Parallel Pathways:

A Comparison of STEM and Culture Programs for Underrepresented Students and Associated Program Evaluation Methods

An Interactive Qualifying Project submitted to the faculty of

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Abstract

This report presents a study of various evaluation strategies utilised by STEM and cultural education programs for underrepresented youth in Australia, New Zealand, Canada, and the United States, primarily focusing upon Indigenous students. Commonalities and variations among approaches to education and evaluation were investigated through conversations with directors of these programs. The report culminates with the introduction of a guide for the assessment of a typical program of this type, which incorporates both qualitative and quantitative assessment techniques. This study seeks to aid program directors in their pursuit of systematic evaluation methods and continuous improvement.

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Executive Summary

Indigenous Australian students are not pursuing science, technology, engineering, and mathematics (STEM) fields at a representative rate for their population size, despite having similar, if not slightly higher levels of interest in STEM subjects compared to Australian averages. In Australia, Canada, New Zealand, and the United States, minority populations are severely underrepresented in the STEM fields: in Australia, non-Indigenous people are more than twice as likely to go into a STEM field as their Indigenous counterparts (McConney et al., 2011).

In response to this particular problem, various organisations, governments, the private sectors and universities in these four nations support the delivery of educational programs with the overarching goal of increasing Indigenous representation in STEM. One such organisation, Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO), has been funded by the BHP Billiton Foundation to deliver the Aboriginal Summer School for Excellence in Technology and Science (ASSETS) program since 2014. ASSETS is a nine-day residential program for rising Year 11 Indigenous students, which mixes STEM education with Indigenous cultural elements to provide an enriching educational experience. Its directors envisioned this research project in order to collectively better program directors' understanding of other existing STEM and culture programs.

In order to accomplish this, the goal of this project was to identify, contact, and learn about other STEM and culture programs in Australia, Canada, New Zealand, and the United States which were similar to the ASSETS program. Using the information gathered, comparisons could be recognised among the programs, and a generalised strategy for assessing the success of these programs could be produced.

To accomplish this goal, experts in educational evaluation were first consulted, who advised that the basis for any evaluation strategy for a program should be its set of overarching aims. To simplify the understanding of a diverse set of programs' aims, a model for an educational program's framework, the *Aim-Outcome Model,* was envisioned. Depicted in Figure 0.1, this model shows that, for every aim of a program, there will be at least one element of the program that contributes to accomplishing that aim. Each aim of the program has at least one indicator to show whether the aim has been achieved. In order to ascertain whether the program is truly achieving its aims, these indicators require measurement and analysis.

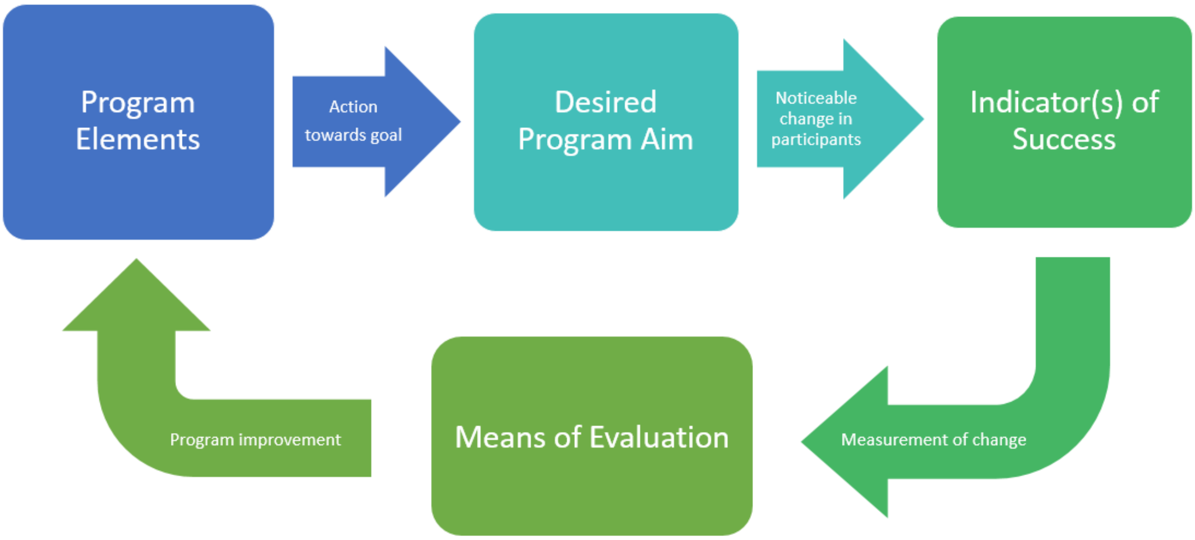

Figure 0.1: Typical *Aim-Outcome Model* for a Program

Once the *Aim-Outcome Model* was developed, search engines were used to discover programs similar to the ASSETS program; ultimately, 29 other programs were identified. The directors of each of these programs were contacted with requests for interviews to learn more about the elements, aims, indicators, and means of evaluation associated with the programs. This and other information obtained online or from program directors was compiled into a database known as the *Comparative Directory*, located in Appendix A. Once the *Comparative Directory* was completely populated with all available data, the most common elements, aims, indicators, and means of evaluation among the programs were identified. Common features of all contacted programs were identified, such as the widespread use of networking events to introduce Indigenous students to professionals in STEM. The five most common aims among all thirty programs, including ASSETS, were to

- increase student *awareness* of Indigenous culture and STEM career options,
- develop students *abilities* in STEM,
- heighten student STEM career *aspirations*,
- increase students' *self-confidence* in cultural identity and STEM ability, and
- aid students in the development of a *social community* of Indigenous STEM students.

Commonly used indicators of a program's success were also noted, including the use of student levels of self-efficacy with regards to attaining a STEM degree, which can be described as that student's belief in his or her ability to succeed at accomplishing that goal. In addition to the commonplace survey following the end of a program, unique means of evaluating a program were also discovered, such as holistic, discussion based assessment.

Following the identification of these trends, the *Assessment Strategy* contained in this report, was produced based on the conclusions drawn from the analysis of programs in *Comparative Directory*, scholarly research, and information collected from experts in the fields of STEM education, Indigenous student education, and educational evaluation. The *Assessment Strategy* includes a detailed framework for evaluating a program's success at attaining each of the five key aims. For example, to assess whether a program increases the self-confidence of its student participants, the *Assessment Strategy* recommends administering a set of Likert scale questions, to students concerning their own beliefs in their abilities to succeed as Indigenous professionals in STEM. Additionally, it is recommended that parents are surveyed before and after the program, to point out changes in their child's behaviour. If the students' scores increase from the start to the end of the program, then an increase in self-confidence can be confirmed. A similar framework is established to address each of the five most common program aims. The use of holistic assessment methods is suggested by the *Assessment Strategy,* such as the use of group discussions to assess the participants' awareness of their Indigenous culture. Lastly, *Assessment Strategy* includes a series of tips for evaluation to guide the administration of valid assessment.

A set of recommendations was developed at the culmination of the project to enable the directors of STEM and culture programs to collectively improve their programs. Among these recommendations, it is advised that program directors consult with a specialised expert evaluator and research best practices to best understand the practice of evaluation. It is finally highly recommended that the directors of these programs maintain communication with the directors of similar programs, engaging in the kind of community-driven improvement as discovered and fostered by this project.

Table of Authorship

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2 Background & Literature Review (Introduction)	All	All
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1 Introduction

Indigenous populations are significantly underrepresented in science, technology, engineering, and mathematics (STEM) fields when compared to their non-Indigenous counterparts in places like Australia, Canada, New Zealand, and the United States. Indigenous populations in these countries have a common history of colonisation by the British. This history negatively impacted the health and wellbeing of these Indigenous populations, contributing to the significant disadvantage they experience today. All four counties have initiatives to address these disadvantages, such as the underrepresentation of Indigenous people in STEM subjects and careers. For example, the Program for International Student Assessment (PISA) test analysis found that whilst Aboriginal and Torres Strait Islander students had a slightly higher interest in science than their non-Indigenous counterparts it was observed that they scored on average 10% lower on the international test than non-Indigenous Australians (McConney et al., 2011). The education gap between Indigenous and non-Indigenous Australian students and their participation in STEM has been recognised as a challenge, and is being addressed through a number of initiatives by organisations, governments, universities, and the private sector.

The sponsor of this project was the Commonwealth Scientific and Industrial Research Organization (CSIRO), the national science foundation of Australia. It runs various educational program for youths throughout Australia, including a summer program known as the Aboriginal Summer School for Excellence in Technology and Science (ASSETS) with funding from the BHP Billiton Foundation.[1] Many other comparable programs exist in Australia, New Zealand, Canada, and the United States in this realm of encouraging the pursuit of STEM studies and careers by underrepresented youth. CSIRO, like many sponsoring organisations for STEM and culture programs, has identified the importance of establishing an evaluation method to measure its success in affecting change in students. This project was envisioned with the goal of both studying the operations of other programs similar to ASSETS, and developing a framework for evaluating the success of a STEM program designed for an underrepresented population. As a result of this project's findings, the directors of these

[1] The Aboriginal Summer School for Excellence in Technology and Science (ASSETS) is a nine day residential program for Year 10 students. This program was established by The University of South Australia in the 1990's and since 2014 has been managed by CSIRO and funded by BHP Billiton Foundation.

programs will be able to create effective and methodological assessment tools, for use in improving their programs accordingly.

2 Background & Literature Review

In order to successfully achieve this project's goal of establishing a set of evaluation tools for programs for underrepresented youth, a significant amount of background research was needed to better understand the context for this project. Because the ASSETS program is based in Australia and serves the Indigenous Australian population, the research team paid particular attention to the Australian context. This included a substantial amount of reading and discussing Indigenous history and social impacts with Indigenous and non-Indigenous staff in ASSETS and related programs. It included developing a broad understanding of key events and policy approaches in Indigenous affairs. This was further complemented by research undertaken to learn more about

- the STEM Crisis,
- education programs for underrepresented groups, and
- the ASSETS program.

The information learned from researching these topics was considered when designing an evaluation plan for programs catering to STEM pursuit in underrepresented youth.

2.1 The STEM Crisis

One of CSIRO's key efforts in the past few decades has been addressing the STEM crisis affecting Australia. This "STEM crisis" refers to the increased demand for professionals in the fields of science, technology, education, and mathematics, combined with the simultaneous sweeping decline of interest in STEM-centric careers and university study. The STEM crisis is an issue affecting not only one or two nations, but rather a significant portion of countries around the world. Westernised countries like the United States and Germany are particularly at risk, as more frequently domestic positions in STEM fields in these countries are filled by foreigners instead of domestic workers (Katsomitros, 2016). It was estimated by the European Union's Centre for the Development of Vocational Training that by 2015, there would be a shortage of between 380,000 and 700,000 information and communications technology workers in Europe alone. The United States has also experienced this decline in STEM. In fact, a study done in 2010 predicted that the number of STEM graduates would need to increase by 20-30% by 2016 to meet the projected growth of the US economy (Katsomitros, 2016).

The STEM decline has also directly impacted Australia, where the number of students pursuing STEM fields has been decreasing over the past few decades. The Australian school system allows students in secondary school to select a portion of the classes they will take from a variety of disciplines; in New South Wales, Victoria, and Western Australia, taking maths courses in Years 11 and 12 is not compulsory (Wilson, 2013). It has been found that a smaller percentage of students each year is choosing to take courses in STEM fields; and the number of students not taking *any* maths or science classes has increased dramatically in the past two decades. For males, the number of students not taking any maths or science courses in secondary school has increased from 2.1% in 2001 to 5.9% in 2014, nearly tripling in just thirteen years. For females, the portion not enrolled in maths or science classes has increased from 5.4% in 2001 to 14.6% in 2014, an even larger increase than for males (Wilson, 2015). These sharp declines in science and maths participation indicate the presence of a significant problem that needs to be addressed before Australia falls increasingly behind in these fields. Fortunately, agencies like CSIRO have recognised this issue and have devoted significant resources to address it.

An important consequence of this STEM decline which concerns this project is the underrepresentation of Indigenous students pursuing STEM careers. As mentioned previously, Aboriginal and Torres Strait Islander individuals suffer a significant quality-of-life disadvantage when compared to non-Indigenous Australians, a fact especially true with regards to education. In Australia, 88% of non-Indigenous students complete Year 12 of their secondary education (the final year before optional higher studies) of schooling, while a mere 59% of Indigenous students complete Year 12 (Australians Together, 2015). This means that, for every five Aboriginal students, only three complete secondary school. Furthermore, the quality of education received by Indigenous students is significantly lower than that received by non-Indigenous Australians. The Australian Council for Education Research analysed the results of the PISA exam, an international standardised test, and found that only 57% of Indigenous students performed proficiently on the PISA test, compared to the 86% of non-Indigenous students who performed at proficient levels (De Bortoli & Thomson, 2009). However, this study also found that, on average, Indigenous students were slightly more interested in science than non-Indigenous students. This indicates that these students often have the desire to pursue science education, but the education is not tailored to Indigenous students, which leads to them falling behind.

Other countries, such as the United States, are experiencing similar issues with STEM decline, especially among minorities. For example, a study published by the American National Math and Science Initiative (NMSI) indicates that only 51% of Latino students in the United States seeking higher education actually complete their degree, while over 65% of white students complete their degrees. (NMSI, 2016). The United States is actively working to achieve measureable improvements. For example, the research done by organizations like the NMSI has led to the formation of a strategy that suggests modifications to the teaching system of the United States. NMSI proposes that teachers from grades 3 through 12 be well-versed in both science and mathematics, such that these teachers would be better able to convey the importance of maths and science to their students.

Programs in Australia have also begun to combat this decline; many programs which would be investigated through this project provide cultural and STEM education for Australian Aboriginal and Torres Strait Islander students. There is also significant investment by the private sector to address the STEM crisis. For example, the BHP Billiton Foundation has invested $55,000,000 AUD over five years in four programs, including the CSIRO Indigenous STEM Education Project which incorporates ASSETS, in recognition of the importance of STEM education for the future of Australian economic opportunity and prosperity (BHP Billiton Foundation, 2016).

2.2 Education Programs for Underrepresented Groups

There exist previous studies focused on potential factors for success in programs aimed at encouraging underrepresented populations to pursue higher education, detailing the various viewpoints concerning what can make such a program effective.

One topic on which significant research has been conducted is *self-efficacy*, or the self-perceived notion that one has the ability to control his or her life and achieve what he or she sets out to do. If a student is convinced that attaining a job as a professional researcher in a cutting edge scientific field is not possible for someone like him or her, the idea will likely go unpursued. Studies concerning the self-efficacy of minority populations and women in STEM have been conducted, highlighting some differences in the mindsets of minority students in comparison to their advantaged counterparts (Wilson et al., 2015). This showcases the fact that members of these populations are more at risk than the average person to have lower levels of self-confidence, and therefore more-likely to experience the problems caused by not pursuing higher education. It was found that "self-efficacy was the variable most highly correlated with math-related major choice," in a study which examined the effects of various factors which impact students' university major choice (Hackett, 1985). If the lack of minority and female representation in STEM is to be addressed, the self-efficacy levels of members of these groups must be addressed.

Another area in which research has been conducted is in the analysis of minority mentorship programs as a tool for encouraging continued study of STEM fields. By introducing both near-age students and older professionals in STEM, these programs seek to create connections between the age groups, showing younger students that it is possible for them to attain a high level of achievement in STEM. A study examined the idea of a "social community," defined as a gathering of people with similar backgrounds and experiences that can help each other grow through their shared perspectives (Mondisa & McComb, 2015). This study recommended the facilitation of both formal interactions with assigned mentors, and informal interactions caused by living in the same place, as important for framing a social community. By encouraging these encounters, those in a minority group have a chance to coalesce in a safe environment, exchange ideas and concerns, and forge supportive networks. When a community has such mechanisms for support to aid members in pursuing a certain field, youth in that community are much more likely to do so (Stolle-McAllister et al., 2011).

Australia is not the only nation to experience issues with minority education and low minority representation in STEM fields in society, nor is it the only nation with plans in place to address the problems. Among other nations, the United States has an identified gap of involvement of female participation in STEM fields, reflecting a situation where women hold close to half the jobs in the American economy, but less than a quarter of STEM jobs (Beede et al., 2011). In the same way that the ASSETS program was developed in order to combat the lack of Indigenous representation in Australian STEM industries, there are comparable programs in nations like the United States, New Zealand, and Canada which aim to increase participation of their own respective underrepresented groups in STEM fields.

2.3 The ASSETS Program

The sponsor of this project was the Commonwealth Scientific and Industrial Research Organization (CSIRO). CSIRO is the Australian government's national science foundation, which endeavours to advance Australian and global society by conducting scientific and technological research, and hosting educational programs for young Australians (CSIRO, 2016a). CSIRO's commitments have continually shifted as the scope of technology has changed since its founding. Since the 1980s, CSIRO Education has provided educational programs and resources for students and teachers around Australia, with projects ranging from in-class demonstrations to residential summer schools.

One such summer school run by CSIRO is the Aboriginal Summer School for Excellence in Technology and Science (ASSETS). ASSETS is a long running program which was established by The University of South Australia in the early 1990s, and ran in Adelaide with various partners including the Australian Science and Mathematics School between 1992 and 2013. In 2014, the management of the ASSETS program was taken on by CSIRO as part of a new Indigenous STEM Education Project, funded by the BHP Billiton Foundation. The 2014 ASSETS program was a transitional year with CSIRO staff involved for the first time, learning about the existing model before taking on management of the program and expanding it in future years (Baker, 2016). Under CSIRO, the ASSETS program was expanded to multiple sites, and a follow up leadership and support program was introduced to provide an opportunity for Aboriginal and Torres Strait Islander secondary school students to learn about their potential in STEM fields. Through interactions with Indigenous mentors and students, the completion of group research projects, and participation in events which celebrate Indigenous heritage, ASSETS introduces high-achieving students to some of the science fields they could become involved with in their future careers (CSIRO, 2016b). Students have the opportunity to gain real-world experience by researching at prominent Australian universities, and by working as teams to complete research projects of their own design. Student participants interact with Indigenous scientists and engineers who serve as role models for their future aspirations, as well as university students and recent graduates who give students first-hand accounts of contemporary university life (Lewis & Tynan, 2016).

Intermingled with the STEM activities of ASSETS are cultural activities which aim to support the Indigenous identity of the Aboriginal and Torres Strait Islander participants. Students and Indigenous mentors engage in discussions where all participants share their perspectives of, and experiences with their Indigenous heritage, forming supportive cohorts to encourage continual growth. Other activities incorporate both STEM and Indigenous culture, such as learning about science inquiry in the context of traditional fire starting methods (Lewis & Tynan, 2016). If the students so choose, they can also investigate traditional topics in their research projects: one group studied the effects of temperature on didgeridoo sound.

3 Methodology

The goal of this project was to understand and then develop an assessment strategy for culture and STEM programs for underrepresented youth. This data would be based on information gathered from directors of such programs and educational experts in the fields of STEM, culture, and evaluation. The resulting *Comparative Directory* of compiled program information (found in Appendix A) and *Assessment Strategy* (found in Section 5 of this report) can be used by the directors of these programs to measure the success of their actions, and to refine their programs. In order to achieve this goal, the team

- learned from educational experts in the fields of STEM, culture, and evaluation;
- established an organisational model for understanding programs' operations*;*
- learned about the curricula, aims, and evaluation methods of a variety of programs;
- identified the common features among programs; and
- developed the *Assessment Strategy* based on research and the most common aims.

The significance and steps taken to accomplish these objectives are detailed in the following sections.

3.1 Learning from Educational Experts in the Fields of STEM, Culture, and Evaluation

Rationale:

The objective of this part of the project was to obtain information from various experts in the field of education and educational methods. Agreement regarding best practices was sought, to be applied in the development of the *Assessment Strategy*. STEM educators would be best positioned to provide information regarding the design of quality STEM education programs. Similarly, Indigenous education professionals would contribute suggestions towards the design of a programs specifically tailored for underrepresented populations. Professional evaluators were contacted to obtain information regarding important considerations in the design of an evaluation scheme for a program.

Methods:

Several experts were contacted to provide insight into STEM education, Indigenous culture education, and educational evaluation, drawn from Australia, Canada, New Zealand, or the United States. Such professionals included professors, university leaders, and researchers in their respective fields.

To learn more about the design of a STEM education program, experts in the field of STEM education were sought out. CSIRO offers a variety of programs in addition to ASSETS, which also aim to increase the participation and achievement of Indigenous students in STEM fields. Joe Sambono, the director of the CSIRO Indigenous STEM Project's Inquiry for Indigenous Science Students (I2S2) program was contacted via connections with the sponsors of this project; he was interviewed regarding the design of an effective STEM program, the design of a STEM program for Indigenous students, and the ways in which the program is evaluated.

The Indigenous education experts who were interviewed include those involved with the development of programs for Indigenous students, such as Aleryk Fricker, the coordinator of Indigenous Participation at Royal Melbourne Institute of Technology (RMIT) University, and Peter Radoll, the Dean of Aboriginal and Torres Strait Islander Education and Research at the University of Newcastle. The directors of the ASSETS program provided the contact information for these professionals, who were interviewed concerning topics such as the incorporation of culture into education.

In addition to interviewing STEM education and Indigenous education professionals, experts in the field of educational evaluation were contacted. The evaluators consulted were Jeanne Hubelbank, Paula Quinn, and kas aruskevich. The former two evaluators had connections to Worcester Polytechnic Institute (WPI), which facilitated the contact of these professionals via connections with professors at the university. Evaluator kas aruskevich was found via connection with the director of the Gaalee'ya STEM Project[2], one of the many similar programs identified. These professionals were selected because each evaluator had experience developing evaluation schemes for STEM programs for underrepresented populations and therefore could contribute to the development of the generalised *Assessment Strategy*. The evaluators were interviewed regarding proper techniques for conducting evaluations and were asked to characterise a good evaluation model. All

[2] The Gaalee'ya program is designed to aid the youth of remote Alaskan Native tribes in acquiring their Associate's degrees, run by the University of Alaska - Fairbanks in Alaska, United States of America. This program is no longer in operation.

questions for interviewees are included in Appendix B. All of the information collected from these professionals was consulted in the creation the *Assessment Strategy*.

3.2 Establishing a Model to Understand Program Operation

Rationale:

In order to pursue further studies of the programs concerning this project, a comprehensive understanding of their operations was needed. Since a large part of this project would involve comparing the programs to each other, a model for these programs had to be introduced to organise the programs in a methodical way.

Methods:

The research conducted in this project would be centred upon the *aims* of programs for underrepresented youth and their evaluation. As suggested by professional evaluator Jeanne Hubelbank, a flowchart was created in order to better understand the aims of these programs and their intended contributions to students. This set of flow-charts for each program, each part of which is defined by one of the major aims of that program, is referred to as the *Aim-Outcome Model* of that program. A typical instance of this model, made for a singular aim of a program, can be found in Figure 3.1.

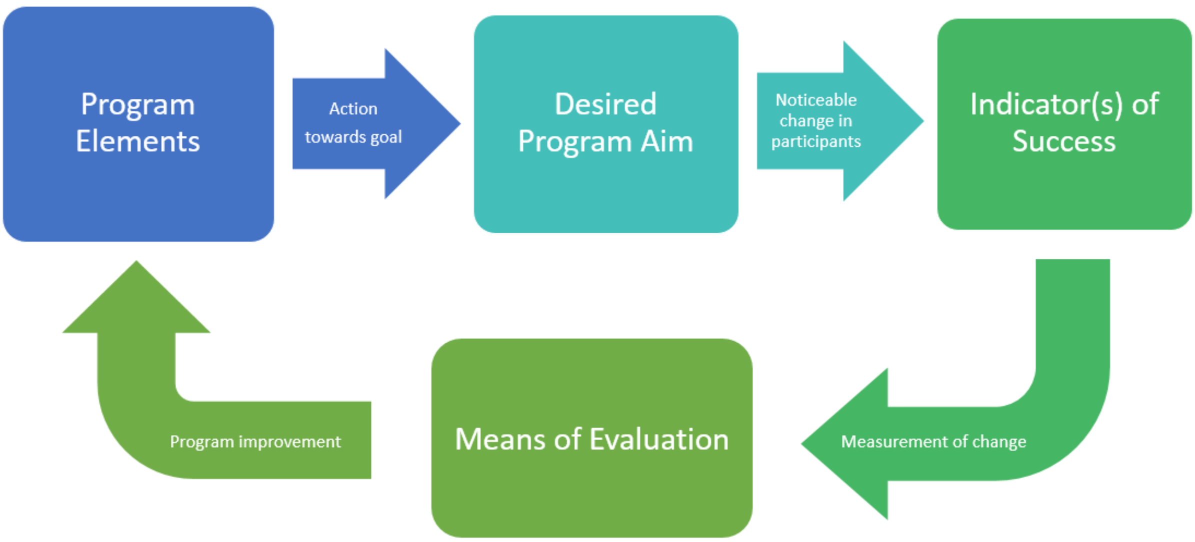

Figure 3.1: Typical *Aim-Outcome Model* for a Program

A program model allows one to see a clear progression of the actions of a certain program towards its measurable success. Each aim of the program should have at least one program element which works towards that aim. If achieved, the results of each aim should be exhibited in indicators which show that a student has been changed by the program. These indicators can then be measured by an evaluation scheme, the results of which can be used to make improvements to the program.

The idea of the *Aim-Outcome Model* was developed as the first step in the organisation of learning about programs, but would ultimately be completed in following sections for the report. Most frequently, “Program Elements” and “Desired Program Aims” could be found stated on the websites of these programs. Contrastingly, the “Indicators of Success” and “Means of Evaluation” of a program were often unavailable to the public, and thus learning about these factors required personal interviews. Once this framework for learning about a program was established, program directors and education experts could be drawn upon to learn about the current scope of this type of program. From these discussions, best practices could be identified and used in the development of the *Assessment Strategy*.

3.3 Learning about Existing Program Elements, Aims, Indicators, and Means of Evaluation

Rationale:

A crucial part in developing the *Assessment Strategy* was learning about successful STEM and cultural programs for underrepresented groups. A program can be declared as being “successful” if it meets its proclaimed aims. ASSETS is not the only program of its kind; many other programs with similar aims and curricula exist in various nations. The goal of this part of the project was to assemble a collection of information from these programs for collective consideration. This includes comparing each program's aims, incorporation of STEM and culture, and evaluation methods in order to form conclusions about the current best practices of this kind of program. Understanding these practices allowed for the design of the *Assessment Strategy,* which drew from programs which have been shown to be successful.

Methods:

In order to accomplish this objective, a variety of programs for underrepresented students were sought out. For a program to be considered, it had to meet the first criterion, and at least one of the second and third criteria. These criteria were:

1. The program was based in Australia, Canada, New Zealand, or the United States.
2. The program was designed with significant STEM elements.

3. The program was designed with significant cultural elements.

In other words, programs were chosen because they were at least somewhat similar to the ASSETS program, since it was the base point of the project. Australia, Canada, New Zealand, and the United States were determined to be the ideal program locations because each of these countries has a significant Indigenous population and has English as a primary language. Since the focus of this project was STEM and culture programs, to be considered for research, a program had to exhibit at least one of those components. Table 3.1 shows the distribution of programs that met the aforementioned criteria.

Table 1: Number of Programs that met Specified Criteria	
Criteria	Number of Programs Program
Meets criteria 1 and 2 ONLY	12
Meets criteria 1 and 3 ONLY	2
Meets criteria 1, 2 and 3	16
TOTAL	**30**[3]

Once these criteria were set, various internet search engines were used to identify programs that met the first, and at least one of the latter two qualifications. As programs were discovered, basic information was tabulated for each program in the *Comparative Directory*, a database for the organisation and comparison of camps' *Aim-Outcome Model* sections and logistic information. The *Comparative Directory* includes information about fields such as a program's target audience, aims (if any were specified on the associated website), and the size of the program. Thirty programs that met the aforementioned requirements were identified, and are all included in the *Comparative Directory*, located in Appendix A.

In order to gain deeper understanding of programs, the project group contacted representatives of all thirty programs via email or telephone, and requested personal interviews with the directors of the program. For those program directors who were available, interviews were scheduled through Skype, telephone, or personal interaction. The ensuing

[3] There were 21 programs specifically designed for Indigenous populations: 14 from Australia, 5 from Canada, 1 from New Zealand, and 1 from the United States.

interviews centred on topics such as a program's incorporation of STEM and culture, its defined success, and the evaluation metrics used to analyse the program. All of the questions posed to program directors can be found in Appendix B. If directors were unavailable to talk, the interview questions were sent via email to be filled out at the directors' convenience; the electronic version of the questions distributed to these directors is included in Appendix C. Of the 30 programs identified, 16 program directors responded to the team's questions (a 53% response rate).

The information obtained from these interviews and surveys was added to the information found online in the *Comparative Directory*, to further comparisons among the programs. Once the *Comparative Directory* was populated with information, the most common elements, aims, indicators, and evaluation methods among programs were identified. These common elements were then applied in the development of the *Assessment Strategy*.

3.4 Identifying Common Features of Programs for Underrepresented Youth

Rationale:

In order to develop a widely applicable and accurate assessment scheme, a common set of aims among programs required establishment before proceeding. According to the professional evaluators consulted, before creating an evaluation method for a program, the program's aims must first be understood (Hubelbank, 2016; Quinn, 2016a). If the program achieves its aims, then the program can be considered a success; therefore, the aims must be known in order to properly evaluate a program. Many programs had similar aims but stated them differently; broad trends among aims could be found easily when standardised. Once these generalised aims were determined, indicators of success for achieving these aims and ways to measure them could be identified.

Methods:

The information compiled in the *Comparative Directory* was analysed in order to identify common elements shared by many programs and was used to develop a set of common aims upon which to base an evaluation strategy. A common set of aims was developed to better understand the scope of the programs studied. A generalised *Aim-Outcome Model* was created to collectively represent common elements of programs. In doing so, common practices were found in the realm of STEM programs for underrepresented youth, to be further supported or discredited by research in the field. Following this categorisation of program aims, the development of the *Assessment Strategy* could begin, tailored to a generalised set of aims.

3.5 Developing the *Assessment Strategy*

Rationale:

An evaluation scheme equips the directors of programs with a robust set of effective industry practices. The *Assessment Strategy* was designed to do this by combining background information, scholarly research, data from the *Comparative Directory,* and the *Aim-Outcome Model.*

Methods:

Once common categorised aims of programs were established, an evaluation method for each generalised aim could be envisioned. The programs which exhibited these aims were individually referred to in the *Comparative Directory*, and were supplemented by expert opinions and scholarly research. In this way, important details about each set of “Means of Evaluation” were developed, including

- what indicators could be measured, and exhibited by whom;
- how and when assessment could be carried out; and
- why such an evaluative measure is important and useful to the program.

As such, the *Assessment Strategy* could function as a guide as to how a typical STEM program for underrepresented youth could be evaluated, presenting a completed cycle of the *Aim-Outcome Model*.

4 Findings

Two major deliverables, the *Comparative Directory* and the *Assessment Strategy*, were created by examining programs for underrepresented youth and their evaluation. Through the creation and analysis of these deliverables, conclusions were drawn about commonalities among programs as well as differing program approaches.

4.1 Commonalities among Program Features

To aid in the creation of the *Assessment Strategy,* the data presented in the *Comparative Directory* and background research were analysed to discover commonalities and theories of best practice among programs. The remainder of this section describes the observed commonalities and trends in the context of the *Aim-Outcome Model*.

4.1.1 Common Program Elements

Many of the programs shared similar programmatic elements which were designed to bring about change in the programs' participants. Figure 4.2 displays the most common elements among the 30 programs that were studied.

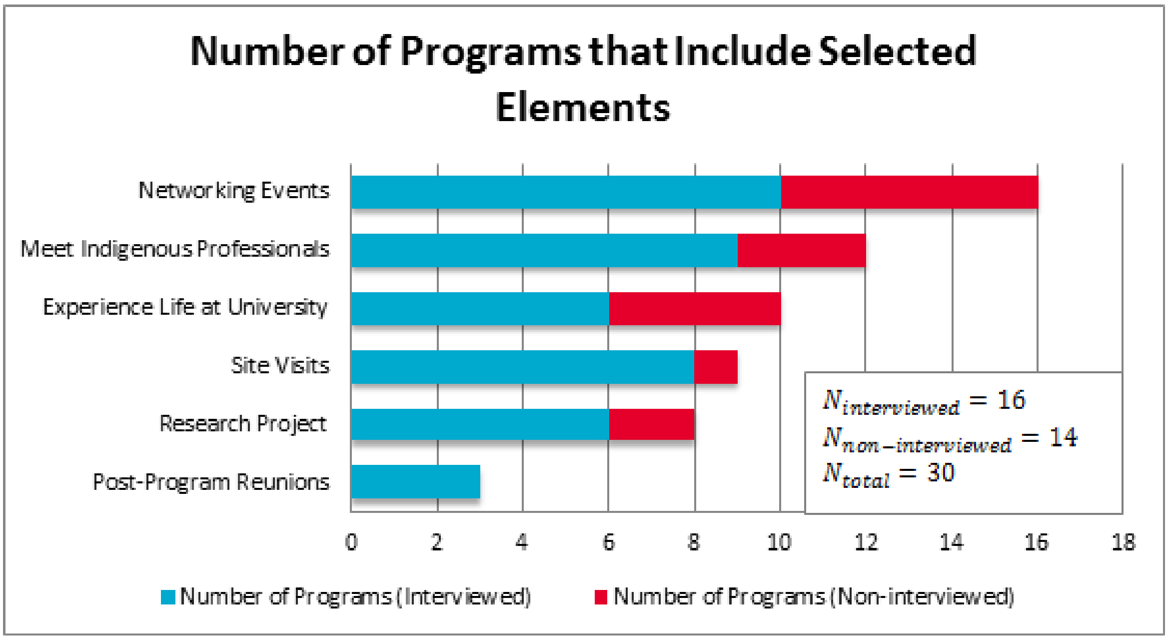

Figure 4.1: Number of Programs with Selected Elements

Blue bars represent information from programs which were interviewed by the group, and red bars represent non-interviewed programs, for which the information was found on the internet.

Sixteen of thirty programs included networking events with professionals in a particular field, peer-aged mentors, or both. Networking events have an abundance of benefits, including creating support networks between the students. Many programs have events such as yarning circle discussions and trivia nights to help form bonds between the students and mentors. Professional networking also introduces various career paths and areas of research to students while also providing the connections to pursue them. Some programs invited professionals to speak to the student participants about how to meet the proper educational requirements for the students' careers, as a way to broaden the participants' perspectives of the wide range of career choices and give them an achievable career goal. Of the ten interviewed programs that conduct networking events, two specifically mentioned that the goal of networking was to build support for the program participants.

Twelve of twenty-one programs specifically for Indigenous students incorporated introductions to other Indigenous people. Some programs had Indigenous elders perform ceremonies, while others invited Indigenous professionals to discuss career pathways in STEM fields. Anita Lee Hong, the program director of the Indigenous Australian Science and Infrastructure Development (SID) Winter School[4] noted that, through interactions with cultural elders, students can learn beyond the scope of what is taught in secondary school and can have meaningful discussions of culture that serve to increase their own understanding of Indigenous culture (2016). Meeting with Indigenous professionals is also a highly valuable element, as it allows students to gain more insight about different fields of study and provides them with the requirements needed to pursue a career in a given field, while also increasing their confidence to actually obtain a career in that field.

Other common elements among the programs include experiencing university life, site visits, and research projects. Program directors recognise the importance of physically bringing students onto university campuses, manifested either through the students living on campus during a program or through students visiting campuses as a part of a program. Jacob Thomas, the director of the Strengthening Engagement and Achievement in Mathematics and

[4] The Indigenous Australian Science and Infrastructure Development (SID) Winter School is a program for Year 10-11 Indigenous students run by the Queensland University of Technology in Queensland, Australia

Science (SEAMS) VCE Program[5], believes visiting the campus makes the concept of attending university seem more realistic to students, especially when they get the chance to interact with current university students and understand what life at university is like (2016). Many site visits, whether to university campuses or corporate locations, include some sort of interaction with individuals connected to the sites. Hearing directly about professionals' experiences augments the students' self-confidence and reinforces the belief that they too can attain these goals in their futures. The same ideology applies for research projects; Sue Sontgerath, the director of Camp Reach[6], mentioned that the feeling of accomplishment student participants felt upon the completion of their research projects left them with a higher sense of self-confidence, proving to be a valuable contribution of her program (2016).

[5] The Strengthening Engagement and Achievement in Mathematics and Science (SEAMS) VCE Program is a program for underrepresented Year 11-12 students at Monash University in Victoria, Australia. All mentions of SEAMS will refer to the VCE program and not the Engaging Youth program, which are separated because of aims of the programs differ.

[6] Camp Reach is a summer camp for Year 6 girls run by Worcester Polytechnic Institute in Massachusetts, United States of America.

4.1.2 Common Program Aims

In compiling the data gathered from programs for underrepresented populations, it was found that many of these programs shared similar overarching aims for their programs, as shown in Figure 4.3.

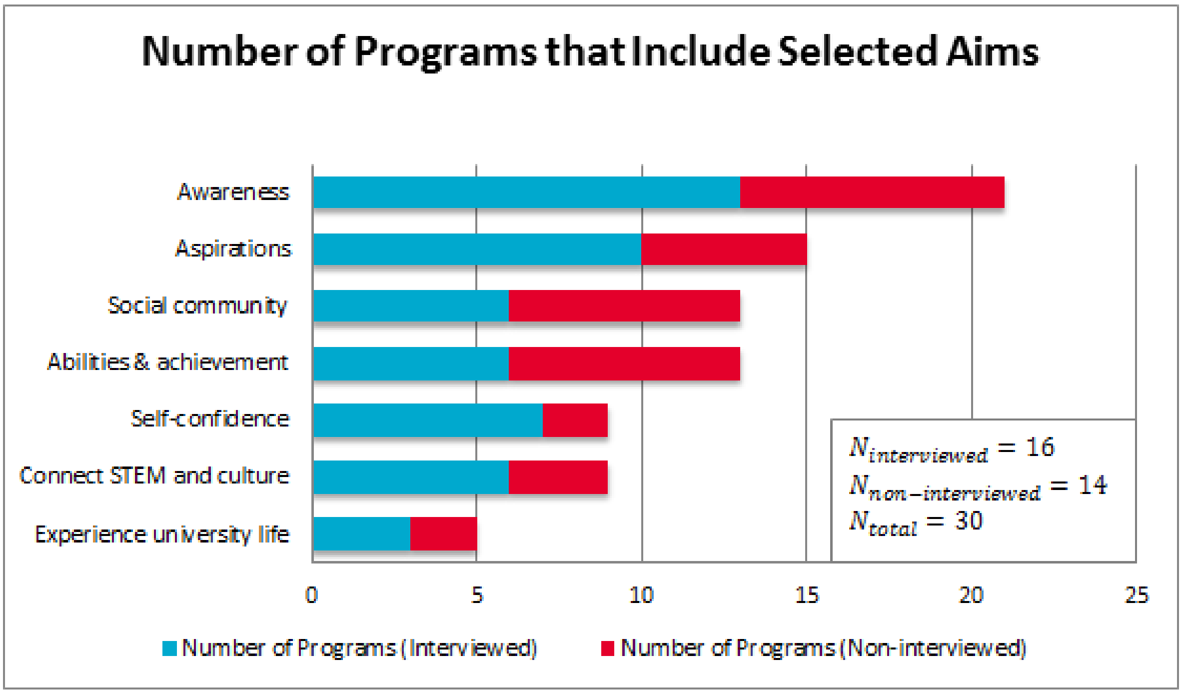

Figure 4.2: Number of Programs Including Selected Aims

Blue bars represent information from programs camps which were interviewed by the group, and red bars represent non-interviewed programs, for which the information was found on the internet.

Twenty-one of thirty programs sought to make student participants more *aware* of opportunities in STEM fields and expressions of culture. Many of these programs focused on educating the students about how to apply to university and the various fields of study that universities have to offer. Many programs had a broad definition of “opportunity,” educating the participants about more than only university opportunities, such as learning a trade or joining the armed forces. Indigenous Australian SID Winter School director, Anita Lee Hong, mentioned that university often seems unattainable for underrepresented students, which is why her program is designed to inform the students regarding other career options, such as obtaining apprenticeships. Other programs, such as the Victorian Indigenous Engineering

Winter School[7] (VIEWS), show students the variety of university options that are available; the twenty-one programs all seek to increase student awareness of the options that are available after secondary school. The programs which incorporate this aim seek to address the issue of underrepresented students lacking the understanding of pathways to university and STEM careers, which indirectly lead to lower rates of representation. In addition, many programs recognise that some students, particularly those with Indigenous heritage, often have widely varying levels of knowledge about their Indigenous culture. In attempting to ameliorate this, many camps seek to provide students with increased understanding of their cultures, the foundational beliefs of those cultures, and their means of expression.

Fourteen of thirty programs aimed to heighten student STEM career *aspirations*. In addition to increasing student understanding of STEM professions, many programs aim to increase student *desire* to pursue a STEM career. Programs achieve this aim through having students conduct experiments and visit laboratories, job sites, and companies. Often, the students have the chance to speak with STEM professionals to further student aspiration. Tim Keely, of the Curtin University Indigenous Australian Engineering Summer School[8], reflected on how inspired the students felt after hearing a guest speaker (2016). By increasing aspirations to pursue STEM careers, it becomes more likely that students will actually obtain careers in STEM.

Thirteen of thirty programs sought to develop student *abilities* in specialised fields. Though specific to each program, these thirteen programs sought to enable students with certain skills, typically being the topics of STEM or culture. In addition to making students aware of STEM careers and fields of study, some programs aim to make students *capable* of succeeding in the sciences they are interested in, by preparing their students with the skills to do so. In working towards this aim, sponsoring organisations intend to increase student participant

[7] The Victorian Indigenous Engineering Winter School (VIEWS) is a collaborative program for Year 11-12 Indigenous students run by four Melburnian universities: Melbourne University, Monash University, RMIT University, and Swinburne University in Victoria, Australia.

[8] The Indigenous Australian Engineering Summer School (IAESS) is a program for Year 9 and 10 Indigenous students funded by Engineering Aid Australia. One program is run at each Curtin University (interviewed) and the University of Sydney (not-interviewed), located in Western Australia, Australia and New South Wales, Australia, respectively.

performance in school subjects and fields, and thus increase their ability to succeed in further pursuit of these fields as a result. Programs also seek to enable students with skills to express their culture, aiming to make students active in their involvement with their cultural identity. These programs prepare students to use the cultural skills learned in the programs in their own lives. Programs such as the Tundra Science and Culture Camp[9] teach students various science skills while also incorporating cultural significance with each activity. Otherwise, programs seek to teach other skills, such as leadership in the Sacred Circle[10] program, or teamwork in the Hands-on Monash Program[11].

Thirteen of thirty programs sought to aid the development of a *social community* of like-minded STEM Students. These programs are designed for the formation of a social community among the underrepresented cohort of students interested in STEM which the programs target. A "social community" (as previously discussed in Section 2.2) can be defined as a gathering of people with similar backgrounds and experiences, wherein participants can help each other grow through their shared perspectives (Mondisa & McComb, 2015). This relates to the idea of the "collective identity," of a group sharing common characteristics and values, fostering a sense of belonging and pride in an inclusive cultural community (Whitesell et al., 2006). A program can set up the framework for students to have interactions with both STEM peers, as well as older cultural mentors in STEM university study and professional fields. In doing so, programs seek to develop an interconnected network of support for students on a pathway to STEM careers.

Nine of thirty programs aimed to increase student *self-confidence* in cultural identity and STEM ability. A significant barrier addressed by the programs studied in this project is the lack of self-confidence exhibited in underrepresented students with regard to their ability to succeed as STEM university students and professionals. To aid students in their belief in their ability to succeed as science professionals and members of underrepresented groups, these programs encourage students to have pride in their identity and their skills in science, both

[9] The Tundra Science and Culture Camp is a camp primarily for Indigenous Year 10 students run by the Government of the Northwest Territories in Northwest Territories, Canada.
[10] Sacred Circle is a program for secondary school students run by the Me to We philanthropic organisation in Ontario, Canada.
[11] Hands on Monash is a program for Year 10-12 students run by Monash University in Victoria, Australia.

of which can be social barriers for underrepresented students interested in STEM careers. It has been found that there is a very strong link between high levels of self-worth and academic success (Whitesell et al., 2009), which is why increasing participants' self-confidence is so important an aspect to include in a program. Many programs, such as the Gaalee'ya STEM Project and Indigenous Australian SID Winter School, will facilitate cultural discussions with elders and the students that help to foster a sense of pride in their culture. It is also important for programs to increase self-confidence in STEM abilities; Sue Sontgerath of Camp Reach mentioned that, often, people considering pursuing STEM fields have little faith in their own abilities, which deters them altogether.

4.1.3 Common Indicators

Several indicators of success were commonly identified as being important for measuring a program's success. In this section, only the 16 programs which were personally contacted were considered, as evaluation materials for the remaining 14 programs were not publically available Figure 4.4 shows the distribution of common indicators of success among programs.

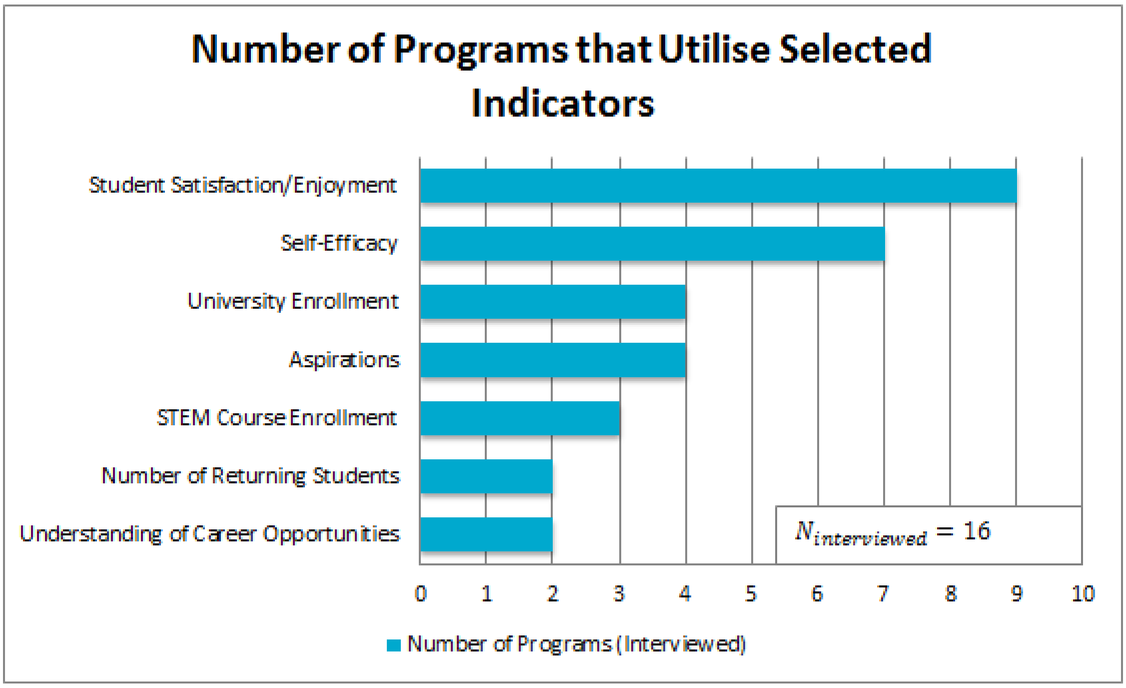

Figure 4.3: Number of Programs Using Selected Indicators

Seven of the sixteen program directors interviewed explicitly stated that they found it important to examine the self-efficacy of the program's participants. Self-efficacy refers to the self-perceived notion that one has the ability to control his or her life and achieve what s/he sets out to do. Self-efficacy is an important idea to consider when assessing programs designed to increase the prospects of students' success in a field because it indicates personal belief in one's capacity to attain the goals set before a person. The seven program directors all mentioned that their programs are designed to provide their participants with a stronger sense of self-efficacy; they also noted that increased student participant self-efficacy levels would show that a student would be more confident in applying for university or a STEM job, and thus increase their potential for success in a STEM field. Therefore, the program's success could be partially assessed by measuring the improvement in levels of self-efficacy among the program's participants.

Student participant satisfaction and enjoyment were examined by over half of the programs whose directors were interviewed. Nine of the sixteen program directors explicitly stated that measuring the participants' overall enjoyment of their program was important; several other directors alluded to such a situation, but did not definitively state so. Ultimately, general consensus among directors of these programs was that, if students had a positive experience during the program, then they would be more enthusiastic about further pursuit of STEM fields. One program director added to this notion, mentioning that often a single negative experience is sufficient to drive someone away from pursuing STEM fields. Measuring participant enjoyment does not serve as a direct measure of STEM or cultural growth, but nonetheless can provide valuable feedback to the program directors that can lead to beneficial modifications to the program. Tim Keely, the director of the Indigenous Australian Engineering Summer School (IAESS) at Curtin University, mentioned that if an activity of IAESS is rated poorly by students, the activity will be replaced with another which could potentially be more enjoyable for students. Thus, student feedback regarding overall enjoyment directly affects future offerings of the program.

Several other indicators were used by small numbers of other programs. One indicator used by some programs was the number of students that enrol in university following the completion of the program; other program directors observed the secondary school and university course selections of participants after the completion of the program. Both of these indicators are long-term indicators that can be used to understand the impacts of a program on student aspirations.

Some indicators were specific to the nature and aims of certain programs. Programs that include significant cultural elements, such as Trent Aboriginal Cultural Knowledge and Science (TRACKS) Youth Program[12] and the Curtin University IAESS program, use the achievement of increased knowledge of culture as an indicator of the programs' success. TRACKS and IAESS also allow participants to attend the program multiple times, which led to the use of the number of repeat enrolments as an indicator of the programs' success.

4.1.4 Common Means of Evaluation

Common tools for the evaluation of education programs were identified for use in examining the success of the ASSETS program. Much like indicators of success, the information considered in this section only considers those 16 program directors who engaged in communication, since most evaluation materials are not publicly available. Figure 4.5 shows some of these common means of evaluation.

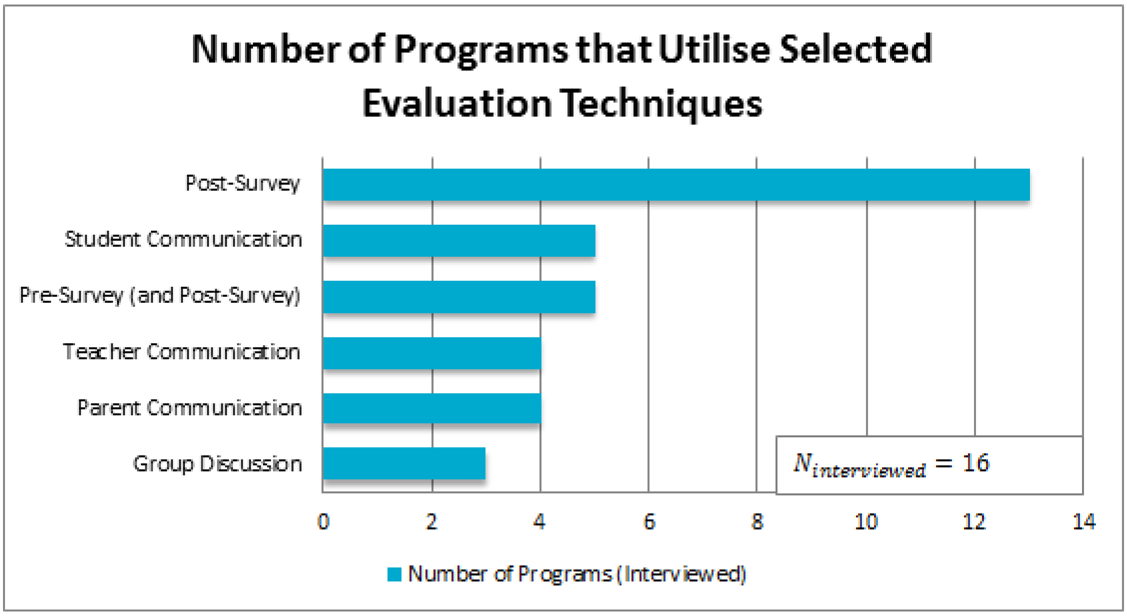

Figure 4.4: Number of Programs Using Selected Evaluative Techniques

[12] The Trent Aboriginal Cultural Knowledge and Science (TRACKS) Youth Program is a program for students aged 6-18 at Trent University in Ontario, Canada

The use of post-surveys was one of the most predominant evaluation methods. Thirteen of the interviewed program directors indicated that they used some form of post-survey to evaluate their program. Based on the sample surveys provided to us by several program directors, the post-surveys used by these programs also tended to be similar in terms of the survey's format and questions asked. For example, the surveys provided by the directors of the Emerging Aboriginal Scholar Summer Camp (EASSC)[13], Camp Reach, and Hands-on Otago[14] asked the participants to rate the quality of different activities, as well as their overall satisfaction of the program. Although the content being measured by the surveys differed among programs (enjoyment, aspirations, self-efficacy, etc.), nearly every survey for student participants used a form of Likert scale, a scale that allows respondents to rate their levels of agreement with a given statement, as a means of assessment.

Five of the sixteen program directors contacted implemented both pre-surveys and post-surveys. Typically, the programs that implemented this strategy used the same (or very similar) questions on both surveys to measure change over the duration of the program, such as change in levels of self-efficacy or change in understanding of STEM careers. For example, part of the survey from the SID Winter School, shown in Figure 4.6, displays the various questions used to measure growth between the beginning and the end of the program.

[13] The Emerging Aboriginal Scholar Summer Camp (EASSC) is a program for Year 10-11 Indigenous Canadian students run by University of British Columbia in British Columbia, Canada.
[14] Hands-on Otago is a program for Year 12-13 students run by the University of Otago in Otago, New Zealand.

We want to know what you are currently thinking about your future. Please answer the questions honestly. There are no right or wrong answers.

PLEASE TICK YOUR RESPONSE TO EACH STATEMENT

	Strongly Agree	Agree	Not sure	Disagree	Strongly Disagree
I am interested in going to uni in the future	☐	☐	☐	☐	☐
I am interested in going to TAFE in the future	☐	☐	☐	☐	☐
I would like to work full time rather than study after leaving school	☐	☐	☐	☐	☐
I believe it's possible for me to go to uni	☐	☐	☐	☐	☐
I think I can afford to go to uni if I choose to do so	☐	☐	☐	☐	☐
There are a number of ways to get into uni, even without a high OP	☐	☐	☐	☐	☐
I have a clear idea of my future goals and plans	☐	☐	☐	☐	☐
I am motivated to do my best at school so I have more choices when I leave	☐	☐	☐	☐	☐

Figure 4.5: Part of the pre- and post-survey from the Australian Indigenous SID Winter School

Anita Lee Hong, the director of the SID Winter School, indicated that this surveying strategy allows the program's staff to observe the immediate impact of the program on the participants.

Communication with teachers of student participants after the program was conducted by 4 of the 16 programs. Directors of programs that implement this strategy, such as Robyn Smith and Kristeen McTavish from the TRACKS Youth Program, indicated that this strategy is useful because teachers spend a lot of time with the student participants, and can observe and report on any changes in the child's behaviour brought about by the program. The means of contacting teachers varied from program to program; the SID Winter School used a formal questionnaire for teachers to complete, while TRACKS uses a written evaluation after their workshops to be submitted by email.

Parents were contacted to assess the impact of the program on their children in 4 out of 16 programs. Camp Reach, the SID Winter School, TRACKS, and the Tundra Science and Culture Camp all contact parents of the student participants through various media, including email and telephone. The motivation for the use of this evaluation strategy is similar to that of contacting teachers, as parents spend a significant amount of time with their children and can comment on any significant changes in attitude or behaviour attributed to participation the program.

4.2 Comparison of Differing Program Approaches

As programs were researched, it became apparent that there were fundamental differences between them. Other programs incorporated features shared with no others. The details of differing approaches have value and required further discussion, as explained in the following section.

Programs included unique elements to reinforce the impacts a program has had on participants. Programs such as Ah Neen Dush[15] and the Residential Indigenous Science Experience (RISE)[16] program provide the teacher and student participants with journals for daily reflection. For RISE in particular, the students are encouraged to write about the surprises, enjoyable experiences, and the questions they had throughout the day. These journals are kept confidentially, and then mailed back to the students about six months after the program to help refresh and reinforce the feelings they had during the program.

Programs included unique indicators and evaluative measures that are specific to individual programs. For example, an indicator of the Gaalee'ya program's success was the number of villages that sent students to participate in the program, a quantity that was not examined in any other programs investigated. TRACKS implemented an evaluative strategy known as the "Head, Heart, and Hands" model; at the end of each day, students engage in group discussions of what they learned during their day (head), how they felt about learning such information (heart), and what they planned to do with this newfound information (hands). This model is particularly interesting as it is a specific example of a non-written, discussion-based evaluation.

[15] Ah Neen Dush is a program for teachers of STEM for Indigenous American students run by University of Minnesota in Minnesota, United States.

[16] Residential Indigenous Science Experience (RISE) is program for Year 9-10 students run by University of Melbourne's Murrup Barak Institute and the GTAC philanthropic organisation in Victoria, Australia.

Some programs targeted students who already excelled in STEM, while others intentionally did not. Some programs, like the ASSETS program, draw their student participants from schools and teachers which have identified these students as “excelling” in science and maths subjects during secondary school. These programs attract students who have demonstrated ability in these subjects, and focus on further augmenting these abilities to encourage the pursuit of STEM in university. Alternatively, some programs remain open to all participants from a certain demographic population, often focusing more on showcasing the various options for pursuing a STEM career, rather than emphasising university study in particular. This demonstrates a philosophical difference in the approaches of these types of programs regarding the introduction of STEM to a particular cohort of underrepresented youths. While some program directors view their programs as useful in introducing STEM to any student, others seek to focus on encouraging high-achieving secondary students to pursue university study in particular.

Networking with professionals is not always focused on a certain demographic group. In some programs, networking has a singular purpose of introducing students to professionals in designated fields. In other programs, networking has an additional purpose of introducing underrepresented students to successful mentors of the same demographic group. In programs opting to incorporate professionals who are ethnically similar to students, networking helps to increase student knowledge regarding future opportunities, as well as increase students’ self-confidence levels derived from seeing others like themselves who are successful in STEM fields. In contrast, networking with a generalised STEM professional constituent is sometimes used to fulfil the purpose of broadening student understanding of STEM careers, without incorporating an aspect tailored to the underrepresented population.

5 The Assessment Strategy

This section of the report consists of a collection of the best practices in program evaluation for typical STEM and culture program for Indigenous students, which could be altered to serve other underrepresented populations. The largely common categories of aims discussed in Section 4.1.2 formed a basic set of aims that a typical STEM and culture program focusing on underrepresented youths could seek to achieve through its actions. The identification of these core aims allowed for a simplified understanding of this kind of program, and allowed the creation of this *Assessment Strategy* for a program exhibiting these aims, restated in Figure 5.1.

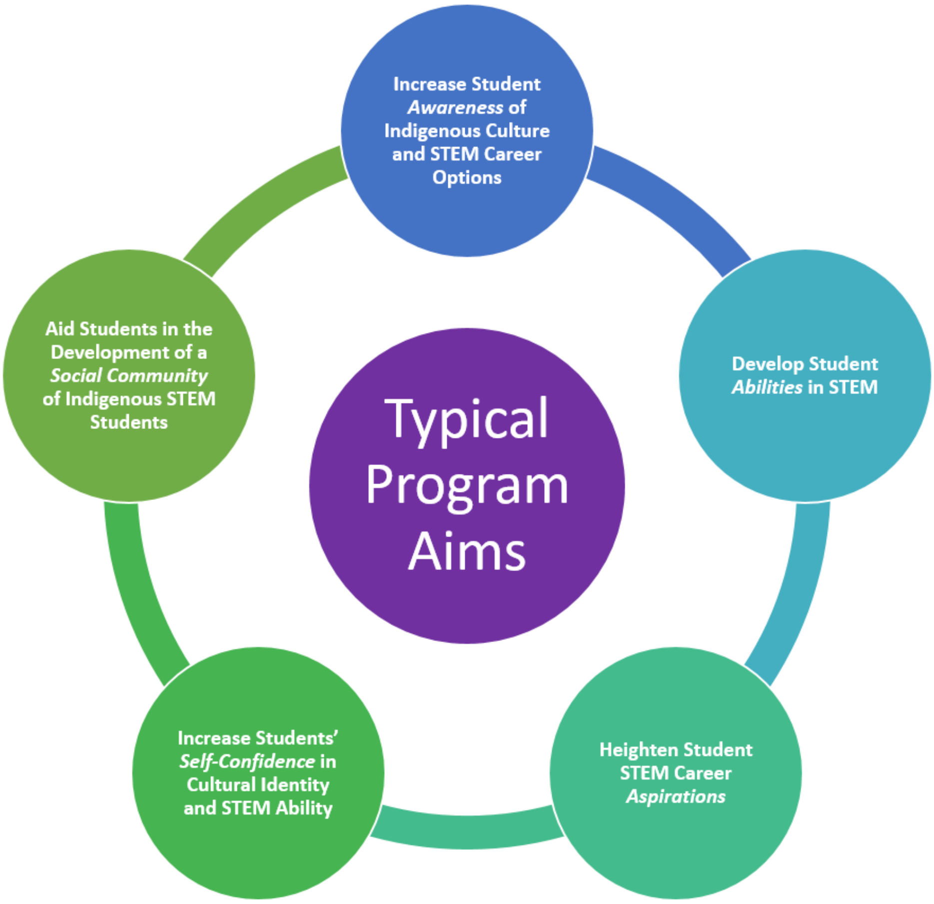

Figure 5.1: Generalised aims among STEM and culture programs

This plan for evaluation incorporates multiple distinct surveys, which incorporate questions to assess the aforementioned aims. These surveys include

- a pre-survey for students at the beginning of the program;
- a post-survey for students at the end of the program;

- a longitudinal survey for the students, administered a significant amount of time following the completion of the program;
- a survey for the students' parents following their child's acceptance to the program;
- a longitudinal survey for the students' parents, administered a significant amount of time following the completion of the program.

The recommended surveys have two main question types: questions that are open ended, and questions that use a Likert scale. Other means of evaluation are also advised, such as knowledge of academic performance and assessment through group discussion. A sample set of survey questions has been created and is included in Appendix D.

Three student surveys were chosen to allow a program's directors and its funding partners to examine and compare the short and long term effects of the program. The two surveys for the parents of students will provide a program's directors with the added perspective of those who can notice the change in their child. The pre-survey for parents is not only to gain a baseline for their responses but also prompt the parents to be aware of the change the program may have affected.

It is advised that the timing of longitudinal assessments is determined according to features of a particular program, including the age of students, time of year of program offering, and desired outcomes. For example, the SID Winter School implements a longitudinal survey three months after the completion of the program, as the directors determined this is a sufficient amount of time to assess whether the program had a long-term impact on its student participants. Alternatively, Camp Reach longitudinally evaluates participants six years after the completion of the program, in order to examine students directly after they graduate secondary school. Most importantly, when choosing a time for longitudinal evaluation, one must know when students will be available to be re-evaluated, and accordingly one should avoid conducting such research during school testing periods. Evaluation consultant Paula Quinn suggested that for many programs, a longitudinal evaluation between 6 and 12 months after the program is appropriate; within this timeframe, the impact of the program should still be relevant, and the number of other impacting factors should be minimal (Quinn, 2016b).

One particularly common tool used in surveys to assess change in levels of certain indicators is the Likert scale, which is used widely in this *Assessment Strategy*. A Likert scale is often used in evaluation because it allows for the measurement of both the polarity and strength of a participant's feeling with regards to a response (Petty and Krosnick, 1995). Likert scales typically contain a cluster of related statements that ask the respondent to rate his or her level of agreement and are carried out using multi-point scales ranging from "Strongly Disagree" to "Strongly Agree." Research has shown that the optimal number of selection points to use in a Likert scale is 5 points, as the quality of results often declines with more options (Revilla, Saris, and Krosnick, 2014). The scales can be evaluated by assigning a number to each point on the scale (e.g., on a 5 point scale, "Strongly Disagree" would correspond to 1 and "Strongly Agree" would correspond to 5). The numerical values can be summed for each cluster, and if the sum changes significantly between surveys, it can be concluded that the respondent's attitude has changed.

Another common tool in evaluation strategies is the use of filter questions. Filter questions can be used to check the validity of survey responses; if a respondent answers filter questions incorrectly, it is likely he or she is devoting minimal attention to the survey. This type of question can be implemented in a variety of ways, such as including a question that is not relevant to the survey topic or utilising a question with reversed wording (Smith, 2013b). For example, if a respondent answers "Strongly Agree" to both "Science is an important subject" and "Science is not an important subject," his or her survey responses cannot be considered valid. It is advised that programs consider including filter questions to improve validity among survey responses.

5.1 Increasing Student Awareness of Indigenous Culture and STEM Career Options

The variety of program and research based approaches to addressing this aim is shown in Figure 5.2.

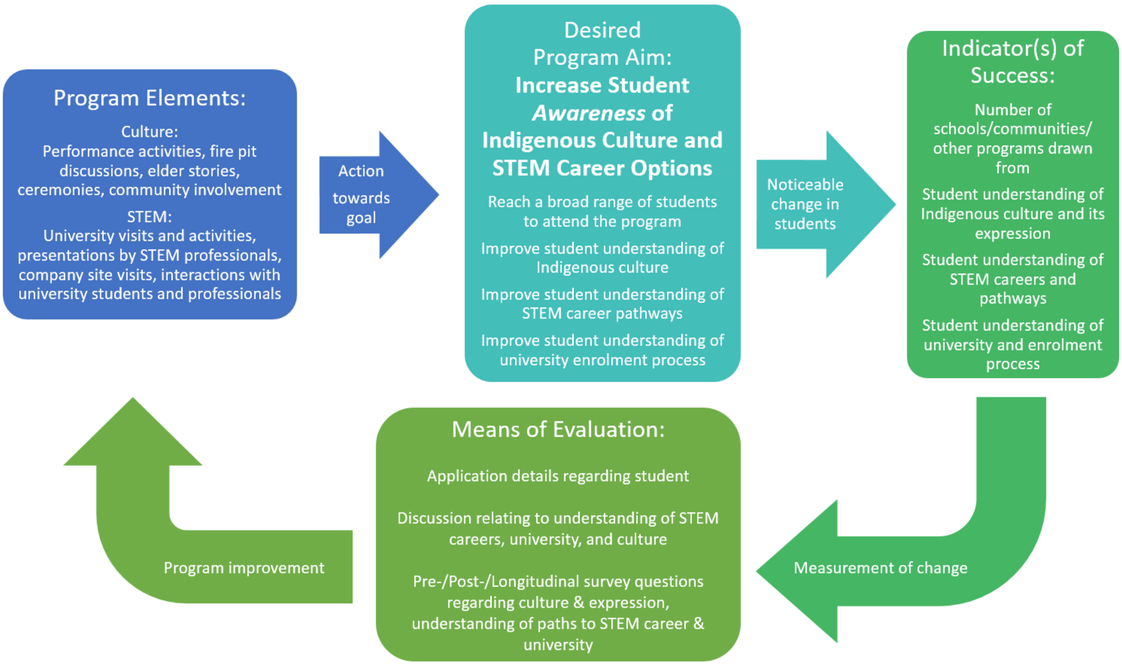

Figure 5.2: *Aim-Outcome Model* for *Awareness* aim

Suggestions for the evaluation of this aim are as follows.

Indicators:

To determine if a program has attained its aim of increasing student participants' awareness of their Indigenous culture and STEM career options, the participants' understandings of these factors can be examined. If a student's understanding of his or her culture has increased over the duration of the program, then it can be said that his or her awareness of culture has increased; similarly, if a student has a better understanding STEM career pathways by the time the program is completed, his or her awareness of STEM career options has increased. The number of communities and other programs which a program draws from can also be used to show the scope of impact a program has on its target community, as used by programs like the Gaalee'ya STEM project.

Means of Evaluation:

Increased awareness of STEM career options and Indigenous culture could be assessed through questions on the pre-, post-, and longitudinal surveys for students. These questions are suggested to consist of both Likert scale questions to quantitatively measure change in understanding, and open-ended questions to probe deeper into student understanding of STEM careers and culture. In order to gather information about the communities students are from, logistical questions can be incorporated into a pre-survey for the program. Additionally, structured group discussions can be used to measure changes in understanding.

Likert scale questions are included to allow for a quantifiable comparison of students' levels of cultural and STEM understanding both directly after the program and substantial time in the future. For example, a statement like "I know where to find information about careers that interest me" allows for measurement of how aware a student is of career options. Data from the three responses can then be analysed to determine if a program has had both short-term and long-term impacts on the participants. Several programs have used similar strategies to assess awareness, and have been successful in doing so. The Wingara Mura and Bunga Barrabugu[17] programs use questions to assess student agreement with statements such as "I know where to find information about careers," and has measured definitive increases in awareness of career opportunities. By using a Likert scale question, it becomes possible to gauge if, and how much more, the student participants became aware of their culture and career options during a program. Sample questions 1-5, and 22 in Appendix D can be used to assess awareness with a Likert scale.

The open-ended responses allow students to provide more depth into their understanding of culture and careers; these responses can be critically analysed by the program organisers to determine the extent to which the student is actually aware of these aspects. Open-ended questions are useful because they allow students to elaborate in their response, whereas multiple-choice responses require a concrete answer. However, a disadvantage of including open-ended questions is that, compared to multiple-choice questions, they require considerably more time and effort to evaluate, as each response must be read and interpreted by trained staff. Sample question 23 (building off of question 22) is an example of this kind of open-ended question.

Because understanding of culture and career options can be hard to quantify, holistic discussions can also be included in the assessment of awareness. Group discussions and focus groups can be included for this purpose, and parallel the Head, Heart, and Hands model

[17] The Wingara Mura and Bunga Barrabugu programs are programs aimed for Years 9-10 and Years 11-12, respectively, run by the University of Sydney in New South Wales, Australia.

mentioned earlier. This model focuses on having participants draw connections from the topics covered at the program to themselves, and emphasises development of a firm understanding of the topics. The leaders of these discussions can guide conversation to both culture and STEM topics, and can note important characteristics of the discussion, with student consent. Such noteworthy points may include how many students participated in the discussion, the extent to which students were engaged with the discussion, and the accuracy of student understanding of topics. Education evaluator for the Gaalee'ya STEM Project, kas aruskevich, mentioned that due to the abstract nature of culture, holistic methods of evaluation are often more appropriate. A rubric created by the Association of American Colleges and Universities suggests that cultural awareness can be measured based upon the behaviour of students. For example, a student who asks complex questions about culture and demonstrates an understanding of the values, beliefs, and practices of any given culture can be considered culturally aware (Rhodes, 2010). For these reasons, observing a structured group discussion is critical to assessing cultural and career awareness. By combining both numerical and holistic means of evaluation, it is possible to measure students' awareness of STEM careers and Indigenous culture.

5.2 Developing Student Abilities in STEM

The variety of program and research based approaches to addressing this aim is shown in Figure 5.3.

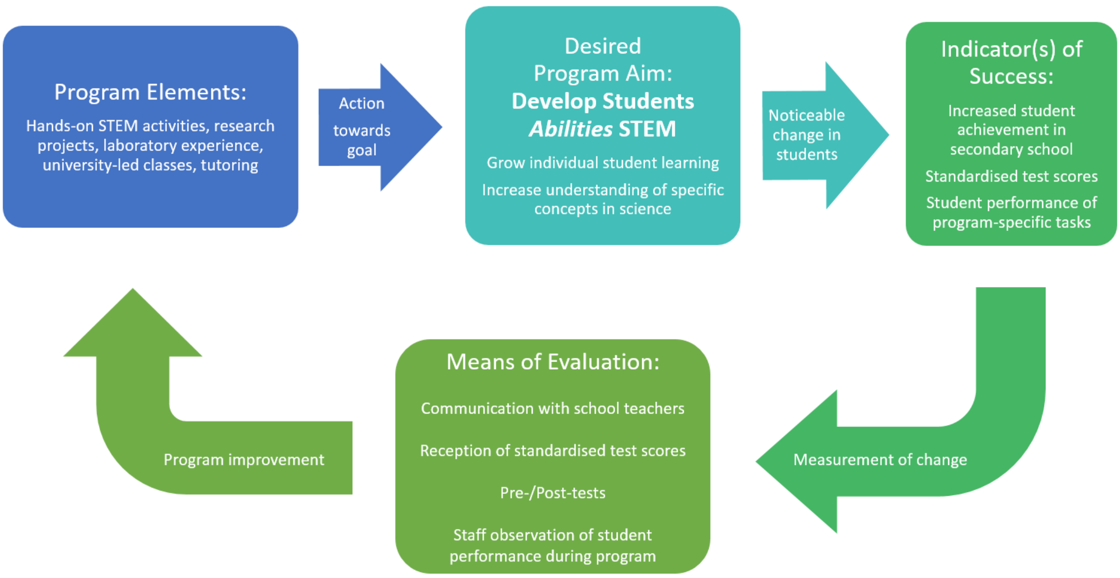

Figure 5.3: *Aim-Outcome Model* for *Abilities* aim

Suggestions for the evaluation of this aim are as follows.

Indicators:

Key indicators for assessing change in student STEM abilities are student performance on testable program components and student success on secondary school STEM exams. Student engagement with program material can be used to show that a student grasps the teachings of the program, indicating that student capabilities have been enhanced during the program.

Measures of Success:

A direct method to evaluate students' ability in STEM is to incorporate testable concepts into the program and assess knowledge of these elements using surveys (Quinn, 2016b). An example of a testable concept could be having the students focus on refining their understanding the scientific method throughout the program. On the pre-, post-, and longitudinal surveys, a relevant open-ended question can be included. For example, in a program designed to educate participants about the operation of solar panels, a question like "Explain how a solar panel converts sunlight to electricity" would be worthwhile to ask. An evaluator from the program can then judge these responses to determine the level of competency a student displays with regards to the testable concept. An increase in knowledge of the topic between the start and end of the program suggests that the program is accomplishing its goal of increasing student abilities in STEM. Sample question 27, in Appendix D, is an additional example of this type of question.

An example of a testable element would be for programs that include student presentations as part of the program, such as Camp Reach or ASSETS. A representative of the sponsor and/or funding organisation could attend the final presentations to observe and evaluate student performance and understanding of STEM concepts. If these stakeholders are unavailable to attend the presentation, the presentation could be recorded and delivered to the stakeholders. In viewing these presentations, stakeholders will have the opportunity to observe what the students learned through the program. This can be achieved through a more interactive method, in which a panel of judges is assembled to score the students' presentations according to a set of criteria agreed upon by the program directors and stakeholders (Quinn, 2016b). The judging panel could consist of people with expertise and experience relative to the intended outcomes of the project, such as college professors, STEM professionals, or representatives from the funding party. In such a way, the professional participants of the program could interact further with students in the program.

Instead of testing students on these concepts at the end of the program, the program staff could also observe the students' growth and engagement during the program. Through staff observation, it is possible to accurately determine the extent to which students understand the material covered. It is recommended that when using this form of evaluation, staff members can monitor specific areas of student activity, such as the extent to which students seek a deeper understanding of the topic being taught, in addition to discussions between students on the material covered (Fermilab, 2005). While staff observation can provide a much better understanding of student ability that the assessment of survey questions, observation requires that staff have some training in evaluating students.

If a program is specifically designed to increase student scores on a particular standardised exam, then student performance on those tests is a valid indicator of the success of the program at enhancing STEM abilities. For example, SEAMS is designed to help students prepare for the ATAR[18]; therefore, student scores on the ATAR can be used to determine if SEAMS successfully prepared students for the test.

[18] ATAR or the Australian Tertiary Admission Rank is Australia's standardised test for secondary school students seeking to attend university, excepting those in Queensland. The scores, percentiles rankings ranging from 0-99.95 are used to compare students when application to university (University of Western Australia, 2014).

5.3 Heightening Student STEM Career Aspirations

The variety of program and research based approaches to addressing this aim is shown in Figure 5.4.

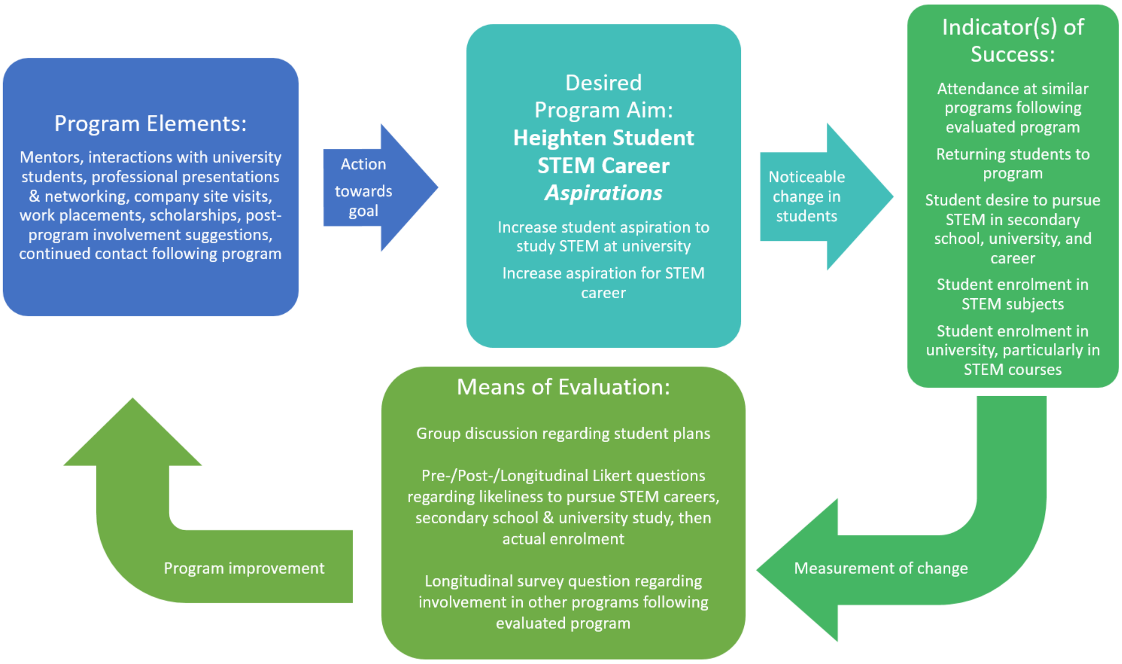

Figure 5.4: *Aim-Outcome Model* for *Aspirations* aim

Suggestions for the evaluation of this aim are as follows.

Indicators:

Since many of the programs were designed for secondary school students, focus was placed upon student pursuit of tertiary school and careers, as befits this age group. To assess whether or not a program heightened a student's STEM career aspirations, three key indicators can be measured when applicable:

- desire to enrol in STEM classes after the program,
- desire to enrol in university, and
- desire to attend other programs following the program.

If, after the program, students express a desire to pursue more STEM opportunities, then it can be concluded that their aspirations have been heightened.

Means of Evaluation:

The most direct method to evaluate student aspirations is to ask a direct Likert scale question on the post- and longitudinal student surveys about the impact the program had on the student's aspirations. Less directly, the three student surveys could contain Likert scale questions regarding ideas such as what career field the students predict they will have in the future, to gauge student interest in university and STEM careers, as both the SEAMS and the SID Winter School programs do. Additionally, student desires for the near future can be measured by a pre- and post-survey Likert scale question gauging their desire to study STEM in secondary and tertiary school; this can be followed by an open-ended longitudinal question which allows students to report what they actually studied. Questions such as 11-13 and 24-26 in Appendix D can be used to evaluate aspirations these ways. For programs that choose to have longitudinal surveys that occur a significant time after the completion of the program, forming questions around student participation in other STEM programs would show sustained aspiration following the camp. Discussions could also be used to replace the aforementioned survey questions, where staff members can facilitate conversation and learn about students' intended future plans.

In addition to asking students to describe their future plans, questions can be included that ask students to describe the STEM experiences they have already had. For example, students can be asked if they have attended other STEM programs; students that have attended a multitude of STEM programs can be shown to have high STEM career aspirations. Programs that allow students to attend multiple times can also ask students on surveys if they have attended the program before or plan on attending the program again; answering yes to either of these questions can be used to indicate high student aspiration.

5.4 Increasing Students' Self-Confidence in Cultural Identity and STEM Ability

The variety of program and research based approaches to addressing this aim is shown in Figure 5.5.

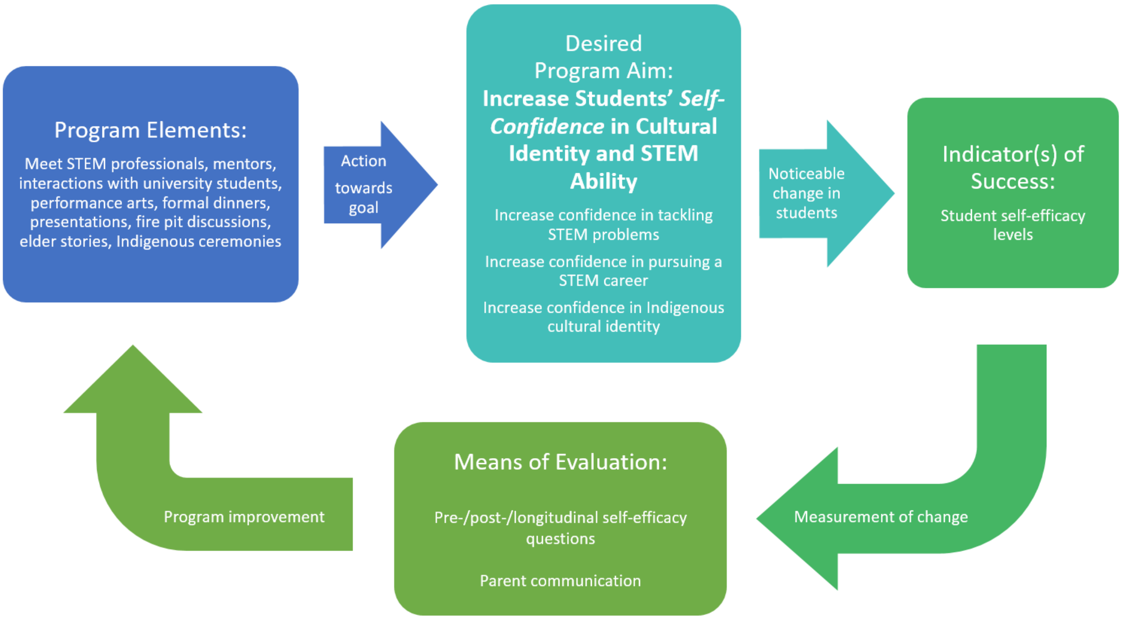

Figure 5.5: *Aim-Outcome Model* for *Self-Confidence* aim

Suggestions for the evaluation of this aim are as follows.

Indicators:

To determine if a program has attained its aim of increasing student participants' self-confidence in their STEM and cultural identities, changes in their levels of self-efficacy could be observed. To reiterate, self-efficacy is the self-perceived notion that one has the ability to control his or her life and achieve what he or she sets out to do. As discussed earlier, six directors of programs that have the goal of increasing student levels of self-confidence have used self-efficacy as an indicator of success.

Means of Evaluation:

In order to measure self-efficacy, students could be presented with the same survey questions on the pre-, post- and longitudinal surveys. The questions posed on these surveys can ask students to rate their level of agreement with a series of statements, such as "It is possible for someone like me to attain a STEM career"; each of these statements can be accompanied by a Likert scale ranging from "Strongly Disagree" to "Strongly Agree," to show varying levels of student agreement. From the responses to these questions, one will be able to directly observe and compare the short- and long- term effects of the program on levels of student self-efficacy. Sample questions 6-10 in Appendix D can be used to assess self-confidence using a Likert scale.

The use of a pre-survey and post-survey instead of a single survey at the end of the program is vital to accurately assessing change in student participants. Although many programs used a post-survey exclusively, it was determined that a single survey would be an inefficient way to measure change as a result of the program. Additionally, the use of both a pre-survey and post-survey is supported by the fact that, of the six programs that identified self-confidence as an indicator of success, four programs implemented this strategy.

It is also important to include a longitudinal means of evaluating the self-confidence of student participants, which will allow the program directors to observe the long-term effects of the program on its participants. These surveys should contain the same questions asked on the prior surveys, so that changes in response over time can be tracked.

Likert scales have been found to be valuable tools for assessing self-confidence; research suggests that a five-point scale should be used, as it allows for accurate measurements of varying levels of a person's self-confidence without presenting an excessive set of response options (Maurer and Andrews, 2000). Other programs, such as the Australian Indigenous SID Winter School and Camp Reach, utilise Likert scale statements to assess self-efficacy in their programs for similar reasons.

In order for the statements used to measure self-confidence to be effective, they must be carefully designed. Desirable statements are ones which are tailored to assessing self-efficacy in specific abilities (Bandura 2005). Therefore, the statements used to assess this aim should directly relate to factors such as a student's pursuit of further education, a STEM career, and cultural identity.

In addition to student surveys, parents could also complete two surveys regarding their child's self-confidence levels: one before or at the start of the program, and the other a reasonable amount of time after the end of the program. Optionally, a third survey could be distributed to parents as the program ends, but it is important to be mindful of survey fatigue. Asking for three surveys to be completed by the parents (who had no direct involvement with the program) may result in some survey fatigue (Fryrear, 2016). Professional education evaluator Jeanne Hubelbank stressed the importance of the triangulation of data, which refers to using more than one source of data to ensure an aim is being met (2016). As with the student surveys, the same questions should be used in each survey; however, the latter survey could also include an open-ended response that allows the parents to openly express how significantly the program impacted their child, should they choose to offer more information. In this way, by surveying both students and parents, the results become increasingly valid.

5.5 Aiding Students in the Development of a Social Community of Indigenous STEM Students

The variety of program and research based approaches to addressing this aim is shown in Figure 5.6.

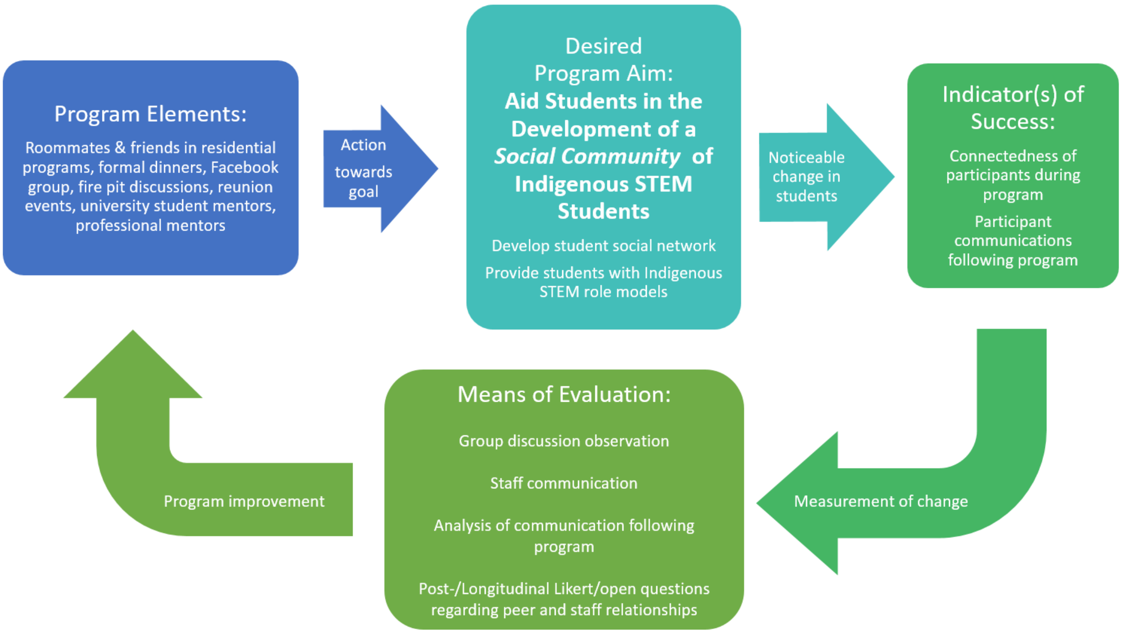

Figure 5.6: *Aim-Outcome Model* for *Social Community* aim

Suggestions for the evaluation of this aim are as follows.

Indicators:

To assess this aim, both student connectedness and interaction among program participants following the close of the program can be measured. These indicators can both be evaluated to determine how effective a program was at forming a social community among its student participants.

Means of Evaluation:

It became apparent through research that there is no general consensus on the proper means for evaluating a social community, as the presence of a sense of community is an abstract concept. However, one approach to evaluate the presence of a social community is to survey students directly regarding how connected they feel to their peers, a measure used by programs such as SEAMS and Camp Reach (Ministry of Social Development, 2010). Likert scale based questions could be included on the pre-, post-, and longitudinal surveys that ask students to indicate the level at which they feel supported by their peers. SEAMS and Camp Reach both use clusters of Likert scale statements concerning social activities to measure the impact the programs have had on student participants with respect to the formation of a social community. Sample questions 14-17 in Appendix D can be used to assess social community using a Likert scale. Additionally, students can be asked directly regarding their communication with program participants following the program in a longitudinal survey. Sample questions 18-21 can be used to measure social community in this way.

Open-ended survey responses could also be used to obtain information for evaluating a sense social community. Open-ended questions give students the opportunity to elaborate on their experiences and interactions with other students, which can be critically analysed to determine the effectiveness of the social community. Such questions could be asked on a questionnaire or through a phone interview (Quinn, 2016b).

In addition to using survey questions to measure student connectedness, student interactions with other program participants can be observed qualitatively through social group activities, such as a cultural discussion or networking event. These participants include not only the other students, but also the mentors, directors, presenters, and other camp staff. These participants can be asked to report on the extent to which they believe a social community was formed. Evaluator Paula Quinn stressed the value in this type of feedback, as testimonials from all program participants provide powerful insight about the effectiveness of the program that can be communicated to the audience of the evaluation (2016b). This strategy also aligns with the idea of the triangulation of data, mentioned by Jeanne Hubelbank; by obtaining input from multiple sources, confidence in the validity of the conclusions drawn from the data increases.

5.6 General Assessment Suggestions

Avoid asking unnecessary questions. A common downfall of evaluation is that too many questions are asked, which results in survey fatigue. Andrea Fryrear of Surveygizmo (the makers of a professional surveying suite) indicated that survey fatigue occurs when "surveys are too long and include questions that aren't applicable to the respondent," (2016), which often leads to the participant skipping questions or providing uninsightful answers. Fryrear also included suggestions to avoid survey fatigue, which should be considered when designing any survey for participants, including asking only questions that relate to the project goals, as well as communicating clearly how the information collected from the surveys will be used. When participants understand the impact their responses will have, they become more receptive to the survey (Fryrear, 2016).

Keep questions as straightforward as possible. Any question presented on a survey to participants should not be left open to interpretation, and determining how to properly respond to the question should not require extensive thought (Smith, 2013a). Amanda Baker of the ASSETS program reflected on a particular question that asked respondents to rate four aspects of each program activity, each with a numerical rating. She indicated that the question wasn't intuitive to answer and that many of the participants failed to answer the question properly. The question would also have taken a substantial amount of time to fill out correctly, which likely resulted in survey fatigue for some participants. Questions like these should be avoided and instead replaced with shorter, more straightforward questions; furthermore, questions can be pilot tested in advance to ensure the questions are unambiguous.

Avoid asking leading questions. There should not be an obvious desired response to a certain question, such that participants feel that they need to produce an answer which aligns with the sought outcomes of the question. For example, asking students "How has this program affected your self-confidence?" is quite different than asking those students to complete a Likert scale question relating to self-efficacy, like sample questions 6-10 in Appendix D. The first question suggests that the program *has* in fact had an impact on participants, while the second measures *if* an impact has been made. In assuring that no questions are unnecessarily linked to the program or are designed in such a way to assure positive responses, the quality and validity of assessment is increased.

Corresponding to each aim of a program should be specific elements acting towards that aim. Some programs sought to bring about change in students, but had no corresponding program activities to bring about such change. One example is the commonality of the "Increasing STEM Abilities" aim among programs which did not feature sufficient education to expect to see noticeable change in future student performance. Since the operations of a program are cyclic in nature, the re-evaluation of either program's elements or its aims is often needed to assure that a program is designed to reasonably affect change in participants.

Target the correct participant group for the correct kind of information. One must know which groups have the capacity to answer certain questions regarding a topic. As an example, it is likely not the case that a student's parents will have a valid grasp on their child's ability in STEM subjects, and thus parents cannot be expected to provide valid responses regarding a student's STEM abilities. It is important to draw data from multiple source groups in conducting evaluation, but different and appropriate data from each group in question should be sought. Similarly, one should make sure to ask the right kind of question to indicate the success of attaining an aim. In order to assess increases in student abilities, for example, one must measure student capability, and not students' *opinions* of their ability.

6 Conclusion & Recommendations

6.1 Summary

A variety of STEM and culture programs were identified and contacted to find trends among similar programs. The trends that were discovered were classified into: program elements, aims of programs, indicators of success and means of evaluation. The collected program information was compiled into the *Comparative Directory*, located in Appendix A which was used in combination with background research to develop the *Assessment Strategy*, located in Section 5 of this report.

The five most common aims among STEM and cultural programs are to

- increase student *awareness* of Indigenous culture and STEM career options,
- develop student *abilities* in STEM,
- heighten student STEM career *aspirations*,
- increase students' *self-confidence* in cultural identity and STEM ability, and
- aid students in the development of a *social community* of Indigenous STEM students.

Increasing student awareness of Indigenous culture and STEM career options can be assessed through surveys of student participants and through group discussion. Likert scale survey questions provide quantifiable measurements of change in levels of awareness, while open-ended survey questions and group discussions allow for a holistic approach for measuring awareness.

Developing student abilities in STEM can be assessed via achievement on testable program components, student STEM exam scores, and observed student presentations. Students can be asked to explain certain concepts that should have been learned in the programs through a post-survey question, while inquiry regarding their test scores can occur following the program. These two approaches contribute to quantitative assessment. Student presentations analysis is a more qualitative measure of assessment, but will allow for demonstrated confirmation of student understanding of STEM concepts.

Heightening student STEM career aspirations can be evaluated with questions for students on multiple surveys. Students can be asked to report the classes they plan to take, and later what classes they actually took. Additionally, students can be asked to report on their plans for after secondary school and many years later over the entire course of evaluation.

Increasing students' self-confidence in cultural identity and STEM ability can be assessed through multiple surveys of both the student participants and their parents. Survey questions using a Likert scale can be asked to student participants as they arrive at a given program, when the leave the summer school, and a reasonable amount of time after the completion of the program. Parents can be surveyed about their perceptions of their child's self-confidence before their child attends the program and a reasonable time afterward.

Aiding students in the development of a social community of Indigenous STEM students can be assessed via questions through multiple surveys of both student participants and other program participants. This section of a survey can combine Likert scale and open response type questions, and be administered to participants immediately after the program and 6 months after the program ends.

6.2 Limitations of Research

There only exist a small number of STEM and cultural programs that could be contacted. Across the United States, Canada, New Zealand, and Australia, only 30 such programs were identified; this small sample size was further reduced to 16 program directors who responded to the requests for an interview. Another subsequent limitation is that there were program directors who responded indicating that they were willing to provide input, but were unavailable for interview until after the project would be complete. When examining evaluation methods and indicators of success, the group of applicable programs grew smaller, due to some programs having no existing formal evaluation strategy. As a result, it was sometimes difficult to draw definitive conclusions from the small sample population of programs.

Research on evaluation methods is often inconclusive. Due to various factors (population size & age, topic in question, limited resources, etc.), evaluation practices are dependent on the situation at hand. Thus, various sources of published evaluation research often contradict each other. In one study, it was found that phone interviews tend to have a high response rate when compared to the response rate of mailed surveys (Yu & Harris, 1983). However, another study found that mailed surveys tend to yield the highest response rate compared to any other surveying method (Thayer-Hart et al., 2010). Therefore, reaffirming claims proved to be difficult in the development of the Assessment Strategy due to the lack of consensus among professionals.

6.3 Recommendations

Several recommendations were developed to aid in ensuring the success of programs for underrepresented youth. The key recommendations for the directors of such programs are to maintain communication with directors of similar programs and to consult with an expert evaluator and to research best practices. These points were identified over the course of the research conducted in this project, and could allow the programs to better achieve its aims.

Program directors should keep in contact with the directors of similar programs. The directors of programs who were interviewed were largely enthusiastic about helping in the development of the *Assessment Strategy*. Several program directors indicated that the assessment strategies of their own programs needed improvements, and requested to see this report, including the completed *Assessment Strategy*. The program directors often viewed communication with the project team as a mutually beneficial process, and future collaboration among directors of programs could stand to benefit all parties involved in attaining the overarching goal of increasing the stake of underrepresented populations in STEM careers.

Program directors should consider consulting an evaluation expert. Many of the evaluation topics discussed, such as drawing conclusions from group discussions, require skill to evaluate effectively. Without the knowledge or experience to recognise key elements of these discussions, it’s likely that a significant amount of insight will be missed. Conference with an expert in the field of evaluation would ensure that a program’s evaluation is best suited for that particular program, benefitting from the evaluator’s specialised experience in the field.

In creating survey for assessment, it is advised that program directors consult online resources regarding best practices for survey-based evaluation. Surveying platforms like Qualtrics, Surveygizmo, and SurveyMonkey all provide such resources for survey design and analysis.

6.4 Conclusion

The results of this project can be applied to improve the evaluation processes of STEM and cultural summer camps. The *Aim-Outcome Model* provides a framework for understanding the interrelationships between program elements, aims, indicators, and evaluation methods. The *Comparative Directory* allows for direct comparisons between a variety of programs that are all similar and allows program directors to understand how their program fits into the global set of STEM and cultural programs. The *Assessment Strategy* presents a sample evaluation scheme for the most common aims identified among other programs, as well as the justification for each aim. Collectively, these tools can be implemented by program directors in Australia, Canada, New Zealand, and the United States to ensure that these programs are highly successful.

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Appendix A: Comparative Directory
Appendix A.i: Interviewed Programs

Program Name:	Contact Name:	Website:	Location:	Run by:	Type (STEM/Culture/Both):	Cost to Students:	Size:	Number of Applications:	Target Demographic:	Length of Program:	Residential:	Project Aims:
Aboriginal Summer School for Excellence in Technology and Science (ASSETS)	Amanda Baker	http://www.csiro.au/en/Education/Programs/Indigenous-STEM/ASSETS/About-ASSETS	Various locations, AUS	CSIRO Education and Outreach	Both	Free	105 Students	Around 100	Indigenus Students	9 days	Yes	Increase students self-confidence in cultural identitiy and STEM ability Heighten student STEM career aspirations Growth in individual student learning Understanding the science inquiry process Increase student apsirations to study STEM at university Increae aspirations for STEM career
Ah Neen Dush	Mia Dubosarsky	http://www.cehd.umn.edu/stem/research/AhNenDush/default.html	Minnesota, USA	University of Minnesota	Both	N/A	37 Teachers	N/A	Teachers of STEM for Indigenous students	3 years	No	Integration of science/math with Ojibwe culture/traditions Develop long term, sustainable programs for native teachers Make connections to family and community
Australian Indigenous Science and Infrastructure Development (SID) Winter School	Anita Lee Hong	https://www.qut.edu.au/about/oodgeroo/Indigenous-australian-science-and-infrastructure-development-winter-school	Queensland, AUS	Oodgeroo Unit at the Queensland University of Technology	STEM	N/A	25-30 Students	N/A	Indigenous Students	5 days	N/A	Explore a diverse range of post--secondary school careers and higher education activities Build higher education aspiration Encourage participants to recognize the value of and take responsibility for their own education Improved access and participation in higher education Indigenous students Equip participants with personal success tools (communication, motivation, respect...)
Camp Reach	Chrysanthe Demetry Sue Sontgerath	https://www.wpi.edu/academics/k12/camp-reach.html	Massachusetts, USA	Worcester Polytechnic Institute	Both	$1,295 USD	30 Students	60-70 Applicants	Women from Central Massachusetts	12 days	Yes	Show students engineering is collaborative and creative in nature, combating perceptions that engineers work alone Show engneering activities in a social context of improving society Provide and create female role models in engineering fields Provide opportunities for hands-on learning Build self-efficacy Sustain contact with participants Increase capacity of local middle school teachers Intel: Increase lack of female representation in the STEM job market
Curtin University Indigenous Australian Engineering Summer School (IAESS)	Tim Keely	https://engineering.curtin.edu.au/outreach/indigsummerschool.cfm	Western Australia, AUS	Curtin University	Both	Free	20-22 Students	On a good year, 25-30 Typically 20-22	Indigenous Students	7 days	Yes	Get kids to become engineers or at least let them know about engineering Better belief in themselves Better commitment to schooling in the future
Emerging Aboriginal Scholars Summer Camp (EASSC)	Melania Alvarez	https://www.pims.math.ca/educational-event/110705-eassc	British Columbia, CAN	Pacific Institute for Mathematical Sciences University of British Colombia	Both	Free	30 Students	N/A	Aboriginal Canadian Students	5 weeks	No	Increase Aboriginal student participation, retention, and HS grad rates by providing a solid foundation in Math, Science, English Expose Aboriginal students to real life working experience with faculty/other members of uni Show students that mathematics can be the gateway to a variety of careers
Gaalee'ya STEM Project	Jennie Carroll	https://www.uaf.edu/iac/projects/gaaleeya-stem-project/brochure/NSF-app.Gaaleeya-Mar10.pdf	Alaska, USA	University of Alaska	Both	College tuition offset by a stipend ($500 USD) if the student was successful	N/A	N/A	Alaskan Native Population (especially those from small villages)	2 years	Some	Increase participation of Alaska Natives in STEM degrees and STEM careers Increase the success of Alaska Native students in STEM courses Show western science and traditional science can coexist
Hands-On Otago	Rose Newburn Judith Bateup	http://www.otago.ac.nz/hands-on-at-otago/about/index.html	Dunedin, Otago, NZ	University of Otago	Both	$650 NZD	350-400 Students	About 2 for every available place	Open to all, Maori, Pacific Islander students and students with disabilities are given extra support	6 days	Yes	Interest in pursuing a science as a career Increase awareness of potential science careers that are available Break down preconceptions surrounding science Personal growth and confidence Provide inspirational role models for students
Indigenous Science and Engineering Program (ISEP)	Rhiannon Allan	http://www.nuragili.unsw.edu.au/Indigenous-science-and-engineering-program-isep	New South Wales, AUS	Nura Gili Indigenous Programs Unit at the University of New South Wales	STEM	Free (except cost to get to & from UNSW)	N/A	N/A	Indigenous Students	3 days	Yes	Provide opportunity to experience university STEM studies, campus Stimulate interests in pursuing STEM career Develop understanding of requirements and options to study at university and lead to a STEM career Develop understanding into the academic and support programs of Nura Gili at UNSW UNSW: Increased enrolment rates of Indigenous students in STEM areas
Residential Indigenous Science Experience (RISE)	Tony Chiovitti Roger Rassool	http://about.unimelb.edu.au/reconciliation/programs/STEM	Victoria, AUS	University of Melbourne's Murrup Barak Institute GTAC	Both	Free	30 students	Varried from ~ 25-50	Indigneous students	4 days	Yes	Improve quality of life for Indigenous People Encourage Inidgenous students to engage in STEM Inspire students to consider a career in STEM Build student confidence to be a leader
Strengthening Engagement and Achievement in Mathematics and Science (SEAMS) - Indigenous Early Years Program	Jacob Thomas	http://www.monash.edu/access/outreach_programs/seams	Victoria, AUS	Monash University University of Melbourne	Both	Free	40 Students	10 Applicants	Indigenous Students	3 days	Yes	Instill early interest in pursuing university study Understand the full breadth of opportunities available
Strengthening Engagement and Achievement in Mathematics and Science (SEAMS) - VCE Program	Jacob Thomas	http://www.monash.edu/access/outreach_programs/seams	Victoria, AUS	Monash University University of Melbourne	STEM	Free	100 Students	N/A	Underrepresented Victorian Students	2 days (?) (two per year)	Yes	Address the marginalisation that status or ethnic backgroud imparts on students Instill a sense of worthiness of high achievement, and a desire to work to achieve such goals Give students a head start on VCE subjects Develop a network of like-minded students to support one another Allow students to experience university life Show breadth of post--secondary education opportunities
TRACKS Youth Program	Robyn Smith Kristeen McTavish	www.trackscamp.ca	Ontario, CAN	Trent University	Both	$150 CAD (Open - younger camp) $175 CAD (Open - older camp) $120 CAD (In-school workshop) Free (Partnering Community C&WS)	Camp (C): 10-15 Workshop (WS): 25-30	C: 10-15 per session, accept all WS: 25-30	Partnering C&WS: Indigenous youth from community University C&WS: Open to all youth (usually near split of Indigneous and non-Indigenous)	C: two 5 day summer sessions & 6-8 other 2-4 day sessions WS: Daily	C: No WS: No	Enable students to draw connections between culture and science Develop a supportive network with peers, role models, and the natural world Develop appreciation and understanding of Indigenous knowledge systems Develop appreciation of own culture and those of others, and science Improve student self-confidence Have fun with science Trent IESS Prorgam: Indigenous education and community building at a young age
Tundra Science and Culture Camp	Tasha Stephenson	http://www.enr.gov.nt.ca/programs/tundra-ecosystem-research-station/tundra-science-and-culture-camp	Northwest Territories, CAN	Government of the Northwest Territories, Department of Environment anf Natural Resources	Both	$300 CAD	18 Students (max)	20-25 Applicants	Primarily Indigenous Students, but open to all	10 days	Yes	Increase scientific literacy Increase apreciation of land Encourage pursuit of science, technology, and environmental studies Highlight similarities and differences of science and Indigenous culture
Victorian Indigenous Engineering Winter School (VIEWS)	Juliana Kaya Prpic	http://www.eng.unimelb.edu.au/engage/Indigenous/views	Victoria, AUS	Melbourne University RMIT University Monash University Swinburne University	Both	Free	26 Students	N/A	Indigenous students enrolled in math/science subjects	5 days	Yes	Provide students with an understanding of studying and working in engineering Learn about the different pathways that can be taken to pursue engineering Learn about the impact engineers have on the world
Wingara Mura - Bunga Barrabugu Summer Programs	Josephine Wilson	http://sydney.edu.au/indigenous-summer-program/	New South Wales, AUS	University of Sydney	STEM	Free	Max numbers: 80 for year 9-10 140 for year 11-12	About 100 applicants for years 9-10 About 150 applicants for years 11-12	Only Indigenous high school students	7 days	Yes	Provide hands-on, experiential opportunitiy to live on campus and experience university life Show students what university offers so can begin to link interests with higher education/careers Provide supportive environment to meet peers, universitystudents, and academics to build confidence and motivation Provide information to make informed choices about subject selection for senior years Provide access to online tutoring to support them during their junior and senior year Will be able to identify how higher education can help them achieve their goals Will be able to recognise that higher education is about options and choices

Appendix A.i: Interviewed Programs

Program Name:	STEM Program Elements:	Culture Program Elements:	Post-Program Elements:	Other Program Elements:	Evaluation Indicators:	Evaluation Tools:
Aboriginal Summer School for Excellence in Technology and Science (ASSETS)	Research project Student presentations	Group discussion / yarning circle Interactions with Indigenous elders Indigenous mentors	Mentorship program	Leadership and support sessions Interactions with university student mentors	Improved self-efficacy Student success in STEM subjects years after project and in university *Understanding of scientific inquiry process Enrolment in STEM subjects after program Enrolment in Univsity STEM classes Participation in other STEM programs	Pre- and post--survey
Ah Neen Dush	Emphasis on teaching science with cultural relevance	Frequent interactions with elders Discussions of traditional Native American Activities (like harvesting wild rice) Cultural Based inquiry units	Program workshops take place over 3 years; lots of contact with participating teachers	The program is really teacher training, not for students themselves, but its a unique perspective that none of the other camps offer Reflective Jounaling	Positive/Negative Climate Classroom Organisation Behavior Management Instructional Learning Formats Conceptual Development Quality Feedback Instructional Support	In classroom measurements (monthly basis) Reflections on teacher workshops Survey after the end of each unit
Australian Indigenous Science and Infrastructure Development (SID) Winter School	Hands-on activities like robot building Site visits (trips to chem lab, etc) City development simulation Real world experience with airforce (including technical jobs)	Many program activities run by student ambassadors Council from Aboriginal elders	Survey of participants 3mo after the program finishes Contact kept with parents of participants via phone & email Debrief between students and ambassadors	Formal dinner on the final night where participants host their families, sponsors Presentation on projects by students at the end of the program	Improved self-efficacy Expanded view of career opportunities Encouragement that university study is an option	Exactly the same pre-and post- surveys Survey from teachers 3mo after completion of program Survey from students 3mo after completion of program Ongoing communication with participant parents
Camp Reach	Hands-on activities Real-world group project sponsored by community organisations: groups of 10, report and presentation at end, opportunity to return to see results Networking dinner, "speed-dating" with female STEM professionals	Session for parents to learn about opportunities for daughters in STEM, encouraging daugthers to pursue STEM, and confronting misconceptions about women in STEM Provide role models in other women in STEM education, careers; close-age mentors Talk about economic factors and benefits of STEM careers Relate activities to social context to make important to women	Reunions twice each year, incorporating STEM activities Opportunity for alumnae to return as TAs/CITs in future sessions of camp Facebook group	Evening fun activities	Improved self-efficacy Understanding of STEM careers Positive attitude toward STEM Interest in pursuing STEM careers Taking higher level maths in secondary education Choice of university field	Dimensions of Success (Harvard PEAR) Common Instrument (Harvard PEAR) pre-and post- surveys (SOURCE) Longitudinal evaluation (SOURCE): parent, middle school teachers that run the workshops, and student surveys Phone interviews in long term
Curtin University Indigenous Australian Engineering Summer School (IAESS)	Hands-on activities in different sorts of engineering: e.g. Lego Mindstorm robotics, water bottle rockets, chemistry Site visits (construction and manufacturing) Talks with engineers Networking events wih STEM company HR representatives	Tradional opening Try to get Indigenous representatives from companies Indigenous Elder or someone in high standing in their company to talk for closing ceremony Indigenous student mentors	Year 11 kids can come back for a more acedemic program Facebook group including both students and director	N/A	Satisfaction: Mentioned they like to track if kids go to C.U. and study engineering Enrollment at university Return to program	Post- survey at the end that asks campers to rank activities
Emerging Aboriginal Scholars Summer Camp (EASSC)	1.5 hours of hours of math/day (professional math teacher) Lab experience / internship with professors	Discussions with village elder once per week English lesson readings chosen to be culturally relevant Some math word problems have cultural context Discussions of being an "urban Aboriginal" (not living on a reserve)	N/A	1.5 hours of English/day (professional English teacher) Undergraduate volunteers work with students in small groups	Increased performance in English and Mathematics Program met expectations/was enjoyable	Pre-test to determine placement of students Post- test to measure improvement in math/English Post- survey with questions regarding likes, dislikes, expectations
Gaalee'ya STEM Project	Meet Alaskan Natives with careers in science Week-long learning sessions on Fairbanks campus Individual tutoring and academic advising Tuition, books, fees provided for up to 2 STEM courses for each semester	Participants mostly learn from home, without having to leave village culture (villages often complained that university greatly changed the student)	N/A	Program designed with villages communities Cohort model - idea that students move through classes together	Increased achievement in STEM Community is satisfied by program Number of students who got a STEM degree; number of villages interacted with; number of associate degrees (metrics for funders)	Students and community members interviewed by professional evaluator (data for community)
Hands-On Otago	Research on project they are interested in Mini- "snacks" projects of different fields of main project Site visits	Tradional Maori welcome Show maori students the type of support programs are on the campus Learn about Science Wanaga	N/A	Scholarships, especially for Maori students	Did students attend University of Otago	End of program student evaulation Pre-survey Post- survey
Indigenous Science and Engineering Program (ISEP)	Engage with UNSW's Faculties of Science and Engineering (one day of each the Science and the Engineering Faculties) Hands-on, interactive STEM projects and group tasks Site visits to Sydney STEM organisations and companies	N/A	Students invited to return annually Promote other STEM related activities held by UNSW Promotion of UNSW Year 10-12 Winter School	N/A	N/A	Online post- survey (seeking to develop pre-survey to accompany) Feedback to Science and Engineering Faculties regaring involvement
Residential Indigenous Science Experience (RISE)	Site visits Immersions Workshops paired with PhD student Interactions with scientists Mentors (2 male 2 female science mentors not necissarily indienous)	Mentors (2 male 2 female Indigenous, not necissarily science) Indigenous museum visit Talk with Indigenous Elder Dance night	N/A	Daily reflection with Journal	N/A	Post- survey Contact with some teachers who send the students to RISE
Strengthening Engagement and Achievement in Mathematics and Science (SEAMS) - Indigenous Early Years Program	Activities: biology, soil, archaeology labs Introduce options for pursuing STEM	Indigenous craft activities: beadwork Performances Peer to peer discussions with current university students Presentations by Indigenous professionals	N/A	N/A	Student confidence Student aspirations Student enjoyment Student connectedness	Post- survey
Strengthening Engagement and Achievement in Mathematics and Science (SEAMS) - VCE Program	Frontloading for all classes students will take in the upcoming school term Speaking panels with faculties Activities: robotics, water testing, 3-D printing Interactive laboratory tours Nighttime social activities Access to university online learning system Learning how to apply for university	Peer-to-peer discussions with current university students	Facebook Contact about future camp dates (recurring program) Work placements	Emphasis of working hard to get to university Use Moodle	Use of online learning tools Number of graduates who go into STEM after Year 12 University enrolment ATAR Scores Student confidence Student aspirations Student enjoyment Student connectedness	Post- survey
TRACKS Youth Program	Field activities: chemistry, biology, health, conservation, ecology hands-on labs and games Building small engineering devices, like a water filter Visits by university students and professionals	Start every day with a smudge (sage burning) Activities each presented from both science and Indigenous knowlegde sides, describing stories behind natural systems	Students invited to return on yearly basis Program viewed as continual Opportunity for students to return as volunteers Occasional contact with students' families	Daily reflection (Head, Hands and Heart)	Self-confidence Knowledge of science and culture Returning students Student opinion	"Head, Hands, and Heart" Model: What did you learn? How did you feel? What will you do after learning this? Daily relfection, sitting in circle (discussion based) Debrief with staff Presenters ask for qualitative responses from students at completion of activities throughout the day Discussion of evaluation with staff Emphasis on unobtrusive evaluation Formerly, survey to parents, then interviews In-school workshops: teacher, student surveys One-on-one interviews with parents and elders (one year)
Tundra Science and Culture Camp	Six days of one hour long classroom sessions, then hands-on in the field for day Research enquiry in last few days	Activities determined by elders Hunted caribou in the past Fishing activity replaced caribou, reflecting changes in traditional hunting habits with scarcity Games, cooking, storytelling, hike Handcrafts: beading, drum-making Skills: hide-scraping, dryfish/drymeat cutting	Photo album for students	Every third year has emphasis on French language (the other national language of Canada) due to agreement with Francophone organisation, but selectivity not forced	N/A	Post- survey Email responses occasionally from students or parents
Victorian Indigenous Engineering Winter School (VIEWS)	Meet engineering students from the various universities Site visits to engineering workplaces (melbo metro, etc) hands-on activities	Yarning circle discussions Meetings with universities' Indigenous support groups Ochre painting	Some communication to see if the students attend uni	Fun trips (Strike Bowling, The Star) Formal Dinner Presentations from high-up Indigenous engineers	Increased enrollment in university Increase aspirations to pursue engineering Increased belief in personal ability to go to university	Qualitative observation of students during activities Discussions with students at the end of program Daily reflections via yarning circle
Wingara Mura - Bunga Barrabugu Summer Programs	For years 9-10, pick 3 different thinking paths and explore them For years 11-12, single subject Note: subjects can be STEM or liberal arts Careers fair event	Program follows rule that cultural programs are optional, shouldn't be forced, should be shared organically	Occational contact with email/texting, hearing back from teachers Online website A-Star to use to keep in touch with everyone and also get free tutoring	If more than 3 students from a school go to the program, a chaperone position is offered to a teacher (good for marketing!) Fun trips (Sydney festivals, etc)	Knowledge of opportunities available at uni Able to make informed decision Express a sense of confidence in the universityenvironment Knowledge about how higher education can help them achieve their goals Develop link between interests and higher edu Recognize that higher education is about options and choices Greater understanding of support services at uni Greater understanding of what universityfaculties offer future students Confidence and awareness in applying for scholarships	Pre-survey Daily surveys Final post- survey

Appendix A.i: Interviewed Programs

Program Name:	Standardised Elements	Standardised Aim Keywords	Standardised Indicators	Standadised Evaluation Metrics
Aboriginal Summer School for Excellence in Technology and Science (ASSETS)	Hands-on activities Meet STEM professionals Research project Provide mentors/role models Presentations from professionals Interaction with university student mentors Communication after program Site visits	(1) Awareness: STEM university, STEM careers, culture (2) Abilities & Achievement: STEM, culture (3) Aspirations: STEM university, STEM careers (4) Self-confidence: STEM, culture (5) Social community (6) Connect STEM and culture	Increased self-efficacy Enjoyment Increased Aspirations STEM course enrolment	Pre-Surey / Post-Survey Student Communication
Ah Neen Dush	Hands-on activities Meet Indigenous elders Site visits	(6) Connect STEM and Culture (8) Teacher capacity	N/A	Post-Survey Group Discussion
Australian Indigenous Science and Infrastructure Development (SID) Winter School	Hands-on activities Site visits Lab experience Meet Indigenous elders Provide mentors/role models Formal dinner Research project Meet STEM professionals Presentations from professionals Interaction with university students Communication after program	(1) Awareness: STEM Career Pathways (3) Aspirations: University, STEM Careers (9) Access to university education	Increased self-efficacy Understanding of career opportunities Understand universityis an option	Pre-Survey / Post-Survey Teacher Communication Student Communication Parent Communication)
Camp Reach	Hands-on activities Meet STEM professionals Research project Provide mentors/role models Site visits Presentations from professionals Interaction with university students Formal dinner	(1) Awareness: STEM Careers (4) Self-confidence (5) Social community (6) Connect STEM and Culture	Increased self-efficacy Understanding of STEM careers STEM course enrollment Choice of university field of study Heightened aspirations Enjoyment	Pre-Survey / Post-Survey Parent Communication Teacher Communication Student Communication Unique (Dimentions of Success, Common Instrament (both from Harvard PEAR))
Curtin University Indigenous Australian Engineering Summer School (IAESS)	Hands-on activities Site visits Meet STEM professionals Presentations from Indigenous professionals Formal welcome Meet Indigenous elders Provide mentors/role models Communication after program	(1) Awareness: STEM careers (3) Aspirations: STEM careers	Enjoyment Attending University Return to program	Post-Survey
Emerging Aboriginal Scholars Summer Camp (EASSC)	Classes Lab experience Meet Indigenous elders Interaction with university students Reserach project	(1) Awareness: STEM careers (2) Abilities & Achievement	Increased Math/English performance Enjoyment	Post-Survey Pre-Test /Post-Test
Gaalee'ya STEM Project	Meet STEM professionals Tutoring Classes	(2) Abilities & Achievement: STEM (6) Connnect STEM and Culture	Increased STEM achievement Students with STEM degree Villages interacted with	Student Communication Community Member Communication
Hands-On Otago	Research project Hands-on activities Site visits Performances Interaction with university students Formal welcome	(1) Awareness: STEM careers (3) Aspirations: STEM careers (4) Self-confidence (5) Social community	Enjoyment Attending University	Pre-Survey/ Post-Survey
Indigenous Science and Engineering Program (ISEP)	Hands-on activities Research project Site visits Meet STEM professionals Communication after program	(1) Awareness: STEM career pathways, university support systems (3) Aspirations: STEM career (7) Experience university life	In Development	Post-Survey Staff Communication
Residential Indigenous Science Experience (RISE)	Site visits Meet STEM professionals Provide mentors/role models Hands-on Activities Meet Indigenous elders Lab experience	(3) Aspirations: STEM careers (4) Self-confidence (2) Abilities & Achievement	In Development	Post-Survey Teacher Communication
Strengthening Engagement and Achievement in Mathematics and Science (SEAMS) - Indigenous Early Years Program	Lab experience Hands-on activities Interaction with university students Presentations from Indigenous professionals	(1) Awareness: STEM career pathways (3) Aspirations: university	Increased self-efficacy Heightened aspirations Enjoyment	Post-Survey
Strengthening Engagement and Achievement in Mathematics and Science (SEAMS) - VCE Program	Hands-on activities Lab experience Provide mentors/role models Presentations from professionals Learn to apply to university Interaction with university students Communication after program	(1) Awareness: STEM careers (2) Abilities & achievement: STEM (3) Aspirations: STEM careers (4) Self-confidence (5) Social community (7) Experience university life	Choice of university field of study Increased standardised testing scores Increased self-efficacy Attending university Enjoyment Heightened aspirations	Post- Survey
TRACKS Youth Program	Hands-on activities Site visits Meet STEM professiionals Interaction with university students Formal Welcome Communication after program Meet with Indigenous elders	(5) Social community (1) Awareness: Culture, STEM (4) Self-confidence (6) Connect STEM and culture (10) Opinions/fun	Increased self-efficacy Return to program Enjoyment Increased STEM knowledge	Unique (Head, Heart, and Hands) Group Discussion Parent Communication Teacher Communication
Tundra Science and Culture Camp	Classes Research project Meet Indigenous elders	(1) Awareness: STEM, culture (3) Aspirations: STEM in university (6) Connect STEM and culture	In Development	Post-Survey Student Communication Parent Communication
Victorian Indigenous Engineering Winter School (VIEWS)	Interaction with university students Hands-on activities Site visits Meet Indigenous professionals Formal dinner Meet STEM professionals	(1) Awareness: university, STEM careers	Heightened Aspirations Attending university Increased self-efficacy	Group Discussion
Wingara Mura - Bunga Barrabugu Summer Programs	Interaction with university students Hands-on activities Meet STEM professionals Communication after program	(1) Awareness: university (2) Abilities & Achievement (3) Aspiration: university (4) Self-confidence (5) Social community (7) Experience university life	Enjoyment Increased interest in STEM Increased self-efficacy	Pre-Survey/ Post-Survey Unique (Daily Survey)

Appendix A.ii: Non-Interviewed Programs

Program Name:	Contact Name:	Website:	Location:	Run by:	Type (STEM/Culture/Both):	Cost to Students:	Size:	Number of Applications:	Target Demographic:	Length of Program:	Residential:	Project Aims:
Camp Jungai	N/A	http://www.campjungai.org.au/	Victoria, AUS	Outdoor Education Group (OEG)	Culture	Group of 56 Year 7 students AUD$ 216 per student (3 day)	N/A	N/A	Indigenous and Non-Indigenous Students	1-5 days	Yes	Provide outdoor experiences that improve the wellbeing of people, communities, and the natural world Help create a world where more people think and act to support: positive relationships with themsleves; dynamic, and healthy communitie.
Creating Awareness of Agricultural and Life Science Disciplines, Degree Programs, and Discoveries (CAALS 3D): Summer Research Experience	Alexandria Graves	https://harvest.cals.ncsu.edu/diversity/programs/recruitment/caals-3d/	North Carolina, USA	North Carolina State University	STEM	N/A	30 Students	N/A	African American, Native American, and Hispanic from the North Carolina School of Science and Mathematics (a two-year university)	1 week	N/A	Increase participants' awareness and interest in career fields within food, agricultural, environmental, and life sciences Increase participants' awareness and interest in cutting-edge research in food, agricultural, environmental, and life sciences Engage participants in innovative, hands-on research with faculty in CAALS Expose participants to committed faculty and students who can serve as mentors and role models
Hands-on Monash	Kristel Keleher	http://www.monash.edu/about/Indigenous/students/outreach	Victoria, AUS	Monash University	Both	N/A	N/A	N/A	Indigenous Students	3 days	Yes	Provide insight into university life Increase teamwork skills among participants Provide cultural insight to participants
InspireU	Andrew Dylan	http://www.atsis.uq.edu.au/inspireu	Queensland, AUS	University of Queensland: Aboriginal & Torres Strait Islander Studies Unit	STEM	N/A	N/A	N/A	Indigenous Students	5-6 days	Yes	Enable insight into university study in chosen fields (Eng., Health, Business, Law, Science) Explore career opportunities Experience university life
Meyerhoff Scholars Program	Keith Harmon	http://meyerhoff.umbc.edu/	Maryland, USA	University of Maryland, Baltimore County	STEM	$-5,000 to $-22,000 USD (Paid scholarships)	50 students	~2000	All, originally for African American	4 years	Yes	Increase diversity in STEM fields Provide a social support network for students Provide personal role model advising Inform parents regarding child's success
Sacred Circle	N/A	http://www.metowe.com/leadership-programs/signature-school-programming/aboriginal-education/	Ontario, CAN	Me to We	Culture	N/A	8-25 Youths		First Nation, Metis, or Inuit	3 days, broken up throughout the year	N/A	Increase academic achievement and engagement Develop advanced leadership skills, self-esteem, and confidence Strengthen sense of belonging and community Inspire and support for youth to participate in their communities as leaders Explore and celebrate personal and cultural identity
Science Wananga	Hiria Tutakangahau	https://sciencewananga.otago.ac.nz/	Various around NZ	University of Otago	Both	Free	50 Students		Indigenous (Maori) Students	2 x 3 day programs	Yes	Understand connections between culture and science Enhance achievment and engagement in science and health
STEM Youth Development Camp	N/A	N/A	New South Wales, AUS	The Connected Communities Directorate The NSW Aboriginal Education Consultative Group (NSW AECG) The Aboriginal and Torres Strait Islander Mathematics Alliance (ATSIMA)	STEM	N/A	About 130 Students	N/A	Indigenous Students	3 days	Yes	Introducing science as an area of study & career Greater respect and validation of indienous knowledge Building confidence in seeking a STEM future
Step Up to Stem	Jen Hill	http://www.ncssm.edu/stepup	North Carolina, USA	North Carolina School of Science and Mathematics	STEM	N/A	16 Students	N/A	African American, Native American, and Hispanic Students	2 weeks	Yes	Improve underrepresented participants' competence in science and math Nurture underrepresented participants' enthusiasm for science and math Increase interest in pursuing careers in science and math
UBC Summer Science Program	N/A	http://health.aboriginal.ubc.ca/education/ubc-summer-science-program/	British Colombia, CAN	University of British Colombia	Both	$200 CAD	N/A	N/A	High school Aboriginal students	1 week	Yes	Inform students of health and science careers Provide information on university pre-requisites, course planning, and admissions Offer a holistic education experience that includes cultural practices Provide Aboriginal role models in health care and sciences Incorporate cultural knowledge into daily activities
University of Sydney Indigenous Australian Engineering Summer School (IAESS)	N/A	http://sydney.edu.au/engineering/iaess/	New South Wales, AUS	University of Sydney Faculty of Engineering and Information Technologies	Both	Free	20 Students	N/A	Indigenous Students	6 days	Yes	Increase understanding of STEM careers and study Provide interactions with mentors in STEM professionals Increase career aspirations Increase representation of Indigenous people in STEM fields
UWA Science Camp for Indigenous Students	Brendon DeGois	s.uwa.edu.au/outreach/camp	Western Australia, AUS	University of Western Australia School of Indigenous Studies	STEM	Free	N/A	N/A	Indigenous Students	4 days	Yes	Increase the number of Indigenous students enrolled in university Increase the number of Indigenous students pursuing STEM at university Increase student aspirations to go to university Increase understanding of the interrelationship of STEM and culture Provide students with role models
VCE Summer School (VCESS)	N/A	http://umsu.unimelb.edu.au/jump-in/summerschool/	Victoria, AUS	University of Melbourne Student Union	STEM	$490 AUD (Residential) $190 AUD (Day Program)	70 Students (max)	N/A	High school students with disadvantaged backgrounds	2 weeks	Yes	Help participants gain a head start on education Create a focus on a healthy study-life balance Correct disadvantages brought about by the Victorian education system
Year 8 Discovery Days	N/A	http://www.sis.uwa.edu.au/outreach/yr8	Western Australia, AUS	University of Western Australia	STEM	Free	100+ Students	N/A	Indigenous Students	3 days	Yes	Broaden the scopes of participants Increase student knowledge regarding university entrance pathways

Appendix A.ii: Non-Interviewed Programs

Program Name:	STEM Program Elements:	Culture Program Elements:	Post-Program Elements:	Other Program Elements:	Evaluation Indicators:	Evaluation Tools:
Camp Jungai	N/A	History: Weapons and artifacts Cultural sessions (stories, games and didgerdoo) Bush Medicine Art Traditional dance and music	N/A	Team building exercises	N/A	N/A
Creating Awareness of Agricultural and Life Science Disciplines, Degree Programs, and Discoveries (CAALS 3D): Summer Research Experience	Hands-on research in CAALS labs Paired with research scientist for the week Presentations of findings at end of program	N/A	Mentorship program	N/A	N/A	N/A
Hands-on Monash	N/A	Cultural activities	Mentorship program	Interatctions with university students Keynote speeches from community leaders and other inspiring people Sport activities	N/A	N/A
InspireU	N/A	N/A	N/A	Six programs: Engineering, Junior Science, Law, Buisness, Health Science, Junior Engineering	N/A	N/A
Meyerhoff Scholars Program	STEM university study Study groups Tutoring Summer Bridge program	Professional mentorship program Faculty advising Peer counseling Summer Bridge program	Reunions Work placements	Financial aid Community service	N/A	N/A
Sacred Circle	N/A	The Seven Teachings (honesty, humility, truth, wisdom, love, respect, bravery) Medicine Wheel Aboriginal youth mentors help facilitate activities and cultural discussions	N/A	Various leadership activities	N/A	N/A
Science Wananga	Hands-on activities Meet professionals	Work with community	N/A	N/A	N/A	N/A
STEM Youth Development Camp	Exploring STEM fields: the mathematics of fire, astronomy, maths and community research, robotics Visting a CSIRO radio telescope observatory	N/A	N/A	Hands-on activities Engaging with industry Talking to role models	N/A	N/A
Step Up to Stem	Hands-on research Daily math, science, engineering activities	N/A	N/A	Sessions to improve writing for research papers Good grades required for admittance Wellness activities Enrichment activities (seminars, career sessions)	N/A	N/A
UBC Summer Science Program	Exposure to science and health activities	Conversations with Indigenous elders	N/A	Insight into future academic and career choices	N/A	N/A
University of Sydney Indigenous Australian Engineering Summer School (IAESS)	Hands-on activities Company site visits Meet professionals Work placements	Indigenous university student & faculty role models Interactive events: dancing, storytelling Indigenous history of Sydney	N/A	N/A	Number of scholarships awarded High school retention rates University entrance rates	Feedback discussion at end of camp
UWA Science Camp for Indigenous Students	Hands-on experiences in science, engineering, medicine, and technology Work with professionals Current university students role models	N/A	N/A	Career forum and information session at the end of the program	N/A	N/A
VCE Summer School (VCESS)	Some science classes (wide variety of course offerings that are not just STEM)	N/A	N/A	Tutoring provided by other students Residential program includes social events like a trip to QVM	N/A	N/A
Year 8 Discovery Days	Hands-on science activities Meet current Indigenous university students	N/A	N/A	Information session for applying to univresities Free t-shirt	N/A	N/A

Appendix A.ii: Non-Interviewed Programs

Program Name:	Standardised Elements	Standardised Aim Keywords	Standardised Indicators	Standadised Evaluation Metrics
Camp Jungai	Meet Indigenous elders Cultural activites	(2) Abilities & Achievement: culture (5) Social community	N/A	N/A
Creating Awareness of Agricultural and Life Science Disciplines, Degree Programs, and Discoveries (CAALS 3D): Summer Research Experience	Communication after program Research project Hands-on activities Meet STEM professionals Lab experience	(1) Awareness: STEM careers, STEM university (3) Aspirations: STEM careers, STEM university (5) Social community	N/A	N/A
Hands-on Monash	Communication after program Cultural activites	(1) Awareness: culture (2) Abilities: teamwork (7) Experience university life	N/A	N/A
InspireU	N/A	(1) Awareness: university, STEM careers (7) Experience university life	N/A	N/A
Meyerhoff Scholars Program	Communication after program Tutoring Research project Classes	(5) Social community (2) Abilities & Achievement	N/A	N/A
Sacred Circle	Provide mentors/role models Meet Indigenous elders Cultural activies	(1) Awareness: culture (2) Abilities & Achievement: leadership (4) self-confidence (5) Social community	N/A	N/A
Science Wananga	Hands-on activites Meet STEM professionals Work with community	(2) Abilities & Achievement (6) Connect STEM and culture	N/A	N/A
STEM Youth Development Camp	Hands-on activites Meet STEM professionals Provide mentors/role models	(1) Awareness: STEM university, STEM careers, culture (4) Self-confidence	N/A	N/A
Step Up to Stem	Hands-on activities Research project Classes	(2) Abilities: STEM (3) Aspirations: STEM, STEM careers	N/A	N/A
UBC Summer Science Program	Meet Indigenous elders	(1) Awareness: STEM careers, STEM career pathways, university application, culture (5) Social community (6) Connect STEM and culture	N/A	N/A
University of Sydney Indigenous Australian Engineering Summer School (IAESS)	Provide mentors/role models Meet Indigenous elders Cultural activies Interaction with university students Hands-on activites Site visits Meet STEM professionals	(1) Awareness: STEM university, STEM careers (3) Aspirations: STEM careers (5) Social community	Number of scholarships awarded High school retention rates Attending university	Group discussion
UWA Science Camp for Indigenous Students	Provide mentors/role models Interaction with university students Hands-on activites	(3) Aspirations: university (5) Social community (6) Connect STEM and culture	N/A	N/A
VCE Summer School (VCESS)	Classes	(2) Abilities & Achievement: STEM, culture	N/A	N/A
Year 8 Discovery Days	Interaction with university students Hands-on activites	(1) Awareness: STEM careers pathways	N/A	N/A

Appendix B: Sample Interview Questions

B.i: Questions for Program Directors

Sample Introduction:

We are students from Worcester Polytechnic Institute (WPI) in Worcester, MA, USA working on a project in Australia with the Commonwealth Scientific and Industrial Research Organization (CSIRO). Our project concerns the Aboriginal Summer School for Excellence in Technology and Science (ASSETS) program for Aboriginal & Torres Strait Islander secondary school students, which aims to increase interest in STEM while drawing connections to indigenous culture. In our project, we will be comparing ASSETS to similar programs and developing an evaluation strategy for the program as a result. In our research, we discovered your program, ____________________, which could stand to offer us some insightful information. We'd like to discuss the elements of your program, the program's goals, and how it's evaluated.

Questions:

- Can you provide a brief description of your program? What is the nature of the program? Who funds this program?
- What do you hope the students will gain by participating in this program? What motivates the students to participate?
- What does your organisation or any external organisation (e.g. funding organizations) hope to gain?
- In what ways do you teach STEM in your program (e.g. projects, lectures, site visits, etc.)? How does this support the program's overarching goals for students, your organisation, and any external parties?
    - (or What did you teach/do in your program (e.g. projects, lectures, site visits, etc.) in order to achieve these goals?)
- Is culture incorporated with your program? In what ways does the program incorporate culture? How does including culture support the goals of the program for students, your organisation, and external parties?
- Do you have an evaluation scheme to ensure the program is meeting these goals? Would you be willing to share the evaluation rubric with us?
    - What evaluation metrics do you use to assess the program?
    - When do you evaluate this program?
    - Who is the audience for your evaluations?
- Is there any communication with program participants following the completion of the program?
- Is there communication or evaluative measures taken with other people at any point (e.g. parents, teachers, community leaders, etc.)?
- Can we use the information you have provided us in our final published report?

B.ii: Questions for STEM and Culture Education Professionals

Questions:

- What are important elements for a STEM program for secondary students to have? Do these changed when a program is targeting an underrepresented population?

What specific needs do indigenous Australian students have in comparison to other students?
- Have you worked with programs which incorporate cultural aspects into the program? How do they include cultural elements?
- How do you evaluate a STEM program for youths?
- How do you ensure the students of STEM are fully engaged in a program?
- Can we use the information you have provided us in our final published report?

B.iii: Questions for Professional Evaluators

Questions:
- How is the evaluation criteria for a program determined?
- How is the evaluation of a STEM program approached differently than a non-STEM based evaluation?
- How are evaluations tailored to an underrepresented population?
- How do you decide on the surveying method (web, phone, survey, interview) to use for an evaluation?
- What is the most important part of a successful evaluation?
- What are some common mistakes that are made when performing an evaluation?
- Can we use the information you have provided us in our final published report?

Appendix C: Survey for Program Directors

Thank you for taking the time to fill out these questions. None of the responses to the questions are mandatory, so if there is a question you don't have an answer to, feel free to skip it.

This student group from Worcester Polytechnic Institute (WPI) is working in conjunction with the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) to develop an assessment strategy for the Aboriginal Summer School for Excellence in Technology and Science (ASSETS), a summer program for indigenous students, which seeks to blend the distinction between the STEM and indigenous culture education which it presents. More information about the program can be found via the following link: http://www.csiro.au/en/Education/Programs/Indigenous-STEM/ASSETS/About-ASSETS

The goal of the following questions is to gain an understanding of how programs similar to ASSETS measure their success in achieving their identified aims, which will aid us in the development of an assessment strategy for ASSETS.

What is the name of your program?

Can you provide a brief description of your program? What is the nature of the program? Who funds the program?

What do you hope students will gain by participating in this program?

What does your organisation or any external party (e.g. funding organisation) hope to gain?

Does the program have an evaluation scheme to ensure the program is meeting its goals? At what point in the program's life cycle is it evaluated? Who is the audience for the program's evaluation?

If the program does have an evaluation scheme, would you be willing to share the evaluation metrics with us?

- ◯ Yes
- ◯ No

Thank you for being willing to share! The metric file can be uploaded here or emailed to our team at csiro-d16@wpi.edu.

Drop files or click here to upload

In what ways is STEM education incorporated into the program? How does this support the program's overarching goals for students? For the organisation and any external parties?

Is ethnic culture incorporated in the program? If so, in what ways? How does this support the program's goals for students? For the organisation and any external parties?

Is there any communication with program participants following the completion of the program?

Is there any communication or evaluative measures taken with other people at any point (e.g. parents, teachers, community leaders, etc.)?

Is there anything else that is special about your program you'd like to share with us?

Can we use and cite the information you provided in our final report on the development of an assessment strategy for the ASSETS program? The report will be published on WPI's project database: https://www.wpi.edu/academics/library.html

- ◯ Yes
- ◯ Yes, but cite anonymously
- ◯ No

Appendix D: Sample Program Survey Questions

For each statement, select the option that best reflects your level of agreement with that statement. (Questions 1-14 can be asked on the pre-, post-, and longitudinal surveys, 15 and 16 are post-survey questions, 17 is only post- and longitudinal)

		Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	I know about the options available for study at university.	◯	◯	◯	◯	◯
2	I know of many STEM careers that I can pursue	◯	◯	◯	◯	◯
3	I know where to find information about a career that interests me.	◯	◯	◯	◯	◯
4	I know about practices and beliefs that are relevant to my culture.	◯	◯	◯	◯	◯
5	I know where to learn more about my culture.	◯	◯	◯	◯	◯
6	I am proud of my Indigenous identity.	◯	◯	◯	◯	◯
7	I am comfortable discussing my Indigenous culture with others.	◯	◯	◯	◯	◯
8	I am capable of being successful at university.	◯	◯	◯	◯	◯
9	I am **not** capable of pursuing a career in STEM.	◯	◯	◯	◯	◯
10	I am motivated to do my best in furthering my education.	◯	◯	◯	◯	◯
11	I intend to go to university	◯	◯	◯	◯	◯
12	I intend to study a STEM field at university.	◯	◯	◯	◯	◯
13	I intend to go into a STEM career	◯	◯	◯	◯	◯
14	I feel I have a strong support network of peers.	◯	◯	◯	◯	◯
15	I intend to keep in contact with friends made at this program.	◯	◯	◯	◯	◯
16	I intend to keep in contact with program staff.	◯	◯	◯	◯	◯
17	I would be interested in attending a program meet-up with staff and other participants.	◯	◯	◯	◯	◯

How often have you… (Questions 18-21 can be asked on the longitudinal survey)

		Daily	Weekly	Monthly	Yearly	Never
18	Talked to program staff?	◯	◯	◯	◯	◯
19	Talked to program mentors?	◯	◯	◯	◯	◯
20	Talked to student participants?	◯	◯	◯	◯	◯
21	Used the program's Facebook page?	◯	◯	◯	◯	◯

22. (Pre) How likely are you to participate in cultural activities?
(Post) How likely are you to participate in cultural activities after this program?

Very Unlikely	Unlikely	Neither Likely nor Unlikely	Likely	Very Likely
◯	◯	◯	◯	◯

23. (Pre) What cultural activities do you intend to participate in?
(Post) What cultural activities do you intend to participate in?
(Long.) In the past 12 months, did you participate in any cultural activities? If so, which ones?

____
____
____

24. (Pre/Post) Do you intend to take STEM classes next year? If so, list the ones you plan to take. If not, explain why.
(Long.) In the past academic year, did you complete any STEM classes? Is so, which ones?

____
____
____

25. (Pre/Post/Long.). What are your plans for after secondary school?

____
____
____

26. (Pre/Post/Long.). Have you attended other STEM programs? If so, which ones?

____
____
____

27. (Pre/Post/Long). Describe the scientific inquiry process and how it's used.

____
____
____