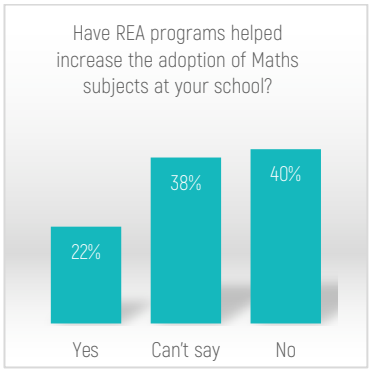
The following responses about the impact these programs had in their schools and their attitudes to the program's outcomes were provided by teachers.

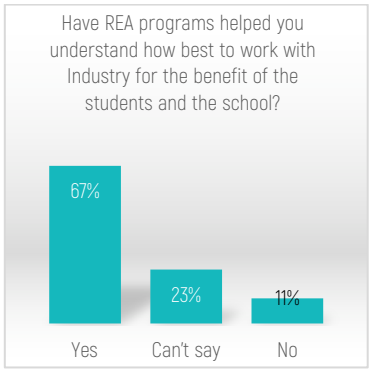


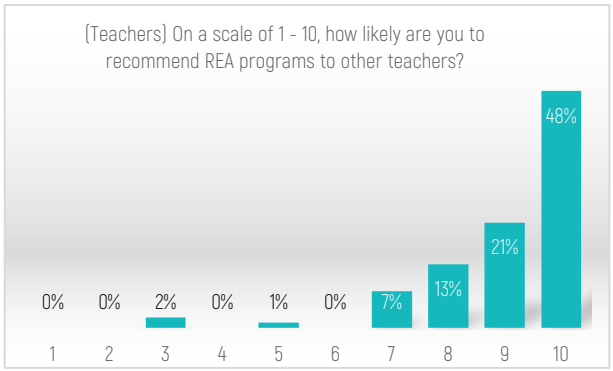


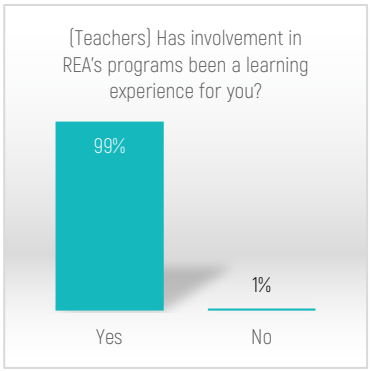












Observations

Teachers enjoy involvement in the program as much, if not more than students, with 99% indicating that participation had been a learning experience for them and 89% willing to recommend these programs to their peers.

The level of work produced by the students and having access to industry scale technology highlights that the students do not fear technology and, to some extent, are more in tune with technology than adults. They understand how to research projects and careers and are willing to accept and absorb high levels of information. Historically, the school system has a reputation for providing technology to schools, which is at a superficial level compared to what is used by Industry. It is common knowledge amongst teachers that students can learn low-level technology very quickly, soon becoming bored. Using the same tools as Industry as part of the program has provided a platform with no inherent limits to the students' scope for learning.

As an example, the CAD/CAM technology the students were using in the classroom was the same as Boeing, Toyota, Ford and many other leading industry organisations. What was evident is that students as young as 12 have no problems handling industry-level technology such as this. Industry needs to be mindful of the technological level students can operate at a very young age - critical information for Industry in terms of developing resources required to attract students to careers in STEM. Industry must treat students with great respect when offering career options and providing students with information about employment opportunities.

It should not underestimate the level of knowledge students seek to help them make career decisions. Overly simplistic intervention programs that do not understand the importance of this will struggle to attract students' intrinsic interest and will fail to provide the motivational fuel to promote career selection toward complex professions like Engineering. The need for relevance in the activities undertaken by students appears critical in targeting their interests. The students see these programs as providing career relevance and recognising their learning capacity.

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 which stand out for YOU as a teacher?

- A program that has an authentic assessment that incorporates teamwork and collaboration.
- A real World Challenge
- All aspects
- Allows students to experience working in a multi-disciplinary team to work together to solve engineering problems in a way that mimics real engineering.
- Attention to detail - Extensive feedback
- Bread range of real-world relevant skills
- The Challenge of the program is to extend Collaboration and involvement with the 'outside' world - i.e. industry
- Collaboration, personal best, personal growth, improved motivation, future engagement with STEM and Engineering career prospects and elective selection choices.
- Collaboration, working to deadlines
- Competitiveness drives their work ethic
- 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
- Creates good experiences for the students
- They are creating maturity in students. Building resilience and collaboration in students expose them to skills outside of what the standard curriculum can offer.
- Development of 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.
- Engagement
- Project management
- Connection with industry
- Growing confidence
- Increased STEM knowledge
- Engagement and ongoing support
- Engagement in challenging and rigorous competitions.
- Opportunities to engage with industry.
- Engagement with the material.
- They develop intrinsic solid motivation amongst students to extend their knowledge and skills in certain areas.
- Everything!
- Excellent authentic assessment
- Engaging and developing several essential critical thinking skills
- Excitement for students competing. Team building.
- Problem-solving for students.
- It gives students experience with how projects run in the real world and an opportunity for students to utilise skills from many different disciplines.
- Global teamwork and initiative
- Hands-on, relevant to career opportunities, real-life deadlines, collaboration
- Hands-on/real-world problem solving
- 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.
- Holistic approach
- A holistic approach to education
- I enjoy the competition and the inherent motivation for students.
- I just 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.
- Increased confidence in students
- Independence, agency, skill development
- Industry collaboration.
- The employability skills students are exposed to during the program
- Innovation and being exposed to nationwide competition

- 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 they would get in a typical curriculum. Creating life-long learners ready for 21st-century life!
- Life skills
- 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.
- Motivation, teamwork, speed, design, aerodynamics, engineering, graphics, manufacturing
- Multi-facetted project work.
- 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 even counting COVID) but still completed the project.
- Positive interactions within teams, but also between groups competing in the same category, mentoring new units, or students who show difficulty within specific aspects of their role.
- Problem-solving, collaboration
- Project management. Teaching and watching as the teams must plan out 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.
- REA programs encourage entrepreneurial thinking and co-operation
- Real-world applications
- See students improve their skills as they progress.
- Seeing students do something they enjoy
- They are setting a rigid structure and professional thinking toward what the students are doing.
- Skills students develop
- Student confidence and the ability to follow their ideas or innovation.
- Student-led project. Industry collab
- Students learn life skills
- Students are learning to communicate with industry, the increase in confidence, real weal experiences.
- Challenging students in lots of different areas.
- Teamwork & perseverance. It's a massive task to develop all the aspects for judging, especially as an extra-curricular
- Teamwork and deadlines
- 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 confidence students build
- 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 increase in student confidence and the development of team building.
- The increase in students' confidence
- The organisation of final events, communication, support & following the rules & regulations for competitions. Make sure everyone is equal.
- The practical nature and the rigour of the program.
- The REA team and support. Dedication to the growth of young Australians. They are providing opportunities like no other STEM program.
- The real-world connections and the sense of competition
- The scaffolding and the real-world interaction
- The student-lead nature of the projects
- 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
- The whole process

ENGAGEMENT WITH INDUSTRY

Students Perspectives

Solving the issues of skills shortages is an issue that requires long term focus and should remain out of reach of the economic rationalists. For both good and bad reasons, Industry tends to allow the strategic focus to be overtaken by issues of economic rationalism, driven by problems that appear to have shorter-term economic benefits for the shareholders. However, influencing the career motivation of children is not an issue that will respond to a short-term 'shoot from the hip' reaction to the problem. The industry needs to be measured in its actions, and those actions must be sustained over a long period if there is going to be a long-term benefit from an improvement in student attitudes toward STEM careers.

A fundamental and critical differentiator of the REA programs has been the requirement for students to work directly with industry partners in their projects. Students see a direct relevance between classroom activities they enjoy and the world of work. All REA programs require students to collaborate and interact with industry and industry mentors to learn about technology and career path options. The assessment regime involved in each program has students dedicating a portion of both their project presentations and project portfolio to highlight the career research they have undertaken. This assessment forms part of the overall marking criteria for each competition. To increase student engagement with Industry career pathways, REA has adopted a pull strategy to focus students on possible career pathways rather than handing career information to students. Each of our programs has students seeking out information about career pathways in Industry that aligns with their skills and motivations. In addition to the more apparent outcomes, students develop many personal and employability skills, learning about working in a team, working towards a common goal, time and resources management, and seeking industry support and mentors.

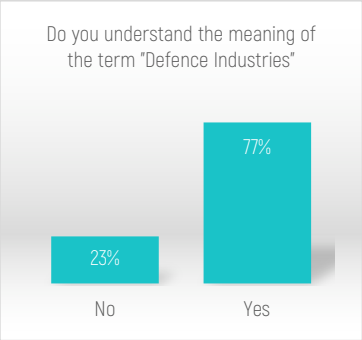
The students who participated can easily link industry, the role of STEM, the career opportunities, and the roles they can play within the STEM professions. Still, without industry support, the final link in the transformation to becoming an Engineer will not happen. Career interventions like these may bring students to the doors of opportunity, but the final step in the process will not occur without industry there to open the doors. Success will only come when the industry engages with the students and commits effort to the process of feeding their intrinsic interest in Engineering beyond the intervention activity. It is about industry providing contact with role models and access to knowledge about the profession. Role models and knowledge are critical for students, and the industry is in the best place to provide both and making a sustained effort to do so that will have the most significant impact.

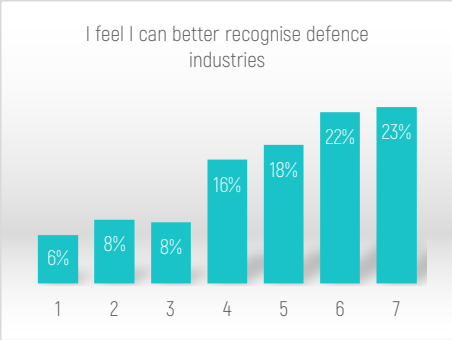
Industry has a critical role in developing student career choices, and there is much that industry must do to encourage students to take up careers in STEM & Engineering. As shown, practical and well-directed interaction with industry can impact the development of an emotional link with the participating students as they step out of the school environment. Providing students with the opportunity to work on real-world projects, and standing beside them as they traverse these projects, is the catalyst they seek to increase their ability to decide which work environment they are will choose to enter.

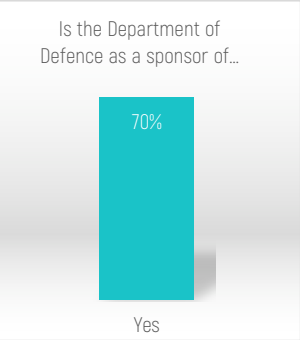
The primary issue for the industry will be to maintain focus on the problem and make the appropriate changes to the normative behaviours of the organisation within the organisation to ensure continued support and sustainability of programs such as these.

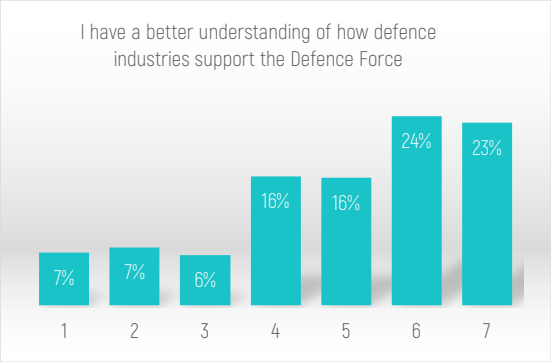
Student Interaction with Defence Industry

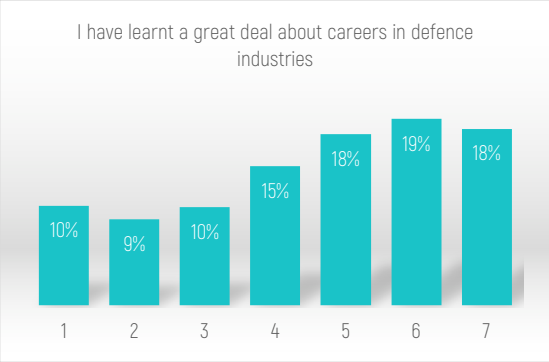
The following are students' responses to their involvement with Defence Industries.

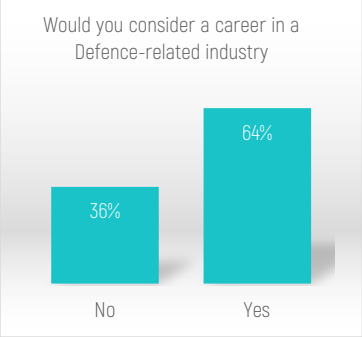


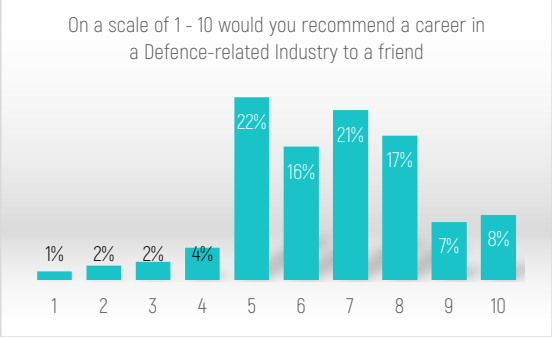


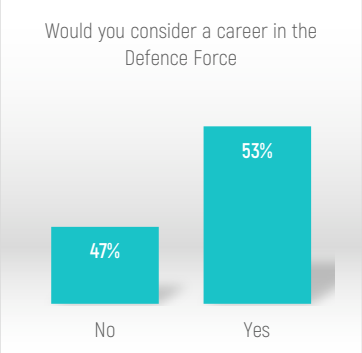


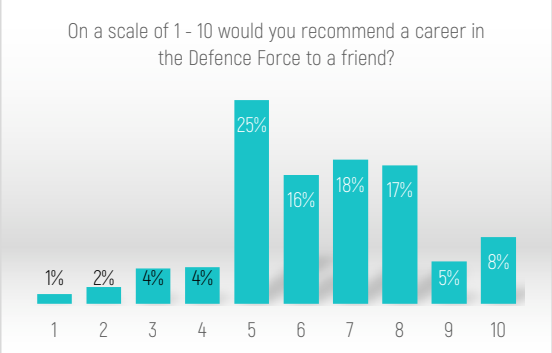




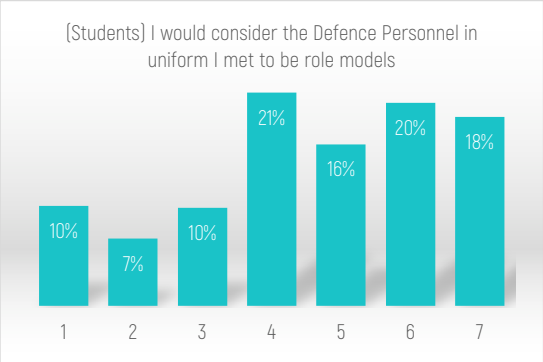


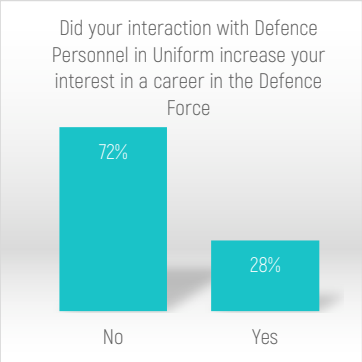


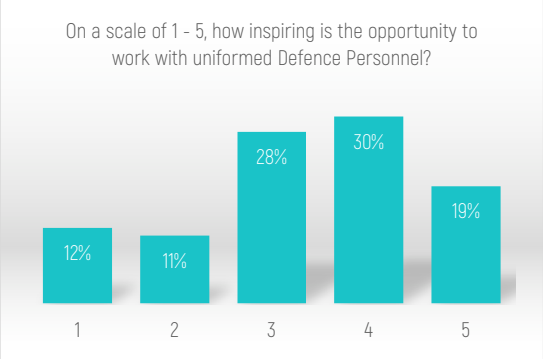


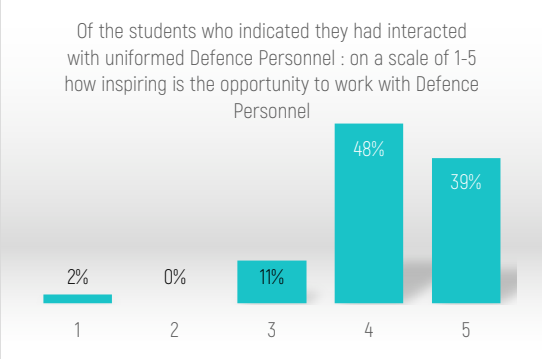


Student Interaction with Defense Personnel









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.

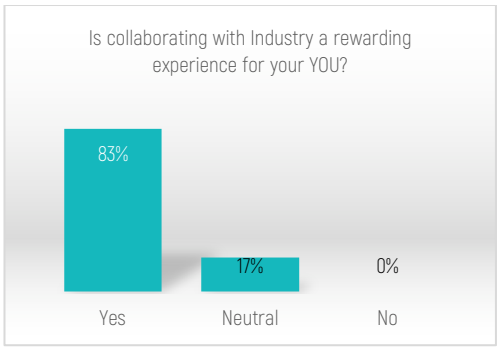
- Helping our country.
- It allows different pathways as well as being a place where you can serve your country.
- Naval Architecture
- Business
- Speaking, leading, physical
- It's exciting, and you can help people and your home.
- The capability of what you can do and how you can inspire other people.
- I would be helping many people and working with a lot of people.
- How they have many different jobs afforded
- The technology used in various defence industry subdivisions
- Teamwork
- Seeing all the machines work.
- 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.
- That you can help people while doing it
- Money
- The diversity of the industry employees and all the different types of jobs that are available for all different skill sets
- Design aspects
- Getting to accept new challenges
- Submariner Engineer
- The ability to use advanced technology to help the defence force
- I think that the roles that support the ADF are essential, and as the Defence Industry supports the ADF, I believe that it is vital to have a range of people and roles involved.
- Chance to build advanced technology
- The feeling of helping the nation
- Helping others
- The multiple aspects to it in enterprise/engineering
- Time Management and Trading
- The hands-on work and meeting new people, and having the chance to make a positive impact.
- I would want to be in the navy to learn discipline and teamwork
- Innovations in future ideas
- Engineering
- Mechanical engineer
- The stringent timetable and organization
- The broadness of the topic and how it involves lots of companies and people
- That it helps make the world a better place
- For starters, the pay. But they look like they involve a lot of problem-solving and leadership skills, which are things I enjoy.
- Working for the Nation
- A large number of possible career choices
- Working for my country
- The freedom and a broad range of careers and paths available

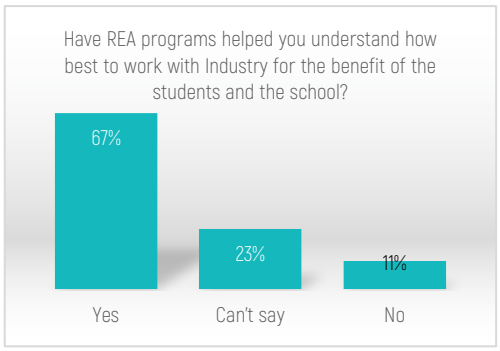
- Can support your country in a variety of ways
- Australian Army Engineering
- The benefits (educational)
- The importance in the society - The great responsibility
- I am most interested in a career in the Defence Industry because of the ability to support people using my knowledge in STEM areas like aeronautical engineering.
- Probably all the STEM-related elements it offers
- The vast number of possibilities that they offer
- Aerospace software engineer
- Engineering
- It would help a wide variety of people
- Opportunities
- Naval Architecture, Aerospace Engineer
- Doctor for the Army
- Human Resources
- If I'm being honest, I'm not 100% sure, and I don't know as much as I would like to, but it all stands out to me that there is more than I thought there was. It makes me want to know more :)
- Supporting the Defence Force.
- 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.
- Mechanical or aerospace engineer
- I am contributing to the protection of our country, and I'm contributing to society.
- It is primarily stem-based, and that interests me a lot
- Government arrangement
- Using STEM in a real-world Industry
- The ability to assist the nation
- Helping people and marketing, as that is what I also specialise in F1 in Schools. Also, a lawyer for the Defence Industry.
- Engineering
- 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
- A chance to support those who sacrifice so much for the safety and freedom of Australians.
- While not perhaps 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
- Electronics and weapons
- Being able to participate in such an important industry sounds like a really cool opportunity
- The engineering aspect of it
- Engineering or graphic designing
- There are many careers you can pursue in the defence force– some of which are engineering and other related fields.
- Variety
- Being able to work side by side with people who have the same goal and Interests as me
- I feel that it interests me because we are serving back to the community
- Helping in a good way
- Helping my country
- 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 people work together in the hardest of times
- Good learning opportunities
- That they protect you
- How you get to use different machines and get to learn about different materials
- At this point, I don't want to pursue a career in the Defence Industry
- F1 in schools has been super fun and interesting then so should the defence industry
- I want to help people; I want to be part of the Military, working with planes.
- It would interest me a bit if I could, but overall, no.
- It doesn't.
- Designing is something I'm very passionate about and having the opportunity to become a graphic designer is awesome.
- I just find the Defence force really cool
- Management industry
- I get to meet new people and go to new places and help people
- 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
- I would prefer to be an EMT, But also, if not, defence is a great career
- I don't want a career in defence
- Intelligence and cyber security
- Marketing
- Aircraft and piloting

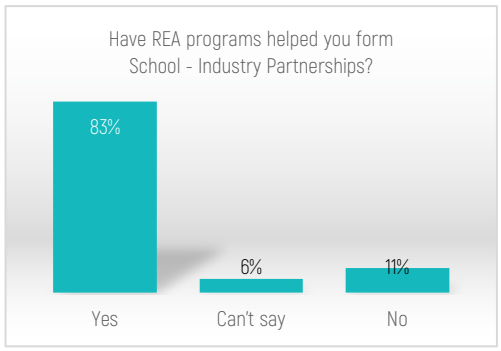
IMPACT OF INDUSTRY ENGAGEMENT ON TEACHERS

Teachers are a critical component in influencing career motivation. Industry and the education system must work together to provide the ongoing guidance and support which will encourage teachers to implement career interventions that are proving effective in producing the outcomes industry is seeking. Teachers regularly raised an issue during the research process, but not explicitly addressed within the scope of this research, about the support provided to implement STEM-based career interventions. Many teachers lack the confidence and competence to explore experiential learning programs within the STEM area and don't understand how Engineering and other STEM professions contribute to societal needs. While this research examined the students' motivational drivers, there is much to be done to support the teachers. They play a pivotal role and, in many instances, operate as the only heroes and role models the students must encourage them to take on activities that are outside the scope of their experience and knowledge.

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.
- All-round integration
- Amazing program
- Been a tough few seasons; 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.
- Bringing kids out of their shells.
- Building teams.
- Chances to network, share knowledge, develop workplace skills, exciting to race cars, feel very professional, plenty of opportunities offered through the program
- Collaboration, confidence, design and engineering.
- Communication, collaboration, the buzz of the boys.
- Competition - students get to collaborate with other students from other schools
- Competition and inter-school relations.
- Competition, life skills, teamwork, motivation for learning.
- Competitive nature, real-world connections, goals
- Confidence building, achievement, social skills, industry collaboration
- Confidence, collaboration, teamwork, tolerance
- Confidence, motivation, passion for learning, teamwork
- Confidence, teamwork, collaboration, engagement.

- 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 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 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.
- Development of the student as a whole. They have improved employability and are better placed to cope with schoolwork.
- Development of the student as a whole. They have improved employability and are better placed to cope with school work.
- Diligence, fairness, engaging competitions.
- Engagement and challenge
- Engages students, STEM-focused, a great mixture of cross-curricular.
- F1 in Schools is a valuable program and has delivered exceptional outcomes for our students. Their personal growth has been a delight to see!
- Fantastic Programs!
- 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.
- Friendly competition amongst schools. Teamwork, collaboration.
- Girls that have participated previously are now studying electronics, advanced design in Yr 12
- Great program pity about 4X4 next year
- Great programs and outcomes for kids. Keep up the good work
- Great skills for future
- Holistic nature
- 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 been beneficial to 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'm lucky that I have highly motivated students who make it easy.
- 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.
- In general, success and participation are celebrated.
- Increased knowledge helps time management
- Increased knowledge, time management
- Industry engagement, real-life problem solving, nationally recognised competition
- Industry-level expectations, great resources, intense competition. Career pathways.
- Integrated subjects, a project for the students to make.
- International comp
- 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 so much more out of this experience compared to past years.
- Keep up the excellent work, and many thanks for running the program
- Keep up the superb work, REA, and thank you all
- 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
- Links in industry.
- I love the program and love the rigour required to be successful. The feedback is excellent
- Meeting like-minded students from other schools.
- A multidisciplinary approach, real life, people skills/confidence involved.
- It's a great program!!!!!
- 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, watching the races...
- Opportunities for the students, project-based learning.
- Opportunity to compete against other schools and see what they've achieved.
- Pathways from primary, secondary, industry, STEM careers.
- Personal growth, confidence, organisation.
- Professionalism and support.
- Project-based learning. Learning to be self-directed learning
- REA is awesome, and we would be lost without them.
- REA makes some disengaged students happy to come to school. They look forward to learning.
- Real-life experiences in learning for students.
- Resilience, teamwork, experience
- Scaffold a project to aim toward competition as a reward and a goal.
- See student's confidence grow, see them become more resilient, see 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.
- Students are a bit overwhelmed with all the rules and regulations
- Students' development of STEM skills
- Supportive, room for the students to grow in their work and different levels of competition.
- Supports cross-curricular STEM projects in our classrooms.
- Teamwork, collaboration, Engineering.
- Teamwork, knowledge of "real world" practices
- Teamwork and innovation
- 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.

- Teamwork, self-esteem (confidence), organisation
- Thank you for everything the team does to facilitate these excellent programs!
- Thank you for running this programme.
- Thank you! Your dedication this year has been over and above. Your commitment has not gone unnoticed - Thank you!
- Thanks
- Thanks for developing a phenomenal program!
- Thanks for providing my students with this great opportunity cheers
- Thanks for running such a great program.
- Thanks for running these fantastic programs for students.
- 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.
- The focus of design through to competition
- 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.
- The teamwork and collaborative nature of the programs.
- This is a wonderful program, and I look forward to expanding it at our school.
- Travel as a team. Success/failure as a team. See the process from start to finish.
- A very worthwhile educational initiative that applies knowledge and skills to relevant contexts for ambitious students
- We didn't know that our students were not competing on the last day. If it was only top 8, how did we know if we were in the top 8 or not? We had parents from Brisbane come up today thinking their children competed. We only ended up getting a race with a BSH team (who also didn't make it) when we questioned things. Possibly a running scoreboard so that students know where they are. Again how do you know if you are in the top 8.
- 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
- I would love some resources on how to use CFD!
- Yes, this is the best experience for any student at a school! Thank you, REA.

CONCLUSIONS

Developmental career theorists such as Super (1996), Ginzberg (1984), Gottfredson (1981), and Vondkracek (Vondracek et al., 1986) have noted the importance of the adolescent years in laying the foundation for future career and educational pursuits. Each of these theorists acknowledges adolescence as a crucial time in developing interests, perceptions of abilities, and knowledge of the world of work.

The students who participated in the research came from various socioeconomic and multicultural backgrounds across Australia. It included students from private and public schools, city and country regions, and every state in the nation. Given this diversity, it is reasonable to assume that the group of students who participated were a broad representation of the Australian high school student population.

This research focused on examining the effectiveness of REA's STEM-based Metamorphic Learning programs, which have as their goal a desire to influence student career motivation and choice toward STEM and Engineering career pathways. This research aimed to measure the success of the programs, the reasons behind their success and gather data on the general factors that influence career choice in students. An important goal is to provide advice Industry on its role in attracting students to STEM and in their direction.

The analysis showed a strong connection between the levels of intrinsic motivation toward careers and the extent to which students reported that they were more interested in careers in STEM because they participated in the program (correlation =0.65). This data supports the view that once students experience STEM activities, their intrinsic interest in those activities increases. If further fuelled by activities that connect them to career pathways, there is an apparent propensity that it will influence student career decisions.

The qualitative data confirmed the connection between program participation and intrinsic motivation. Students recorded "learning about STEM careers" and "learning that STEM was fun and exciting" as their two highest responses to those aspects of the programs, which changed their perception of STEM as a career path.

The key elements which we learned from the data of this research are the following:

1. The Metamorphic nature of the learning process within these programs delivers a transition in student (and teacher) capabilities so profound that they don't just change a person's knowledge base; they change them fundamentally: Student maturity, self-efficacy toward career choice, personal drive, communication skills, self-confidence and capacity to work in a team to resolve issues all show dramatically improvement.
2. Students displayed high levels of intrinsic motivation and a propensity to respond to those activities which attract their interest. The high levels of intrinsic motivation toward STEM recorded in the students, combined with an activity that rated very highly on their "Cool" scale, has resulted in a significant impact on the students, with 77% of students indicating that the program had influenced a change in their career motivations toward STEM.
3. Within their immediate peer environment, students respond to parents and critical individuals. However, this level of response changes depending on the people they interact with, the knowledge they gain and the experiences they encounter within an intervention program. The extent of this change is different for boys compared to girls.
4. Student career decision-making self-efficacy is high, which translates to the students feeling very confident in their abilities to choose a career path.
5. While students are influenced by those in their surrounding environment, including their parents, they are predisposed to respond to their mates' influence over establishing a Cool status for a particular process or activity. For this reason, the industry needs to raise the image of significant projects.
6. Students' response to their involvement in the programs was led by how much they had learned about STEM and how fun and exciting they found it.
7. 50% of students are interested in careers in Manufacturing.
8. In over 94% of students, there has been a significant increase in employability skills capabilities.

9. In 84% of students' their academic achievement increases across all subject areas because of their participation.
10. 99% of teachers felt they learned significantly from their participation (Inspired teachers create inspired learners).
11. Industry involvement plays a crucial role in attracting students' interests and facilitating students to take the last step and enter the doors of opportunities in specific companies.
12. Learning environments that facilitate an increased understanding of careers that fit with the different motivational drivers of Boys and Girls will go a long way to providing the guidance and understanding the students seek as they make critical career choices.

Discussion

Long term sustainability of career choice toward STEM is influenced by the level of societal reaffirmation the students receive about STEM and magnifies if the messaging syncs with what they experience while undertaking a STEM-focused career intervention activity. Changing the messages delivered to students by both Industry and society is critical to the success of any career intervention. Without a change in the way we market STEM to attract students' interest, the sustainability of any intervention program aimed at attracting students could be questionable.

The story about STEM needs to be told differently to Boys than to Girls.

Boys need continuous human interaction, particularly with role models and mentors, to perform at their peak and upon which they can build career motivation. Boys learn by apprenticeship and respond to the influence of role models. They need to touch jobs before making an emotional decision about career engagement. The movement of Boys into STEM careers will increase by facilitating interaction between students and adults in STEM roles. Part of the messaging to boys is that there will always be professionals around them during their career journey who will help them learn and grow. For boys, STEM career pathways are an opportunity for continual learning. The elevator pitch to attract Boys to Engineering/STEM careers could be the following:

- STEM careers will allow you to design many Cool things throughout your career. You will have the opportunity to work in great teams and learn continuously from the very experienced professionals around you, and your career will be one of continuous discovery.

Girls respond to managing complexity in environments. Highlighting the processes and complexity involved will attract them to STEM professions. Girls will respond to the project management aspects of STEM careers and need to understand the processes involved in complex projects. The elevator pitch to attract Girls to STEM could be the following:

- STEM professions require a great deal of management to bring together all the different skills and processes needed to achieve an outcome or solve a problem … throughout your career, you will be required to manage and coordinate complex sets of tasks to bring a project to a successful conclusion.

Cool vs Role Model

The term "Cool" has been mentioned many times throughout this document. Many things can be cool: people, projects, and companies, with some propensity to present a "cooler" than others. While students equate cool as being linked to exposure, there do not associate a direct link between being cool and being a role model. In students' eyes, a role model is a person (company or project) they perceive as doing good in society. Students are very clear in this definition of role models. Thus, a dilemma exists for Industry: should they focus on becoming visible (cool) or being perceived as a role model in society which may require different marketing strategies. To some extent, you need to be both. Being cool enough to attract students' attention while being a role model that students would like to be employed by.

In general terms, students consider STEM "Cool", which has a propensity to attract their intrinsic interest. Once the door of inherent interest is open, it is additional motivators delivered by Industry and an image of "doing good in society" in a

way that the students can relate to that will change their career choice norms. To grow the number of students taking up STEM, the Industry needs to lead how it presents itself to the next generation if it is to place STEM careers on students' radar and within their scope of acceptability.

Defence & Defence Industry

As highlighted by Bandura's (1969, 1977, 1982, 1986) social cognitive theory, well-regarded people in society have a strong capacity to influence action and self-efficacy. The size and visibility of projects provide a unique opportunity for Defence and Defence Industry to impact students' understanding of the application of STEM. However, when dealing with Defence and Defence Industry, there is a significant dilemma regarding the normative imagery that exists in the community. The classic research definition of a role model is "someone who does good in society". The role of Defence in the recent natural disasters we have faced, flood and fire, has strengthened Defence's image in the community. Defence is seen to do good things in society. People in Defence, particularly those who present in uniform, fit with this image of positive role models. And in many instances, better than most other professions and could be comparable with the social image of Doctors and nurses: their uniforms, structure, and role in protecting the community. Defence is surprisingly Cool, and its employees/members are considered strong role models. A component of this research examined the impact on student motivation that interaction with Defence Industry and Defence Role models has and they capacity to influenced students' motivation toward STEM career pathways.

Students do not associate Defence with "NOT good for society" for several reasons. The proliferation of computer-based war game, which the younger generation see as fun, helps promote a mental model of Defence that would not drive them away from careers in Defence Industries or Defence. Additionally, it has been 50 years since our last visible conflict (Vietnam), and the current students and most likely their parents do not connect fully with negative images of war. The negative images which could be attached to Defence, to some extent, are more front of mind in a mature aged (baby boomer) market, and there is no reason yet for students to assimilate with this mental model.

When it comes to attracting students to careers in Defence and Defence Industries, the current perception in society is excellent. The many of the significant and visible projects Defence and Defence Industry are involved in, Jet fighters, Submarines, and Ships are of intrinsic interest to students and fall into the category of role model projects and are from a student's perspective undoubtedly cool.

Determining the difference in the impact of Defence personnel vs Defence Industries role models on career motivation is complex. It would require a significantly complex multivariable analysis to determine which has more or less impact on student motivation. We did, however, see in the qualitative responses that students did not, in many cases, separate Defence from Defence Industry. For them, the two are one. When asked if they would consider a career in Defence or Defence Industry, 64% would consider Defence Industry, and 54% would consider Defence. Students also highlighted a positive emotional connection with the Defence and Defence Industry's role in society. If harnessed as a single marketing image, i.e. not explicitly separating Defence from Defence Industry, and using merging the image between the two could help significantly influence students' career motivation for careers in STEM, not just Defence or Defence Industry.

Summary

If nothing else, Industry must take from this research that the capabilities and enthusiasm of our children are profound. Given the high levels of intrinsic motivation and the strong linkage in the literature between intrinsic motivation, self-efficacy and innovation, it is reasonable to assume that this new generation of students will be highly innovative. An excellent position for Industry, and our nation, moving forward in a competitive world.

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