RE-IMAGINING FUTURE INNOVATORS

CO-CREATING NETWORKS TO HARNESS DIVERSE KNOWLEDGE

A PROJECT PROPOSAL FOR SCITECH

CREATED BY:
MUKTAR ABDI
HANNAH BAYLISS
DARCY BURNS
SASKIA MORTIMORE
NINA TOMAS

CONTENTS

WE WOULD LIKE TO ACKNOWLEDGE THE WHADJUK NOONGAR PEOPLE, THE TRADITIONAL CUSTODIANS OF THE LAND ON WHICH WE WORK AND LIVE. WE PAY OUR RESPECT TO ABORIGINAL AND TORRES STRAIT ISLANDER PEOPLE, CULTURES AND TO ELDERS PAST, PRESENT & EMERGING.

WE ALSO ACKNOWLEDGE THAT ABORIGINAL AND TORRES STRAIT ISLANDER PEOPLES HOLD, MAINTAIN AND SHARE KNOWLEDGE OF THESE LANDS THROUGH ORAL TRADITION WHICH HAS BEEN PRACTICED FOR THROUDANDS OF GENERATIONS.

01 INTRO-DUCTION

WHO ARE WE?

We are a multidisciplinary service design team from Murdoch University, consisting of five postgraduate students, mentored by Erica Ormsby and Eko Pam. Our core design team is supported by a larger class of students, all from culturally and linguistically diverse backgrounds, who supported problem exploration and idea generation. Their range of experience helped to inform understanding of the problem space from multiple contexts and frames of reference. Within the field of human-centred design, we know the importance of working in diverse teams with a wide range of world perspectives and experiences when tasked with exploring complex problems (Stickdorn & Schneider, 2011). Their contribution to our understanding is invaluable. We are proud to bring to the team a range of skills across the disciplines of Graphic Design, Web and UX Design, Strategic Communications, Game Design, Community Development, Teaching, Business, Sports Science and Health Science.

With an empathy driven approach and a focus on the importance of co-design we aim to work alongside Scitech and the community to facilitate the development of innovative and effective outcomes that address the needs of the Stakeholders for this project.

a collaborative way of working that utilises the perspectives, experiences and expertise from a range of stakeholders to examine a problem and innovate valuable design outcomes. Co-design involves "designing with" rather than "designing for", actively involving those who are most impacted by a problem or service in the process of generating outcomes that meet the needs of these people (Stickdorn & Schneider, 2011; Penin, 2018).

WHO IS THE CLIENT?

Scitech is a not-for-profit organisation, established in Perth, Western Australia in 1987. For over 30 years, they have been focused on delivering experiences that inspire curiosity and engagement with STEM (Science, Technology, Engineering and Mathematics). Scitech is on a mission to "be a world leader in providing innovative and creative STEM programs that inspire, engage, and develop citizens for Western Australia's social well-being, economic prosperity and sustainability" (Scitech, 2018). Through their Science Centre, based in West Perth and their outreach programs that take the Scitech experience to the furthest corners of the State, Scitech can impact the lives of 500,000 members of the community every year. In addition to their community based educational programs, they play an important role in the support and training of 4,000 educators to promote the delivery of STEM in the classroom (Scitech, 2018). Research shows that 75% of the fastest growing occupations now require STEM skills and knowledge (Government of Western Australia, 2019). It is estimated that shifting just 1% of the workforce into STEM careers would add $57 billion to Australia's GDP over 20 years (Pwc, 2016). But without a stable and secure pipeline of STEM graduates entering the workforce, these economic benefits will not be achieved. Therefore, Scitech is focused on their role in empowering all Western Australians to be equipped with the 21st century skillsets needed now and for the future.

Figure 1: "GRD503 Meeting with Danielle Giles"

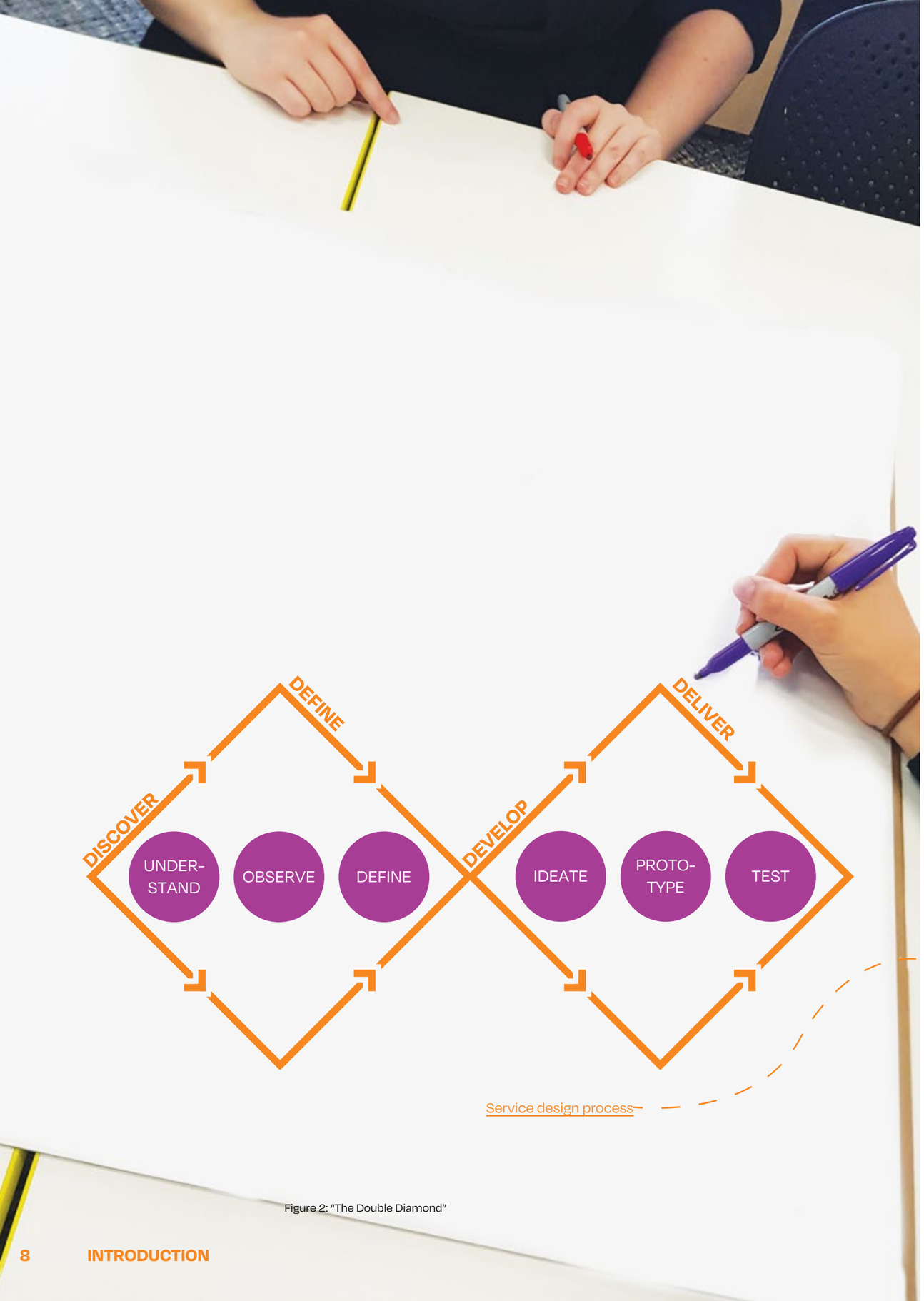


Figure 2: "The Double Diamond"

WHAT IS THE PROJECT?

In 2018, met with the changing face of STEM in the global economy, Scitech developed a New Scitech Strategy which outlines their new vision "to be a world leader in providing innovative and creative STEM programs that inspire, engage, and develop citizens for Western Australia's social well-being, economic prosperity and sustainability" (Scitech, 2018). This new vision is supported by 4 pillars which involve establishment of state-of-the-art science centres, targeted deeper reach beyond the centre, an informed public voice for STEM and the development of a highly connected STEM community.
Scitech approached our team to help them with their second objective of a targeted deeper reach beyond the centre, looking for a way to:

"EXPAND OUR FOCUS AND INCREASE OUR POSITIVE IMPACT ON TARGET AUDIENCE SEGMENTS, ESPECIALLY YOUTH, FEMALES, INDIGENOUS PERSONS, PEOPLE IN REGIONAL AND REMOTE WESTERN AUSTRALIA, AND PEOPLE IN LOW SOCIO-ECONOMIC AREAS." (SCITECH, 2018).

Scitech emphasised that the project is not a brand challenge or a sales funnel challenge. focused on driving visitation to the Discovery Centre but we concluded that.
whilst not a primary focus, increased engagement with the Discovery Centre may be a result of the proposed design outcomes.
With a Service Design approach, our team will work alongside Scitech and identified stakeholders in two stages. In the first stage of the project (Semester One) we will understand, observe, and define the problem, and ideate potential outcomes. In the second stage of the project (Semester 2) we will prototype and test proposed outcomes for their implementation.

Service design process

a user-centred, co-creative and multi-disciplinary approach to designing innovating services and experiences that are desirable, feasible and viable (Stickdorn & Schneider, 2011; Lewrick et al. 2020).

WHY ARE WE DOING IT?

The future of industry in Western Australia is rapidly changing and it is estimated that 75% of future jobs will require the high levels of STEM literacy for us to innovate ways of understanding and dealing with the environmental and social challenges we are yet to face. Foundational numeracy and scientific proficiency is an important focus in the early years of schooling. In much of the same way that key literacy skills are a precursor to success in other disciplines such as HASS or performing arts, foundational numeracy and scientific skills are an essential preparation for the future study of physics, chemistry, biomedicine and much more.

The target segments that Scitech identified in their New Strategy face some of the largest barriers to engaging in STEM learning which has resulted in under-representation of these people in STEM careers (Government of Western Australia, 2019). For instance, female students from low socioeconomic areas and indigenous people are less likely to study STEM subjects at school. Only 16 percent of STEM qualified Australians are female with the number as low as 13 percent in career fields such as engineering (Government of Western Australia, 2019). This gender gap prevents productivity and overall growth via under-utilisation of minds and the valuable diversity of ideas and experiences that can be obtained with a diverse workforce to tackle the world's challenges and problems.

Indigenous people are also significantly under-represented in STEM learning and careers. For example, Indigenous people represent less than 1 percent of higher education engineering and science students (Government of Western Australia, 2019). Addressing the current lack of diversity in STEM related learning and participation is an important and valuable aspects of this proposal. We want all Western Australians to be empowered to participate in a STEM enabled future regardless of their gender, ethnicity, and cultural background.

All people have the right to access educational opportunities that will enable them to actively participate in their communities. We know that designing in a way that considers, integrates, and celebrates the range of human diversity in users means that more people are included; design for one, and extend to many (The Centre for Inclusive Design, 2019). For instance, promoting a student-centric way of learning for children that allows them to develop the necessary skills to navigate their own learning, to explore and make choices that unlock their curiosity and potential.

Highlighting the importance of educators and their deep knowledge of each student individually can be key in helping them guide them on their educational journey. In a strong STEM culture people understand the importance of STEM. They see its relevance to their everyday lives and support close family and friends to participate in STEM learning that could be beneficial in their communities. STEM literacy allows people to make informed decision and participate in community engagement. This is increasingly vital as innovations rapidly change the world that we live in.

By increasing participation in STEM learning for communities that are currently falling behind, we all benefit from the richness of knowledge, experience, and expertise that informs the future of innovation and development in Western Australia. By working alongside Scitech and these stakeholders, we have the opportunity to innovate outcomes that will overcome barriers to access, contribute to shared ownership of learning experiences and empower these groups to become active contributors to the future of Western Australia.

WHO IS IT FOR?

Scitech came to our team with an objective that focused on the target segments of youth, females, indigenous persons, people in regional and remote Western Australia, and people in low socio-economic areas. While this objective provided a strong starting point, it was important for us to investigate who this project had the ability to impact as well as who would in fact be interacting with the outcomes we are to propose. For this, we utilised brainstorming and stakeholder mapping to define our primary core stakeholders:

- Culturally and linguistically diverse students, Students from low socio-economic communities and Indigenous students
- Remote primary school teachers, metro primary school teachers, public school teachers and private school teachers
- SciTech customer insight team, SciTech content team, SciTech experience team, SciTech state-wide team and SciTech professional learning team

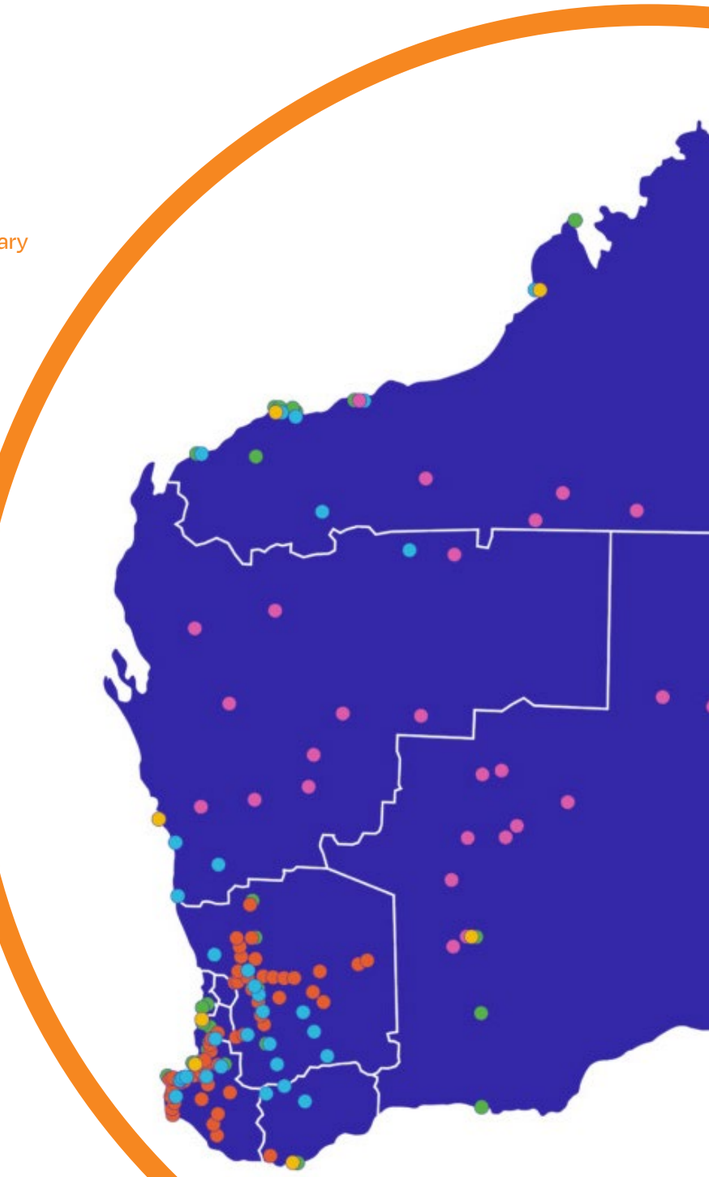


Figure 3: "Scitech Statewide Reach" retrieved from https://www.scitech.org.au/about/our-statewide-reach/

02 INITIAL PROBLEM

INITIAL PROBLEM STATEMENT

In early March of 2021, we met with Danielle Giles who introduced us to the initial problem statement.

"HOW MIGHT WE TAKE STEM TO THE COMMUNITY?"

This was explained further as a way to explore the second pillar of the New Scitech Strategy (2018).

TO '...EXPAND OUR FOCUS AND INCREASE OUR POSITIVE IMPACT ON TARGET AUDIENCE SEGMENTS, ESPECIALLY YOUTH, FEMALES, INDIGENOUS PERSONS, PEOPLE IN REGIONAL AND REMOTE WESTERN AUSTRALIA, AND PEOPLE IN LOW SOCIO-ECONOMIC AREAS.'

PROBLEM CONTEXT

In addition to the statement, Danielle also identified 5 areas that informed the context of the problem space

GLOBAL FACE OF STEM

The presentation included statistics regarding the role of STEM in industry, specifying that STEM skills are required in 75% of growing occupations. The statistics also showed that 44% of current jobs are impacted by digitisation and automation.
Equipping young people with the skills to succeed in future workplaces is a pressing concern for Scitech.

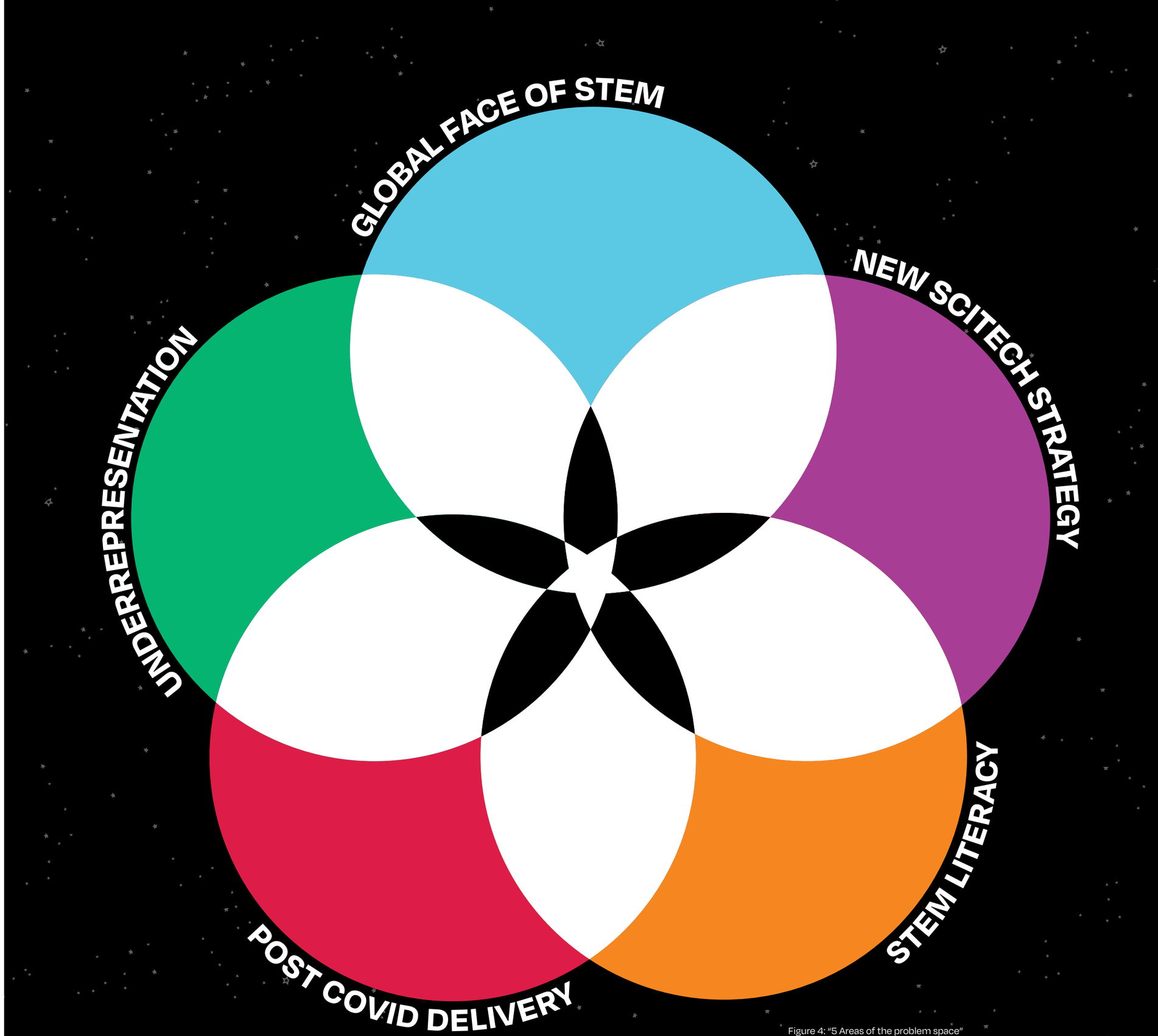


Figure 4: "5 Areas of the problem space"

UNDERREPRESENTATION

Other statistics included in the presentation showed that the rate of diverse STEM qualified Australians is worryingly low, with women making up only 16%, and Indigenous people making up less than 1%.
Scitech aims to increase their impact on these groups, and wants to know how their current approach can be expanded to achieve this.

STEM LITERACY

The presentation observes that many 15 year old's are falling behind in math's and science, along with Indigenous students are falling up to 2.5 years behind non-Indigenous students.

Giles brought up the concept of 'T-shaped people' in her presentation, which is integral to understanding Scitech's goals . A T-shaped person is someone is fully equipped to enter the workforce of the future, as well as navigate a rapidly changing world. They are exactly the type of person Scitech aims to create through their educational experiences.

The current state of STEM education within the curriculum is not enough to create T-shaped people, and the current statistics on STEM proficiency in these demographics show that the need to deliver these skills to young Australians is stronger than ever.

POST COVID-19 DELIVERY

It is difficult to overstate the impact that COVID-19 has had on all aspects of society. Scitech was not immune from this impact. Visitation to the science centre, their primary point of contact with the community, was rendered inaccessible during lockdown. In addition, incursions to school are hard to conduct when said schools have also been shut down.

However, this did not halt Scitech's efforts to bring STEM to the community. Scitech's website was put to use hosting content that the community could interact with from home.

Now that COVID-19 restrictions have been mostly lifted, Scitech is now left wondering how to proceed. Like many other organisations, Scitech has been made aware of alternative methods of delivery through the necessity of moving their operations online. The situation has also further revealed the limitations of the centre as the primary point of contact between Scitech and the community.

NEW SCITECH STRATEGY

In 2018, Scitech released the New Scitech Strategy. This document outlines Scitech's vision for the future, and what areas they want to target in order to achieve this. The main areas of interest are as follows:

- State of the art science centre(s)
- Targeted deeper reach beyond the centre
- Informed public voice for STEM
- Highly connected STEM community
- Business Growth and Sustainability

This document proved invaluable in understanding Scitech's proposed goals. However, the team was immediately curious as to how extensively this plan has influenced the way that Scitech operates, and this was not immediately clear upon preliminary research.

In-line with the New Scitech Strategy, Scitech underwent an internal restructure, introducing a number of new Teams. Giles explained that the Scitech Experience Team, with which we would be working, is relatively new. This means that our access to user data and feedback may be limited, and that it may take more time to build up rapport with these employees.

03 RESEARCH METHODS

RESEARCH STRATEGY

FOLLOWING THE PRESENTATION OF THE INITIAL PROBLEM, WE ENTERED THE DISCOVER PHASE OF DESIGN THINKING, WHICH INVOLVED OUR RESEARCH PROCESS. THE GOAL OF THIS PHASE WAS TO BETTER UNDERSTAND THE INITIAL PROBLEM IN CONTEXT, AS WELL AS FROM THE PERSPECTIVES OF THE PEOPLE AND COMMUNITIES IT IMPACTED.

RESEARCH TOOK THREE MAIN LINES OF ENQUIRY; A REVIEW OF LITERATURE, DESK RESEARCH AND USER RESEARCH. AS A FOUNDATION, A LITERATURE REVIEW WAS CONDUCTED INTO THE IMPORTANCE OF ETHNOGRAPHIC RESEARCH AND VISUALISATION IN THE PROCESS OF SERVICE INNOVATION. THIS AIMED TO GROUND OUR WORK AND PROCESSES IN THEORY AND GUIDE THE WAY IN WHICH WE GATHERED DATA AND PRESENTED OUR FINDINGS.

DESK OR BACKGROUND RESEARCH INTO THE PROBLEM SPACE ENABLED A GREATER CONTEXTUAL UNDERSTANDING OF THE PROBLEM WHICH WAS THEN SUPPORTED BY USER RESEARCH. THIS WAS CONDUCTED DIRECTLY WITH STAKEHOLDERS TO UNDERSTAND THEIR EXPERIENCE AND INTERACTIONS WITHIN THE PROBLEM SPACE FROM MULTIPLE FRAMES OF REFERENCE.

LITERATURE REVIEW: DATA VISUALISATION AND RESEARCH METHODS FOR INNOVATION

INTRODUCTION

Research is the process of collating, analysing, and interpreting data to better understand a phenomenon (Leedy & Ormrod, 2010). The research process is systematic and occurs within an established framework that provides researchers with an idea of what the research should contain, how to conduct the research and what kinds of inferences can be made based on the findings of the research (Williams, 2007). There are two main methods of conducting research: they are qualitative and quantitative (Williams, 2007). The researcher assumes the type of data required to answer the research question. For example, is numerical data needed or textual data? A third approach also exists called mixed methods which is the combination of both qualitative and quantitative data. This method is the least used out of the three due to its conflicting nature. Conducting this research, the researcher selects one of three methods to conduct the research (Strijker et al., 2020).

Quantitative research is linked with the positivist paradigm. It usually entails the collating and transforming data into numbers so that statistics can be calculated, and conclusions drawn. Quantitative research came about in 1250 A.D and was utilised by researchers who had the need to quantify data. Since then, quantitative research has become the predominant form of research method used in the western world (Moksha, 2013). Qualitative research is associated with the social constructivist paradigm which reinforced the socially constructed nature of reality. It involves the documenting, analysing, and attempting the find the deeper meaning and explanation of human behaviour and experience. It revolves around the complex understandings of people's experiences and not in collected data which can be hypothesized to other groups of people (Kim, 2014). Mixed methods approach is defined as a combination of qualitative and quantitative research methods and concepts into a single study (Johnson & Onwuegbuzie, 2004). Mixed methodology today is a feasible complement to purist qualitative and quantitative research because its pluralistic nature allows researchers to increase both the scope and the depth of analysis (Collins et al., 2006).

Since the service business contributes heavily to national economic growth, the importance of service innovation has received significant attention in recent years (Cho et al., 2011). Innovation has been a key element for firm competitiveness. However, most of the pre-existing research focuses on innovation in the manufacturing industries or the technology sector (Tether, 2005). The importance of innovation has not been completely acknowledged in the service industry (Crevani et al., 2011). Driven by demanding yet intelligent customers, global competition and a rapidly changing market environment, many organisations look to find new ways to obtain and retain a competitive edge. The main source for this edge in service firms is customer satisfaction via superior customer value delivery, which contributes positively to increased purchase power (Roofthooft, 2010).

Service firms in the corporate industry approach design differently compared to those in-service design. Service designers follow design thinking and prioritise the experience of people. Design thinking is useful for tackling complex problems that are ill-defined/unknown

due to its understanding of the involved human needs, reframing of problems in human-centric ways, creating a range of ideas in ideation sessions, and having a hands-on approach during prototyping and testing (Dam & Siang, 2019). Comparing and contrasting between a "corporate" and a "design" approach to service innovation, Wroblewski (2005) mentions that the end goal for for-profit firms in a traditional business setting is based on the bottom line whereas in a service design setting, finding reward in quality solutions is the main objective. Therefore, Service innovation best thrives when it's not constrained by traditional barriers of researching.

Visualisation is a vital method of communication. Usually, visualisation entails translating complex forms of data or information into something more accessible and tangible. Humans are naturally primed to absorb visual language, and visualisation can often be more universal in practice than written language (Al-Kodmany, 2001). There is a long precedent for this line of reasoning, for example humans have used visual language to communicate long before written language existed. For a long time, visual language was the only way to preserve a story, memory or lesson that would survive past the lifespan of the person recording it, or even long past the lifespan of anyone alive who remembered it (Friendly, 2009). Scholarly sources about this topic as a general concept are rare; many papers talk about visualisation and visual communication within a specific context. According to Hepworth (2014), visual language has been used throughout history to assert power.

A universal approach to visual communication is hard to come by because of the disagreements about the fundamental definition of it. This is surprising since the field of visual language and linguistics has been a vibrant research field (Avgerinou & Pettersson, 2011; Erwig et al., 2017). However, this does not in any case render these sources useless. Many of the theories presented by these sources still apply to visual communication as a general concept, and many of the ideas about how visual communication functions, as well as its applications, overlap significantly. In addition, the wide variety of contexts in which aspects of visual language theory have been applied reinforces the idea of its overall significance.

A key context that visualisation is useful in is its ability to aid in making complex ideas easier to understand and share (IDEO, 2019). We use visualization as an effective way to communicate ideas, and we have been doing this since the dawn of human civilisation with the first cartography map being carved into stone 6000 years ago. (McCandless, 2010). Since then, we have seen the form of visualization turn into a widely recognised satellite image of street maps and Google earth. We saw visualizations increasingly become useful when the development of science was being applied in the Middle Ages. (McCandless, 2010). Visualization is a key component in 'Design Thinking', capturing ideas through visual sketches, photographs, animations, videography, cartoons, 2D and 3D Diagrams, role play, artefacts and more, where we can conceptualise these ideas and turn them into living experiences that are working in the real world. (Brown, 2021).

Tim Brown describes 'Design Thinking' as "a human-centred approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success" (Brown, 2021, pp. 1). The application of the designer's tool kit is used in domains such as healthcare, IT, business or to tackle wicked problems that many organisations and businesses face. (Kernbach & Nabergoj, 2019). Engineering utilises visualisation to process data, referring data visualization as "transforming figures and raw data into visual objects: points, bars, line plots and maps". (Sadiku et al., 2016). By combining user-friendly and aesthetically pleasing features, these visualizations make research and data analysis much quicker and are also a powerful communication tool. (Toco, 2018; Sadiku et al., 2016). According to Kernbach & Nabergoj (2019) visualization is fundamental in Design Thinking as it shares ideas, creates ordinary understanding, speeds up processes for efficient and faster innovation cycles and enables insights that lead to actions. A better understanding is necessary of the different forms of visuals, their use in phases, what principles they convey and how they affect cognitive, social, and emotional dimensions of the design thinking work. (Kernbach & Nabergoj, 2019).

The field of design has seen a progression away from focus on product to a focus service and experience (Polaine et al., 2013). The formal emergence of design thinking as a human-centred, collaborative process for creating meaningful and purposeful design outcomes has given emphasis to the importance of research and discovery in the process of designing innovative services (Polaine et al., 2013). Humans are central to the design and delivery of such service experiences (Stickdorn & Schneider, 2011). The value of a service only comes to exist when a person decides to use it. This engagement marks a key difference between the essence of product design and experience design; rather than consumption, engagement with services requires the entering of a relationship between a person and an organisation providing the service (Polaine et al., 2013). Relationships are complex and require more personal understanding of context, values, needs, and everyday experiences. By this very nature, creation of services requires a deep understanding about the personal stories each service user brings to the relationship, meaning that it is essential that research for the creation of services should revolve around the very people they relate with (Stickdorn & Schneider, 2011; Polaine et al., 2013).

This literature review will be divided into 5 main chapters. The first chapter will look at comparing qualitative research methods, quantitative research methods, mixed methods approach, and looking at the reliability of mixed methods approach. The second chapter will look at the differences in approaches to innovation from a business first approach and a service design approach. This chapter will also examine the complexities of design thinking. The third chapter will look at the history and early utilisation of visual communication, modern uses of visual communication as well as analysing how visual communication overcomes traditional barriers of understanding. The fourth chapter will look at the 5 Stages involved in the design thinking process and examine each one as well as looking at how each of these stages use visualization activities and why design thinkers use them. Lastly the fifth chapter will explore the importance of user voice in research for service innovation. This will be done by examining the importance of storytelling in design. It will also focus on interviewing as a method for story collection. The purpose of this critical review is to provide the scholarly, literary, and contextual commentary to support the perspectives, context, and approaches that the authors utilised when co-designing the service design project with SciTech.

CHAPTER 1: QUALITATIVE, QUANTITATIVE AND MIXED RESEARCH METHODOLOGIES: COMPARING THE THREE METHODS

QUALITATIVE RESEARCH APPROACH

Qualitative research is mostly interested in analysing subjective latent meaning of issues, practices, and events by collating non-standardised data and performing textural analysis on the texts and images rather than numbers and statistics (Flick, 2014). From this definition it appears that qualitative research is an overarching concept under which a wide range of issues may be placed, and it has both positive and negative stances. There are some advantages to using qualitative research. For example, it produces a robust description of participants feelings, thoughts and experiences and interprets the latent meanings of their responses (Denzin, 1989). Another benefit of using qualitative research is that it has a flexible structure as the framework can be designed and re-designed to a greater depth (Maxwell, 2012). Therefore, the deep level analysis of a problem can be produced by utilising qualitative research and therefore the participants have ample freedom to choose what appropriate for them (Denzin & Giardina, 2016). Qualitative research also has its fair share of limitations. First it sometime disregards the contextual sensitivities and emphasises more on meaning and experiences (Silverman, 2015). Second, policy deciders may give low priority and credibility to the results from a qualitative research due to its too subjective nature. Stakeholders use quantitative research when they need to. For example, if a policy maker needs to vote on a problem, they could not wait for a qualitative research study to be conducted as this would be time consuming. The legislator may want a quantitative research study

instead of a qualitative research despite qualitative research having the ability to highlight to the stakeholder what works and what does not as the qualitative research provides a robust abundance of hidden subjective latent information that numbers cannot reveal (Sallee & Flood, 2012)

QUANTITATIVE RESEARCH APPROACH

Quantitative research emphasises on the quantification of the collected data. A research method that relies heavily on numerical measurement of variable that exist in the social world (Becker et al., 2012). Additionally, Becker et al., (2012) identifies positivism as a nomothetic approach in which knowledge gained from empirical testing. However, interpretivism in qualitative research opposes the positivist approach when the researcher argues that interpretivism focuses on the study of individual cases and the meaning that derived from the knowledge. This seems to reinforce as mentioned previously that there is a 'paradigm war' that exists in the research world in which researchers are playing on different sides of the academic sphere (Weber, 2004). Advantages to using quantitative research is that the results of the study are likely to be inferentially generalised to the larger population because it involves a larger sample size of randomized participants (Carr, 1994). This results in the data analysis being less time consuming since it uses statistical software's such as SPPSS software (Connolly, 2007). Given the benefit of using quantitative research it does have its drawbacks. For example, the positivist research paradigm excludes the meaning of social phenomenon as well as failing to delve deeper into the underlying hidden latent meanings underneath the numbers (Morgan, 1998). Quantitative research when conducted in a highly controlled setting can miss the participants experiences and perspectives because there does not seem to be a direct connection between the researcher and the participants when conducting the research (Ary et al., 2018). As a result, the results gathering method becomes objective.

MIXED METHODS APPROACH

Mixed method approach is defined as research in which the researcher collects and analyses data, integrates the results and draws inferences using both qualitative and quantitative methodologies (Tashakkori & Creswell, 2007). Mixed methods research has come along away since the paradigm wars that involved qualitative purists vehemently opposing the quantitative purists leaving little room for an intersectional collaboration (Onwuegbuzie & Leech, 2005). Post paradigm- war resulted in the arrival of three major schools of thought, the purists, the situationists and the pragmatists (Madill & Gough, 2008). The pragmatists aim to focus on the similarities between qualitative and quantitative research rather than the differences. Mixed methods are still not universally accepted in the mainstream academic sphere but is often looked at as an appropriate way to gauge ideas on the grounds of empirical and practical accounts (Collins et al., 2006). In mixed research there are several ways of collecting data. The first one is conducting close-ended and open-ended surveys depending on weather it is for the quantitative portion of the research of the qualitative portion. The second method is conducting interviews with the participants. These two methods of gathering data can complement each other well and therefore increase the validity and reliability of the results (Zohrabi, 2013). Surveys are without a doubt one of the most effective methods of collecting quantitative data in research. Surveys can be constructed in three formats which are close -ended questionnaires that yield numerical data, open-ended questionnaires which yield textural data and lastly a combination of the first two methods culminating in a mixture of closed and open-ended surveys. (Acharya, 2010). Interviews are a popular method of collecting qualitative data. The purpose of an interview is for the researcher to gain firsthand information directly from the participants. The researchers pay attention to not only the verbal responses but the non-verbal communication responses that the participant exhibits (Knox & Burkard, 2009). There are two ways interviews can be conducted in a mixed methods research. The first is a person-to-person format and secondly a group interview format in which both methods are structured in a goal-oriented conversational format.

STRENGTHS AND LIMITATIONS OF MIXED METHODS RESEARCH

Optimally designed surveys have several advantages (Boynton & Greenhalgh, 2004). They are an extremely efficient form of collecting data on a large scale, they can be administered simultaneously to many participants and the anonymity of the participants can be maintained on an elevated level which makes it easy to share the information (Jones et al., 2008). Survey questionnaire is also having their fair share of drawbacks. In some cases, the responses from the participants are inaccurate which can affect the overall validity and reliability of the research project, the return rate of surveys that are sent to participants via email or mail have been shown to slow and lastly some of the questions may cause confusion to the participant due to the wording of the questions not being clear enough (Bound et al., 2001). Interviewing as an instrument of qualitative research has several strengths in it use. Some of these strengths are: they are good at measuring attitude of a participant, they allow the researcher to use probes to elicit further detailed responses, they show to provide sufficient validity when it comes to interpretation, they have a very quick turnaround in response time if they are conducted over the phone, they have a high response rate and they give the researcher insight into nonverbal communication that the participants use such as facial expressions in response to a question and postural patterns (Zohrabi, 2013). Conducting interviews also comes with its fair share of drawbacks. Some of them are interpersonal interviewing can be time consuming and costly depending on the context your research, perceived anonymity of the participants could be low and lastly data analysis from interviews can be time consuming as you must transcribe the interviews before you can conduct a textual analysis (Johnson & Turner, 2003).

Reliability of mixed methods approach

One of the key prerequisites of any research endeavour is considering the reliability of the results and findings. Reliability refers to the replicability of the results obtained from a research that is to what extent can the results be duplicated if the same research was conducted by either someone else or yourself (Roberts & Priest, 2006). Ensuring high reliability is achieved in quantitative research is much simpler since the data consist of numbers form. However, in qualitative research to achieve the same level of reliability is much more difficult. This is due to the data being in narrative and subjective form (Syed & Nelson, 2015). To standardise this outcome, instead of aiming to get identical results in a mixed research, as a research its more optimal to focus on the dependability and consistency of the results gathered (Lincoln & Guba, 1985), This thought process aims to not obtain the same results but to agree either with yourself if your conducting intra-personal reliability testing or with another research during an inter-personal reliability testing, that based on the method of data collection and analysis the findings are consistent and dependable. Reliability can be examined through two specific lenses, external reliability, and internal reliability. External reliability refers to the ability for the researcher to duplicate the study and obtain identical or equivalent results to the initial research study. Internal reliability on the other hand refers to the consistency in the data collection and analysing process of a research project. Internal reliability can be achieved if a separate research conducts the same experiment and obtains similar or identical results as the original researcher (Nurani, 2008).

The last chapter discussed the origins and importance of qualitative research methods, quantitative research methods and mixed methods approach. Each method was compared against each other while touching on the importance of reliability of mixed methods approach. The aim of this chapter was highlighting each approach in a variety of contexts while primarily focusing on their application to research. In the next chapter we will examine the differences in approach to innovation by corporate sector firms compared to service designers. This chapter will also investigate the complexities of design thinking.

CHAPTER 2. COMPARING AND CONTRASTING DIFFERENT RESEARCH METHODS REQUIRED TO ACHIEVE SERVICE INNOVATION

BUSINESS ORIENTED APPROACH COMPARED TO SERVICE DESIGN APPROACH.

When looking at the differences between a "business-oriented approach" as supposed to a "design" approach to service innovation, Wroblewski (2005) highlights that

the reward structure in traditional business settings is based on corporate focus on the bottom line. This varies from a design structure finding reward in quality of solutions. To examine these profound differences between these two approaches playout in the real world, Liedtka & Ogilvie (2011) explored how business students and design students both conducted research into a hypothetical problem facing a leading consumer products firm. Leidtka and Ogilvie (2011) reinforced this difference methodology by highlighting that the business students would start by researching social, technological, environmental, and political trends in the marketplace, read analyst reports, interview industry experts, and benchmark leading retailers and competitors. From here they would recommend a set of strategies with ROI (return on investment) and NPV (net present value) calculations, then deliver a PowerPoint presentation (Liedtka & Ogilvie, 2011). Something to note here in the research practice of business students is that there is a heavy reliance on quantitative measures. Wroblewski (2005) explains that in a business approach to addressing problem-solving, it is more definitive and relies on proof through equations. Their approach is validated through what stakeholders say, and supported by market analysis (Wroblewski, 2005). Business oriented professionals are focused on the results of stakeholder activities and find that their product development phase can begin once their research is complete (Wroblewski, 2005).

Before it can be understood how people in the design world approach research for a problem, it is important to understand the design thinking process. There are five stages involved in the design thinking process. They are empathise, define, ideate, prototype, and test (Dam & Siang, 2021). The first stage, empathise, requires empathy to understand the problem at hand and involves research methods such as consulting experts, observing, engaging, and empathising with stakeholders, and immersion into the physical environment (Friis Dam & Yu Siang, 2021). Gasparini & Chasanidou (2016) notes key research methods when empathising is using personas, surveys, direct feedback, and focus groups. The define stage involves compiling the information previously gathered, and synthesis of observations to define the core problems (Friis Dam & Yu Siang, 2021). Research methods that are used during the define stage include brainstorming, surveys, co-design, interviews, workshops, customer journey maps, design scenarios, and focus groups (Gasparini & Chasanidou, 2016). Following to the ideate phase, Dam & Siang (2021) explain that now the designers can begin generating ideas. Gasparini & Chasanidou (2016) list the research methods involved in this phase. They involve using survey, co-design, interviews, workshops, observations, focus groups, and personas. Then comes the creation of inexpensive, scaled down versions of problem ideas, supported by research methods such as prototyping, co-design, stakeholder maps, workshops, and scenarios (Gasparini & Chasanidou, 2016). Lastly, the testing phase is where there is rigorous testing of the best prototype solutions during the previous phase (Dam & Siang, 2021). Research methods involved at this point include design scenarios, storyboards, co-designing, prototyping, workshops, focus groups, and stakeholder maps (Gasparini & Chasanidou, 2016).

The main takeaway from the entire design thinking process is that unlike a business approach, it is not a definitive linear approach. Instead, the process is iterative, and designers will consistently research throughout the entire process and simultaneously re-visit the distinct phases involved. The authors who are part of Murdoch universities design Team have spent the first semester of the SciTech co-design project working through the empathise, define, and ideate phases. Throughout the course of the semester, they have been travelling back and forth between stages, as each stage is an opportunity to learn more information. For example, when the Design Team began to ideate and generate ideas for SciTech's problem, they realised that they did not know enough about it to generate effective "solutions" therefore resulting in them having to find out more information by conducting qualitative interviewees of key stakeholders.

THE COMPLEXITIES OF DESIGN THINKING

Various sources within the pre-existing have discussed how issues can arise when design thinking is adopted by organisations to innovate services. For example, Mootee (2013 pp.16) proposes that applied design thinking is strategic innovation. He goes on to explain that innovation is more than simply planning of new products, services, brand extensions, technological inventions, or novelties, but is instead about imagining, organising, mobilising, and competing in new ways. Mootee (2013 pp. 59) further details that more than 80% of business management tools, systems, and techniques are for value-capture efforts, rather than value-creation. According to Ersoy (2018) design thinking has been misused by organisations in recent years, and as a result has led to mediocre and expensive design solutions. The fast-paced environment of traditional businesses looks for immediate proof of results. Ersoy (2018) mentions that in design thinking, expectations should be pushed to want more, but when it is adopted by businesses, they can settle into thinking "this is good enough". Research methods such as co-design and collaboration are a highly valued asset to a design thinking process because it gets multiple experts working together on one common goal. Ersoy (2018) finds that organisations can run into problems while attempting to do this due to design skills and problem-solving evaporating when there are too many people involved in the process at once. Being able to co-design with a range of people is also time-consuming. Sessions of group brainstorming, and co-design can fail because everyone's minds are limited to what they know at that point. With deeper exploration leads to a greater chance for a well-designed experience (Ersoy, 2018). As mentioned by Kueh (2019), there is a great need to insert the "thinking" back into design thinking. Thinking as a concept is the in-depth understanding of design while practising design. Kueh (2019) mentions that thinking initially had a strong tie with both academic conceptual research and industrial production advancement but now been adopted by organisations and has subsequently lost its initial value and touch with this new mantra of a "designedly way of knowing" becoming the new norm. This mantra reinforces today's attitude towards solving issues which is creating clear and fast steps to solve the issue at hand.

When trying to use research methods from design thinking, organisations can face problems when adjusting. For example, Carlgren et al., (2016) looked at five large firms and their use of design thinking. They identified seven types of challenges. The first one being "Misfit with Existing Processes and Structures." When using design thinking, it was perceived as resource-intense and front-end heavy, thus difficult to prioritise. The iterative work and encouraged deviations from the initial problem definition was contradictory to the logic of the linear mainstream processes (Carlgren et al., 2016). Carlgren et al. (2016) also encountered the problem that resulting ideas and concepts were difficult to implement. The insights that were gained through user studies and expanding problem definitions led to concepts that blew outside the scope of future products descripted in their product planning/conflicted with it (Carlgren et al., 2016). The third problem was that the value of design thinking was difficult to prove. This led to pressure to obtain quick results to justify using design thinking, and the difficulty to measure the outcome of the design thinking activities was hard for industries that measured value with ROI (Carlgren et al., 2016). The fourth issue the firms experienced was that design thinking principles and mindsets clashed with business culture. Design thinking's use of rapid testing of hypotheses and failing frequently to learn was hard for organisations with aversion to risks (Carlgren et al., 2016). The problem of threatened power dynamics was also present. Professionals felt threatened by design thinkers coming into their areas of expertise and questioning the functioning of organisational processes (Carlgren et al., 2016). The sixth challenge that Carlgren's et al. (2016) identifies was that the skills were hard to acquire. Research methods that are most valuable to design thinking are visualisation and qualitative user research, but firms reported finding it difficult to learn and overwhelming. It was hard to find the right people to recruit for the design thinking teams. The last issue that the firms faced was the difference in communication style (Carlgren et al., 2016). It was difficult for the firms to present and argue based on subjective data and human-oriented values, along with use of visual representations to explain ideas. These are challenges that can be overcome but requires a transformation in business culture. It is important that the design thinking process is not rushed, and all research methods are carried out to arrive at an experience designed to fit the appropriate stakeholders.

The last chapter discussed the differences in approach to innovation by business-oriented organisations and design-oriented organisations. The chapter also looked

at the complexities of design thinking and how business-oriented organisations need to reconsider how they approach their design thinking if they want to mitigate some of the barriers to success. The aim of this chapter was to compare different research methods into service design from a business first mindset and a service design mindset. In the next chapter we will examine visual communication and its evolution from traditional methods of approach to modern contemporary approaches. This chapter will also investigate how visual communications can overcome traditional barriers to understanding.

CHAPTER 3. THE PRECEDENT AND LEGACY OF VISUAL COMMUNICATION

THE EARLY TRADITIONAL UTILISATION OF VISUAL COMMUNICATION

Visual communication has been used throughout human history, in many different forms. Written language is a new development of humanity, and even more recent is elevated levels of literacy across the general population. It was therefore necessary for information to be transferred in a way that could be understood easily. This usually came in the form of items or imagery that offered context clues or induced certain associations in the viewer. One example is the use of crowns by monarchs. Within the context of medieval England, for example, a crown instantly conveyed a substantial amount of information about the person wearing it. This person is powerful, this person has a direct line to God, this person is rich, this person should not be approached or offended under threat of death, etc. All this information could be gleaned through the presence of a single object and is still used today to induce certain emotions in the viewer (Hepworth, 2014). Another example of visual communication from this time is the use of stained-glass windows in churches. Many barriers faced church attendees attempting to read scripture in the past. Many were illiterate, and even if they were able to read their own language, the Catholic bible and the sermons given by Catholic priests were in Latin. Even if this barrier was removed, reading comprehension was not a common skill. Therefore, stained-glass windows provided a way for these church attendees to understand at least some of the stories found in scripture. This was also a way to encourage the viewer to feel certain emotions about the events being portrayed. Aside from just the provocative imagery portrayed by the stained-glass, the sight of the sunlight shining through the beautiful, coloured glass was intended to inspire awe and reverence within the viewer. These emotions could not be otherwise induced by hearing the same story droned in a language one does not speak (Allen, 2012). These methods were often used with vague intentions. However, it was taken for granted that any individual who looked upon a crown or stained-glass window would have the context to react in the desired manner. This means that these methods of communication may have lost some or all their significance should someone without this context see them (Hepworth 2014). This is also reflective of the disconnect between those creating the images and those viewing them. The creators could not even imagine that someone would not share their context, and so did not account for this contingency. This was, in their own time, a fair choice to make. They were unlikely to interact with anyone not of their own status, race, religion, etc. There did not exactly exist a need to tailor visuals to a highly specific audience, especially one outside their own homogenous cultural context (Dyer, 1982).

MODERN CONTEMPORARY USES OF VISUAL COMMUNICATION

The reasons that visual communication is utilised in modern times are far more varied and intentional. The most prominent way that most individuals are communicated with visually in the modern era is advertising. Advertising is prominent in most channels of communication that modern humans have; print media such as newspapers, digital media such as television and websites, social media platforms, and many more (Bulmer & Buchanan; Oliver, 2006). This also means that there is a substantial number of sources concerning visual language in advertising. Therefore, it is fair to use advertising practices as an example of how visual communication is utilised in modern times. Advertising marked significant changes in the way humans communicated. It was the advent of widely circulated printed media, especially newspapers, that advertising began to change from a simple form of communication to its own overly complex ecosystem. In the beginning, visual aspects of advertising were small and simple; only meant to draw the eye of the viewer to the accompanying text (Dyer, 1982). It was often formal and to the point, until the rise of advertising agencies, and bans on illustrations and typographical restrictions being lifted. With particular focus on advertisements used by soap and detergent merchants, the illustrations commissioned by A & F Pears, for example, often depicted women, children, and mother and child pairs, partaking in baths or other household chores. The advert was attention-grabbing on its own, but it also put the product into a scenario their target consumer, homemakers, could recognise. The ad created an instant connection between the target consumer's own life and habits and the product itself (Erwig et al., 2017). These methods only became more refined by the 20th century. Adverts began to encourage insecurity and self-judgement within the viewer, asserting that the only way they could hope to mend their personal flaws was to invest in a certain product (Dyer, 1982). This is further reinforced by Hepburn (2014) who highlights the idea of the function of visual communication artefacts. She argues that these seek to change and produce certain emotions and behaviour in the viewer. In the context of a crown or stained-glass window, the intended message was designed to impact viewers of an overly broad shared-context - such as country of origin. In the case of advertising, advertisers reached a point where they were able to use tools such as social psychology to target specific segments of society, and in the process evoke specific emotions or behaviours out of there intended target audiences (Dyer, 1982).

HOW VISUAL COMMUNICATION CAN OVERCOME TRADITIONAL BARRIERS TO UNDERSTANDING

Visualisation can facilitate the transfer of ideas between individuals of different areas of expertise or study. Different areas of study all contain their own language, with complex vocabulary and concepts. This nuance can be difficult to convey to anyone who has not spent years steeped in a specific area of expertise. For example, most individuals in the service design industry know words such as prototyping, conceptualisation, ideation, etc., as well as what those words mean, the context in which they are used, and the impact of these practices. This vocabulary, however, can mean little to nothing, to an individual outside of this industry (Engbretsen & Kennedy, 2020). This is significant, as service design is usually outsourced to a design firm since the client facing the design problem may not specialise in this area. Once the design firm has identified what needs to be changed to address the design problem, they must then inform the client. It is vital for the client to understand the significance of the ideas being presented. As mentioned by Hepworth (2014, p.228), "A crown is only awe inspiring to people who are both aware of its importance in a given tradition and have a meaningful connection with that tradition". A client may not have the context needed to make sense of design theory. Therefore, visualisation, if used effectively, can make design theory tangible to the client, as well as convince them of its value and potential impact on their design problem. It is important that, if visualisation is being used with a specific individual or group in mind, the context of that group or individual is considered. Language and meaning do not exist in a vacuum. A designer cannot simply create an image based solely on their own context and understanding and expect every single viewer to instantly comprehend the intended meaning. At best, the communication will simply fail. At worst, the designer could cause great harm or offence to a community (Bederson & Shneiderman 2003). This can partly be attributed to the highly subjective nature of visual analysis. According to Hepburn (2014), the bias of individual historians, whether they are aware of this bias or not, colours their final conclusions significantly. Hepburn (2014) also argues that the power of visual language comes from a pre-existing shared context between the viewer and the creator. While this may seem to weaken the power of visual communication, in certain contexts this can be considered a strength. If an individual understands the context of people they are trying to communicate with, they may be able to communicate concepts or ideas even more effectively. This has been proven in the context of advertising, with advertisers able to target specific groups and their specific insecurities to create consumers (Dyer 1982). Using methods of visualisation or aspects of visual language that are familiar to the

viewer can help to convey the full significance of the message in ways the creator's own context could not.

The last chapter discussed the evolutionary history of visual communication and more specifically focusing on the differences in approaches to visual communication from a traditional point of view as supposed to modern contemporary points of view. The chapter also looked at how visual communication can overcome traditional barriers of understanding to success. The aim of this chapter was to examine how visual communication has evolved over time and how different industries and fields approach and utilise visual communication differently to achieve a specific goal. In the next chapter we will examine the importance of visualisation methods in design thinking. This chapter will also investigate why we need visualisation in service design to achieve innovation.

CHAPTER 4. AN EXAMINATION OF THE IMPORTANCE OF VISUALIZATION METHODS AND PRACTICES IN DESIGN THINKING AND SERVICE DESIGN FOR ACHIEVING INNOVATION

EMPATHISE PHASE

According to Kernbach & Nabergoj (2019, p.3) describes the main function of the empathise phase for the Design Thinking team is to "observe, engage and immerse" with the user and their experience. At the core of this stage, it is to identify the right users and stakeholders, uncovering their needs and discovering their emotions by conducting exercises, which guides innovation efforts.. (Kernbach & Nabergoj, 2019; Gibbons, 2018). To identify the right users, one key exercise that occurs is the identification and mind mapping stakeholders and using this information to create a 'stakeholder map'. These are produced to understand the different users, the diverse groups, and how they are connected and in what system they operate. We can establish the relationships between stakeholders, their needs and requirements which are visualized as a conceptual diagram, positioning who are most affected closer to the middle of the page, supplying us additional meaning using space. These are created by hand and are replicated easily on a computer software system. Kernbach & Nabergoj (2019) concludes that it is important for the Design Thinking team to visualize the user and the stakeholders, to make the context that is tangible and clarified, however not prematurely commit to a tangible solution design. Kernbach &Nabergoj (2019) identified how visualization makes concepts more concrete and manageable. Having stakeholder maps visualized is useful for other team members, board members, employees, stakeholders, users etc, who can "see" the relationships, identify missing links, and discover the core issues of the organisation where feedback and co-design can occur. An example is sketching up a stakeholder map on paper, it allows for easy modification and additions, and it is collaborative. Rapid changes are facilitated, emerging the ideas and options.

Other exercises that are conducted in this phase are "empathy mapping". These are efficient tool to understand user's behaviour, attitude, along with visually communicate their feelings. (Browne, 2020; Gibbons, 2018). We can develop a deep understanding of the users, revealing holes in existing data research. We can establish a common ground among team members and prioritise the needs of the users when developing the project. These are conducted at the beginning of a project and should be revised as research continues. (Gibbons, 2018).

DEFINE PHASE

According to Kernbach &Nabergoj (2019) the define phase is, where we unpack and synthesize our findings into needs and insights, this is to find a scope and the unique, relevant design challenge. This includes developing a rich understanding of the user and create an actionable problem statement, also known as "point of view" (POV). The POV is a literary device used in writing that indicates the perspective of which a narrative is told. A professionally written POV is a guiding statement that frames the problem, captures the needs and insights of the user, influences the team and acts as a reference for innovative ideas. Templates such as a "Venn diagram", or a "Matrix diagram" help synthesize research allowing us to analyse the issue. (Pollastri, 2012, p. 27-28). The dimensions of these templates derive from the data about the users and are used at a large scale with post-it notes to make necessary changes until it is digitized. The main function of the define stage is to synthesise findings into needs and insights, to be able to find the overall scope of the design challenge. What is represented are the interviewed and observed users, organised in two dimensions: Time of Diagnosis and type of coping activity. (Kernbach & Nabergoj, 2019; Pollastri, 2012). It is visualised using a 2 by 2 matrix or Venn diagram template to then be digitized on the computer. Other tools used by design thinkers in this stage are "Personas", that help give faces and personalities to the customers, "Mind Maps" and "Customer Journey Maps" that allow us to understand the deeply rooted issues, "Mood Boards" and "Visual Stimuli's" to create an identity for the project. (Toco, 2018).

IDEATE PHASE

The main function of this phase is to generate ideas and explore wide solution spaces and focus on the diversity of concepts before evaluating and choosing an idea. This phase represents the transition from identifying problems to exploring solutions for users. This phase allows design thinkers to rely on simple visualization that will create impactful designs such as visual metaphors. (Kernbach & Nabergoj, 2019; Pollastri, 2012; Grochowska, 2015). These metaphors offer advantages such as they convey insights about the represented information through key characteristics. The main functions of ideate are enabling free visualization of ideas and concepts that can develop a solution to the problem, and these are done through activities like "Multiple Universe" and "Crazy 8's". It represents the spectrum of ideas that have been generated by all team members, to find the best solution. (Kelcher, 2021). They are conceptualised with metaphoric hand drawings and post-it-notes on a poster or whiteboard before it becomes digitized. The range of visual metaphors is vast, especially when the Design Thinking team is large and diverse with people from diverse backgrounds. Ideation prompts emotional responses from the audience and are remembered better. (Kernbach & Nabergoj, 2019). In many cases, these concepts of rough low fidelity drawings can be left as they are and not be digitized to show the stakeholders the progress of the Design Team. In this phase, many ideas end up converging and turning into concepts that can be used by the organisation or business with the original problem.

PROTOTYPE PHASE

The main function of the prototype phase is to translate ideas from the ideate phase, into the physical world and create something tangible and real. Creating them in the early phase should be rough and rapid. They are the most successful when users can interact with them, allowing an opportunity to see how it works. (Pollastri, 2012). They help to further gain empathy, explore, and test ideas, get inspiration to develop designs, start conversations. (Kernbach & Nabergoj, 2019), open a dialogue when a disagreement arises, allowing failure to happen quickly and cheaply. (Brown, 2021). Prototypes are distinguished between low fidelity and high fidelity. (IDEO, 2019; Tufte et al., 2013). Low fidelity is recognised as sketching and drawings while high fidelity is objects and role play. The results of a low fidelity prototype are a "Customer Journey Map," a "Storyboard" or concrete sketches which shows the process of the user. It is important to have rough and rapid sketches that signify "work in process" and "low perceived readiness" to invite ample modification and feedback. (Kernbach & Nabergoj, 2019). Here we allow people to engage with the prototypes to test out the ideas. We can receive customer feedback and experience which can either be the finished result or used to improve the design. (Pollastri, 2012). What is represented is the customer journey, and the phases of each touchpoint and interaction, their emotions along the way. It is visualized with concrete and metaphoric hand drawings on paper.

TEST PHASE

The "test" phase is for refinement of the proposed solution by putting the prototype to use by the users, customers or even employees, testing them to refine the design. By testing and refining these prototypes, design thinking teams learn more about the user and might even refine the original problem statement (POV) that

was created earlier in the project. (Kernbach & Nabergoj, 2019; Leifer & Meinel, 2019). Design Thinking teams are required to test their prototypes early to learning from their experience that can refine the design for the new prototype. (Grochowska, 2015). This phase requires prototyping and testing to occur rapidly, to fail early and cheaply. (IDEO, 2019). Testing organises the feedback into four pre-defined categories such as what works, what does not work, what improvements can be made and what innovative ideas have formed?

WHY DO WE NEED VISUALIZATION?

Visualization has the power to quickly generate a tangible output by sketching, allowing an emotional response to occur by the audience, and make it easier for them to give feedback as these prototypes are the signals for "work in progress". (Kernbach & Nabergoj, 2019). The beauty of data visualization is that it gives context to numbers and establishing a relationship between them. (Rosling, 2006). Today in our digitized world, data is the new oil; it is all around us to be mined and sold off for profit. (McCandless, 2010). We need to imagine a landscape of this information as we are told the numbers, but we do not see the relationships, so we turn numbers into a landscape. In the TED Talk by David McCandels he quotes "If you are navigating a dense jungle of data and information, it is a relief to see visualization as it feels like a clearing" (McCandels, 2010. 9.03min).

The use of visualization in design thinking is fundamental as it helps to share and communicate ideas, create mutual understanding, speeds up the process for more and faster innovation cycles, and enables insights leading to actions that achieve innovation. (Kernbach & Nabergoj, 2019). Our eyes are exquisitely sensitive to patterns and colours, it is like speaking two languages as your eyes look and interprets the information through your perception. We utilise data visualization to squeeze an enormous amount of information into something visual and understandable. It provides solutions by allowing people to see the enormous amounts of data that is gathered efficiently. (McCandless, 2010).

The last chapter looked at the visualization methods and the 5 stages involved in achieving innovation. These stages consist of empathize, define, Ideate, Prototype, and Test. The chapter also examined how these stages of the design thinking process use visualization activities and why design thinkers use them. The aim of this chapter was to examine the importance each phase in contributing to optimal innovation as well as discussing the key role visualisation plays in service design. In the next and concluding chapter, we will discuss the importance of user voice in research for service innovation.

CHAPTER 5. THE POWER OF STORIES TO DRIVE SERVICE INNOVATION

IMPORTANCE OF STORYTELLING IN DESIGN

Connelly & Clandinin (1990, p.2) said that "humans are organisms who, individually and collectively, lead storied lives". Stories, like experiences, reflect exchanges and encounters between people, objects, and environments over a period (Brun, 2017; Quesenbery & Brooks, 2010). The act of telling a story seeks to make meaning of these experiences (Celikogin et al., 2020; Bleakley, 2005) and have this meaning understood by others (Brun, 2017). Whether spoken, written, or visually articulated, the environment in which storytelling occurs impacts the process of producing knowledge through the sharing of experience (Hampshire et al., 2014). For this reason, stories are subjective; the storyteller cannot describe every minute detail of their experience, so it is up to the audience to interpret the blank spaces (Quesenbery & Brooks, 2010). The aural or written mode of sharing these experiences relies heavily on the use of language and narrative structures which help to organise the structure and order of a story over time through the idea of narrative arc (Celikogin et al., 2020). A narrative arc divides a story into the exposition, rising action, climax, falling action and denouement, and provides an expectation that there will be changes in tension and emotion that reflect the experience of the storyteller (Lupton, 2017). Therefore, depending on the experience and expectation of the storyteller and listener, the exchange that occurs when a story is told results in the co-creation of shared knowledge and understanding. This gives rise to the possibility that the same story may generate different meanings depending on the context of these two parties (Hampshire et al., 2014; Parrish, 2006).

Stories provide a valuable contribution to the field of service design as tools to better understand user experience (Quesenbery & Brooks, 2010). The process of actively listening is a crucial step in the exercising of empathy which allows a designer to understand the actions, needs and desires of users, and how they interact with services from the user's perspective (Carmel-Gilfilen & Portillo, 2015; Parrish, 2006). While quantitative or 'big data' may provide statistical insights into patterns of interactions with services, stories provide the 'thick data' or qualitative insight as to 'why' such interactions occur (Bleakley, 2005). They provide understanding of the social, political, environmental, and cultural context in which users engage with services. Stories and experiences are both context specific therefore understanding the conditions in which users experience or would like to experience a service can result in design of delightful service interactions (Brun, 2017). In addition to context, stories provide powerful insight into the values, beliefs, and motivations of their tellers (Quesenbery & Brooks, 2010). Most often with a foundation in cultural context, stories give insight into why a user engages with a service by going beyond temporal events and connecting action to motivation. Understanding motivations is key to creating services that have value for users in meeting their needs and desires (Stickdorn & Schneider, 2011; Polaine et al., 2013). The process of engaging users in storytelling in research for service design can help to empower them to be active participants in the design of services, otherwise known as the process of co-design (Stickdorn & Schneider, 2011). Service design is a field that aims to design with, not for, users, so it only makes sense to employ storytelling to "research with, not on, people" (Bleakley, 2005, p. 535).

INTERVIEWING AS A METHOD FOR STORY COLLECTION

In the field of service design, the goal of research with stakeholders is to understand their experience, values, and beliefs, needs and desires to create services and experiences which provide value and meaning (Stickdorn & Schneider, 2011). This research may be conducted in several ways to generate both quantitative and qualitative data. Quantitative methods commonly include a landscape analysis of secondary data including prior research, reports or papers, existing market, and behavioural research, as well as tools like surveys (Penin, 2018). Research for service innovation places emphasis on more qualitative and ethnographic research methods due to their focus on the lived experience of participants (Wilson, 2014).

In a review of key service design literature, Segelström (2013) reports that interviewing is a key method used to conduct qualitative research with users. Interviews encourage sharing of stories and experiences and provide the opportunity for researchers to listen in for deeper contextual meanings which can provide useful insights for developing services that seamlessly meet the needs of stakeholders (Quesenbery & Brooks, 2010). It is important to note that interviews occur in a context that is typically unnatural for the participant due to their staged nature. This means that researchers must consider that stories offered in the interviewing process have the potential to be performative due to a participant's response to the context of the interview (Csordas et al., 2009).

Adopting more loosely structured, casual interview techniques is a way to make participants feel more at ease and safe in sharing their perspectives (Wilson, 2014). This style of interviewing is known as a semi-structured interview and involves the use of closed questions that allow the researcher to establish a topic or experience, supported by open-ended exploratory questions that are used to elicit detail about individual experiences and interactions relating to the topic (Csordas et al., 2009). It is important for gathering rich information that the interviewer speaks as little as possible to create space and time for the participant to share stories (Wilson, 2014). Beyond asking initial questions, the interviewer may use gentle interventions and neutral prompts in the form of gestures or verbal cues to encourage a participant when they become stuck or unsure how to continue (Crouch & Pearce,

2012). This technique, known as probing (Given, 2008), requires active listening by the interviewer who can prompt the participant for clarification or elaboration. This may be through paraphrasing, physical and verbal signs of encouragement like nodding, smiling, or 'hmm'ing, or by further succinct questions like "can you tell me more about that?" (Given, 2008; Crouch & Pearce, 2012). All questions and probes should be non-leading to not put words, ideas, or statements into the participant's mouth or to give cues to the types of information or experiences the participant may think is required of them (Crouch & Pearce, 2012; Wilson, 2014). The interviewer should remain as neutral but encouraging as possible, pushing aside their own beliefs and opinions to create an unbiased space for the sharing of stories and insights (Clandinin & Connelley, 2000).

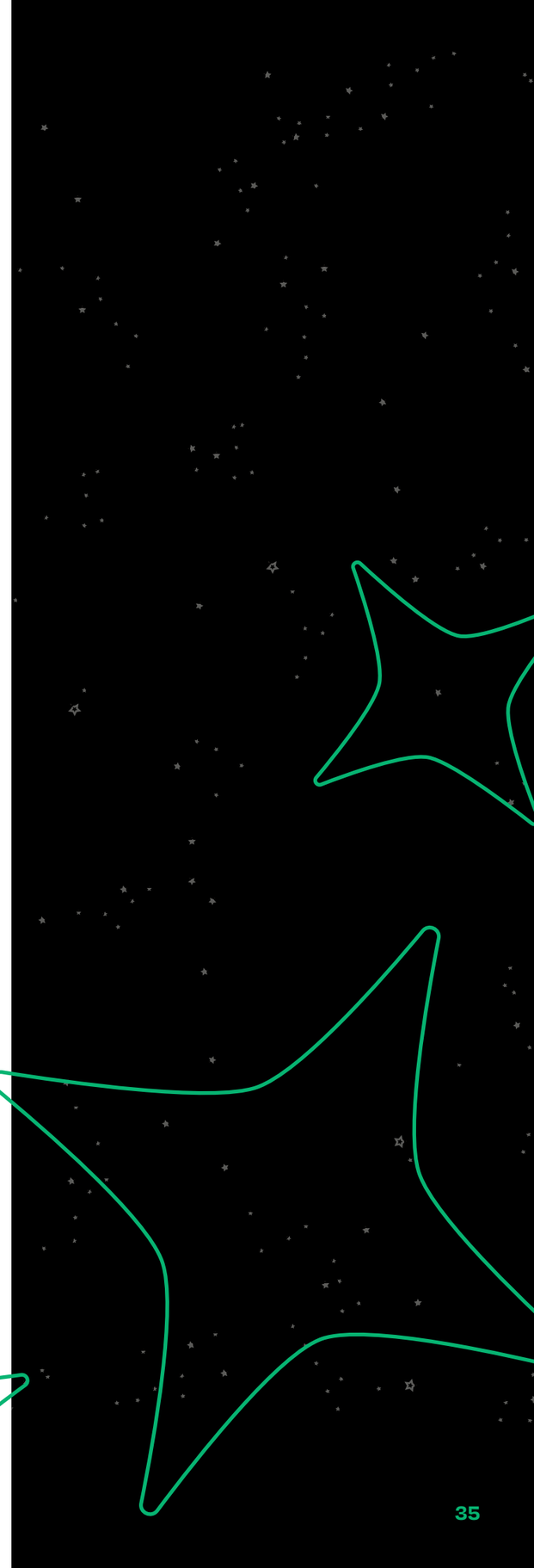
Conducting interviews in an environment that is familiar, comfortable, and non-threatening for the participant further promotes open conversation and helps to build empathy by understanding the participant's world (Penin, 2018). In this way, stories can be supported by observation of the participant's space, generating richer insights into behaviours, motivations, and relationships. Benefits of interviewing in this setting can also include access to personal items and objects which can be used to prompt stories, memories, and interactions (Wilson, 2014). Introduction of such interview aids is an important adaptation that may cater to the needs of some participants and help to generate richer data when there may be communication difficulties due to perception of safety in disclosure or cognitive need for assistance (Fearon, 2019). Fearon (2019) suggests that adapting interview techniques to support participant engagement helps to shift power from interviewer to interviewee which is supported by Segelström's (2013) observation that research methods and tools should be tweaked and adapted depending on the context in which they are applied.

Hampshire et al., (2012) noted that the sharing of a story results in knowledge and understanding that is co-created between teller and listener. It is important draw attention to the fact that stories must be interpreted by an interviewer to understand not only what was said but how the cultural context, values, beliefs, and opinions of the storyteller shape what was shared or, sometimes more importantly, what was not shared (Crouch & Pearce, 2012). Owen and Westoby (2012) refer to this as creating understanding by examining text, sub-text, and context. Denscombe (2014, p.190) introduces the "interviewer effect" to think about the impact that the interviewer's own identity (age, sex, ethnicity, position, or religious beliefs) has on how comfortable a participant feels in sharing details or areas of their story. In addition, Clandinin and Connelley (2000, p.45) discuss the importance of being "autobiographically conscious". When co-creating knowledge and understanding with storytellers. They highlight that the way we make meaning of information is informed by our own lived experiences, context, values, and beliefs, specifying that as researchers and designers, it is crucial to question whether understanding and knowledge is reflective of what the participant knows to be true or their own personal perspectives. Segelström's (2013) research with practising service designers highlighted difficulties relating to the interpretation of interview stories. They found that it was difficult to include clients in the interviewing process because they did not have the reflective skills required to remain autobiographically conscious or understand the interplay of text, sub-text, and context, considering their interpretation of stories to reflect a participant's true lived experience. This highlights the need to synthesise insights gained from stories and visualise them to create shared understanding for participant, interviewer/design team, and all other stakeholders. It is only when the insights gained from participant stories are reflective of their true lived experience that they are useful to informing service innovation (Polaine et al., 2013). If not, designed service experiences will fail to meet the expectations and needs of stakeholders.

CONCLUSION

In conclusion this critical literature review examined several key research areas that influenced our work working with SciTech in co-designing a service design project. We narrowed our scope to 5 key areas that were covered critically. The first chapter examined the different research methodologies that exist in academia. These methodologies covered quantitative, qualitative, and mixed methods. Comparing and contrasting these methods to illustrate their use in service design innovation. The second chapter covered the differences in approaches to innovation specifically from a business-oriented nature as supposed to a service design nature. This chapter also covered the complexities of design thinking. The third chapter discussed the history and early utilisation of visual communications compared to modern uses of visual communications. This chapter also analysed how visual communication can overcome traditional barriers of understanding. The fourth chapter looked at the 5 stages involved in the design thinking process and examined each stage critically as well as looking into how each state uses visualisation activities. Lastly the fifth chapter discussed the importance of user voice in research for service innovation. This was further examined by focusing on storytelling in design as well as interviewing as a method for story collection.

The purpose of focusing in on these 5 key themes was intentional as it provided the scholarly background and foundational knowledge for how we were going to approach the co-design project with SciTech. Key areas such as visualisation and research methods reinforce the important roles, they each play in ensuring due diligence is undertaken when working with a client in attempting to "solve" a problem. The research conducted within this review has strong implications for service designers, for-profit organisations who aim to "solve" a wicked problem as well as design thinkers who are currently working with clients in a co-design format.



DESK RESEARCH

SCITECH

Research into Scitech was crucial to understand the company from both internal and external perspectives.

Exploration was conducted into their mission and values which drive commitment and interest in the project. This was achieved through analysis of Annual Reports, Business Plans, the New Scitech Strategy and a review of the website. From our external position, we had the opportunity to explore Scitech's service offerings from an outside perspective.

This was achieved through a review of the website and social media pages while keeping the actions and needs of key users in mind. In addition, we analysed a number of Customer Insight reports to understand the relationship between Scitech and its key user groups.

A BRIEF OVERVIEW:

Scitech is a not-for-profit organisation, established in Perth, Western Australia in 1987. For over 30 years, they have been focused on delivering experiences that inspire curiosity and engagement with STEM (Science, Technology, Engineering and Mathematics). Scitech is on a mission to "be a world leader in providing innovative and creative STEM programs that inspire, engage and develop citizens for Western Australia's social well-being, economic prosperity and sustainability"(Scitech, 2018). Through their Science Centre, based in West Perth and their outreach programs that take the Scitech experience to the furthest corners of the State, Scitech is able to impact the lives of 500,000 members of the community every year. In addition to their community based educational programs, they play an important role in the support and training of 4,000 educators to promote the delivery of STEM in the classroom (Scitech, 2018).

Figure 5: "Scitech website landing page"

FUNDING AND PARTNERSHIPS

Scitech partners with a number of stakeholders across government, corporate industry and community groups to fund and deliver services across WA.

Primary Partner:

State Government of Western Australia Department of Jobs, Tourism, Science and Innovation

Corporate Partners:

- Alcoa
- BDO
- BHP
- Chevron Australia
- Fluor
- Mitsui Iron Ore Development
- Perth Airport
- Rio Tinto
- Santos
- Shell
- WESCEF
- Western Power
- Woodside

Funding from corporate partners enables delivery of locationally specific programs around WA. These include the Lighthouse Maths Program, Champions of Maths, as well as support for Statewide outreach tours to regional and remote areas. These funding partners accounted for $2,665,181 of revenue in 2020.

THE NEW SCITECH STRATEGY

In 2018, Scitech presented a new strategic vision for equipping all Western Australians with the 21st century skills needed now and for the future (Scitech, 2018); The New Scitech Strategy. This plan outlines four pillars that support this vision:

- State-of-the-art Science Centre(s)
- Targeted deeper reach beyond the centre
- Informed public voice for stem
- Highly connected stem community

This strategy is to be enabled and supported by business growth and sustainability.

Whilst our initial problem statement draws directly from the second pillar of targeted deeper reach, it was important to understand the context and environment that the project had to support rather than hinder.

SERVICE OFFERINGS

Scitech offers a range of services through three primary modes of delivery; direct engagement at the Science Centre, Outreach experiences, and online engagement through social media.

Science Centre:

The Science centre, located in West Perth, provides STEM based exhibitions available to be experienced by the general public, schools and community groups. Currently, the centre hosts a range of permanent exhibitions, supported by the Rio Tinto Tinkering Space, The Earth Matters Exhibition, shows in the Chevron Science Theatre, the Science Lab and the Southern Hemisphere's largest Planetarium.

Outreach:

Yearly, Scitech visits 493 schools, engages with 160,000 students, and drives 112,000km on 18 Statewide Outreach tours. They deliver school based programs for Early Childhood, Primary and Secondary Schools as well as specialised programs for educators and Indigenous students, visiting every school across WA at least once every three years.

Figure 6: "New Scitech Strategy" retrieved from https://www.scitech.org.au/about/reports-financials/

In addition, they also offer DIY Kits which provide a term's worth of curriculum aligned lessons to deliver in the classroom, accompanied by all consumables and equipment required for implementation.

Online Content:

Scitech offer a number of online resources to extend learning beyond the centre. A range of video content is supplied through Youtube and Facebook, providing guidance to conduct activities and experiments at home.

Scitech also deliver three podcast series, Particle, Wonder Kids, and The Audio Guide to the Galaxy, accessed through all podcast providers.

The Particle Podcast is also supported by an online blog, aimed at readers over 18 years of age. Their Facebook page provides the link between all of the online resources and the activities/programs in the centre. The Instagram page supports content shared on this platform.

Whilst Social Media pages draw direct attention to specific content through the blog style of posting, it takes more effort to navigate past the landing page of the Scitech website to access 'at home' content.

STEM

WHAT IS STEM?

The Australian Department of Education defines STEM as **"AN APPROACH TO LEARNING AND DEVELOPMENT THAT INTEGRATES THE AREAS OF SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS".**

Through STEM, students develop key skills including:

- Problem solving
- Creativity
- Critical analysis
- Teamwork
- Independent thinking
- Initiative
- Communication
- Digital literacy

They also present STEM as valuable in terms of responding to automation shrinking roles in trade-based industries, and in preparing students to fill emerging roles within the STEM industry. The Department of Industry, Science, Energy and Resources (2021) defines the value of STEM strictly in relation to how it can increase Australia's stake in the global economy, and what innovations in STEM can bring to public infrastructure. In a similar vein, Scitech (2021), as an organisation, views STEM as '...the driving force behind growth, innovation and change in humanity's future'.

It is important to note that this definition of STEM is not recognised by all organisations in the industry, especially those in education. There has been a longstanding push for integration of The Arts into STEM, transforming the acronym into STEAM (Khine & Areepattamannil, 2019).

Approaching traditional STEM fields through the lens of creativity is said to increase capability to comprehend complex ideas, increase capacity for innovative problem solving and provide context and application for isolated STEM ideas (Gibson & Ewing, 2020). The Arts provide the understanding of the environment and people that influence and are impacted by STEM.

WHY IS IT IMPORTANT?

The global economy is changing; current jobs are disappearing due to automation, updated and new technology, while new jobs are emerging every day because of these technological advancements. The continual advancement in technology is also changing the way students learn, connect and interact every day. Skills developed through STEM by students will provide them with the foundations to succeed at school and beyond, in the work force.

There is a high demand for STEM skills and qualifications by employers, and this will continue to grow in the future. Currently, 75% of jobs in the fastest growing industries all require workers to have STEM skills. The Australian work force needs people to adapt to the changing face of the workforce (Government of Western Australia, 2019).

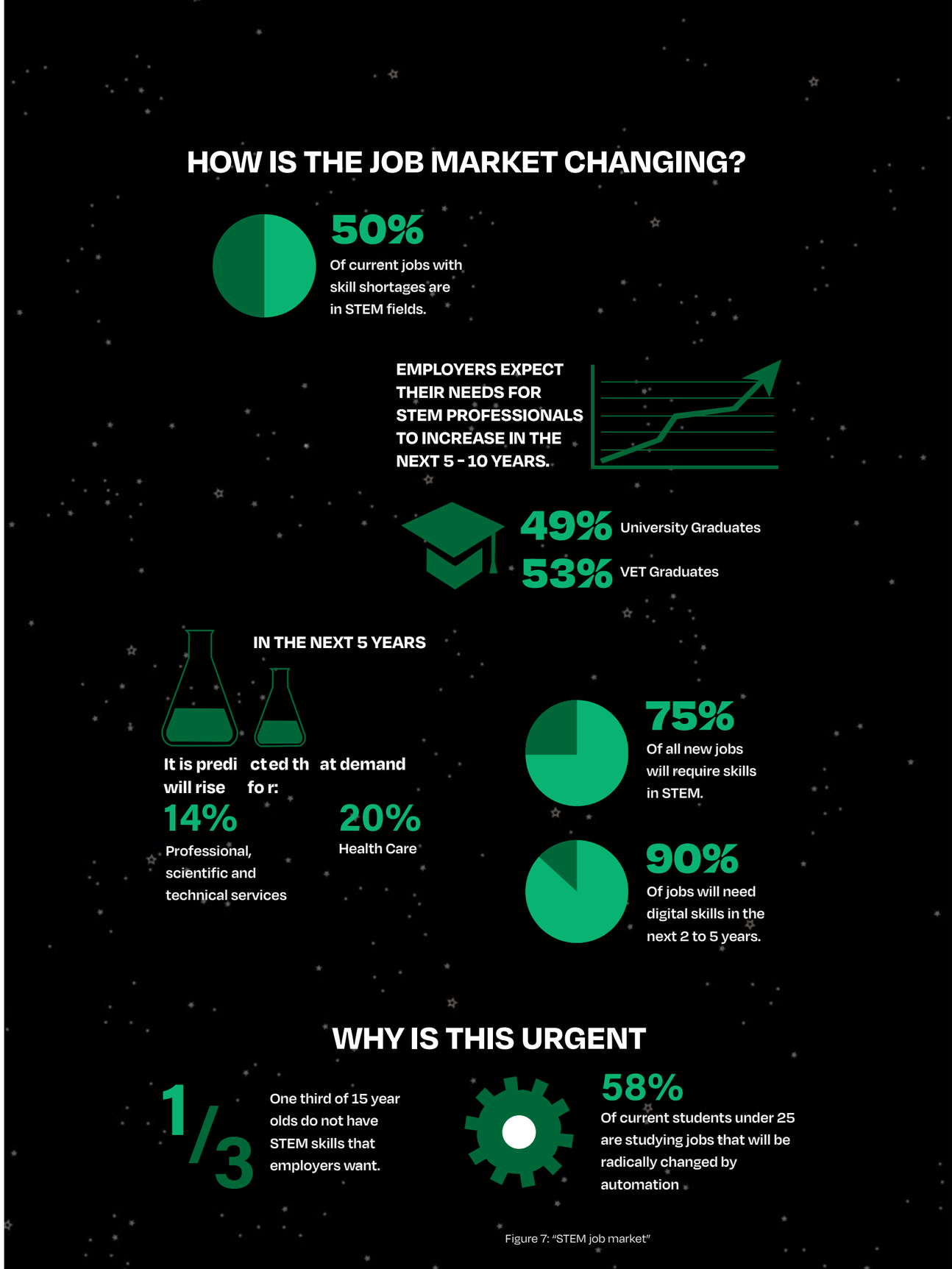


Figure 7: "STEM job market"

Figure 8: "CSIRO's Indigenous STEM Education Project" retrieved from https://www.csiro.au/

PARTICIPATION IN STEM

The Department of Education research (2021) has shown that in Year 5 and 6, girls' perception of STEM subjects and STEM based learning begins to change. Girls tend to:

- Loose confidence
- Believe that STEM is something only boys do well in
- Not an area a girl can excel in

These perceptions continue to grow throughout school and into career choices after graduation. There are many myths and misconceptions in society about what girls do, and don't do well in. This is reinforced by the under-representation of girls in STEM related jobs.

To meet the needs of a dynamic workforce centered on innovation and creativity, girls represent a unique perspective and untapped talent. All young people need to be learning STEM skills and qualifications to ensure Australia's competitiveness on the worlds stage.

It is urged that schools empower girls from a young age, challenging myths and misconceptions, and showing them that STEM can help change the world.
Girls feel less confident when studying STEM courses, however they perform at the same level as their male peers, and often even surpass them. However, only 7% of girls study the most challenging mathematics subject. There is 1 girl to every 3 boys studying Physics, and 1 girl to every 2 boys studying mathematics (Department of Education, 2021).

Indigenous participation in STEM education and industry is also an area that requires attention. There is evidence of increasing uptake of STEM in secondary education for Aboriginal and Torres Strait Islander students, and whilst this does follow through to tertiary enrolments, the completion rate of these enrolments drops significantly. These facts indicate there is still much work to be done before equal representation can be seen in STEM participation for Indigenous Australians (Department of Education and Training, 2015).

Participation needs to be supported by the implementation of culturally relevant, sensitive teaching pedagogies that integrate indigenous knowledge, develop more relevant methods for communication and assessment, and engage broader communities in the educational environment.

KEY FINDINGS

- Uncertainty and differing opinions about the nature and definition of STEM make it difficult to come up with a shared vision for its importance
- The skills provided by STEM are crucial for building capacity of future generations to adapt and respond to global challenges
- Women and Indigenous communities face barriers to engagement that must be addressed to encourage participation and greater knowledge of the future workforce

DELIVERY OF STEM IN CURRICULUM

The Western Australian Curriculum and Assessment Outline sets out the curriculum for children from Kindergarten to Year 10. STEM knowledge and skills are embedded across multiple disciplines.

In year 11 and 12, students work towards gaining their Western Australian Certificate of Education (WACE), choosing either academic or vocational pathway. There are a range of STEM related courses that children can access.

SCIENCE

The S stands for science which children from Pre-primary to Year 10 are required to study.

TECHNOLOGY

The T stands for Technologies, and it is an important part of the Western Australian Curriculum. It allows students to study the following:

- Engineering principles and systems
- Food and fibre production
- Food specialisations
- Materials and technologies specialisations

ENGINEERING

The E stands for Engineering. Engineering principles can be integrated into science, technologies, and mathematics learning programs.

MATHS

The M represents Mathematics which all students from Pre-primary to year 10 are required to study.
(Australian Curriculum Council, 2020)

STEM IN HIGHER EDUCATION

Some of the emerging careers in STEM fields are:

- Environmental studies
- Other natural and physical sciences
- Fisheries studies
- Engineering related technologies
- Information technology
- Earth sciences
- Forestry studies
- Biological sciences
- Agriculture, horticulture, and viticulture

Employer demand for graduates with these qualifications and skills is on the rise and will continue to increase as job roles diversify. However, larger proportion of students are not studying STEM subjects or considering STEM related careers.
Alarmingly, 60% of students are studying for jobs that will not exist or that will be radically affected by automation in the next 10 to 15years.

Employment opportunities in STEM related industries are increasing each year. Future career paths are changing due to the job market being less predictable, automated machines performing human tasks, and globalisation that allows people to work around the word. When the15-year-olds of today enter the workforce, they will have navigated 17 different job changes and 5 different careers in their lifetime.

Figure 9: "Students and STEM"

IN THE FUTURE YOUNG PEOPLE WILL NEED TO:

- BE ACTIVE PROBLEM SOLVERS
- BE COMMUNICATORS OF IDEAS
- HAVE A MORE ENTREPRENEURIAL MINDSET
- HAVE A DEDICATION TO LIFELONG LEARNING

DELIVERY OF EDUCATION EXPERIENCES

DIFFERENCE BETWEEN REMOTE & LOCAL

When examining the factors that either hindered or supported learning in remote and metro settings, we identified locational barriers, as well as access to technology and resources, as the primary source of disparity between these communities.

LOCAL (METRO)	REMOTE (REGIONAL & ISOLATED)
» Travel & access to Scitech via parents or school excursions are largely manageable	» Travel to Scitech centres is difficult - big time + cost investment
» Travel to school via Scitech's outreach team more manageable	» Scitech outreach incursions are limited - regional schools are only visited every 3 years, and incursions are limited in content and time. There is also no way to measure audience experience
» Access to technology and the internet is common - distance learning options are available	» Access to technology and the internet more limited in some areas - distance learning options may not be viable

Figure 10: "Scitech AEP Incursion" retrieved from https://www.scitech.org.au/incursion/aboriginal-education-program-student-workshops/

IMPORTANCE OF CULTURAL AWARENESS & SENSITIVITY

The lack of diversity within STEM industries implies a lack of consideration for the needs of anyone in a currently, underrepresented group. The focus of research regarding participation in STEM-based studies, and by extension organisations such as Scitech, is on current participants. Precedent studies into the underlying reasons that ethnically, culturally, linguistically, or otherwise diverse individuals do not participate in STEM do exist, but they are rare, and do not take place in Australia.

It is rarer that the responsibility is not placed upon these communities to assimilate into a dominant culture, and set of standards in order to access STEM learning experiences. Many STEM initiatives are designed without the input of diverse communities and cultures. This can result in the people designing these initiatives to make assumptions about what the 'ideal' participant looks like, and in doing so, unconsciously exclude anyone who does not fit this archetype.

In a 2014 study conducted in the United Kingdom by Emily Dawson, observed were many instances in which people of a low-income and diverse background were made to feel inferior or excluded from the learning experiences they interacted with. Dawson describes an occurrence where a group of Muslim Somali immigrant women were denied patience, time and the opportunity to learn and engage with science, as the staff member assigned to work with them was only trained to interact with young, fluent English-speaking school students, with a good foundation of scientific concepts (p.995-996).

In addition, there are many reasons that members of diverse communities can be repelled by the idea of STEM and STEM learning institutions before they even walk through the doors (Dawson, 2014). Common is the belief that various aspects of identity inherently disqualified individuals from STEM learning and STEM learning institutions. Culture, level of background knowledge, behaviours, and even dress style, are considered barriers to fitting the 'ideal' participant archetype for STEM learning environments (p.990).

It must be noted that embracing unique cultural knowledge and contexts has the potential to enrich STEM experiences. Dawson notes, a group of Sierra Leonean women began singing and dancing together upon spotting a bird in which this ceremonial practice was associated with (p.998-999). In another instance, a Latin-American father, who had previously failed to help his daughters due to an inaccessible English-language only activity, used his own memories and knowledge of the flora and fauna of Colombia to educate his daughters upon seeing such specimens (p.991). These examples show the power that including aspects of different cultures into STEM learning can not only allow participants to engage with STEM on familiar ground, but also facilitate connections between community members, peers, and families.

Despite the insights that this study provides, it is

important to remember that findings are context specific. The dominant cultural standards of Australia are unique from the context of this study in many ways. The study was also conducted with immigrant participants, who cannot be a substitute for Australia's First Nations people but may be able to establish an understanding of immigrants within Australia. The drought of precedent studies into the relationship between diverse communities and STEM participation in an Australian context, however, speaks volumes by itself.

It is the responsibility of facilitators of STEM learning and education, to make steps to include communities outside the dominant culture, and the first step to achieving this is as simple as including these communities in the creation of inclusive learning experiences. These communities know how to make learning environments comfortable and accessible for themselves. Valuing such knowledge is a vital element in engaging in effective work with communities (Ife, 2010) and this knowledge should not be undervalued. Affording these communities, the voice and respect they deserve in spaces where they can effect real change is vital for Scitech to expand their cultural competency as they move into the future, whilst allowing communities to feel valued and respected by the wider publics, the dominant culture.

CATERING TO NEEDS OF LEARNER

As this project requires many groups in many different contexts to be taken into consideration, it stands to reason that each of these groups have different requirements for making STEM learning accessible.

As an example, one of the stakeholders we interviewed, a rural primary school teacher, recalled a Scitech incursion visit that her students participated in. She told us that her students were completely unengaged throughout the visit. She attributed this to the fact that her students were simply not equipped with the precedent scientific knowledge to understand what was going on, and that the way the show was being presented did not suit the hands-on learning style of these students. She was forced to step in in order to bridge the gap in understanding between the outreach team and her students in order for the children to get any value out of the experience.

Figure 11: "Teacher & Student" retrieved from https://www.scitech.org.au/pro-dev/making-makers-the-design-and-engineering-process/

Another stakeholder, an educator that works with Indigenous communities, told us about his experiences teaching Indigenous students. Indigenous students simply do not respond to the same teaching methods that non-indigenous students do, and so the educator must create a link between the student and things that are valuable to them, such as the environment around these students as indigenous cultures are deeply connected to the land and have an underlying respect for flora and fauna. This cultural knowledge and understanding needs to be understood and implemented to make an impact on these children.

Different accommodations are needed for different communities to ensure that they are able to fully benefit from STEM skills and learning experiences. Whether someone is from a low-income background, from a community outside the dominant culture, or experiences a physical, mental or developmental disability, it is not their responsibility to overcome any gaps in understanding or access to engage successfully with STEM.

The above examples are not failures of the educators or of the students. Everyone should have the opportunity to engage with STEM learning, regardless of their context. It is the responsibility of the education provider to ensure the proper accommodations are in place to make this a reality. This is achievable through robust and in-depth research and user-experience testing.

PRECEDENCE STUDIES

IT IS IMPORTANT TO LOOK BEYOND THE SCOPE OF SCITECH AND EXAMINE THE IMPACT THAT OTHER ORGANISATIONS WERE HAVING WITHIN THE PROBLEM SPACE. ASSESSING STRATEGIES THAT HAVE BEEN EFFECTIVE AS WELL AS THOSE THAT NEED IMPROVEMENT IS HELPFUL WHEN IDENTIFYING AND RE-FRAMING OPPORTUNITIES FOR THIS PROJECT. IT SHOULD BE NOTED THAT THESE PROGRAMS ARE CONTEXT SPECIFIC AND THEREFORE SUCCESSFUL OUTCOMES CAN NOT BE CONSIDERED DIRECTLY TRANSFERABLE ACROSS CONTEXTS. RESEARCH LOOKED INTO PROGRAMS ENGAGING WITH INDIGENOUS COMMUNITIES, AS WELL AS THOSE DELIVERING LEARNING IN AN ALTERNATIVE WAY.

Figure 12: "Polly Farmer Foundation" retrieved from https://pff.com.au/

THE POLLY FARMER FOUNDATION

https://pff.com.au/

The Polly Farmer Foundation was established in 1994 with a vision to empower Indigenous students through education to pursue their aspirations at school and beyond. Through the delivery of STEM focused after school programs for both primary and secondary students, the foundation develops sustained academic engagement and supports the transition into post-school pathways. Programs are delivered across 35 locations across Western Australia from Esperance to Kununara and offer participants opportunities to engage with offsite learning experiences across the state.

Program Offerings:

- Learning Clubs (primary School)
- Stem Centres (primary school
- Follow the Dream (Secondary school)

Key features:

- Sucess of programs relies on training of educators to deliver program with the flexibility to adapt content to meet the needs of their community of learners; educators are the link between curriculum and culture
- Emphasis on the importance of cultural enrichment in the learning environment means time is dedicated for a yarn and sharing of cultural knowledge
- Provision of healthy snacks to fuel children to participate
- Funding to train educators at a central location before sending them back to their communities means that students are able to gain value and access without having to travel
- Facilitation of programs at schools means that students don't require use of personal resources

CSIRO TWO WAY SCIENCE PROGRAM

https://www.csiro.au/en/education/Programs/Indigenous-STEM-Education-Project/Science-Pathways-for-Indigenous-Communities

The CSIRO Two Way Science Program is part of the larger Indigenous STEM Education program. It is implemented with remote communities in Western Australia and the Northern Territory. The program aims to facilitate community participation in learning to build ownership and empower communities to support learning of their children. With this approach, the program encourages development of relationships and sense of cultural identity.

KEY FEATURES:

- **Partnership between educators and Indigenous communities to link Indigenous knowledge to the curriculum**
- **Establishes the importance of learning on country before linking to classroom learning**
- **Increased confidence of teachers to deliver Science learning as well as understanding of Indigenous knowledge**
- **Strengthened connections between teachers, schools, families and broader community groups**
- **Holistic approach to including community in the process of education**

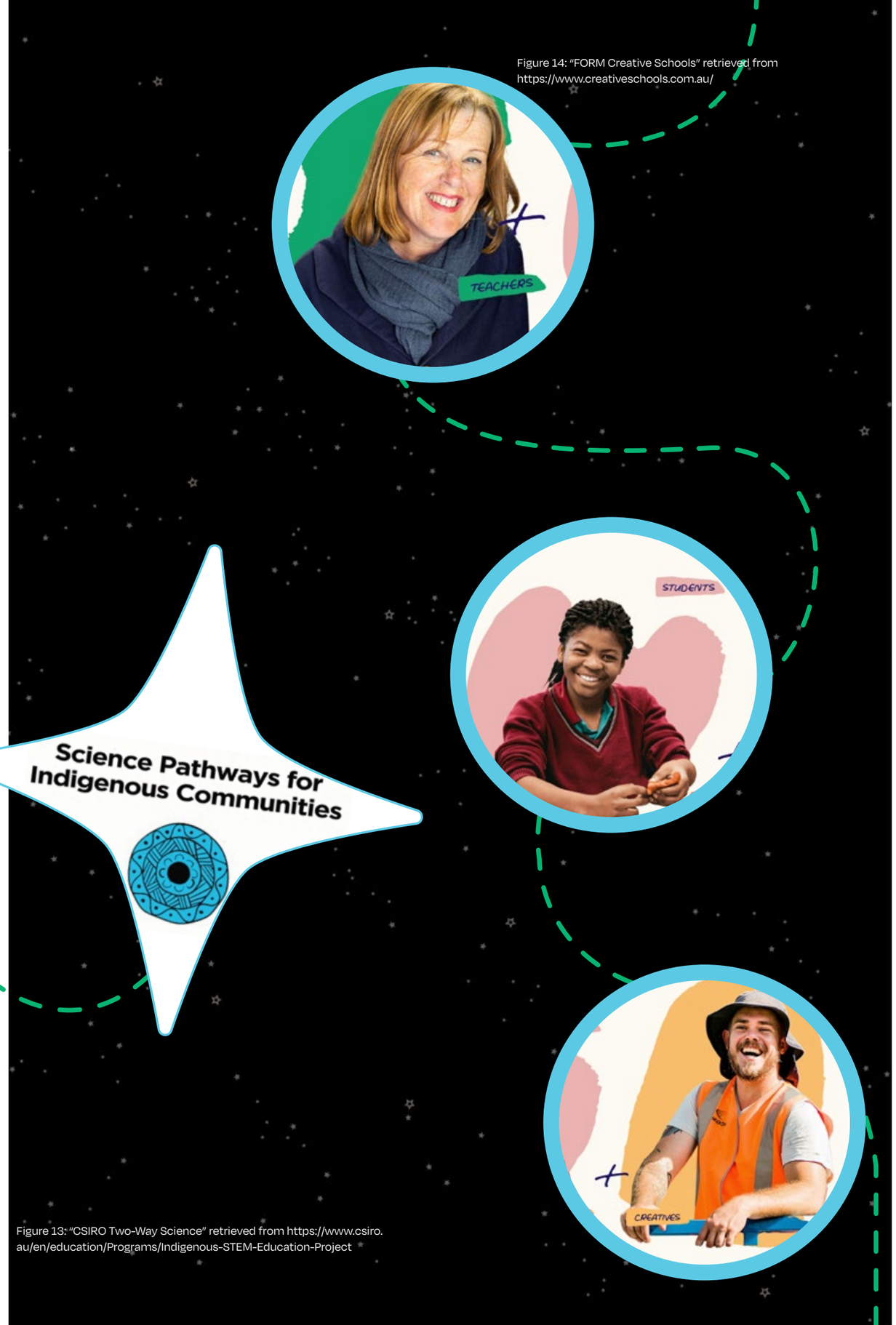


Figure 13: "CSIRO Two-Way Science" retrieved from https://www.csiro.au/en/education/Programs/Indigenous-STEM-Education-Project

Figure 14: "FORM Creative Schools" retrieved from https://www.creativeschools.com.au/

FORM CREATIVE SCHOOLS

https://creative-schools-stage.webflow.io/

The Creative Schools Program was developed by Form with partnership with Culture and Creativity in Education with an aim to inspire creative collaboration to empower children to learn in creative ways. The program revolves around developing partnerships between teachers and creative practitioners who work together across a school year to learn, develop an innovate an approach to teaching an area of the curriculum (one of these being STEM) in order to engage students who may struggle to learn or even be in the class room (particularly common in low socioeconomic and culturally diverse communities). These programs are available for both primary and high school students.

KEY FEATURES:

- **Utilising creativity can help to make curriculum more engaging and manageable for all learners**
- **Development of creative partnerships helps to link curriculum learning to external contexts and opportunities which strengthens understanding of content**
- **Education is most effective when learners are involved in it's creation and direction**
- **Changing the context of learning helps to break stigma and reluctance to engage based on past experiences in education systems**
- **Acknowledges the importance of diversity in the approach to learning and innovating**
- **Content of programs is developed to reflect the interests and needs of the learners and teachers meaning**

CURTIN STEM OUTREACH

https://scieng.curtin.edu.au/about-us/outreach/

The Curtin STEM Outreach program aims to increase interest in fields of Science and Engineering through engaging workshops, programs, camps and competitions. They are dedicated to creating opportunities for engagement between future students and educators to generate excitement about the possibilities of STEM in higher education and industry

KEY FEATURES:

- **Emphasis on building aspirations of the community**
- **Engage with high school students to support them into STEM in higher education**
- **Strong focus on young women and indigenous communities who are under represented in STEM**
- **Understanding style of communication as the key to engaging these groups**
- **Drive to link programs with innovative and exciting careers in the community to create understanding about how culture shapes the applications of STEM**

Figure 14: "Curtin STEM Outreach" retrieved from https://scieng.curtin.edu.au/about-us/outreach/

KEY FINDINGS

- **SUCCESSFUL PROGRAMS PLACED STRONG VALUE ON THE IMPORTANCE OF CULTURAL KNOWLEDGE AND LEARNING.**
- **CHANGING THE CONTEXT OF EDUCATION DELIVERY CAN PROVIDE MORE ENGAGING LEARNING EXPERIENCES WHICH ARE ACCESSIBLE FOR A GREATER RANGE OF STUDENTS**
- **LINKING TO COMMUNITIES AND CULTURAL CONTEXTS ALLOWS STUDENTS TO MAKE LEARNING MORE MEANINGFUL TO THEIR EVERYDAY EXPERIENCES**
- **COMMON FUNDING PARTNERS ACROSS PROGRAMS MAY GIVE RISE TO THE OPPORTUNITY TO COLLABORATE OR PARTNER TO SUPPORT LEARNING AND EDUCATIONAL OPPORTUNITIES**

USER RESEARCH

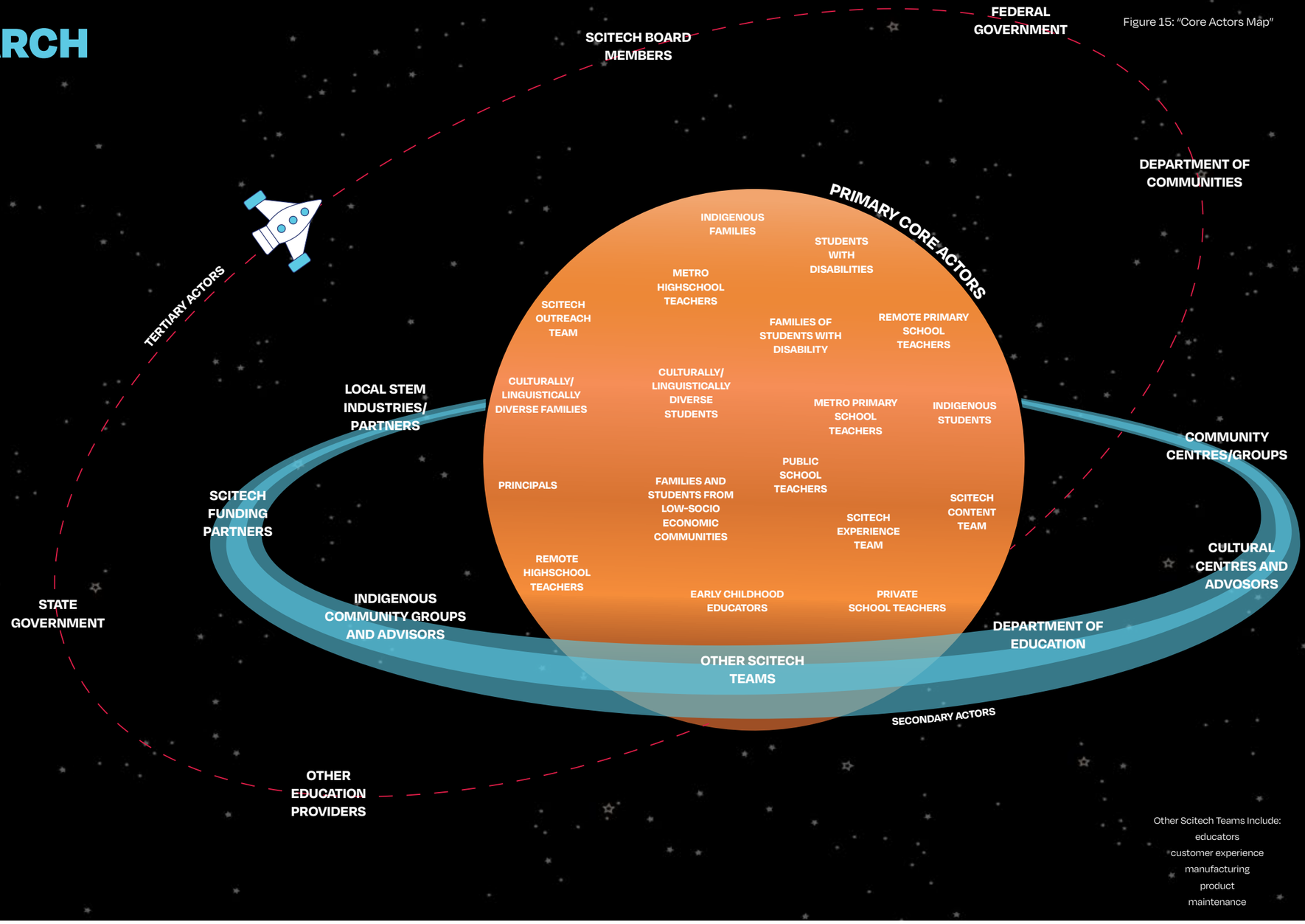


Figure 15: "Core Actors Map"

WHO ARE THE ACTORS?

Determining the core actors involved in this project developed over the course of the semester. Initially going with the people outlined in the problem given to us by SciTech, we went from women, First Nations people, remote and regional, and low socioeconomic status people to considering everyone else that has the capacity to affect the project. At this point in the project, we kept the scope broad to understand everyone that could have an influence in the project outcomes.

In this core actors map features primary, secondary, and tertiary actors. This map highlights the main stakeholders that will be focused on in this project in order of relevance across the groups. Primary actors include examples such as "SciTech Outreach Team" and "Remote Primary School Teachers" because they are most directly impacted, whereas tertiary actors' feature the "State Government" because they have a presence that isn't as directly impacted by the project. From the creation of the core actors map, we could then create an informed strategy when identifying who we needed to interview.

INTERVIEW STRATEGY

After identifying our primary stakeholders and core actors, a list of questions was developed to ask each group.

More specific questions were then created to target stakeholder roles, especially with internal stakeholders of SciTech. This allowed us to find out information about the dynamics and relationships within the internal teams.

Questions for groups outside of Scitech were related to their relationship and knowledge of the organisation, particularly if they have ever encountered Scitech outside of the centre, what they think Scitech offers, their relationship with STEM, and STEM learning/teaching.

Our interviews were conducted face to face, over the phone and online through Zoom, and took several weeks to complete due to the scope of the project. We found that face to face interviews were the most insightful due to the ability to analyse body language, interactions with environments, and the ability to build report upon more casual introductions and commencement of interview sessions. Phone and Zoom interviews posed restrictions with technological difficulties, less openness to sharing due to their more formalised nature, and the lack of non-verbal communication. The process of transcribing interviews proved more time consuming than anticipates, extending the process by two or three weeks.

Analysis of raw interview data for themes, commonalities, key quotes, and insights provided a basis for further understanding through creation of empathy maps, story-worlds, and development of initial personas.

QUESTIONS FOR SCITECH

- What is your role at Scitech?
- What teams do you engage with?
- How has the new strategy informed the way you work at Scitech?
- How do you think the role of Scitech will change in the next decade?
- What do you think Scitech does well?
- What do you think Scitech could improve on?
- How effective do you think Scitech are at delivering STEM learning experiences?
- How does Scitech cater to diversity?
- What demographic of people do you think Scitech have the most impact on?
- How do you manage feedback?
- How is feedback implemented at Scitech?

QUESTIONS FOR STUDENTS

- Have you heard of STEM? Can you tell me what it means to you?
- What is your favourite way to learn at school?
- What's your favourite thing about school?
- Do you use any technology or equipment to help you learn?
- What do you want to be when you grow up? How could you use STEM when doing this?
- Are you studying any STEM subjects? Is so, which ones?
- What are the challenged you face when learning in a school setting?
- Have you ever been to or heard of Scitech? What do they do?
- Has Scitech ever come to your school? What was your favourite part of their visit?
- Have you been to Scitech centre? What was your experience?
- What does your homework routine look like?
- » Do your parents/caregivers help you with your homework?

QUESTIONS FOR PARENTS/CAREGIVERS

- Has Scitech come to your child's school before? If so, when was the last time? What was this process like for you?
- Have you taken your child to Scitech before, and if not, are there any barriers for you to access Scitech?
- Do you think that you have a good understanding of the current education system?
- Are you aware of what STEM is?
- Does STEM have any relevancy in your life?
- Do you feel supported throughout the education of your child?
- What is your perceived role in the education of your child, and what does your involvement in your child's education look like?
- What resources does your child have access to at home?
- Do you feel that the individual needs of your child are accommodated within their educational experience?

INTERVIEW STRATEGY

Figure 16: "Interview strategy"

1. QUESTION GENERATION

Creating targeted, open ended questions while eliminating bias. Related to stakeholders' roles, dynamics, thoughts, and feelings.

2. INTERVIEW ORGANISATION

Organising consent forms. In person, over the phone and on zoom. Conducting 30 minute interviews.

3. ANALYSING THEMES

Collating the information and compiling common themes from our interviews for the Empathy Maps.

4. DETERMINING GAPS

Analysing if qualitative data has gaps. Determining relevant questions and re-writing others from a different perspective.

5. IDENTIFYING FURTHER PARTICIPANTS

Who else will have valuable insights for the project? Organising interviews with actors who were recommended to us.

STAKEHOLDER MAPS

After being able to better understand the people involved in the project and how they interact, research allowed us to create a stakeholder map. A stakeholder map differs from a core actor map in that it shows the value exchanges between the stakeholders. Through interviewing and desk research, we began to see the channels of exchange between actors more clearly. In our stakeholder map, the white circles signify a group of stakeholders, whereas the smaller black circles represent the specific individual stakeholders. They are linked between one another with lines of four colours found in the key. “Cultural knowledge” indicates the exchange of information relating to one’s cultural background. It can be noted that there are lacking connections for cultural knowledge to be channelled back to educational knowledge providers. “Educational knowledge” relates to the transfer of educational experiences, such as a teacher to a student. “Funding” shows how stakeholders are provided with money to facilitate their services. “Influence” indicates the link of personal vested interest between stakeholders. suggests other projects to move on to as well as Scitech Incursions that could support areas of learning.

KEY INSIGHTS

» Closer examination of the exchange of educational knowledge revealed that it is a one-way transfer from Educators and Scitech to Students. This sparked questions into what could be considered as educational knowledge and if there was capacity for students to play a role in educating Educators and Scitech about their own knowledge and interpretations of the world.

» The exchange of cultural knowledge is concentrated between Students, Parents and their communities with little to no exchange occurring with Scitech and the broader schooling system. To create a shared understanding of cultural knowledge, needs and experiences, this exchange needs to be promoted and supported within the whole system.

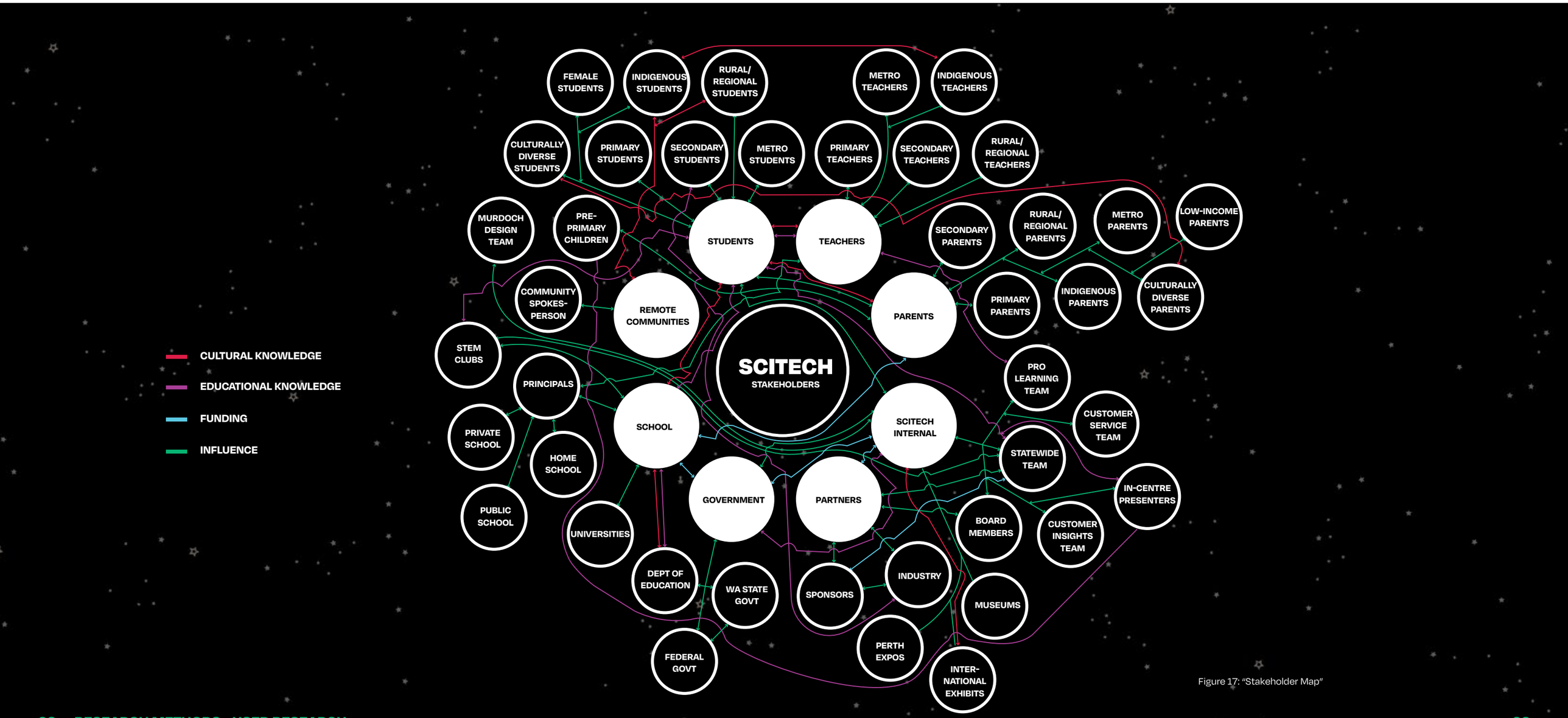


Figure 17: “Stakeholder Map”

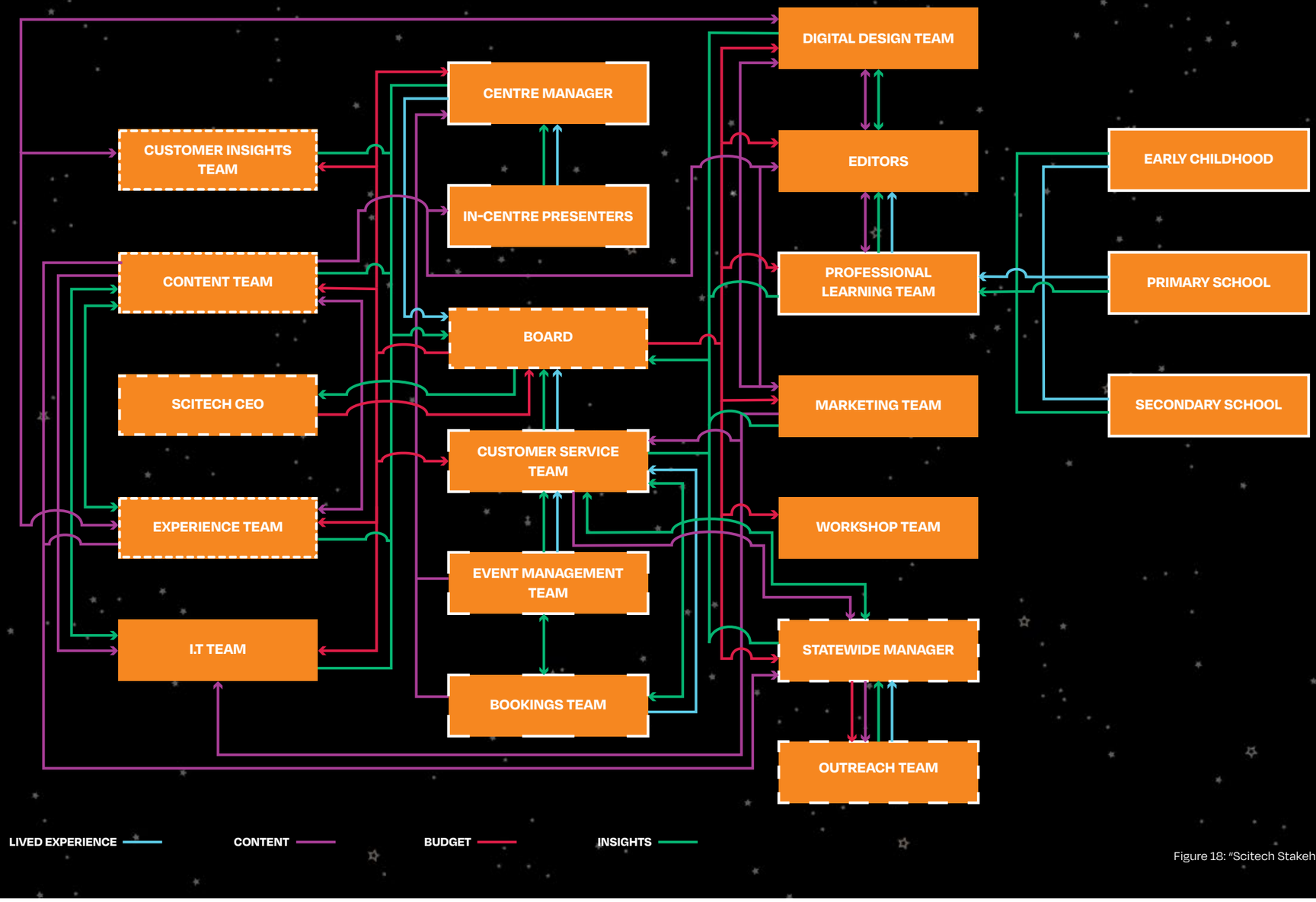


Figure 18: "Scitech Stakeholder Map"

INTERNAL SCITECH STAKEHOLDER MAPS

Our interviewing of employees from various teams at Scitech allowed us to grasp an understanding of the inner workings and functioning of the teams together. From this we gained valuable insight into Scitech internally and identified opportunities to, improve the functioning of the teams together.

The key pertaining to this internal map includes lived experience, content, budget, and insights. "Lived experience" relates to each individual team member's personal background experience informing what they bring to SciTech. "Content" is the transfer of physical or digital assets between teams. "Budget" shows which stakeholders are receiving funding from other stakeholders. "Insights" relates to the communication of new relevant information between stakeholders.

KEY INSIGHTS

- The Professional Learning Team and Outreach presenters have valuable insights and experiences to share relating to their direct engagement with core actors.
- There is an opportunity to increase the sharing of insights and lived experiences between all teams to better inform future design and delivery of programs.

PERSONAS

Personas are fictional representations of the core groups of people we have interviewed throughout the semester, as well as people we hope to interview in the next half of the project. The creation of personas allows us to better understand and empathise with the people that we are designing for by considering their context, needs, values and motivations. There are five core groups of personas that we have created: students, teachers, parents, SciTech staff, and education. These persona groups were informed by the identification of the core actors.
The creation of personas allowed us to continue ethnographic research and further refine our understanding of the challenges these people face. These personas were revisited throughout the project to aid in keeping a human-centred focus and guide decision making.

FAYE WAGNER

REMOTE PARENT

AGE
38 yrs old

PROFESSION
Vitage Cellar Hand

BIOGRAPHY
Faye is a working parent in the rural town of Bridgetown, WA. She and her partner have 3 energetic, primary school-aged kids to wrangle on any given day. While she loves the lifestyle of their quiet community, she feels that the south-west is lacking in resources to really engage the kids. She worries for the future, and whether their rural home will be able to provide the kids with career oppurtunities when they're older. Jobs in regional areas become more illusive every year, and Faye wonders if her children will have the drive or the resources to get an increasingly necessary university education. Faye and her partner have no idea how to support their children in this regard at all!

All in all, Faye wants her kids to have all the tools they need to suc-ceed in a world that is very different from the one she grew up in, and is still constantly changing.

INTERESTS
» Hiking
» Tennis
» Basketball
» Gaming
» Listening to True crime podcasts
» Watching documentaries
» Socialising

VALUES
» Working hard to earn success
» Life-long learning & growth
» Strong familial bonds
» Ensuring a viable future for future generations
» Financial stability

ASPIRATIONS
» Prepare her kids for a stable and successful future
» Enrich the experiences of the local community
» Continue to learn & grow

BRANDS
Microsoft
TRUECRIME
NATIONAL GEOGRAPHIC

NEEDS
» Emotional support from partner
» Strong relationship with children
» Strong relationship with community
» More ways to help children succeed
» Ways to be involved with children's education

POWERS
» Strong presence and influence in the local community
» Influence over her children
» Respected by co-workers
» Strong opinions, beliefs and convictions

BEHAVIOURS
» Regular socialisation with other parents, co-workers and community members
» Participates in local sports events
» Spends weekends with children
» Volunteers for school and community events regularly

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 19: "Remote Parent Persona"

ANJALI KAUL

METRO PRIMARY SCHOOL PARENT

AGE
26 yrs old

PROFESSION
Stay at Home Mother

BIOGRAPHY
Anjali moved to Perth, WA with her husband from India in 2017. They live in Mirabooka with their 9 year old daughter and 3 year old son. Anjali's husband works at a data storage company in the city whilst she stays home to look after their youngest child and their home. Whilst Anjali doesn't have any close family to help her with the children, she has made friends with other mothers at Mirabooka Primary School where her daughter goes to school who provide her with social support. These relationships have been of great help to Anjali as navigating the Australian schooling system has been difficult and she wants the best educational outcomes for her children.

INTERESTS
»Gardening and cooking
»Watching Bollywood movies to stay connected to home
»Loves to see her kids achieving

VALUES
»Family traditions and cuture
»Spending quality time with family
»Taking a nurturing role
»Selflessness

ASPIRATIONS
»Establish strong roots in Australia
»Wants her children to be successful in well-paying jobs
»Gain casual employment when her son starts school

BRANDS
food network
ALDI

NEEDS
» To feel accepted and welcomed in her community
» To better understand what her daughter is learning at school
» Assistance and support to understand the schooling system
» A sense of purpose in bringing up her children

POWERS
» Power over her children's activities
» Has a voice amongst her friends
» Opportunity to shape learning of her children at home
» Power to instil in her children the importance of history and culture as foundations for identity

BEHAVIOURS
»Daily before and after school run
»Spends weekends with family and attends church
»Weekly dinner with her husband's work friend
»Spends at local businesses and Amazon
»Facetimes family back in India weekly

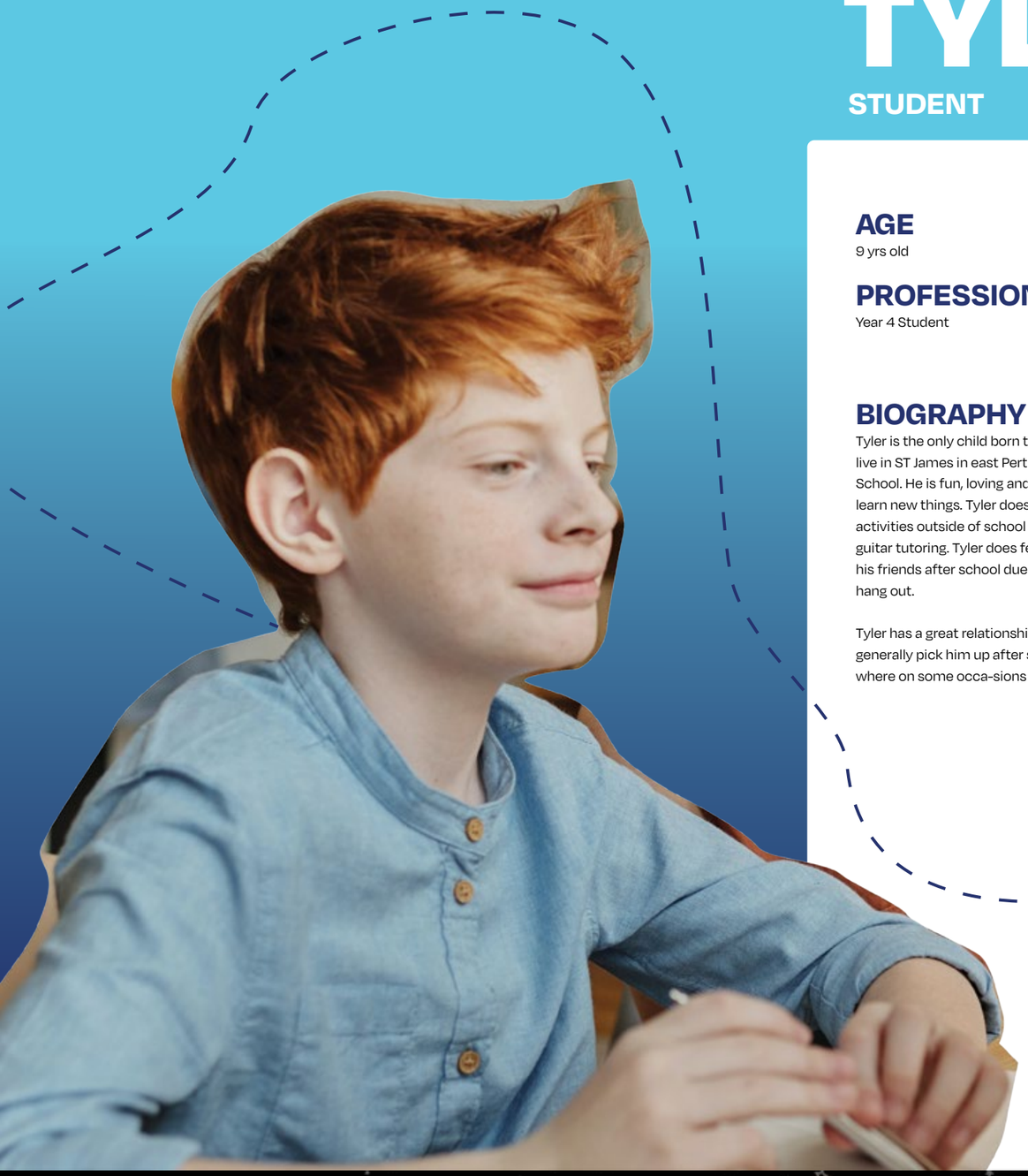
TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 20: "Metro Parent Persona"



TYLER GUILFOY

STUDENT

AGE
9 yrs old

PROFESSION
Year 4 Student

BIOGRAPHY
Tyler is the only child born to a very hardworking parents. They live in ST James in east Perth. Tyler attends Kent Primary School. He is fun, loving and adventurous who doesn't fear to learn new things. Tyler does many extra curricular subjects and activities outside of school such as after school sports and guitar tutoring. Tyler does feel sad when he can't see some of his friends after school due to his activites and can't always hang out.

Tyler has a great relationship with his grandparents who generally pick him up after school, and after his extra activities, where on some occa-sions they take him out for icecream.

INTERESTS
» Football and Swimming, along with attending training classes on the weekend
» Singing and Drawing
» Watching content about aircrafts
» Spending time with friends at school

VALUES
» Loves animals, particularly his dog Oscar
» His Ipad
» His friends and family

ASPIRATIONS
» Either to be a professional football player;
» or an aircraft pilot

BRANDS
FREMANTLE DOCKERS

FORTNITE

NEEDS
» Support from parents to bring out his potential areas of interest
» Needs help and encouragement with difficult math homework rather than being pushed to complete it by his parents

POWERS
» Tyler believes that his education is important in becoming a pilot if he cannot be a professional football player
» Understands navigation and cartography well
» Excellent with georgraphy and orientation

BEHAVIOURS
» Goes to school every day
» Will ariive home to complete his homework and watch aircraft videos by his favourite YouTuber
» Plays sports after school and on the weekends
» Goes over to his friends place every few days after school

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 21: "Metro Primary School Student Persona"

ESTHER MAVUTULA

PRIMARY SCHOOL METRO STUDENT

AGE
8 yrs old

PROFESSION
Year 4 Student

BIOGRAPHY
Esther is student at a public primary school in the Langford area of Perth. She is the daughter of second-generation Nigerian immigrants, who have always been adament about preserving their attachment to their parent's home and culture. This has manifested in a lot of ways; Esther can speak English and French fluently, as well as some creole, for example. This hasn't prevented Esther from feeling somewhat exclude, howev-er. While she isn't the only student from a diverse background, it feels like a lot of areas are full of people that don't look or think the way she does. Esther wonders if her perspective and ideas will ever be valued in the same way as her classmates, and if she will ever have the op-purtunity to effect the future.Esther also tends to have trouble focusing in class. The things her teacher says don't tend to stick, unless she's talking about something Esther is deeply interested in. Esther worries that she's falling behind her classmates, and doesn't understand why.

INTERESTS
» Nature
» Biology
» Watching nature documentaries
» Zoology
» Netball
» Playing with her dog

VALUES
» Creativity
» Time to relax
» Stability
» Strong community
» Strong familial bonds
» Hard work

ASPIRATIONS
» Work with animals
» Learn about how the world works
» Help to reduce waste, polution, etc.
» Make a real difference in the world

BRANDS
Smiggle
NINTENDO SWITCH

NEEDS
» Emotional support from family
» Validation from peers
» Constantly mental stimulation
» Extra learning support and accomodations from school

POWERS
» Well-liked by peers
» Strong recall for subjects of interestStrong sense of justice »
» Endless curiosity
» Emotional resilienceSocialable personality

BEHAVIOURS
» Frequent socialisation with friends and classmates
» Weekly bonding with parents and extended family

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 22: "Metro Primary School Student Persona"

DANIELSTUART

SECONDARY RURAL STUDENT

AGE
16 Years Old

PROFESSION
Secondary Student, Part-time retail assistant

BIOGRAPHY
Daniel has lived in the small southwest town of Pemberton all of his life, just like his parents before him. He attends the local district highschool, along with his siblings. Daniel sees the way the town, and the southwest in general, has changed just in the last few years; timber mills and coal mines that have guaranteed employment for generations suddenly shutting down. Longer and longer trips for his mum, back and forth to a much bigger city, every single day, to put food on the table. He has some security, as least. His grandfather and uncle are tradesmen, and Daniel is pretty much guaranteed a place with them once he's old enough. He's told by people who don't seem to get it that his grades mean he's got more to offer than laying bricks, whatever that may mean. He doesn't really care about some nebulous 'greater' future he can't see. He cares about being able to support himself as soon as possible, to take some burden off of his mum as soon as possible.

INTERESTS
» Club Football
» Gaming
» Fiction writing
» Hiking
» Coding

VALUES
» Strong familial bonds
» Strong community bonds
» Adaptability
» Selflessness
» Emotional resilience

ASPIRATIONS
» Earn stable income
» Become self-sufficient
» Be comfortable
» Help support his mother & siblings

BRANDS
JB HI-FI
EVERLAST
AFL
beats

NEEDS
» Emotional support from family
» Outlets for creativity
» Economic support
» Educational support
» More free time

POWERS
» Popular among peers
» Liked by community
» Good rapor with teachers
» Independent

BEHAVIOURS
» Volunteers during community events
» Works part-time locally
» Socialises with peers outside of school regularly
» Active in local community

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 23: "Rural Secondary School Student Persona"

SHANAE WHITE

REMOTE PRIMARY SCOOL STUDENT

AGE
8 yrs old

PROFESSION
Year 3 student at Roebourne District High School

BIOGRAPHY
Shanae belongs to the Ngarluma people; the traditional owners of the land that the town of Roebourne sits on. She grew up in this area with an older brother and a younger sister. Shanae attends Roebourne District High School frequently, only missing days when her family are on country for important culturally significant events. At school, she loves to participate in art, sport, and especially loves when she gets to bring in something special to her to share for 'show and tell'. At the moment, her class is learning to use the computers for maths which is very exciting as she doesn't have a computer at home. After school, Shanae doesn't have much time for homework as she spends the time running around with her friends. On the weekend, she spends time with her mother and aunties who are teaching her to paint and weave at the Ganalili Centre.

INTERESTS
» Art and painting
» Spending time with friends
» Learning from her family
» Playing sport after school

VALUES
»Time spent outside
»Spending time on country with her family
»Playing with her friends after school

ASPIRATIONS
» Wants to be an artist just like her Aunties but also wants to play sport forever!

BRANDS

NEEDS
»To support her learning Shanae needs her teacher to develop a strong relationship with her family
»Time to complete homework tasks in class to aid her learning
»Morning snack at school to ensure she starts the day energised
»Space and time for cultural learning and exchange
»Tasks catered to her level of understanding and her interests

POWERS
»Power to share her thoughts with friends during show and tell at school
»Responsibility to help look after her younger sister
»Power to carry on the stories of the Ngarluma people which will be passed down to her
»Power to care for country

BEHAVIOURS
» Plays sport most days after school
» Spends weekends making art at the Ganalili Centre
» Monthly trips onto country
» Most of her belongings are passed on from other family members

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 24: "Remote Primary School Student Persona"

ANNA CARROLL

PRINCIPAL AT KOONDOOLA PRIMARY SCHOOL

AGE
48 years old

PROFESSION
Principal at Koondoola Primary School

BIOGRAPHY
Anna lives in Karrinyup, WA with her husband and two 18 and 22 year old children. She has been a primary school teacher for 24 years, working across a number of public schoold in both metro and regional areas with a diverse range of students. From her vast experience in a variety of school communities and personal experience in the importance of maintaining cultural identity (Anna's family moved to Australia from Indonesia when she was in primary school), Anna understands the importance of celebrating diversity and providing space and support for children and their families to inspire confident, resilient, and successful learners. Anna became the Principal at Koondoola Primary School which is one of the State's most culturally diverse educational communities, in 2015. She is passionate about her role in supporting learning at this venue and is honoured to be able to assist families in their transition to life in Australia through the school's community programs and engaging, supportive environment.

INTERESTS
» Coast walks with her husband and their dog
» Learning about the experiences of her students
» Emmerging teaching theories

VALUES
» Learning as a tool to unlock opportunities
» Importance of celebrating diversity
» Equal and equitable access to education for all members of the schooling community, including families
» Sharing of cultural knowledge

ASPIRATIONS
» Hopes to one day mentor other Principals around the state about the importance of building strong relationships in schooling environments

BRANDS
Microsoft
fitbit
perthnow
GREENPEACE

NEEDS
» To feel supported by her family as her job can be stressful
» To be surrounded by a group of likeminded staff who share the same vision
» Funding to provide educational experiences for students with limited resources

POWERS
»Spark excitement in students
»Sharing of knowledge, experience and expertise to schools
»Provides access to resources and inspiration to peers working in education
»Sharing insight and feedback amongst team

BEHAVIOURS
» Prioritises time to actively engage in classroom environments
» Attends P&C meetings and school meetings to understand the needs of the community»Collaborates with festivals, fairs and carnivals.
» Fornightly dinners with her extended family
» Supports local businesses and spends most of her money to benefit her family

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 25: "Metro Primary School Principal Persona"

LAUREN HILL

SCITECH STATEWIDE PRESENTER

AGE
27 yrs old

PROFESSION
Scitech Statewide Presenter

BIOGRAPHY
Lauren grew up outside of Perth, in the south-west regions near Albany. Growing up in a small town, Lauren grew accustomed to town life and developed a strong sense of community and social responsibility. During her studies in the city, Studying for a bachelor of education at ECU, Lauren managed to score a job in Scitech as a part-time worker. Over time, Lauren grew to love her work and the children she was interacting with and wanted to make more of a difference when teaching children the STEM skills they need. Hearing about Scitechs on road tours through the state, Lauren wanted to join the team to teach and influence children growing up in rural communities, giving to these kids due to understanding the realities and difficulties of education in rural communities.

INTERESTS
»Teaching and education,
»Loves drama and theatrics and using these skills while she works
»Blogging travel experiences
»Drinking tea

VALUES
»Providing a thrilling learning experience,
»Improving how kids learn and how to change and update education in remote locations
»Values STEM skills, creativity, knowledge and passion

ASPIRATIONS
»Wants to continue working as an educator and reach all communities in WA.
»Wants to get involved with expanding tours, creating online platforms and collaborating with communities and schools.
»Wants to create an impact on Indigenous communities and improve education facilities and inspire kids.

BRANDS
Kathmandu
T2
URBAN LIST

NEEDS
» Support from peers and family when away from home for long periods of time
» To have the space to share experiences and get feedback
» To have her voice and opinion heard in the workplace to help improve quality of program delivery
»Opportunity to use and expand disciplinary skills

POWERS
»Spark excitement in students
»Sharing of knowledge, experience and expertise to schools
»Provides access to resources and inspiration to peers working in education
»Sharing insight and feedback amongst team

BEHAVIOURS
»Works away on the road as a Scitech educator completing tours around Western Australia.
»Weekly meetings to make sure tours are run smoothly.
»Collaborates with festivals, fairs and carnivals.
»Supports local businesses where ever tour stops.

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 26: "Scitech Statewide Presenter Persona"

KEITH HOFFMAN

SCITECH PARTNER

AGE
42 years

PROFESSION
Scitech Partner

BIOGRAPHY
Keith as been a partner on Scitech's board for 14 years and counting. He has watched the organisation change a lot over his time there. However, the goverment's recent push for Scitech to become an essential part of pre-paring WA's future generations for STEM careers, he wonders if Scitech has changed enough to rise to the occasion. Keith honestly can't figure out what appeals to children these days, and he doesn't know how to get a hold of someone who can. Not to mention, they're saying they want to target older people, which honestly, Keith doesn't feel Scitech is equipped for.Keith wants to make a tangible impact on Scitech's method of operations to ensure the organisation can meet expectations and survive into the future. He just feels so detached from the goings on of the rest of the company, and doesn't know to start addressing the gaps in his knowledge.

INTERESTS
» Jogging
» Hiking
» Reading
» Travelling
» Fishing
» Chess

VALUES
» Dedication to profession
» Perserverance
» Objective reasoning
» Social capitol
» Adaptibility

ASPIRATIONS
» Become a key contributor in Scitech's evolution as an organisation
» Watch Scitech become an intergral part of STEM education in WA

BRANDS

NEEDS
» Access to communities outside own experience
» Direct line of communication with other areas of organisation
» Access to educators & educational recources

POWERS
» Influence over colleagues
» Respected by peers within organisation
» Has a say in discisions within organisation

BEHAVIOURS
» Withdrawn from local community
» WorkaholicSocialises with select social group on semi-regular basis
» Keeps interactions at work within own department

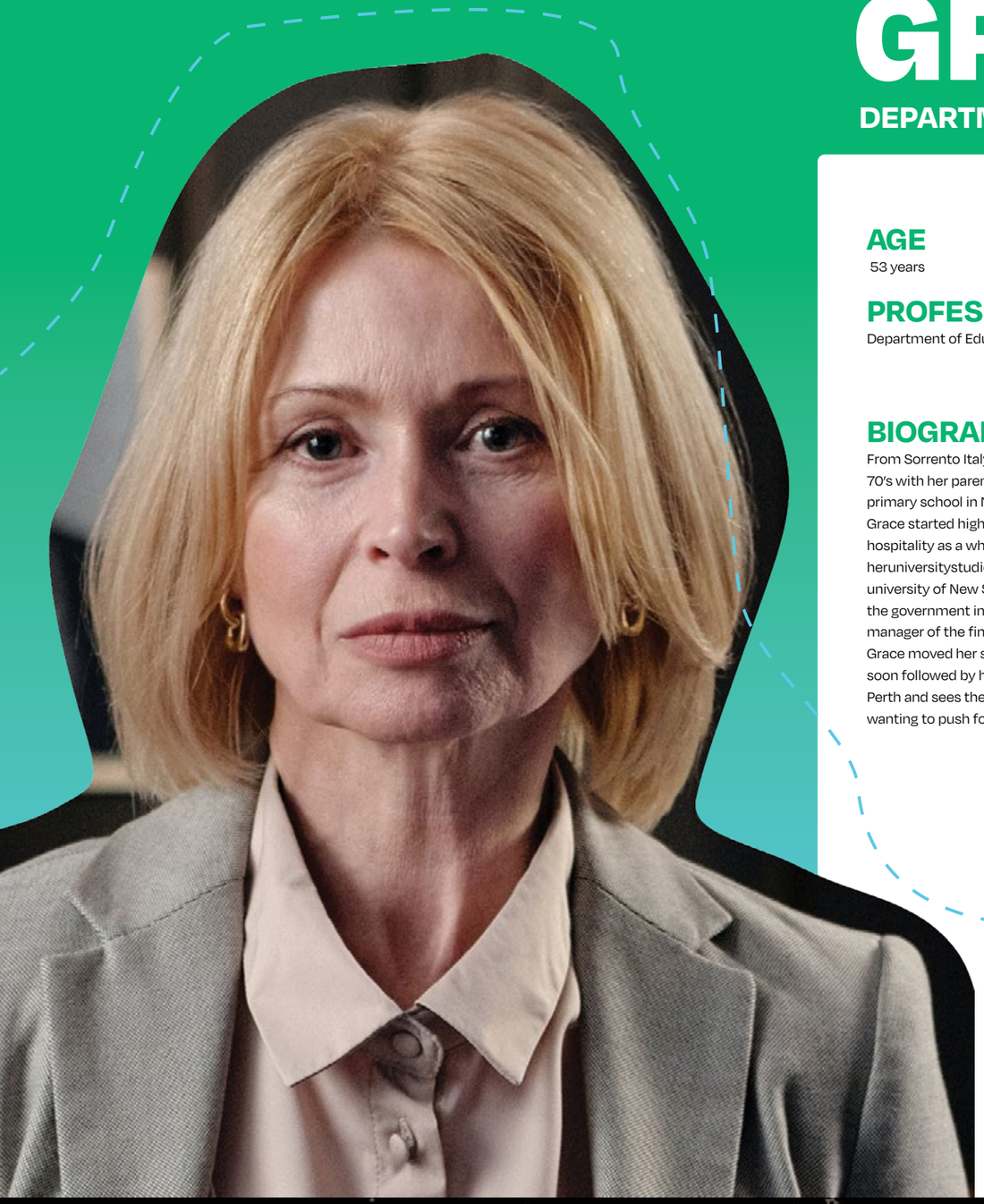
TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 27: "Scitech Partner Persona"



GRACE WESLAND

DEPARTMENT OF EDUCATION

AGE
53 years

PROFESSION
Department of Education Funding Manager

BIOGRAPHY
From Sorrento Italy, Grace migrated to Australia in the early 70's with her parents to run a market garden. Grace attended primary school in NSW with little english knowledge. Once Grace started highschool she soon started working in hospitality as a which she stayed in throughout heruniversitystudies. Grace went on to study finance at the university of New South Wales. After many years working for the government in NSW, Grace was offered a position as manager of the finance and funding department in Perth, WA. Grace moved her small family of one daughter over, and was soon followed by her parents. Grace lives in the Metro region of Perth and sees the importance of education for public schools, wanting to push for equality of rescources throughout WA.

INTERESTS
» Enjoys reading crime novels
» Watching drama films
» Listening to a wide range of podcast genres
» Spending time with her daughter and her partner
» Staying active by walking and kick boxing

VALUES
» Quality time with family and friends
» Individual indipendence
» Passionate about empowering others to strive for the best
» Frustrated when individuals are being oppressed, when the system does't help everyone

ASPIRATIONS
» Wants to be a fully capable single mother, but loves and wants to spend her life with her current partner
» To be a Grandmother one day
» To be a leading employee and co-worker, striving for the best.
» To travel in her retirement

BRANDS
OROTON

NEEDS
» To occupy time with work and interests
» Interested in learning new skills to develop
» Relies on acceptance and social interactions with friends, family and colleagues
» Exceeding to be the best and change education for the better

POWERS
»Big influence in the decision of where and how much government funding will go towards
» Able to work and communicate with multiple groups in the education department
» Strong ties to the community
» Enforcing initiatives

BEHAVIOURS
» Extreemely organised
» Busy schedule, preoccupied with work and family commitments
» Great at budgeting
» Insists on taking her daughter out once a week for family time

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 28: "Education Department Partner Persona"

SARA WILSON

HIGH SCHOOL METRO TEACHER

AGE
35 yrs old

PROFESSION
High School Mathematics Teache

BIOGRAPHY
Sara works as a maths teacher in a public high school. The area where her school is located is a majority middle-class affair, with reasonable access to resources. What Sara lacks in a way to fully engage her students. They're usually bored out of their skulls, and the drab textbooks and complex con-cepts seem to ensure all the infomation she she imparts bounces right off her students. Look, she gets it; they're all tired, they have so much work from other subjects already, they're all too aware of the world seemingly burning down around them. Sara isn't immune to burnout or stress herself. However, this situation is far from the active learning environment she always dreamed of creating when she chose this career. She wonders how she can get her students to enage with her content, as well as undo their apparent apathy.

INTERESTS
» Mathematics
» Watching trash TV to turn her brain off just a little
» Cooking
» Philosophy

VALUES
» Passion & Motivation
» Optimism
» Environments that foster creative thinking
» Innovative teaching strategies

ASPIRATIONS
» Make students excited about learning
» Prepare students for future
» Engage students with teaching materials
» Make a tangible impact on working/teaching environment

BRANDS
TED audible amazon

NEEDS
» An engaging teaching method
» Resources that engage students
» Support from school board, parents and peers
» Perspective from students

POWERS
» Liked by co-workers and parents
» A Contact with peers in other learning institutions
» Good rapor with students
» Access to further education resources
» Likable demeanor
» Hightly motivated

BEHAVIOURS
» Socialises with peers and co-workers regularly
» Completes teaching workshops regularly
» Engages with students to better understand their learning style
» Tutors struggling students regularly
Provides extra learning resources when needed

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 29: "Metro High School Teacher Persona"

AMANDA VUONG

METRO PRIMARY SCHOOL TEACHER

AGE
35 yrs old

PROFESSION
Metro Primary school teacher specialising in year 3 to 6.

BIOGRAPHY
Born in Fremantle, Western Australia, Amanda attended Christ the King primary school and John CurtinCollege of the Arts. Amanda loves the arts, however she was never skilled at any of the subjects and wanted to find a role in teaching due to her love for working with children. She attended UWA and recieved a Bachelor of Education. Her part-time work throughout highschool was babysitting, which translated during her studies along with working in hospitality on the cappuccino strip.
Amanda is ambitious, constantly helping her partner with his business and striving to improve themselves personally and their situation every day. Amanda loves joining groups and projects, and she is involved with the council. Amanda and her husband have a son and lives very com-fortably in Fremantle where she grew up.

INTERESTS
» Spendng time with family
» Enjoys cooking
» Watches Drama, and comedy TV shows
» Exercising

VALUES
» Loves her family
» To be a good and influential teacher
» Feels satisfied when a job is done well
» Learning new skills and learning in unique ways

ASPIRATIONS
» Wants to be a role model teacher
» Would love to continue to study and complete a masters degree
» Inspire her kids to strive for careers they love

BRANDS
lovingearth
TIME
WITCHERY

NEEDS
» To create a better work and life balance
» Getting respect and attention from her students
» To provide fun and engaging learning experiences
» Create a safe environement

POWERS
» Does not have too much power within the school
» Has all the power within the class room, makes her own rules
» Able to advocate for different learning experiences

BEHAVIOURS
» Reads and researches during the day
» Busy with family life, helping out with her partners business
» Little social time, always running around for the kids
» Attends council meetings

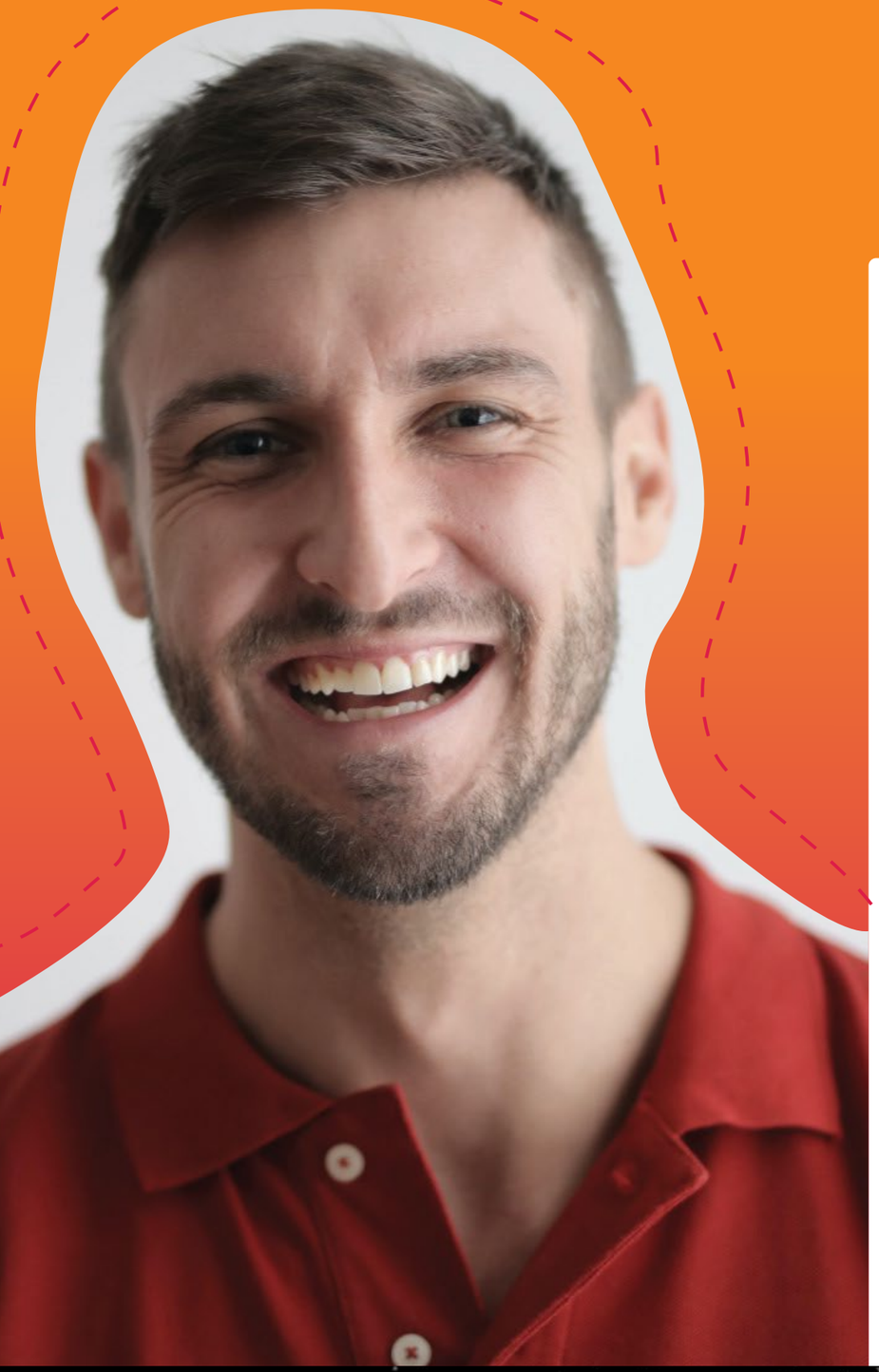
TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 30: "Metro Primary School Teacher Persona"



ADAM LOCKYER

REMOTE PRIMARY SCHOOL TEACHER

AGE
31 yrs old

PROFESSION
Primary School Teacher @ Geraldton Primary School, currently teaching year 4 students

BIOGRAPHY
Adam grew up in the Northern Suburbs of Perth in a footy crazy family. After he finished highschool, having not loved the academic side of things, he took up a trade and continued to coach junior footy on the weekends, following the team around the state for their matches. After realising the importance of his mentoring role on the live's of his team, Adam decided to study Primary School Teaching at ECU. He was offered a position at Geraldton Primary School when he graduated on 2019 which he jumped at, remembering how much he loved the relaxed vibe of the town during one of his footy trips. Outside of work, Adam loves to get down to the beach for a surf, head away on weekend 4WD trips and get back down to Perth once a month to visit his family. To build his connection to the town, Adam also took up junior footy coaching for the local team which has been a great way for him to make friends and engage with the community outside of school.

INTERESTS
» Loves playing cricket, footy and going out for a surf
» Coaches at the local footy club
» Consumes most news through social media platforms

VALUES
»Education and the importance of mentorship
»Being flexible and understanding to cater for his diverse class of students
»Bringing nature into the classroom and vice versa

ASPIRATIONS
»Inspire independent, brave and passionate learners
»Help children to realise their potential
»Inspired by work of the Graham Polly Farmer Foundation.

BRANDS
AFL
NETFLIX
triplej

NEEDS
»To feel supported by collegues to provide meaningful educational experiences to a challenging group of students
»More resources to engage his class and get them excited about learning
»Strong social structures to support him through what can be a stressful job
»Open communication with families which he ttries to bolster through community involvement

POWERS
»Power to influence learning and engagement of his class
»Power to engage with collegues to develop a supportive school environment
»Power to engage parents and help them to become more involved educators of their child

BEHAVIOURS
»Spends time after school one day a week to help students who need access to technology at school for their homework
»Makes class time for children to share things they have learnt/experiences outside of the classroom
»Tries to run class outside at least once a week
»Spends spare time playing sport, surfing and watching Netflix

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 31: "Remote Primary School Teacher Persona"

HANNAH TOWNSEND

REMOTE HIGH SCHOOL TEACHER

AGE
25 yrs old

PROFESSION
Secondary Science Teacher specialising in Chemistry for upper school students. Teaches 12-18 yr olds at Karratha Senior High School

BIOGRAPHY
Hannah grew up in the northern suburbs of Perth, WA with a single mother and two older brothers. As a child and adolescent she was a member of the local netball club and played every weekend. She studied a Bachelor of Education (High School Teaching) at Curtin, graduating in 2019. She wanted to be a teacher after experiencing the profound impact her own teachers had on her learning. Hannah moved to Karratha in early 2020 with her partner who works at one of the local primary schools as they wanted an adventure. She is a member of the local netball club, plays waterpolo with colleagues/friends from work and spends weekends exploring with her partner in their 4WD. At school, Hannah takes pride in mentoring her students outside of the classroom and is passionate about using interactive techniques to make Science more engaging.

INTERESTS
» Netball and waterpolo
» Exploring nature
» Listens to self-help podcasts
» Consumes news through Facebook, local newspaper and school newsletter
» Watches crime documentaries

VALUES
» Providing opportunities and safety for her students
» Inspiring her students to build meaningful futures
» Spending time in nature
» Providing opportunities for disadvantaged/marginalised students

ASPIRATIONS
» Wants to inspire creative, passionate and critical thinkers
» Continue her own learning
» Inspired by those doing work in Indigenous communities

BRANDS
YETI
bundarra

NEEDS
» Emotional support from partner
» Freedom to be innovative at work
» Feel fulfilled and appreciated
» More resources/development to create more engaging learning opportunities

POWERS
» Influence over her students and fellow colleagues
» Access to further education resources
» Advocating for her students to authority figures in school
» Engaging in meaningful ways
» Teaching/mentoring role with other Science teachers

BEHAVIOURS
» Monthly Zoom session with Perth-based mentor
» Plays netball and waterpolo in Karratha and Dampier
» Supports Indigenous and local business
» Spends weekends away from home

TECH
IT & INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORKS

Figure 32: "Remote High School Teacher Persona"

EMPATHY MAPS

An empathy map is an exploratory tool we used to build empathy with our core actors by helping us to understand their feelings, experiences and actions. Empathy maps allowed us to gain valuable insights into the people that we interviewed. Based on insights gathered during interviews, we could map out what these groups of people were seeing, hearing, feeling, doing, saying, and thinking in relation to our questions. Empathy maps were created to understand the experiences of students, teachers, Scitech, and parents. From this, we learnt about the different groups' opinions on STEM, teaching of the school curriculum, and experiences with SciTech. Gathering insights into the experiences of these core actors helped guide our research into understanding their behaviours and needs, which further informed our understanding of Scitech's problem.

Creation of empathy maps allowed us to identify key themes and valuable insights that informed the direction of the project. Here we have summarised our key findings.

PRIMARY SCHOOL TEACHERS

» Hard to pair the unstructured nature of STEM with the structured nature of classes and reporting.

STEM being a multidisciplinary approach to learning that incorporates different subjects and learning areas can make it difficult to synchronise it with the school curriculum. The school curriculum is very specific and strongly emphasis on meeting KPI deadlines to ensure every criterion is achieved. This can make it difficult for teachers to deviate from the curriculum and incorporate their own STEM activities.

» STEM is for science and maths-based subject, doesn't include art.

The perception that STEM only revolves around Maths and Science makes it difficult to incorporate other areas such as HASS and Art to ground the STEM skills. Especially since STEM learning requires critical thinking and innovation, this requires a combination of different learning disciplines to best stimulate critical thinking and problem solving.

» Partnership between community and classroom is important to integrate life experience with classroom teaching.

In some cases, local environments play an important role in the success of a student's life at school. Involving the local community in STEM partnerships could be key in promoting reciprocal learning and teach real-life experiences that utilise critical thinking and problem-solving. Educating children on the importance of STEM learning in the real world outside of the classroom is essential in promoting STEM career readiness.

» "I used to think STEM was structured activities that integrate Science, Engineering, and Technology but now I think it's about self-guided enquiry and letting go".

The definition of STEM seems to be confusing even for teachers let alone students. The divide in definition and implementation makes it difficult to narrow down the areas of learning that need to address. Finding a way to universally define STEM for starters could be key in delivering impactful sustained ongoing STEM learning.

INTERNAL SCITECH STAFF

» Teachers want more customisation options for DIY kit content.

Tailoring DIY kits for specific schools and their students could be key in seeing improvements in the impact of STEM learning. Understanding the needs and wants as well as the curriculum of the school is important as schools are paying for these kits.

» High schools aren't interested in Scitech because they are busy.

This isn't necessarily true. Based on the interview with Thornlie Senior High School year 7 and 9 science teacher and STEM coordinator, high schools that are more vocational in nature respect SciTech and what they offer in their outreach programs. However, it is important for SciTech's outreach team to understand their target audience, finding out the best way of interacting with high school students and ensuring your presentations are not 1-way learning but 2-way in which reciprocal teaching is utilised could be instrumental in SciTech's success in penetrating the high school market.

» Scitech does well when catering to diversity but could do better.

Diversity in this context is important. Not only referring to gender diversity but also taking into consideration culturally and linguistically diverse (CALD) children, indigenous children and children that come from low socioeconomic statuses. Understanding their values and attitudes could be important in delivering optimal STEM learning.

» Disconnect in the perception of STEM.

STEM is too broad of an acronym. Students need to be able to bring all the skills they get from their math, sciences, English, HASS, and arts into one space and combine them to ensure they are industry-ready. STEAM or even project-based learning could be a more acceptable way of defining STEM.

PRIMARY SCHOOL CHILDREN

» Kids see STEM as a project, not a multidisciplinary learning.

Children perceiving STEM as a "project" that their teacher assigns to them is a key insight into how the definition of STEM differs between teachers and children.

» Teachers are still delivering learning in a traditional format.

Teachers are still delivering learning in a traditional format. 1 way learning from teacher to student. Not enough reciprocal 2-way learning in which the student's input on the best method of learning is still not prevalent in the primary school market.

» Children today are more tech-savvy and prefer digital learning rather than traditional methods of books, and pencils.

Children today are more tech-savvy. They use iPads, laptops, and interactive devices at home for personal use. However, the school market still utilises traditional books and pencils. There seems to be a disconnect between the best method of interactive learning. School budget and resource limitations are some of the main barriers to optimizing primary school learning.

PARENTS OF PRIMARY SCHOOL CHILDREN

» "Unfortunately, the grades are based on the assessments not necessarily on the hard work you do during class hours".

This quote from a parent reinforces the bottom line of education, which is to pass. This doesn't only reflect the student but also the teacher and the school.

» Science is not a subject that is heavily taught to primary school students. The curriculum is more focused on English, maths, drama, and IT.

In primary school curriculum, science is not a subject that is heavily taught. Schools prioritise English and maths as well IT. This insight could be key for SciTech who specialise in science in their presentations and experiments.

» STEM to include arts, humanities, and language.

One of the parents highlighted the need for the STEM acronym to include arts to become STEAM. This growing demand doesn't only exist amongst teachers but even parents who agree that STEM is outdated and not practical as problem-solving requires innovation and critical thinking. Both attributes come from a multidisciplinary approach to learning.

Figure 33: "Primary Teacher Empathy Map"

PRIMARY TEACHERS

Primary Remote Private Teacher
Year 3 teacher at a catholic school

Primary Remote Public Teacher
Level 3 teacher and Maths Specialist

Primary Metro Public Teacher
4 years teaching in rural and metro areas

Primary Metro public teacher
Teaches year 1 to 6 science

HEARS

Lack of understanding about how to integrate STEM

Hard to pair **unstructured nature of STEM with structued nature of classes** and reporting

At the root of STEM is providing resources and tools to let kids self-discover and investigate

Most kids and families have a **connection to the land** and integrating the environment with STEM teaching celebrates that

Lack of understanding in weaker subject areas can lead to stress when trying to teach curriculum in exciting ways

Arts doesn't matter in a child's education, that is a fun subject.

Art is not linked to STEM, does not require creativity.

Have to **keep costs under budget** so letters don't have to be sent home for paid experiences

Scitech is well known, reputable and easy to work with in comparison to some other community groups

Scitech is more of aplay centre for kids.

Lack of making STEM an exciting subject to learn

SEES

Excitement of kids @ Scitech Incursions

Some kids don't have access to technology and the internet.

Looking for Scitech to provide experiences that are relevant to what I'm teaching; **"know exactly where it slots in"**

Remote teachers struggle to recall their last Scitech interaction

Scitech is a focus for **Science teachers**

Access to projectors, interactive whiteboards and ipads; even more so in metro schools

Parents who bring their kids to a catholic school care about religious education.

Students are kids who all have basic needs that need to be met before education

Hands on learning is the most engaging

Parents are more involved in lower school and level of engagement depends on their own experience in education systems

Every student have different needs and all learn with unique abilities (seeing, hear, touch, showing etc)

Logistics of creating incursion is time consuming.

SAYS

HAAS grounds STEM skills in context

STEM teaching could involve giving students open ended projects within the realm of STEM where they get to creatively solve problems for themselves; **I'm just a facilitator to help guide that self-direction**

Indigenous people were the first to be involved in STEM; they were the first Scientists in Australia

Talking is the foundation to build relationships that foster understanding of culture and need

Wishes the school would provide more for STEM subjects rather than having to spend time outside of the classroom preparing.

"I haven't prioritised it; we do a little bit in Science"

Schools and teachers still don't understand the **importance of expanding the acronym STEM**

It is useful to **make learning meaningful and relevant** to kids understand there is a point

"Does [STEM] it always have to include Science?"

Scitech experiences are valuable because **you can only do so much in the classroom**, it pushes the education experience further

The syllabus doesn't recognise the arts and humanities that are involved with STEM education

Kids are tactile; they want to see, hear and feel

DOES

Shares lesson plans across classes of same year so every teacher teaches same lessons and workload is reduced

Promotes **group work** and open enquiry to help scaffold and push students

Puts effort into their education by going out of the way to provide a better experience (will buys supplies, look for content online – **all out of school hours**)

Organise activities with industry and community groups with focus on those that are **easy to organise/reliable** to work with

Attends **curriculum network meeting** to learn about areas of curriculum where weaknesses lie and share resources in areas of strength

Take kids on excursions to relate their learning to the 'real world'

Have to adapt to school's approach to teaching

Puts effort into **establishing relationships with kids and their families** to build trust, educational partnership and common ground

Has a drive to excite kids at school with fun ways to approach subjects

THINKS

I used to think STEM was structured activities that integrate Science, Engineering, and Technology but now I think it's about **self-guided enquiry and letting go**

Diffcult to plan and scaffold learning for students who don't attend regularly

Hard to know what resources are out there and which are actually suitable

I wish someone would tell me how to integrate STEM

Hard to allow for unstructured nature of STEM when you **have to mark against the curriculum and are time poor**

Their method of teaching is not effective and not benefcial to students.

Resourcing is hard and expensive

Adding more things to teach with **no more time**

FEELS

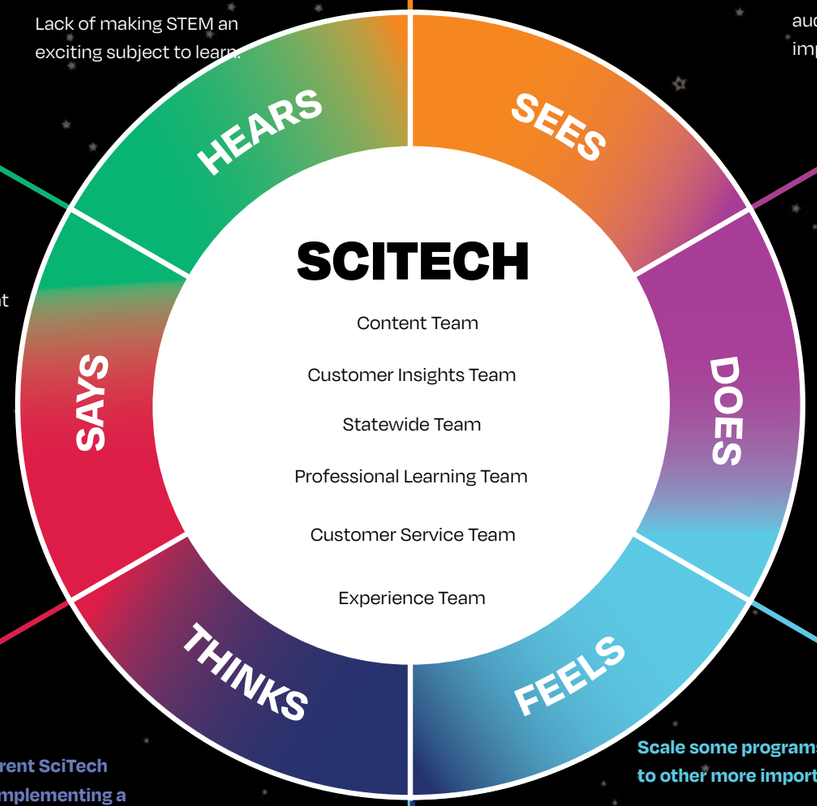
Partnership between community and classroom is import to integrate life experience with classroom teaching

I want to provide my kids with **life skills** that STEM teaches

Integrating HAAS into STEM through place and geography created cultural understanding for my students

I'd love an outline of a project that **linked to the curriculum** so I can **tick off criteria**

Great to have a **support system** that provides rescources to teachers who do not know how to conduct STEM based learning.



Scitech executives **need to invest more resources into early learning outreach programs.** Valuable target audience to SciTech who are simultaneously the least impacted target audience.

Scitech don't cater outside the family of young children demographic.

Scitech says no to a lot

Scitech is a playground for children

The current **SciTech outreach impact on high schools is "poor at best" and that SciTech could have a greater impact on this demographic**. I imagine his explanation would be that high school students are too busy to deal with SciTech and that perceptual attitudes of SciTech being a playground for young kids could be the main barrier to entry into the high school market.

DIY kits have huge potential to provide learning resources for rural/remote schools

"It's a fun thing, it's that joy of changing people perception that science is boring"

[STEM is] Not necessarily working in the stem field but asking questions and figuring stuff out.

Chose to work for Scitech because it's more fun.

Scitech does well when catering for diversity but could do better

The **reason he chose to work at SciTech was due to his passion for engaging with young children and his own personal experiences** with SciTech when he was young.

Teachers want more customisation options for DIY kit content

Scitech needs to do better in entering the high school market.

High schools aren't interested in Scitech because they are busy.

The **outreach team build strong impressionable relationships with the outreach audience** whether it is giving a high-five or a having quick conversation before and after the delivery of a science show.

Lack of making STEM an exciting subject to learn

Scitech are good at what they currently do with a 98% satisfaction rate.

Teachers want more agency over content of DIY Kits

Scitech more of a science engagement centre

STEM isn't well defined

I'm not sure whether our role is to inspire or educate

We are separating design and delivery

Concerns with the **current SciTech content strategy not implementing a feedback loop** to modify the outreach experiments.

Not diverse enough, only create exhibitions for the centre and don't cater beyond families and young children. STEM is for boys. Science isn't creative enough

Lack of upgrade in the new SciTech strategy for the outreach team **could lead to the outreach team falling behind in content delivery as they visit once every three years** and only spend one hour with their target audience.

The current SciTech strategy not changing much from the previous strategy for the outreach team which could be problematic for ongoing targeted deeper reach.

The lack of resources allocated to the early learning outreach programs and the lack of success in the entry of the high school market are clear frustrations.

DIY kits don't take advantage of technology – less accessible and less customisable

Scitech is a science engagement centre rather than a true STEM learning provider

Kids have a universal interest in learning.

Hope Scitech inspires learning.

Vast difference between indigenous communities and metro communities in terms of resources, the number of students and staff and the way the programs are delivered

Scitech falling behind in the way they work and the experiences they deliver

No model for outreach team feedback loop to improve their programs. State-wide team has minimal creative control over design, only delivery.

Scitech could improve on in target ages. **Can change demographic from families with 4 to 6-year old's**. Exhibits are made for them as it works.

The SciTech executive team are not investing enough resources to outreach initiatives relating to state-wide early learning audiences who are the least impacted demographic.

Metro schools will organise the one visit to a class to align with current learning curriculum to benefit their class.

High schools being "iffy on the uptake" of Scitech visits because they "just have so much to get through"

Scitech has a good group of creative people who are passionate about what they do.

Plans what they will do, how they will do it going forward. Running the team through briefs. Writing every day, brainstorming, working with the design thinking process.

Designing a new exhibit at the moment by figuring out what Perth wants. **They sell to an international market so need to figure out what the international market wants.** Gets the first part of the double diamond done and passes it on to another team.

The behaviour that he has observed that he believes is irreplaceable is the outreach teams' passion and enthusiasm in their interaction with the outreach target audience.

Scale some programs down to give more to other more important programs

Scitech is a creative environment, many inspirational hard-working people, a great company and brand.

Everything that Scitech does has a 98% satisfaction. They are good at what they do.

Trying to **improve entry into the high school market.**

Wants acknowledgement that **children who develop certain skills can succeed in STEM fields regardless of their performance in science or maths subjects in school** Add digital/online component to DIY kits

Moving away from numbers and more towards impact. "Maybe we need to see a few less people but have more impact. Can we spend more time and do something more with them?"

The current SciTech strategy to update the state-wide outreach programs by bridging the gap in digital growth of regional target audiences and subsequently improving the content delivery of these outreach programs.

Wants to have more impact on diverse groups.

Works with many different teams within Scitech. Started to work with state-wide team for their shows.

Manager of content. news, scripts, shows (very broad) particle website, fringe shows, videos, podcasts, animations.

Tell Schools about new upcoming shows/exhibits that "not very many people have seen" to try and spark interest

His day to day encompasses meetings, budget updates and liaising with program coordinators within the outreach team.

Professional Learning Consultant – develops learning experiences

Works in a pipeline rather than collaboratively with peers

State-wide manager- currently works out of the SciTech's corporate office where he spends 95% of his time.

Working on a new program involving teachers from kwinana to bunbury.

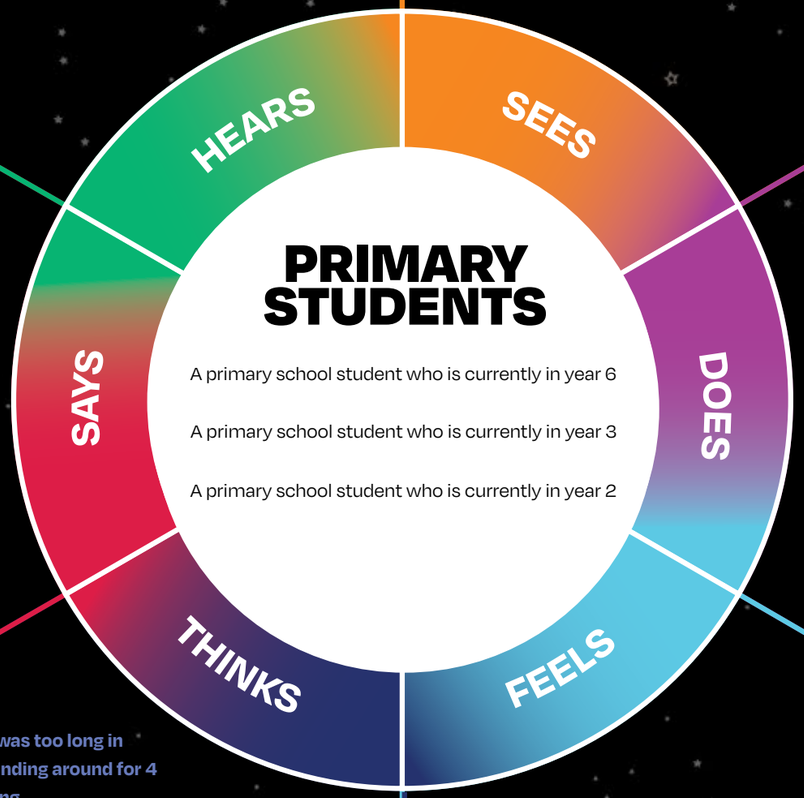
Working on reconfiguring STEM club.

Research language, what information is going across other sites to determine what is good, what is working well.

The SciTech executives allocating adequate resources to early learning outreach

State-wide playing a larger role in the modification of the content within the state-wide programs from the feedback of the outreach team on the ground.

Figure 34: "Scitech Empathy Map"



If you want to be an engineer you have to try really hard at school and go to university

SciTech visit was too long in duration – standing around for 4 hours was tiring.

"I heard real estate agents get money" (future career aspirations)

Getting help from parents for maths homework not English.

He likes playing with friends during recess and lunch.

STEM is defined as a project that a teacher gives you which involves building things.

He enjoys writing as his preferred method of learning.

Favourite thing about school is playing and eating

Learning maths is his least favourite thing about school.

Has heard of SciTech but has never been there.

Enjoys reading homework.

Thinks science and maths are not really needed for engineering career "only a tiny bit is required".

You **dont need to be academic** to be creative

I can do anything if I put my mind to it

We do STEM when we build projects

Maths is his least favourite subject at school.

Using technology and going to computer lab classes is his favourite thing about school.

Favourite way of learning is though watching videos and documentaries.

SciTech has come to his school but not his specific class or year group.

Has been to SciTech and thinks it's fun and educational.

I have to memorise what my teacher tells me

Hear **my teacher use things in our environment** to explain new ideas

School days are long requiring 6 hours of learning.

The method of delivery is important "if the teacher explains in a fun way, then I like it but if she talks a lot then I don't like it".

Last visit to SciTech centre he remembers seeing the planetarium where science presentations are (he remembers lasers being used)

Dad helping him with is maths homework

Lots of books used for homework (not enough computers)

The computer lab, lunch, recess, and friends are his favourite things about school.

He has been to SciTech and can only remember science shows (nothing more specific)

Lots of technology use at home and school including computers, interactive whiteboard in the classroom and Computer labs at school.

Not much homework is assigned other than some reading and some spelling words.

SciTech visit was too long in duration – standing around for 4 hours was tiring.

You must stay in school for over six hours.

He likes maths but sometimes he doesn't "Only time I don't like maths is when its division and timetables".

Teachers not being interactive enough (too much talking)

Doesn't like maths.

Learning maths is his least favourite thing about school.

Doesn't like writing.

Wanting to become a real estate agent.

Teachers to become more engaging during STEM learning.

Dream of becoming an engineer.

Less maths and more science homework

Get ready for school in the morning with the help of his mother.

Go to school on time by 9am

Attend every subject (same class different teacher rotations)

Do homework when he arrives at home.

His science teacher giving him a STEM project this term involving making a reusable mask (in response to COVID-19) "I think I'm going to use some silk, some stretchy fabric and then fold it and cut holes for the ears".

Get ready for school in the morning with the help of his parents.

Receives maths and science homework only twice a week.

Receives daily reading and writing homework.

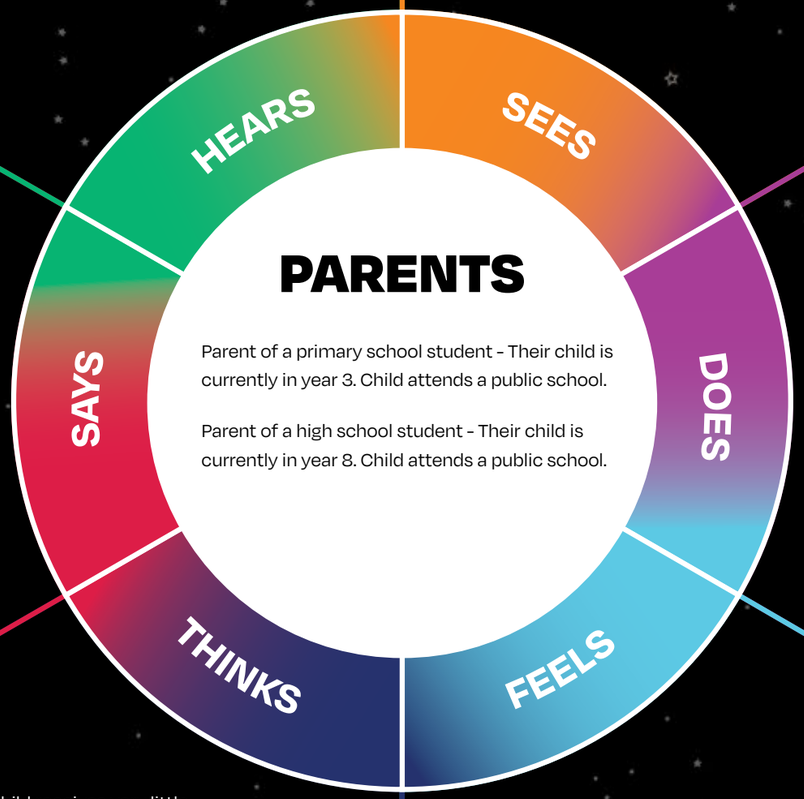
He would need to learn more about science and how life evolved on our planet if he wants to become an evolutionary biologist.

Parents help him out with homework by conducting mini spelling tests. They also help with timetable maths.

Wants to become an Evolutionary biologist after watching a documentary on Netflix.

Prefers interactive methods of learning rather than traditional methods of reading and writing.

Figure 35: "Primary Students Empathy Map"



Her child attends a good school with a good reputation that is still growing. Her child might be interested in pursuing a STEM related career based on her current interests in science. There's multiple of ways to get into university outside of ATAR.

Her child attends a good school with a good reputation that is still growing. Her child may have **1 block of science learning per week.**

She has taken her child to SciTech during the school holidays as a day out. "Perhaps a **bit less so as they have got older** as other sport and activity commitments take over". She has a reasonably better understanding of the school curriculum as the child's older sibling went to the same school. She understands what STEM stands for but would prefer it to be changed to STEAM. **"I quite like the STEAM version where we include art/humanities as well'.**

Expensive private school are not worth it financially as they offer the same educational content as regular high schools. "And maybe this is me being Swedish, it doesn't mean that you get a better education, it means you have a nicer uniform, and maybe some shiny computer labs. I think it's the teachers at the end of the day".
STEM as an acronym doesn't take into consideration languages, humanities and arts which is required for most if not all industries. STEM should be changed to STEAM to accommodate this.

"Unfortunately, the grades are based on the assessments not necessarily on the hard work you do during class hours". Fair bit of homework is given. Quiet of few assessments are handed out "just like university" per term. One in the beginning of the term, one mid-term and a final assessment at the end of the term. Learning how to manage time is also very prevalent in a high schooler's life.
Her child attends a good school with a good reputation that is still growing.

Science is not a subject that is heavily taught to primary school students. Curriculum is more focused on English, maths, drama, and IT. It's only a small school, it's about 500 students. **School fundraisers require parent participation to aid in acquiring resources for school.** Science project would be brought home once a term or semester but English homework essentially every week. School is good in providing adequate resources to the child. School teachers are great.

Help with any homework they can. Provide the child with necessary equipment to succeed at school (technologies)

Sign permission slips for SciTech excursions. Get involved in homework. **Provide the necessary technological resources for homework at home.** Provide the resources to the child that the school can't. Partake in school fundraisers to help school in acquiring resources.

Staying up to date with child's high school curriculum and study schedule. **Preparing for ATAR subject selection once it comes along.** Aligning current subject selection to that of which she hopes to do once she reaches ATAR selection period. Organising tutors for necessary subjects that the parent/s cannot help with.

Organising after school tutor for child. Help with any homework they can. Provide the child with necessary equipment to succeed at school (technologies)

Her child receives very little science homework.

School grades are determined by grades rather than how hard her child works. Starting high school during COVID-19 pandemic – made it a bit more difficult. **Both parents did not attend school in Australia. So, they are both learning about the WA's education curriculum as they go along.** Her child receives a fair bit of homework and assessments.

STEM to include arts, humanities, and language. **For school to increase science learning into curriculum**

STEM to include arts, humanities, and language. Her child to not worry too much about ATAR – not being too forceful as a parent and allowing her to play to her strengths when deciding her future.

Figure 36: "Parents Empathy Map"

PERSONAL STORY WORLDS

Differing slightly from personas and empathy maps, personal story worlds provide us with a more personal connection to the core actors. Personal story worlds paint a picture of a specific individual we have interviewed from a core actor group. Instead of trying our best to imagine what it would be like to be a person from one of these groups, we have direct quotes and insights from individuals we have interviewed and collated them into story worlds. Using these personal story worlds gave us a direct understanding of what it is like to be a person belonging to our core actor groups, therefore further informing the project problem understanding.

Key findings were as follows:

OUTREACH

- Scitech's strongest asset are their presenters, especially within the Statewide team. They are elite at their job and can teach over a broad variety of contexts.
- Ran a program at a detention centre where a large portion of people there were of indigenous descent.
- Thought that Scitech outreach program was valuable for people like that who are more at-risk.

HIGHSCHOOL METRO TEACHER

- Scitech incursion to school did not hit the mark in terms of engagement and impact.
- Scitech outreach team should improve audience engagement (understand your target audience).
- Scitech outreach team need to utilise more hands-on activities especially for year 7 students.
- STEM is too broad of an acronym. Students need to be able to bring all those skills they get from their math, sciences, English, HASS into one space and combine them to ensure they are industry-ready.
- Aim to improve STEM program by making it more "industry-ready".
- Students should continue maths and English learning in high school while doing workplace learning to integrate real-world experiences with academic learning.
- Far too many students are leaving school with silo skills, but they're not leaving with the prerequisite teamwork skills, problem-solving skills, innovative thinking, and overall critical thinking skills.

PRIMARY METRO TEACHER

- Need guidance on how to integrate STEM in the classroom whilst still meeting marking criteria.
- Lack of collaboration between disciplines makes integrating lessons difficult.
- Activities in the classroom are driven by pressure to teach content heavy curriculum, no time for unstructured lessons.
- Scaffolding lessons for wide-spread of language skills is difficult and no student should be left behind.

OUTREACH AND BOOKINGS

- Teachers book incursions that align with what they are teaching in the curriculum.
- Customer Service team offers DIY kits IF a visit is not possible.
- Outreach presenters are crucial to the success of engaging students, regardless of the program.
- Number of kids dictates how personal an experience is.
- Scitech is about inspiring fun and interest, not necessarily educational content.
- Confusion about the meaning of STEM and who is included; should be more about skills of enquiry, problem-solving and curiosity.
- Need to move away from KPI's and towards actual impact

STORYWORLD
METRO PRIMARY SCHOOL TEACHER

CURRENT SITUATION

- I am currently working at a large primary school in the North Eastern Suburbs.
- The school has 850 students, is extremely culturally diverse with a special EALD program, and is in a low-socioeconomic area.
- We use an explicit instruction approach to teaching at the school and teachers share lesson plans to ensure all students are taught the same.
- I specialise in literacy and I don't feel my strengths lie in Science. There is a strong focus in Literacy and Maths to build the fundamental skills of my students.
- We just don't have enough time or resources to teach STEM; I haven't prioritised it because the school hasn't prioritised it.

THE BACKSTORY

I am a 31 year old primary school teacher. I grew up in the northern suburbs of Perth, WA with my parents and younger sister. I have a keen interest for travelling and conservation which I developed from a young age, inspired by family trips and my parents jobs in the environmental sector.

Further travel once I left school inspired me to study geography and conservation at University, going on to do my Masters. When I struggled to get a job in the field in WA, I studied my Graduate Diploma and became a primary school teacher.

I did rural placements in The Pilbara and The Wheatbelt before settling back in Perth where I now teach 45 minutes away from my home. I am still an avid adventurer with my partner and our dog.

I THINK/FEEL/KNOW

- I think you have to make learning meaningful and relevant for kids so they realise why it is so important; our kids have been spoon-fed for so long that they don't know how to think for themselves
- I feel I don't know enough about STEM to teach it but I'd love to know how to do it
- I know collaboration is required in my school to make a plan to integrate STEM, especially when there are cross-disciplinary links that are identified in the curriculum

KEY INSIGHTS

- Need guidance on how to integrate STEM in the classroom whilst still meeting marking criteria
- Lack of collaboration between disciplines makes integrating lessons difficult
- Activities in classroom are driven by pressure to teach content heavy curriculum; no time for unstructured lessons
- Scaffolding lessons for wide spread of language skills is difficult and no student should be left behind.

BELIEFS ABOUT CHANGE

I believe change is necessary to improve the learning experience and outcomes of our students but I think it is challenging when the school is not united in it's approach to change. We are forced to drive change from the bottom up and it takes time and energy that we don't have.

DEVICES & TECHNOLOGIES

- Limited tech - 28 Chromebooks for 6 classrooms, 6 ipads, e-board
- Students have limited access to tech at home
- Minimum budget for resources in design & technology VS Science Specialist

ISSUES & CHALLENGES

- Small budget and lack of resources - lesson planning is extremely time consuming
- Can'tdelive unstructured STEM activities when teaching with explicit instructions
- Parents have to give permission for their children to use technology in the classroom through the communication portal but lack of tech in homes makes communication hard
- Teachers have a specific subject they write lesson plans for so integrating activities is difficult
- Students aren't motivated to learn, it's not something that they value/see the point of
- I have to mark against the curriculum and I don't know how STEM fits into that

WORKAROUNDS

- Try and use interests of students to spark interest in learning
- Share lesson plans with other teachers to ease workload

GOALS & VALUES

- Wants kids to love learning & be able to apply knowledge to building a future for themselves
- Learn to integrate STEM & the support of other teachers to achieve this
- Wants school to prioritise STEM & put resources & time into helping us teach it

CAPACITIES & RESOURCES

- School has subscriptions to a number of online programs
- Number of resource books in library
- Constrained by a heavy curriculum and lesson planning; very time poor

RELATIONSHIPS WITH ORGANISATIONS

Building a relationship with the local Tip and Recycling Facility for the development of a sustainability unit

WEAK TIES WITH

- Year 4 Science Specialist
- Parents of students

STRONG TIES WITH

- Teachers in the same year level across disciplines

STORYWORLD
SCITECH OUTREACH AND BOOKINGS TEAM MEMBER

CURRENT SITUATION

- I currently work in a management position in the Event Coordination department at the Scitech Troode St Office
- I'm realtively new to the role, having previously worked in the Outreach team
- Having seen Scitech re-evaluate its focus with the New Scitech Strategy has been really exciting, as it has injected a new energy that we all felt when we first joined the team
- I'm getting to the age where I want to settle down, so being permanently based in Perth has really benefitted my wellbeing and relationships

THE BACKSTORY

I am 34 years old, and I live in an apartment with my partner and our cat .

When I am not working, I love to spend time hiking around Perth, hitting up cafes around my home and hanging out with my family.

I grew up as the youngest of three siblings with my parents in a coastal Perth suburb. My family would spend holidays out camping where I developed a curiosity and love for being in nature.

I attended university & graduated with a Bachelor of Science (Biochemistry). I worked for a short period in research labs, but was really lacking a social element to work.

By chance, I applied for a role in the Outreach Team at Scitech & was accepted. I spent the last 7 years touring around WA sharing my love for Science with children. This job provided such an amazing level of satisfaction as I got to inspire a passion for curiosity and learning. It also meant I have travelled to some amazing locations around WA and worked with such a tight knit and supportive team.

I transferred to the Event Coordination Team early last year as being on the road for so long was starting to get tiring.

I THINK/FEEL/KNOW

- I think that there are so many differnet ideas about what Science & STEM actually are
- I feel Scitech could do more to cater to diversity
- I know the staff out on the road are the reason Scitech has been so effective

KEY INSIGHTS

- Teachers book incursions that align with what they are teaching in the curriculum
- Customer Service team offers DIY kits IF a visit is not possible
- Outreach presenters are crucial to the success of engaging students, regardless of program
- Number of kids dictates how personal an experience is
- Scitech is about inspiring fun and interest, not necessarily educational content
- Confusion about meaning of STEM and who is includes; should be more about skills of enquiry, problem solving and curiosity
- Need to move away from KPI's and towards actual impact

BELIEFS ABOUT CHANGE

I think that change is necessary to adapt to how fast the world is changing.

We don't want to be left behind.

GOALS & VALUES

I want all kids to be excited & engaged with STEM.

If I can get kids asking questions and have them not be afraid of being wrong, I'll be happy.

DEVICES & TECHNOLOGIES

- Shared mailbox for emails
- Phone enquiries
- Spend most of the time at my desk and computer

CAPACITIES & RESOURCES

- Knowledge of in-centre & outreach programs
- Direct link with schools
- Coordination of Outreach tours

ISSUES & CHALLENGES

- Physicality of Outreach job
- Not able to instantly offer incentives to Schools who can't access Scitech (need approval)
- Communication with teachers who are in the classroom during work hours

RELATIONSHIPS WITH ORGANISATIONS

- Close communication with annual Science event organisers
- First point of call for communication with schools; reaching out to schools on regional tours

WORKAROUNDS

Ensuring that resources are available for teachers as soon as they finishing teaching for the best chance of communication.

STRONG TIES WITH

- Statewide Team
- Budget and KPI Reporting Head
- In-Centre Team
- Less so with marketing team for knowledge on promotions

WEAK TIES WITH

- Content and Experience team
- Customer Insights team

STORYWORLD
METRO HIGH SCHOOL TEACHER

CURRENT SITUATION

- My day to day involves being primarily a youth service specialist
- I currently run two classes for math and science in year 7 and 9.
- I currently run the STEM robotics club and this year it is competing in the First Lego League competition that is facilitated through partnerships with Macquarie University and Curtin University here in Western Australia

THE BACKSTORY

I am a maths and science teacher at a Thornlie Senior High School. I have been teaching here for six years. This is my 6th year and last year I was awarded the position of STEM coordinator.

I come from a geologist background. Prior to teaching, I worked in the mining industry, working alongside engineers, environmental scientists, processing plant operators and other geophysicists.

I THINK/FEEL/KNOW

- I think as a STEM teacher using life experiences to highlight the skills and concepts I'm teaching that are relevant to the real world is the most effective way in instilling STEM values in high school students.
- I feel you need kids to be able to bring all those skills they learn in English, HASS, communication to one space & combine them as integrated learning because that's what they do in the industry.
- I know how important maths and science is, but I also know based on my industry experience that writing and communication skills are equally important, and you can only learn these skills by incorporating arts into STEM.

KEY INSIGHTS

- Scitech incursion to school did not hit the mark in terms of engagement & impact
- Scitech outreach team should improve audience engagement & need to utilise more hands-on activities (especially for Year 7 students).
- STEM is too broad of an acronym. Students need to be able to bring skills they get from maths, sciences, English, & HASS into one space and combine them
- Aim is to improve the STEM program by making it more "industry ready"
- Students should continue maths and English learning in high school while doing workplace learning - integrate real world experiences with academic learning.
- Far too many students are leaving school with silo skills, but they're not leaving with the prerequisite teamwork skills, problem solving skills, innovative thinking, and overall critical thinking skills.

BELIEFS ABOUT CHANGE

I think change needs to occur to the acronym STEM to include arts & therefore transforming it to STEAM. This is important because it incorporates the communication skills as well the research skills you pick up studying HASS. For kids to enter STEM careers they need to learn how to write and communicate.

DEVICES & TECHNOLOGIES

Fairly low-level resources such as pop sticks, skewers, straws, paper and also, we use cardboard of various sorts.

ISSUES & CHALLENGES

- Far too many students are leaving school with silo skills, but not with the prerequisite teamwork skills, problem solving skills, innovative thinking, and overall critical thinking skills to succeed post-school
- Communicating with the school regarding improving the current STEM program in order to take it the next level
- Navigating mixed academic levels of students when delivering universal STEM activities

WEAK TIES WITH

- Real life STEM industries for workplace learning
- Chevron
- National Science Youth Forum

WORKAROUNDS

Ensuring high school students are industry ready by accessing real-world STEM programs

GOALS & VALUES

I want all high school kids to be industry ready with STEAM skills that are influenced by their life experiences as this will shape their career progression after school.

My goal is to stimulate competition in the kids to expose them to what the larger world is like. Deviating from the traditional STEM teachings and incorporating more real-life learning experiences is my primary goal.

CAPACITIES & RESOURCES

With the robotics programme that I run after school we use ABC Lego robots as well other non-technological resources such as pop sticks and skewers etc. We are also experimenting with design projects via excursions to penguin island and doing case studies on the penguins and other endangered species.

RELATIONSHIPS WITH ORGANISATIONS

- CSIRO with indigenous STEM academy
- Curtin University with the LEGO League
- Indigenous engineering camp at Curtin University
- ABC through Bankwest

STRONG TIES WITH

- STEM departments within school
- Department of Education

STORYWORLD
SCITECH STATEWIDE TEAM MEMBER

THE BACKSTORY

I grew up in the Pillburra region, which is rural and quite isolated. I vividly remember seeing the Scitech van coming down the road to visit my school. This visit inspired my life-long facination and love for science.

My background is in neuroscience, earned my doctorate in the subject. During this time, I realised I enjoyed interacting with younger students. I am passionate about providing STEM education to all schools in Western Australia, as I know how vital Scitech's outreach can be in inspiring kids to pursue STEM studies or careers.

I THINK/FEEL/KNOW

- Believes there is a lot of misinformation in the world.
- Thinks that children should start developing critical thinking skills from an early age
- Everyone should have a scientific mindset
- Feels passionate about the capabilities of Scitech presenters

CURRENT SITUATION

- Engaging with clients in the community
- Running programs that Statewide offer
- Maintaining/upkeeping current programs
- Training presenters how to deliver
- Developing new content with the addition of other teams

KEY INSIGHTS

- Consistent, open communication between different teams within Scitech is limited
- Exchange of knowledge and resources between different teams is limited
- Outreach has not been able to provide feedback or contribute the knowledge they have gained while on the road
- Employees unsure if they are ablew to truly create change within their positions

BELIEFS ABOUT CHANGE

I believe that change is needed, but I have doubts that it will happen in any meaningful capacity.

I also do not know how I can have much of a role in that change.

GOALS & VALUES

I am passionate about bringing Scitech to Indigenous and rural children, as well as those with a low socio-economic status. I know how vital that contact is to inspiring children's interest in science.

DEVICES & TECHNOLOGIES

I have my laptop, phone, tablet, and access to most tech at the offices.

CAPACITIES & RESOURCES

- Easy communication with the outreach team
- Cannot easily communicate with superiors
- A decade of experience in current role

ISSUES & CHALLENGES

I must work within the parameters set by my superiors, and this can clash with the intentions of myself & the teams I manage or engage with.

RELATIONSHIPS WITH ORGANISATIONS

- Partners that fund outreach programs to go to certain areas
- Employee at Scitech with ties that go back a decade

STRONG TIES WITH

- Statewide team
- Content Team
- Media Team
- Partnership Team

WEAK TIES WITH

- Indigenous communities
- Diverse communities
- Other educational outreach orgs

WORKAROUNDS

- Has power within own sphere
- Able to make some descisions in relation to funding
- Able to grant finanical assistance for rural and remote schools, as well as schools in low-socio economic areas

STORYWORLD
SCITECH STATEWIDE OUTREACH TEAM MEMBER

THE BACKSTORY

I came from an engineering background, I did engineering and physics at Australian National University and then worked in an engineering start-up for a few years.

I eventually migrated to working full-time in science & communications. I also worked for 5 years in Canberra at National Science and Technology Centre. Then, I moved to WA and landed a role at Scitech.

I THINK/FEEL/KNOW

- Believes there is a lot of misinformation in the world.
- Thinks that children should start developing critical thinking skills from an early age
- Everyone should have a scientific mindset
- Feels passionate about the capabilities of Scitech presenters

CURRENT SITUATION

- Engaging with clients in the community
- Running programs that Statewide offer
- Maintaining/upkeeping current programs
- Training presenters how to deliver
- Developing new content with the addition of other teams

KEY INSIGHTS

- Scitech's strongest asset are their presenters, especially within the Statewide team. They are basically elite at their job and can teach over a broad variety of contexts.
- Ran a program at a detention centre where a large proportion of people there were of Indigenous descent.
- Thought that Scitech outreach program was valuable for people who are more at-risk.

BELIEFS ABOUT CHANGE

Children should be learning critical thinking skills from an early age to combat misinformation. People will have a bigger contribution to society if they have a scientific mindset.

Wants to see Scitech become more of a learning hub that engages with people across the entirety of the state and gives them skills to run their own programs that Scitech can check back in on. Scitech could de-centralise their role and become a distributive network.

GOALS & VALUES

Wants to foster critical thinking skills to overcome misinformation in the world. Wants more people to have a scientific mindset so that they can contribute more to society. State-wide team tend to share similar values. Believes in transferring skills, not content.

DEVICES & TECHNOLOGIES

Streaming services, prompted by Covid. There is a lot of room for Scitech to grow further into the digital space. There are a few videos on the website.

CAPACITIES & RESOURCES

- Providing programs via State-wide to schools.
- Runs a STEM Club program which goes for a whole semester at schools. There is the potential there to do longer studies of the kids that attend and see what skills they have developed

ISSUES & CHALLENGES

Scitech's business strategies may not be in line with what they are trying to achieve.

May lead to a reduction in capacity to achieve compared to what previously happened.

RELATIONSHIPS WITH ORGANISATIONS

Partners that fund outreach programs to go to certain areas

WEAK TIES WITH

- Indigenous communities
- Those that can't afford to interact with Scitech.
- Disadvantaged groups (such as detention centres)

WORKAROUNDS

Presenters have capability to change script on the fly and tailor/adapt to the audience. Presentations are flexible so long as not compromising the key messages in them.

STRONG TIES WITH

- Sponsors
- Outreach Presenters

FUTURE OUTCOMES NETWORK

A future outcomes network highlights across different contexts of the problem the things that are in place and working, not in place but should be, and in place and not working. These are important for us to figure out opportunities to improve future outcomes. The various contexts of the problem include SciTech identity, programs, outreach, diversity, regional, access to data, educational partnerships, educators, and SciTech partners.

KEY FINDINGS

Key areas to note pertained to Scitech's identity, outreach, diversity, and regional. We highlighted opportunities to improve by showing what isn't in place but should be:

Scitech identity

» Catalyst to entice people into Scitech.

Outreach

» Stronger relationship with communities, and information from schools pre-visit about their needs.

Diversity

» Not enough focus on diversity. More access to these communities, such as remotely located stakeholders. Indigenous consultants.

Regional

» Quicker return time. An alternate channel for instant access. Technology/infrastructure for facilitating access.

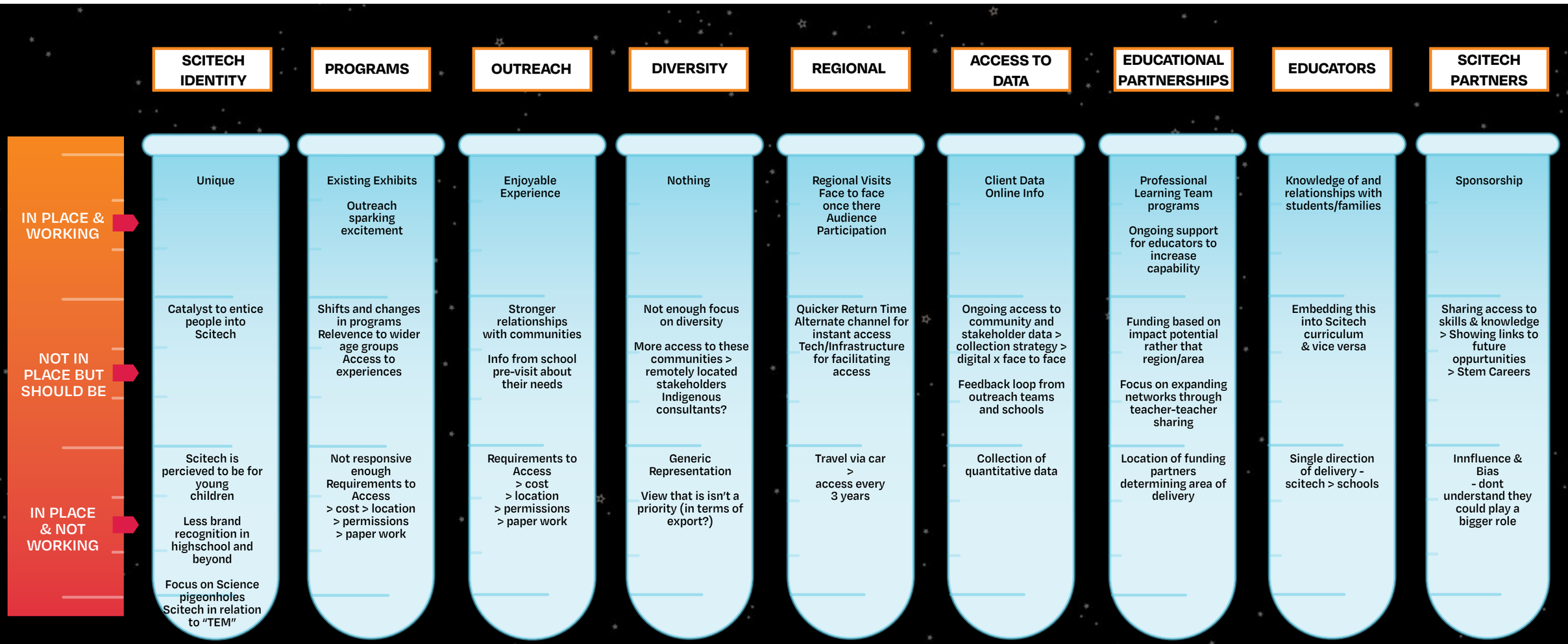
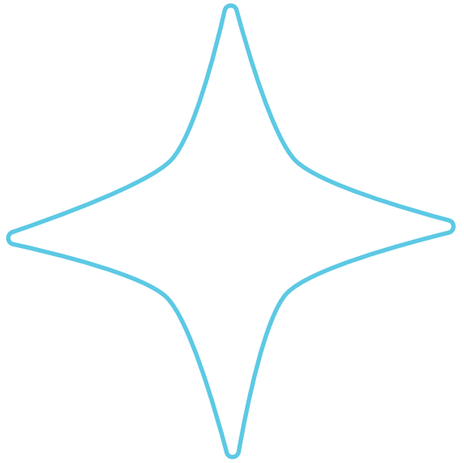


Figure 37: "Future Outcomes Network"

TOUCHPOINT USER JOURNEY MAP

User journey maps detail a persona's experience when going through the steps of a proposed scenario. They show the touchpoints they will interact with and the actions they will take. Importantly, they show how the persona feels throughout the process. The two scenarios we proposed for a rural primary school teacher were booking a DIY kit to substitute an outreach visit or being contacted by SciTech for an outreach tour. An understanding of teachers from our prior user research and the touchpoints that are involved with Scitech aided in the accurate creation of these user journey maps.



KEY FINDINGS AND OPPORTUNITIES

Opportunities to improve the experience of people that would interact with SciTech came up when creating two scenarios for user journey mapping.

BOOKING A DIY KIT TO SUBSTITUTE AN OUTREACH VISIT

- Opportunity for Scitech to find out more about the needs of the school
- Option for instruction videos or a phone/ conference call to provide instruction or advice.
- Option to let teacher keep lesson plans or resources for future use. Maybe a subscription rather than a one-off hire?
- Opportunity to link to next DIY kit.

SCITECH CONTACTING A RURAL PRIMARY SCHOOL FOR AN OUTREACH TOUR

- Opportunity to find out more about the school in terms of ideas about STEM, cultural backgrounds and learning needs.
- Opportunity to provide guidance to teachers about how to prepare for and integrate the visit.
- Opportunity to learn more about how environment and culture impacts ideas about STEM and learning.
- Opportunity to engage the teacher in active improvement of the program and link them with useful resources for use in the classroom.
- Opportunity to link with other teaching staff in school.

JOURNEY MAPS

Figure 38: "Rural Outreach Journey Map"

PERSONA : RURAL PRIMARY SCHOOL TEACHER

SCENARIO: CONTACTING RURAL PRIMARY FOR AN OUTREACH TOUR

	BEFORE VISIT			DURING VISIT		AFTER VISIT		
TYPICAL JOURNEY	School receives email from the Customer Service Team informing of Scitech tour in their area, extending invitation to book a session	Confirmation of session with Customer Service Team and selection of a show that aligns with curriculum focus of school	Uses DOT session to organise permission slips and organise lesson plans to integrate the session with classroom learning	Sees arrival of Scitech bus on school campus, organising students to head to the assembly area and briefing them for the session	Observes Incursion session and oversees class for behaviour and questions	Reflection session with students	Complete feedback survey for Scitech	Share experience with colleagues
TOUCHPOINT	Email	Email Scitech Website	Scitech Website	Scitech branded red bus	Branded presentation materials Potential prizes for students		Email and survey	Word of Mouth
ACTION	Consultation between teaching staff to determine budget, interest, and teaching or curriculum focuses	Staff research types of Incursion shows Admin sends confirmation email to book session with dates and show	Further research into show and review of Scitech online resources for lesson planning inspiration	Confirmation of session time with admin staff to get students assembled for the correct time	Takes note of topics of interest for class to use in later lessons	Runs feedback session to assess the effectiveness of session Asks about how this relates to classroom learning	Completes and returns feedback survey via email	Has conversation in staffroom with collegues about experience and how they are integrating it into the classroom
THOUGHTS AND EMOTIONS	Curiosity about programs and excitement that there is an opportunity to get kids excited about Science	Pressure to fit session into classroom schedule to align witho other classes	Excited about announcing visit to students and getting them engaged with the experience	Pressure to get kids organised on time and for them to behave Anticipation for session	Relief the students are having a good time learning Motivation to implement ideas in the classroom	Interested to hear about the kids interpretation of session and find out what is of interest in the classroom	Happy to provide feedback but I wish there was more guidance for how to integrate the session into the classroom	Interested to find out how others have extended the experience and if they have any ideas I could use
OPORTUNITIES		**Opportunity to find out more about the school in terms of ideas about STEM, cultural backgrounds and learning needs**	**Opportunity to provide guidance to teachers about how to prepare for and integrate the visit**		**Opportunity to learn more about how environment and culture impacts ideas about STEM and learning**		**Opportunity to engage teacher in active improvement of program and link with useful resources for use in the classroom**	**Opportunity to link with other teaching staff in school**

JOURNEY MAPS

Figure 39: "DIY Kit Journey Map"

PERSONA :
RURAL PRIMARY SCHOOL TEACHER

SCENARIO:
BOOKING A DIY KIT TO SUBSTITUTE OUTREACH VISIT

	BEFORE VISIT			DURING VISIT			AFTER VISIT	
TYPICAL JOURNEY	School receives email from the Customer Service Team informing of Scitech tour in their area, extending invitation to book a session	School turns down offer due to lack of budget so Customer Service Team offer DIY Kit as substitute, providing information resources	Consultation with teaching staff results in booking of a kit for the year 4 class for the start of the following term	School received DIY Kit in the mail at the end of the term in preparation for next term	Teacher takes DOT session to familiarise with the DIY Kit and plan implementation	Teacher runs through term's worth of sessions with class, using consumables in the Kit	Upon completion, Teacher mails the DIY Kit back to Scitech	Teacher recieves email with survey to complete regarding their experience with the DIY Kit
TOUCHPOINT	Email	PR/Promotional material to share with staff	Email Website Teaching blogs	Parcel and packaging	DIY Kit with packaging, lesson plans & consumables Website	DIY Kit with packaging, lesson plans & consumables Website	Postage Satchel	Email and form
ACTION	Email is filtered through to head of finance who reviews budget and staff need	Reviewing of budget, discussion regarding value of Scitech visit with staff; Principal/vice principal reply to Customer Service team declining offer	Research DIY Kits, reading reviews, initial plan for integreation	Signing for parcel, delivering to classroom	Teacher scans through lesson plans, organises consumables for each session and plans approach, talks to other staff about Kit	Implementation in the classroom, minimal planning outside of class time as Kit has everything provided	Teacher returns Kit to administration staff who post it back to Scitech, taked photocopies of lesson plans for record	Fills out digital form during DOT period, talks to other staff about experience
THOUGHTS AND EMOTIONS	Excitement that there is an opportunity to get kids excited about Science	Disappointment that students will miss out on an exciting and rare visit	Hopeful that the DIY Kit will still be engaging and the students will be inspired by it	Excitement to receive the package mixed with apprehension about the process	Motivation to get started and relief that all the resources are provided and ready to go	Relaxed about running the lessons and inspired to get the kids involved in the sessions	Slightly inconvenienced to have to organise postage and wishing the kit could be kept to future use	Nice to have a follow up but would like support to be continued
OPORTUNITIES	**Opportunity to find out more about the needs of the school**			**Option for instruction videos or a phone/conference call to provide instruction or advice**			**Option to let teacher keep lesson plans or resources for future use. Maybe a subscription rather that a one off hire?**	**Opportunity to link to next DIY Kit**

NEUTRAL

04 INSIGHTS & DIFFICULTIES

ANALYSIS OF OUR RESEARCH AND INSIGHTS FOR THEMES, COMMONALITIES AND LINKS ENABLED US TO IDENTIFY A NUMBER OF PROBLEM AREAS, OPPORTUNITY SPACES AND GAPS IN OUR KNOWLEDGE THAT CHANGED HOW WE VIEWED THE INITIAL PROBLEM.

THROUGHOUT THE PROJECT WE KEPT TRACK OF A LIST OF QUESTIONS THAT WE FELT WERE RELEVANT TO OUR LINE OF ENQUIRY. THESE HELPED US TO THINK ABOUT THE AREAS OF CONCERN, FUTURE OPPORTUNITIES AND THE IMPACT THAT FACTORS OUTSIDE OF OUR CONTROL HAD ON THE PROBLEM SPACE. WE HAVE DECIDED TO INCLUDE THESE TO GIVE

- IS THE AIM TO INSPIRE OR EDUCATE?
- CAN WE MAKE STEM THE FOUNDATION FOR LEARNING OTHER SKILLS (SUCH AS LITERACY)?
- ARE SCITECH LIMITING THEMSELVES BY STICKING TO STEM? DOES IT EVEN NEED A TITLE?
- WHY ARE THERE NO WALK-THROUGHS OF THE EXHIBITIONS ON THE WEBSITE FOR THOSE THAT DO NOT HAVE ACCESS TO THE PHYSICAL CENTRE?
- CAN SCITECH STREAMLINE LEARNING BETWEEN IN-CENTRE AND OUTREACH? WEBSITE RESOURCES?
- IS THE CURRICULUM CORRECT?
- CAN THE GOVERNMENT CHANGE THE WAY STUDENTS LEARN?
- ARE SCITECH LIMITING THEMSELVES BY VIEWING SIMILAR SERVICE PROVIDERS (SUCH AS THOSE IN THE PRECEDENCE STUDIES) AS COMPETITORS RATHER THAN OPPORTUNITIES TO COLLABORATE?

PROBLEM AREAS

DEFINITION AND BARRIERS TO STEM

A combination of our initial desk research into the definition of STEM and the user research we conducted exploring meaning and perception highlighted that there was a disparity between the understandings of the stakeholders about a concept which was intended to be a point of engagement. As a term that is often perceived as a literal reference to Science, Technology, Engineering and Maths, this has the potential to create a barrier to stakeholders engaging with Scitech for STEM based programs. From our interviews, we know that the skills identified as valuable by our stakeholders included things like critical thinking, problem solving, creativity, and analysis. Although these do align with the skills Scitech aim to deliver through their STEM based programs, it appears that labelling them with the term STEM may limit engagement based on interpretation.

This is further amplified by research into participation in STEM by women and Indigenous communities. As a term associated with a male dominated industry that requires a tertiary qualification to enter, connotations of the term present barriers to engaging with Scitech's programs for these key target groups.

In addition, we found that STEM is an area that teachers struggle to integrate in the classroom due to a lack of understanding about how the literal subjects can be taught in a way that aligns with the curriculum and marking criteria. The unstructured nature of STEM delivery poses challenges for teachers who are time and resource poor and may not specialise in these subjects.

DIVERSITY AND REPRESENTATION

Lack of diversity and representation of program design and delivery is an area that creates challenges for engaging with diverse communities. Children are most likely to engage with learning environments in which they see themselves represented and have their cultural identities acknowledged and celebrated. This includes placing value on different types of knowledge and the personal experiences and contributions of each student. Feeling valued and included provides an empowering environment in which students are engaged and motivated. Inclusion of more diverse representation and knowledge in the design and delivery of Scitech's programs has the ability to increase impact and engagement with diverse communities around the State.

IS THE AIM TO INSPIRE OR EDUCATE?

Throughout our user research and review of strategic plans, we uncovered differing views about whether the aim of outreach programs was to inspire and spark interest in STEM or provide STEM education. This view was also echoed in opinions of stakeholders, some of which viewed Scitech as a fun, one off experience, while others were more aware of the educational capacity of service offerings. Becoming clear on the aim of Outreach is a way to unite staff about their role and vision for development and delivery of programs, as well as delivering a strong message to key stakeholders who benefit from services.

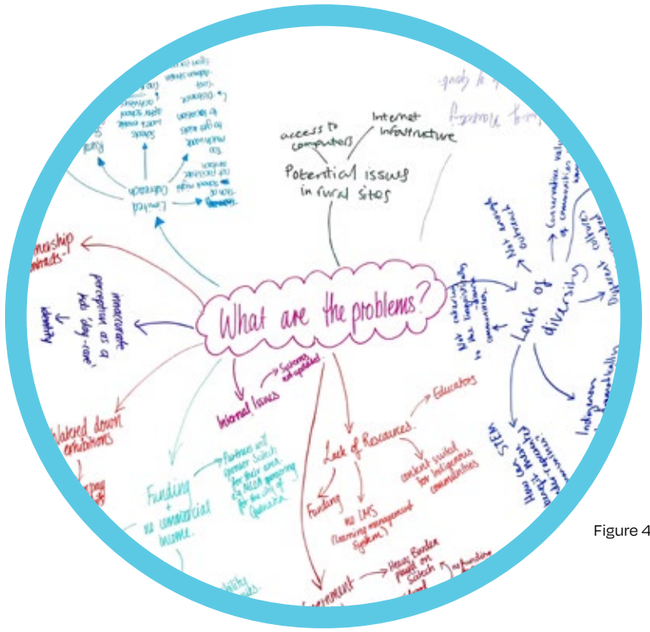


Figure 40: "Problem Brainstorming"

OPPORTUNITY SPACES

CAPACITIES AND EXPERIENCES

Through our user research we uncovered incredible knowledge and experiences of Scitech teams that could prove incredibly valuable in the evaluation, improvement and design of programs. In particular, we found that teams who were the main point of contact between Scitech and the core actor groups were incredibly insightful in both their professional knowledge and their understanding of the needs and experiences of those they were engaging with.

The Professional Learning Team holds in-depth knowledge into the Australian Curriculum as well as understanding the needs and experiences of teachers in the classroom on an everyday basis. Through their personal networks they can expand the reach of program delivery and engagement.

The Statewide Team holds invaluable insight into the experiences and needs of communities when engaging with Scitech on the road. As part of their delivery of programs they have the skills required to adapt content and delivery to meet the requirements of audiences and understand the challenges faced when implementing standardised programs with diverse communities who each have their own cultural, resourcing and learning needs.

Through analysis of the way in which knowledge and insight is passed between the teams within Scitech, we identified the great opportunity which harnessing this knowledge and experience could have in shaping and improving program design and delivery.

MODIFICATION OF DATA GATHERING

Through journey mapping, we were able to identify several key points that Scitech engages with core actor groups to gather information throughout their interaction. These points highlight key opportunities to expand the types of data Scitech are collecting to include information on cultural diversity, ideas about STEM, resource requirements and learning needs. Increasing channels for Scitech to understand the unique circumstances and requirements of communities will enable delivery of services that are more personalised and useful to stakeholders.

UTILISING COMMUNITY KNOWLEDGE

It is important to note that every stakeholder is an expert of their own situation, experience and needs, providing valuable knowledge and insight that can be used to inform program design and delivery. Going beyond just collecting data through existing channels, embedding these people and communities in the process will result in highly functional, effective and relevant programs that will help to build cultural competency of not only Scitech but the broader community. By creating an interconnected web of insight and knowledge exchange, we have the opportunity to create deeper impact as well as the development of a highly-connected STEM community, building on pillar two and four of the New Scitech Strategy.

PARTNERSHIPS AND COLLABORATION

In our review of organisations that were delivering projects in the same space, we identified programs with shared funding partners which lend to the opportunity to pool resources for service delivery. Whilst these organisations are usually considered competitors, we uncovered that each shares a vision to increase participation, break down barriers and create more engaging, culturally relevant and inclusive educational experiences. If not to partner, this shared vision provides a foundation to create complementary services that will support this goal, playing to the strengths of each organisation to provide an educational experience that will enhance the lives and experiences of core actor groups now and in the future.

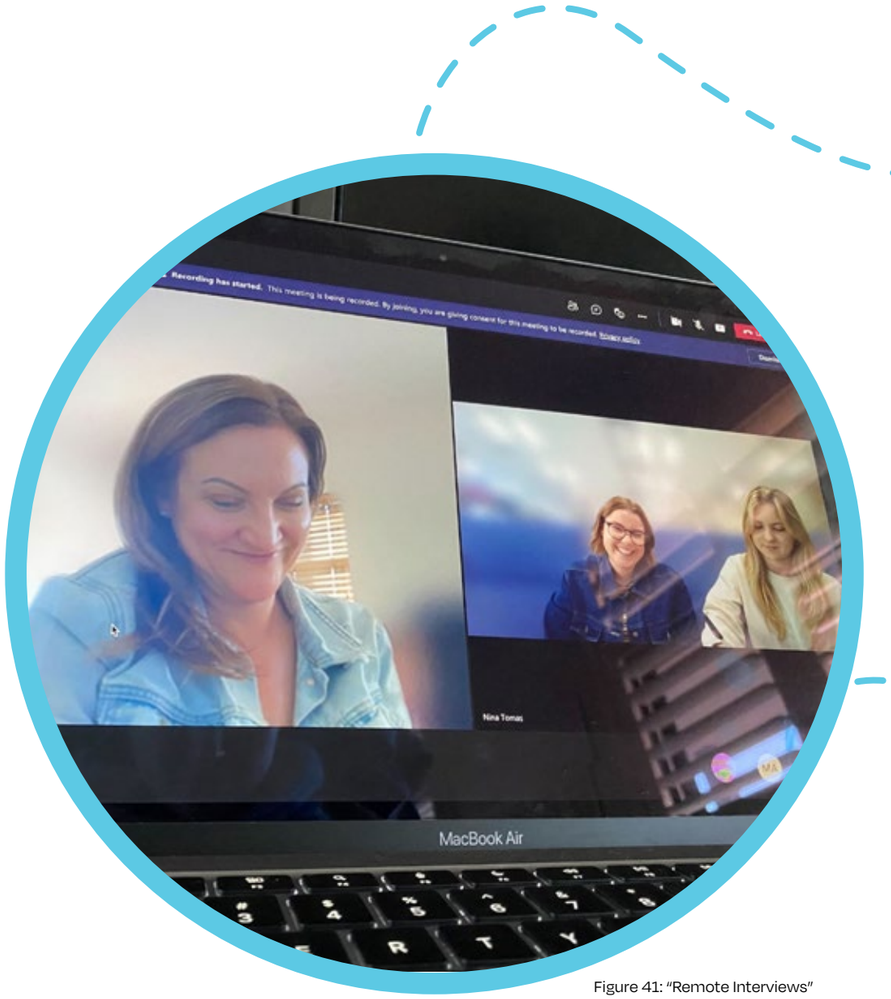


Figure 41: "Remote Interviews"

DIFFICULTIES & GAPS IN KNOWLEDGE

ACCESS TO KEY STAKEHOLDERS

Conducting intensive user research with remote communities proved difficult for our team. Locational barriers and the lack of pre-existing relationships which would allow for open, trusting communication of rich insight meant that we were only able to engage with members of remote communities who held positions as teachers and program providers. Moving forward into the second phase of the project, we would like to work closely with Scitech to identify and develop avenues to begin developing these relationships so we can better understand the needs of these communities.

Another significant barrier we faced was access to Indigenous communities. These communities, more so than any other within the core actors, require a prolonged period in which to build trust in organisations and individuals. The team understood from the beginning that designing with Indigenous communities, rather than for, was essential to addressing the design problem. We also understood that Scitech showed a strong desire to connect and co-design with Indigenous communities. However, we found that no infrastructure for a relationship between Scitech and Indigenous communities existed. In addition, the team did not have the time or resources in which to lay the groundwork for this relationship over the course of a semester.

EXPERIENCE OF A REMOTE INCURSION

Due to restrictions faced by COVID-19 and time constraints around school holidays and the timeline of the project we were unable to observe an outreach incursion. We understand that this is a crucial element of current program offerings and although we sought to understand through review of video content and interviews with the 2020 Murdoch Project team, this is an experience that we have prioritised to observe early in the second phase of the project.

05 REDEFINING THE PROBLEM

WHERE ARE THE FOCUS AREAS?

The project is still focusing on state-wide and how to engage students outside of the metro area. We drew in the key actors and focus to teachers, students, and communities. We will be focusing less on internal Scitech teams, board members, government departments. We determined the importance of community engagement with students' studies which can inspire them to obtain STEM-based jobs in their communities. We determined the importance a teacher plays in the delivery of STEM. If a teacher is supported and equipped with the appropriate tools for delivering programs that are to influence the decisions students make to pursue higher education and get into these areas, the probability of these students making it is higher.

Students need to be inspired by engaging STEM programs that are supported by arts and humanities. The word STEM is restricting students and placing them at a disadvantage. STEM has a broader term beyond science and maths, and using this phrase will rule out girls wanting to study these subjects as they perceive this as something boys do, that it is not for girls even though they perform just as well or even better in these subjects. By creating programs that use the outside environment, supported by HASS and arts subjects will inspire children to pursue these jobs later in life, it is all about the right type of influence that is culturally inclusive and diverse.

NARROWING DOWN THE SCOPE

TERTIARY ACTORS

DEPARTMENT OF COMMUNITIES

SCITECH BOARD MEMBERS

FEDERAL GOVERNMENT

OTHER EDUCATION PROVIDERS

STATE GOVERNMENT

SECONDARY ACTORS

STUDENTS WITH DISABILITIES

FAMILIES OF STUDENTS WITH DISABILITY

INDIGENOUS FAMILIES

CULTURALLY/ LINGUISTICALLY DIVERSE FAMILIES

SCITECH FUNDING PARTNERS

OTHER SCITECH TEAMS

COMMUNITY CENTRES/GROUPS

DEPARTMENT OF EDUCATION

PRINCIPALS

EARLY CHILDHOOD EDUCATORS

HIGH SCHOOL TEACHERS

LOCAL INDUSTRIES/ PARTNERS

CULTURAL COMMUNITY GROUPS AND ADVISORS

Other Scitech Teams Include:
customer service
manufacturing
product
maintenance

PRIMARY CORE ACTORS

CULTURALLY/ LINGUISTICALLY DIVERSE STUDENTS

STUDENTS FROM LOW-SOCIO ECONOMIC COMMUNITIES

INDIGENOUS STUDENTS

REMOTE PRIMARY SCHOOL TEACHERS

METRO PRIMARY SCHOOL TEACHERS

PUBLIC SCHOOL TEACHERS

PRIVATE SCHOOL TEACHERS

SCITECH CUTSOMER INSIGHTS TEAM

SCITECH CONTENT TEAM

SCITECH EXPERIENCE TEAM

SCITECH STATEWIDE TEAM

SCITECH PROFESSIONAL LEARNING TEAM

Figure 42: "Refined Core Actors Map"

NARROWING DOWN THE SCOPE

After evaluating all of our information that we gathered through our preliminary and user research, we were determined to narrow down the scope of the project. We revisited our original core actors map and adjusted based on new insights. Our narrowed core actor group includes:

- Culturally/ linguistic diverse communities
- Indigenous students
- Students from low socioeconomic communities
- Remote primary school teachers
- Metro primary school teachers
- Public school teachers
- Private school teachers
- Scitech Customer insights team
- Scitech content team
- Scitech experience team
- Scitech statewide team
- Scitech professional learning team

REDEFINED PROBLEM STATEMENTS

Problem Statements are a phrase or sentence that articulates the key challenges of a project, potentially from the perspectives of the different stakeholders. They help to develop a shared understanding as a result of initial analysis of the problem. There is potential for the problem statements to shift and change throughout the course of the project as new insights are gained and further problems are uncovered (Lewrick et al. 2020).

Our key insights and narrowing of the scope culminated the generation of problem statements that would guide the project forward into the next phase.

1. HOW MIGHT WE CREATE CHANNELS FOR THE EXCHANGE OF ALL TYPES OF KNOWLEDGE BETWEEN DIVERSE COMMUNITIES AND SCITECH THAT WILL LEAD TO GREATER AGILITY AND REPRESENTATION IN PROGRAM CREATION AND DELIVERY?

2. HOW MIGHT WE CO-CREATE SHARED VALUE FOR FUTURE FOCUSED SKILLS THAT WILL EMPOWER COMMUNITIES TO BUILD MORE SUSTAINABLE, INNOVATIVE AND INCLUSIVE FUTURE-ORIENTED OUTCOMES?

06 IDEATION

WHAT IS IDEATION?

Will Kenton (2021) describes ideation as "the process of developing and conveying prescriptive ideas to others through a descriptive sequence of thoughts, from the original form of conception to implementation." Ideation is expressed using visualisation tools, that is comprised of multiple written, concrete or abstract techniques, activities or even verbal methods. Ideas from these sessions can arise from past and present knowledge, influences, opinions and experiences of the group completing the tasks. Anyone can take part in this process, regardless of position, qualifications and skills. This process relies on the contribution of everyone within a team or organisation, to cultivate and include everyone's ideas. The sole concentration is to create, generate, develop and communicate ideas for the construction of concepts towards a problem. The supporting group of students played a key role in the Ideation phase of the project, sparking innovative and original ideas based on their varied contextual backgrounds. This strengthened our ability to consider multiple perspectives and frames of reference when ideating to address the problem statements.

Figure 43: "GRD503 Design Thinking Tools Workshop "

IDEA GENERATION ACTIVITIES

- Crazy 8s
- Alternate Universe Challenge
- Word Association
- 30 Different Ways to Learn

CRAZY 8'S

Crazy 8 is an exercise where those that are working on a project must sketch 8 ways to use an object, to complete a task, or to perform a service in a restricted amount of time. This generates creative and abstract ideas in an unrestrictive way, forcing participants to share ideas without the time to cast judgement. We started off with an example exercise looking into 8 ways we could use a paper clip. The second time we did this exercise, we explored a task related to the problem space; 8 different ways we can communicate with each other. Some ideas that spawned were using smoke signals, sign language, brail, message in a bottle and more.

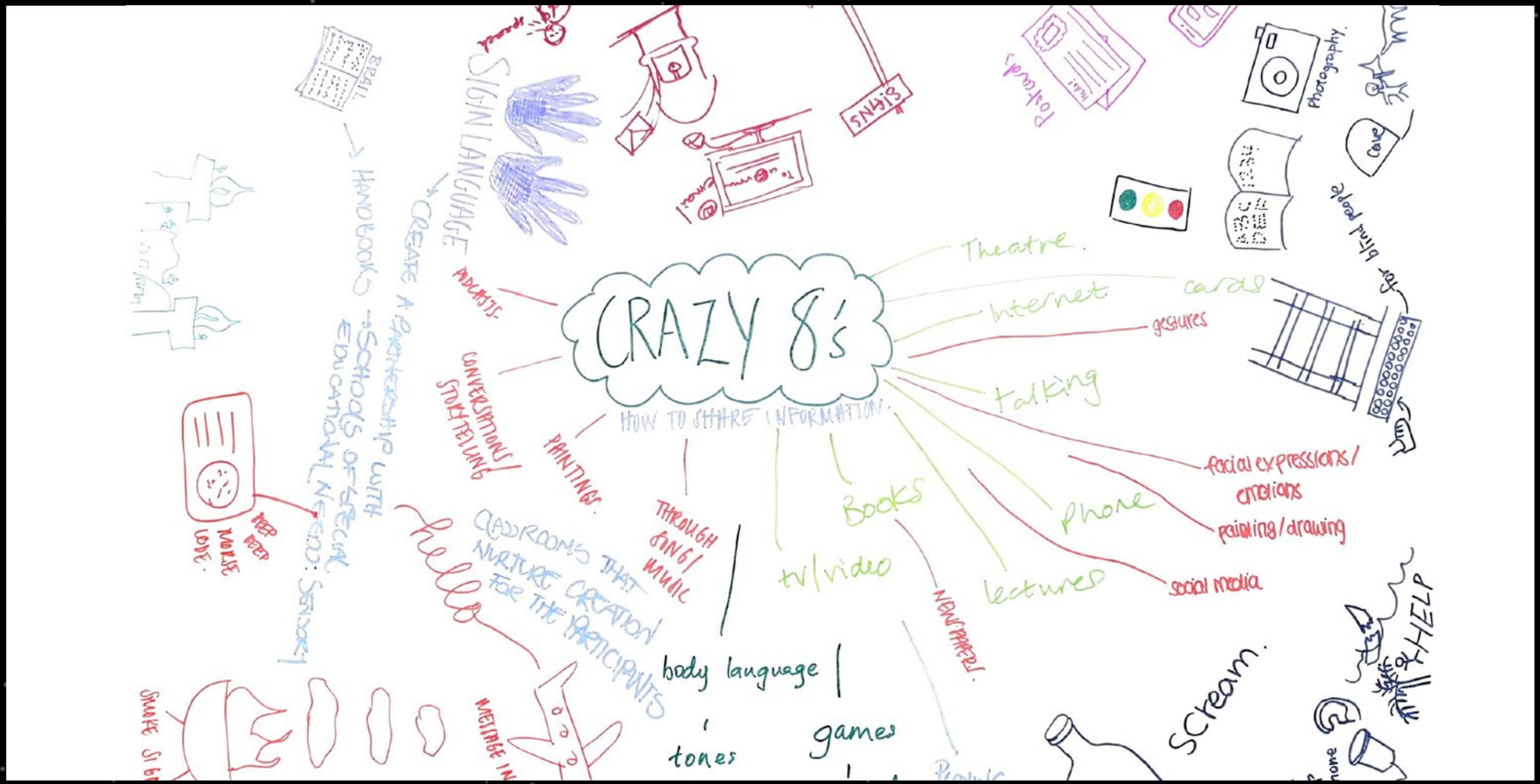


Figure 44: "GRD503 Design Thinking Crazy 8's Workshop "

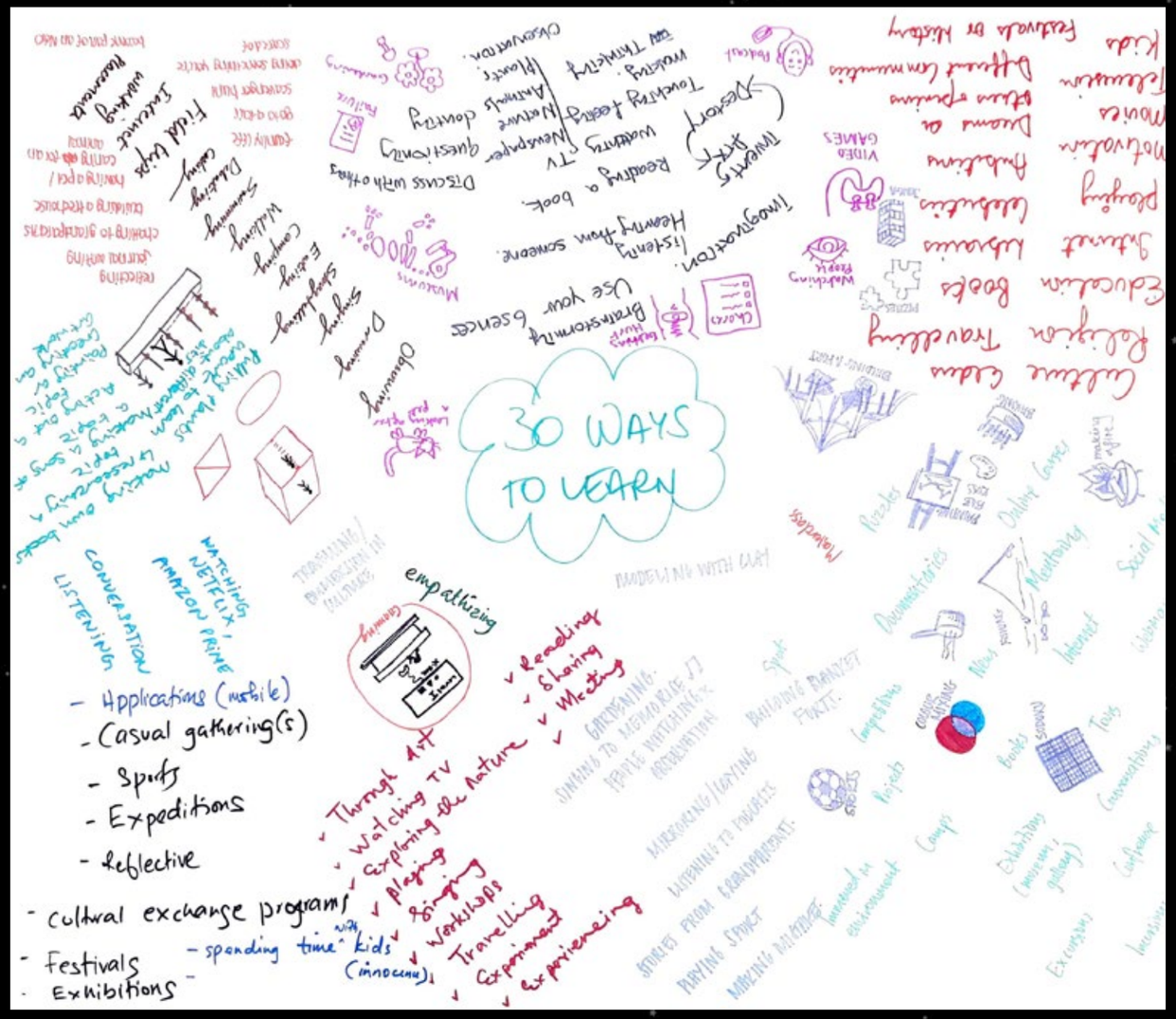


Figure 45: "GRD503 Design Thinking 30 Ways To Workshop"

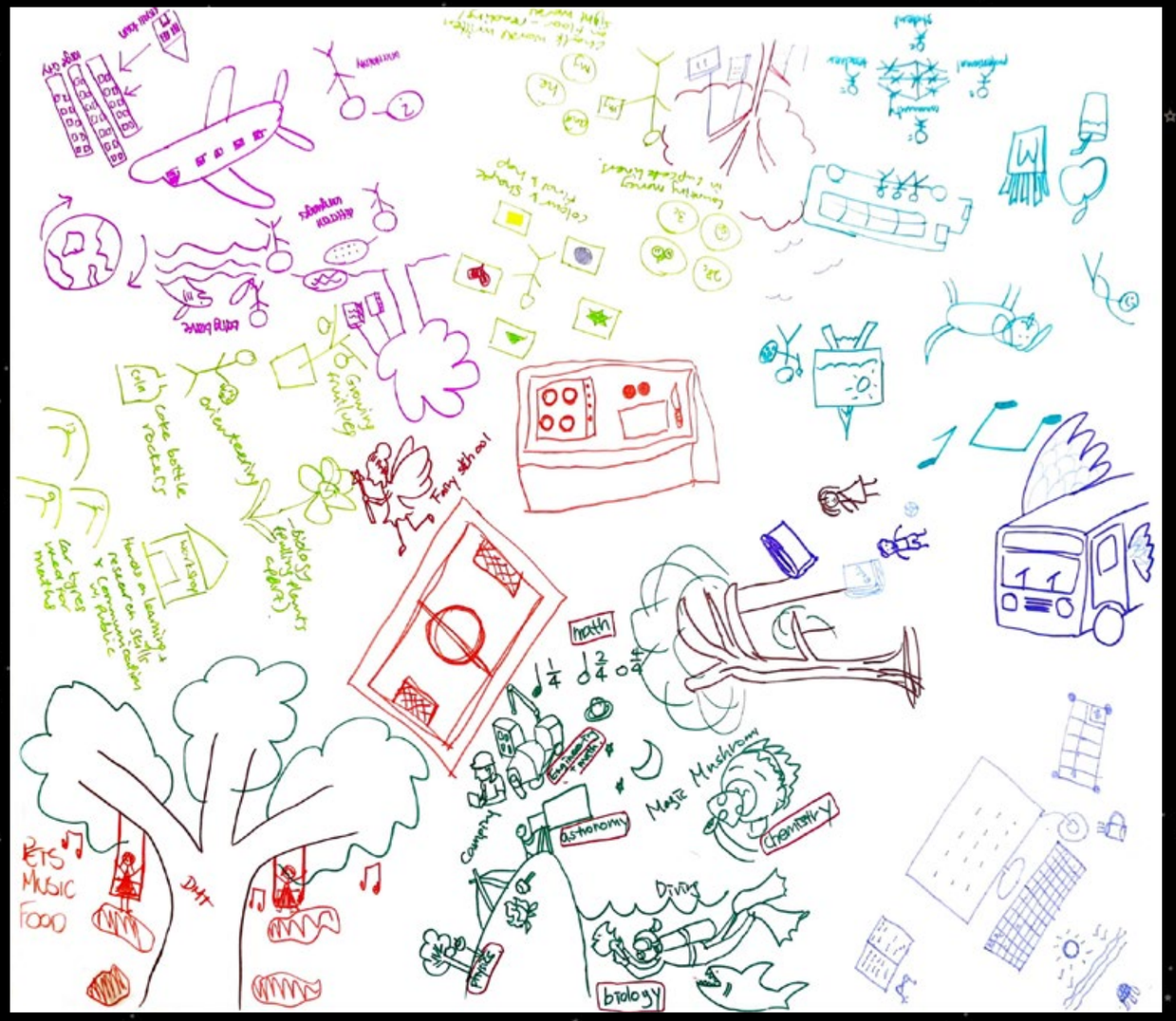


Figure 46: "GRD503 Design Thinking Alternate Universe Workshop"

30 WAYS TO...

Following this we completed an exercise to come up with 30 ways to learn, which allowed us to investigate the project problems with an unconventional approach. This exercise forces us to think in unique and outside of the box ways in which we share, consume and think about learning. These exercises provided output ideas and delivery methods that could be combined to explore more conceptual ways to address the problem statements.

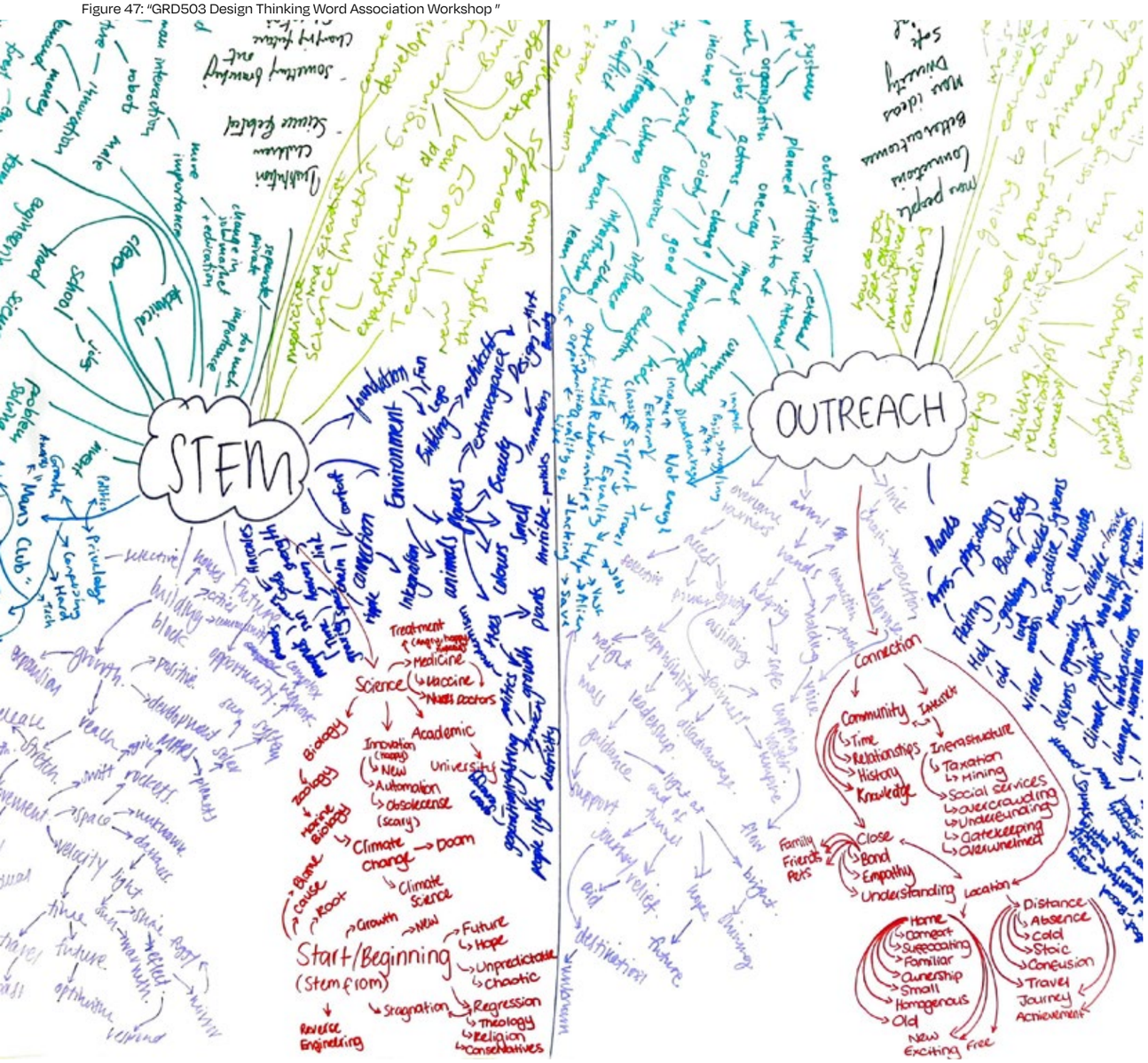
ALTERNATE UNIVERSE

This exercise encourages thinking using abstract techniques. We explored ways to address the problem statement by imagining them in other contexts. An example would be to imagine ways we can travel in the world of "The Hunger Games", or in "Star Wars". By introducing universes to the problem statement, we can think of abstract ways to address the problems in this project. We explored ways we can share learning in the worlds of "Harry Potter" and "Narnia". By removing that barriers that make our ideas unviable in the 'real world' we are able to ideate without restriction, resulting in more innovative and creative ideas. These ideas can then be re-framed in the current world to explore ways to overcome the limitations we know to exist.

WORD ASSOCIATION

In this exercise, we took the words that have been common to this project, such as, “STEM” and “Outreach”. We recognized these as the most significantly recurring words to the project and its problem. We were able to come up with an immense list of words associated with the meanings of both “STEM” and “Outreach” and compiled two large lists. This was an important exercise in re-affirming our research into the differing definitions and interpretations of STEM. Conducting this exercise with a group of culturally diverse students helped us to understand that personal contexts have an incredible influence on perceptions and understandings of words and shape the ways in which we relate and engage. The value each individual placed on STEM was directly reflected in the types of words they chose to describe it. These two lists were then used, taking one under “STEM’ and a second under “Outreach” to form a small phrase that created a new meaning. For example, some of the new meanings were “Unity Trees”, “Lightning Arms”, “Rigid Matrix”, “Academic Myths” and many more. These phrases would give new meanings to the project while also helping the team come up with ideas for the project.

Figure 47: “GRD503 Design Thinking Word Association Workshop ”



CONCLUSION

With these exercises completed, we managed to prep our minds to become ready for taking these ideas to create rough concept stories. After creating these concept stories, we then determined their viability against our problem statements, determining if it was possible to create the idea both economically and if it manages to address the problem statement.

CONCEPT STORIES

When working on several idea generation activities in large groups of multidisciplinary teams, a range of concepts tend to emerge. To flesh these out in greater detail, we create concept stories that position us to build a backstory and provide context. This is to help others understand the ideas that have been created. These ideas need to be supported by who will use it, and what the experience and value measure is.

In this exercise, we all took our ideas and drew them out to work out the fine details in the clearest way possible. We use texts, drawings, diagrams, interaction, and sometimes create them on a linear story-line.

Figure 48: "GRD503 Design Thinking Concept Stories 01 "

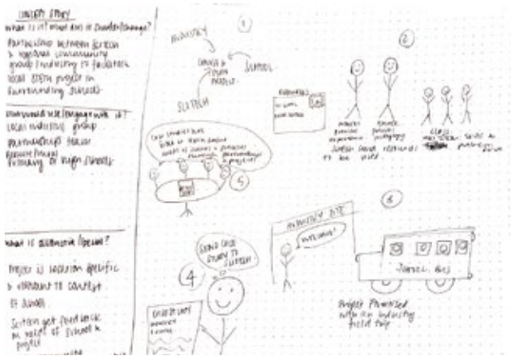


Figure 49: "GRD503 Design Thinking Concept Stories 02 "

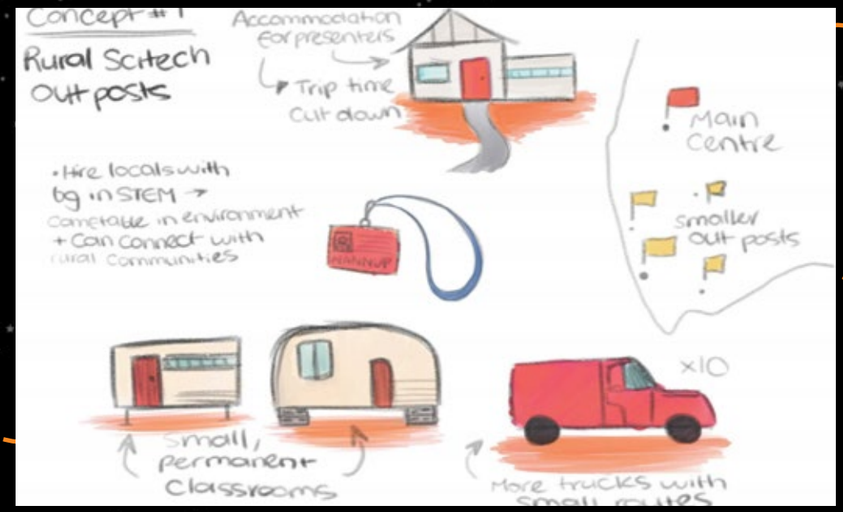


Figure 50: "GRD503 Design Thinking Concept Stories 03 "

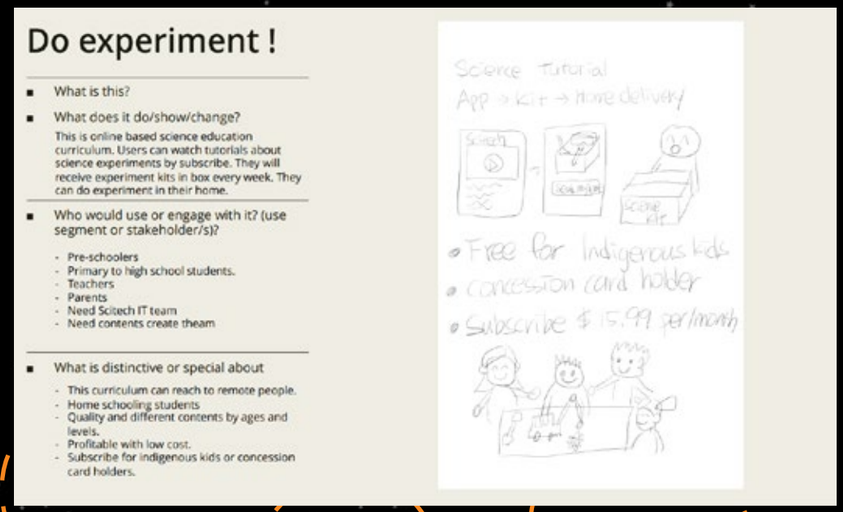


Figure 51: "GRD503 Design Thinking Concept Stories 04 "

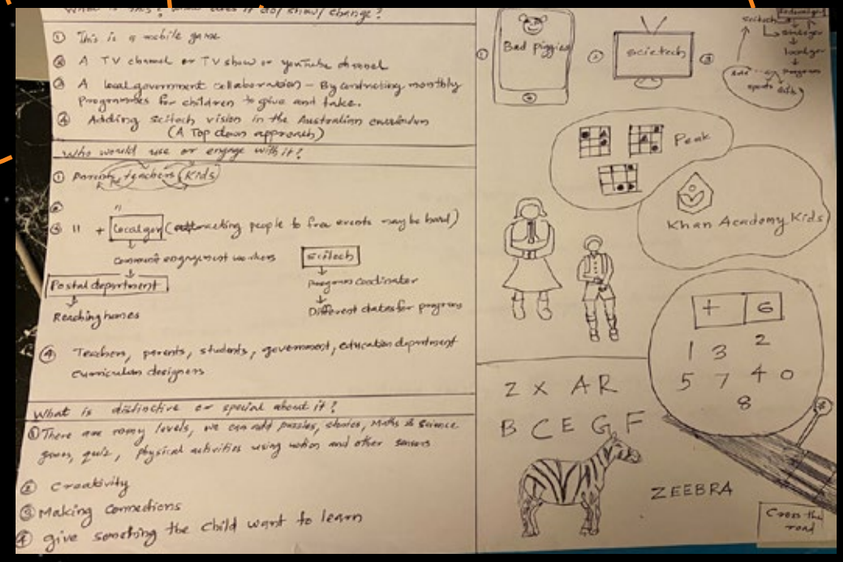


Figure 52: "GRD503 Design Thinking Concept Stories 05 "

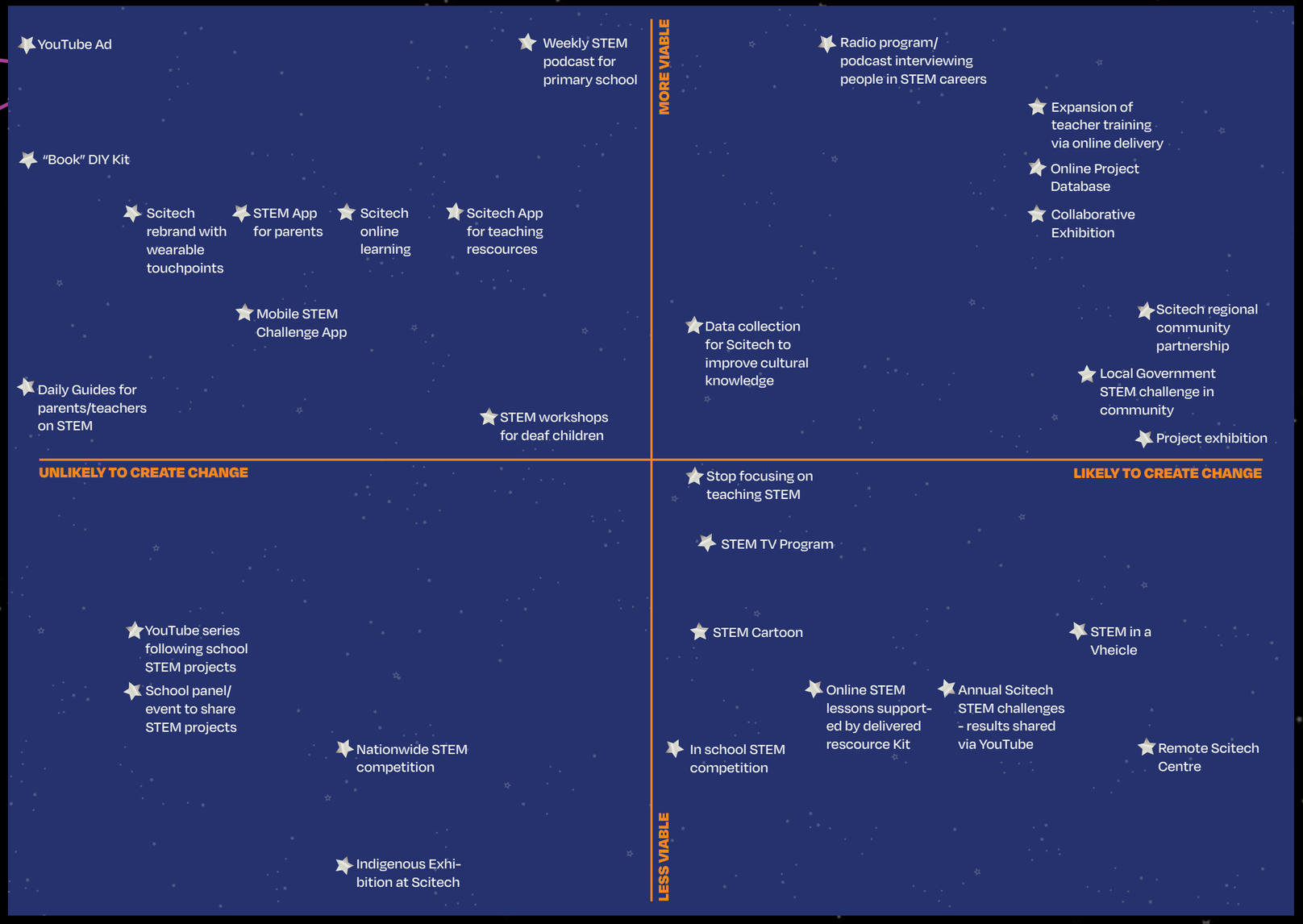


Figure 53: "GRD503 Design Thinking Viability Map "

VIABILITY MAPPING

Viability mapping is an essential part of the process, this allows us to narrow down the concepts that were generated in our ideation activities in relation to our problem. By narrowing these concepts, it also allows us to converge multiple aspects to create stronger concepts. This allows us to assess our ideas in terms of how viable they will be and comparing the economics and reality, along with how well it fits our redefined problem statements and addresses all issues relating to the project. Thinking about concepts is this way enables us to consider the types of exchanges that would need to occur between stakeholders in order for them to be successful, as well as the types of infrastructure required for implementation.

On the top right-hand corner, these are the ideas that seemed the most viable for the project, while the bottom left shows us the least viable ideas that would not contribute to the project adequately. This gave us a clear indication of which of the ideas were most useful in supporting our problem statements, further narrowing down the possible project ideas that contribute to the experiences we are aiming to create.

07 PROPOSED OUTCOMES

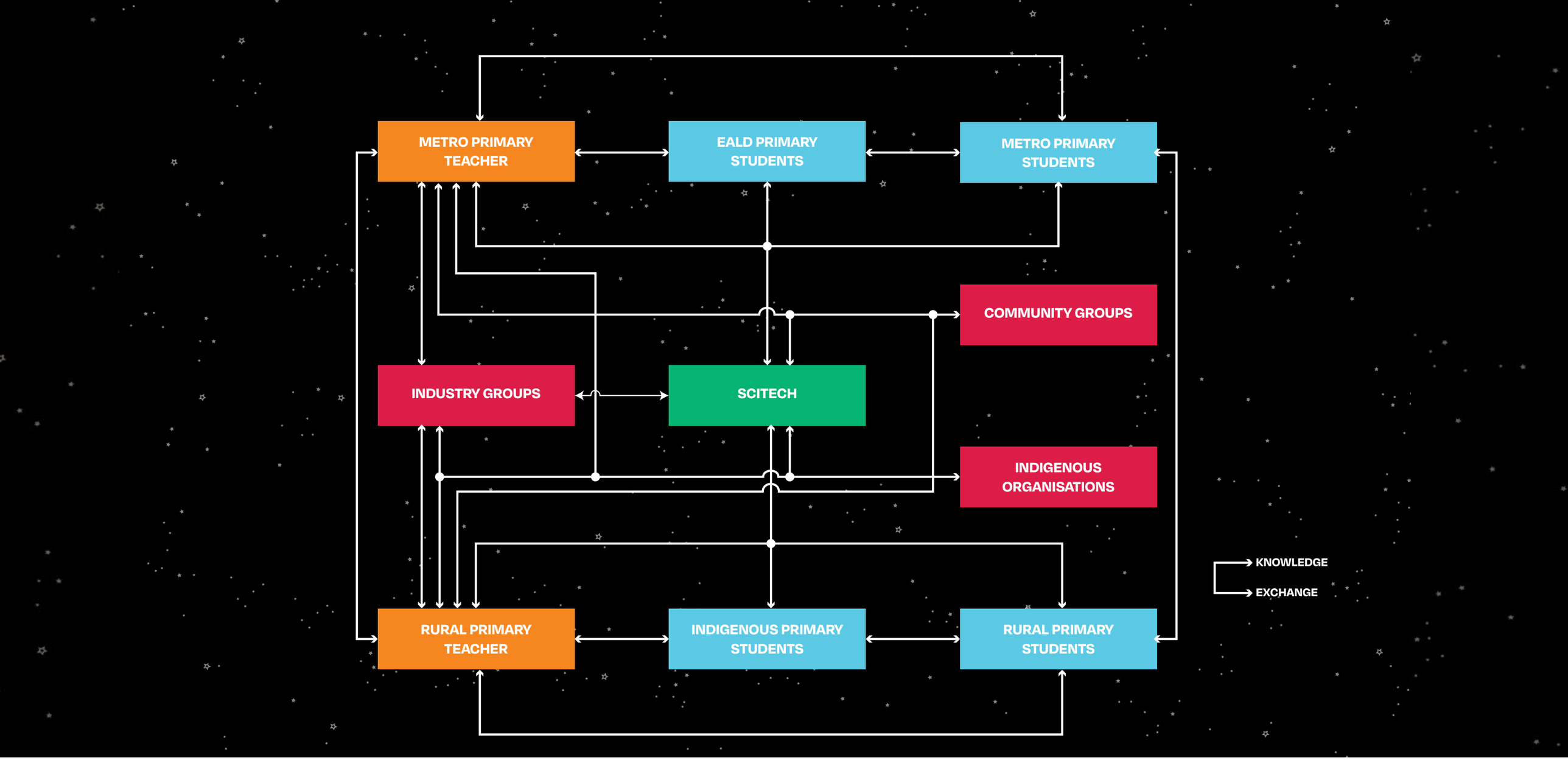


Figure 54: "Future Service System"

IMAGINING THE FUTURE SERVICE SYSTEM

What became apparent through this exploration was the importance of shared and reciprocal knowledge exchange between all stakeholders. The future service system can be imagined as a network that allows sustained sharing and building of understanding through acknowledgment and celebration of diverse experience and insight that all can contribute.

In order to show how this network can be supported and implemented, storyboards of three concepts were developed to illustrate diverse types of knowledge exchange that occur within this system. A storyboard acts as a graphical representation of the idea as a sequential drawing, with the addition of dialogue that explains the process in a linear storyline to show the passage of time. Similar to a comic book, a storyboard is used to identify the core elements, actors, and narrative that allows us to see the insights of the ideas generated from the planning phase.

It must be noted that these concepts are by no means proposed as finalised outcomes, they purely demonstrate exchanges.

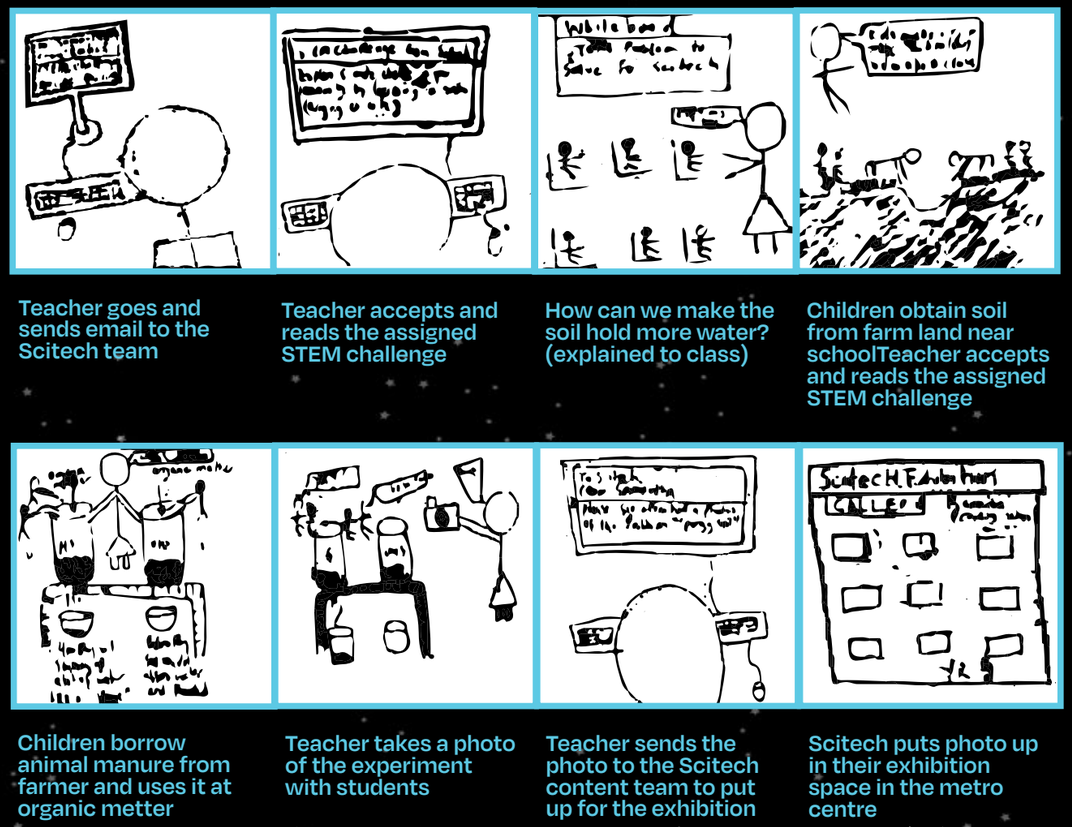
COLLABORATIVE EXHIBITION

This concept entails a two-way collaborative interaction between SciTech and Karratha Primary school. Engaging with year 4 teacher Samantha Stewart. Samantha currently teaches maths and science to year 4 students. She is also the STEM coordinator at Karratha Primary school. She is currently teaching her science students the importance of climate change and its implications for farmers in rural Western Australia. She has been in contact with the SciTech outreach team and has expressed interest in co-designing a STEM project with SciTech that involves a hands-on experiment that deals with climate change due to its implications of farmers in the Karratha region.

EXCHANGES

- Remote communities share cultural knowledge, community perspective, and specific skills and context with Scitech
- Scitech shares this perspective with Metro audiences through a display at the Science Centre.
- Contributes to shared understanding about the applications of critical thinking and problem solving and how cultural context shapes the way we engage with problems and challenges.

Figure 55: "Collaborative Exhibition Storyboard"



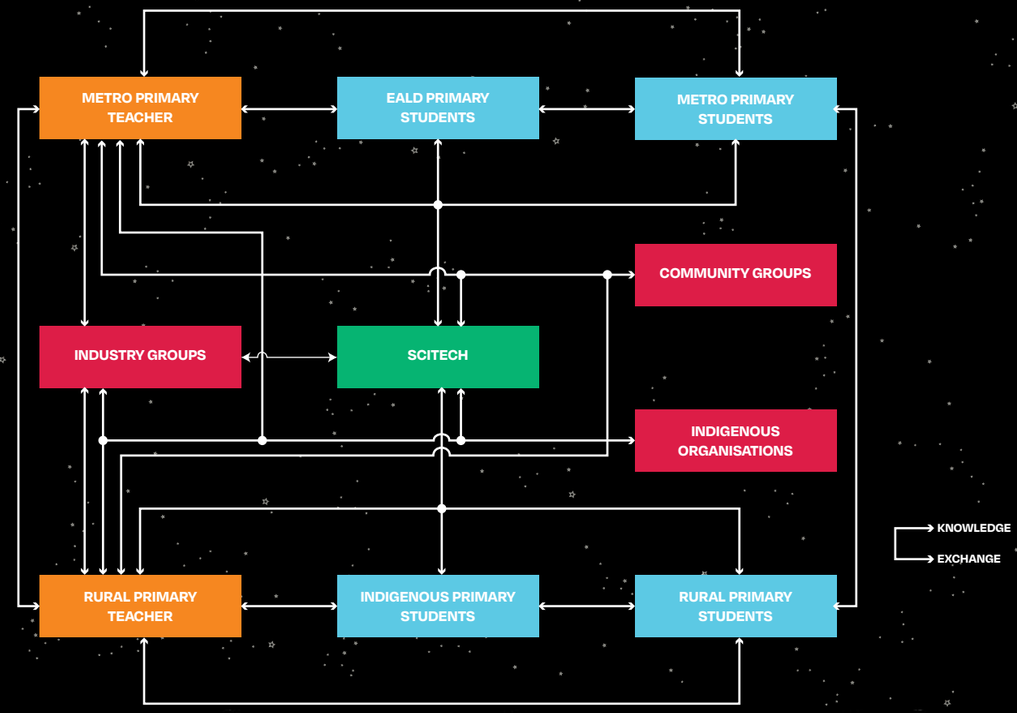
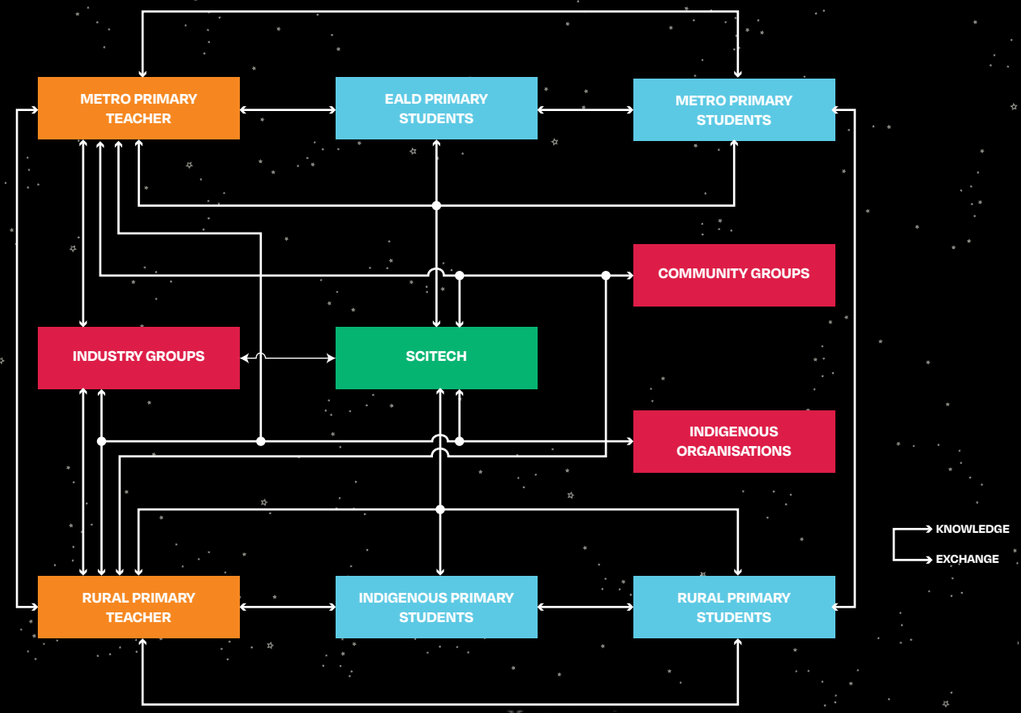
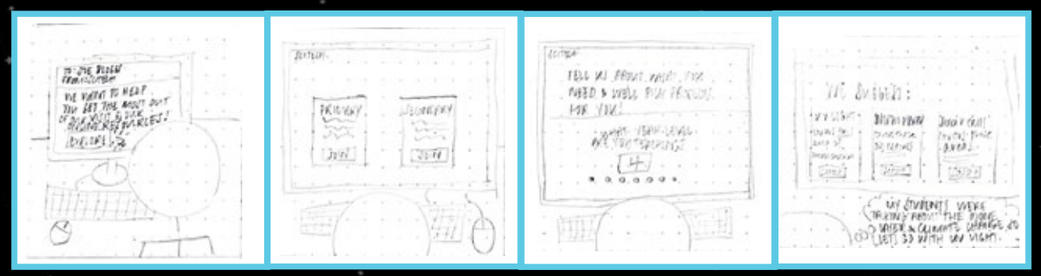


Figure 56: "Online Resource Storyboard"



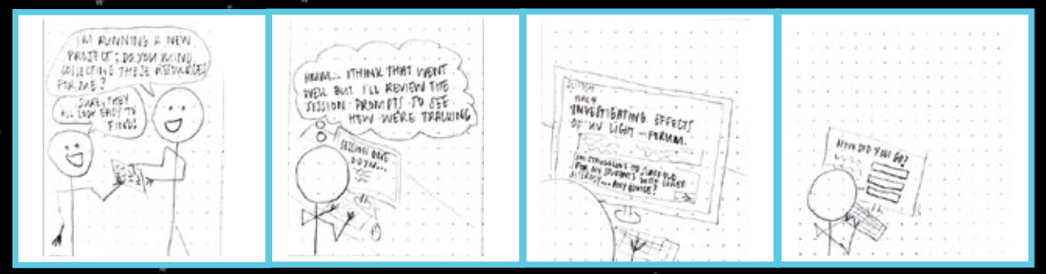


Teacher receives promotional email from Scitech as a followup from visit, announcing online resource for STEM

Lands on page and selects education stream

Answers scoping questions and platform generates suggestions for projects

Picks project that sounds engaging and watches info video that talks about learning outcomes and adapting the project



Downloads project session plans and sends materials list to EA to collect

Runs first sesion in classroom with prompts, reviewing session afterwards

Notes areas of struggle and accesses project blog/forum to teacher experiences and advice

Submits review & evaluation of student outcomes on forum before accessing new project

ONLINE PROJECT RESOURCE FOR TEACHERS

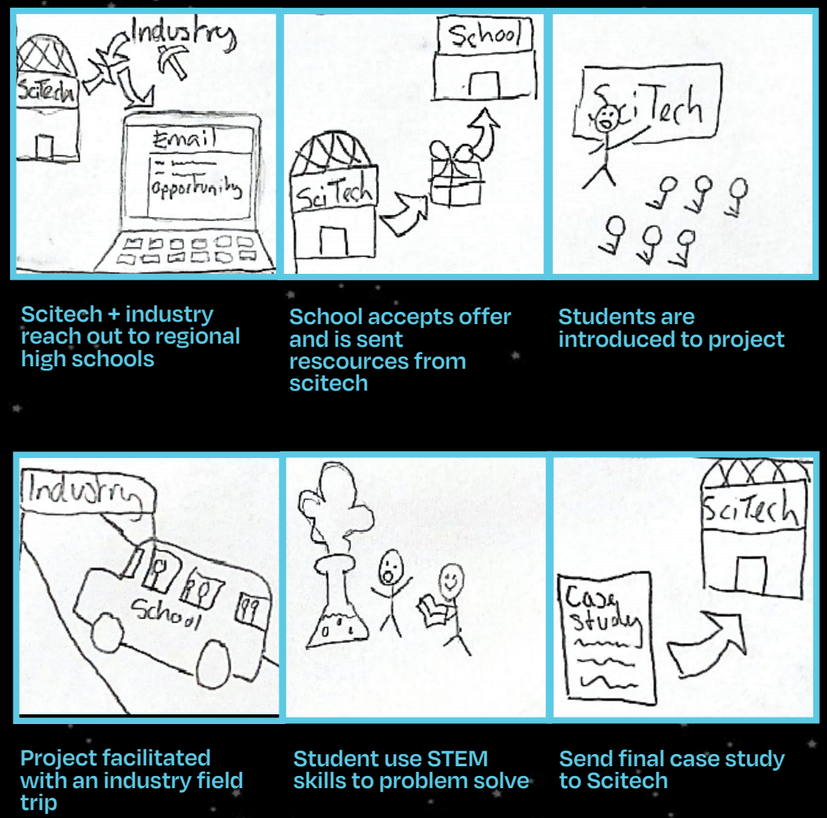
Online platform providing curriculum-aligned projects for primary and high school teachers that help to develop critical thinking, problem-solving and enquiry skills across range of subjects, developed by the Professional Learning Team (PLT). Teachers can sign up, select their teaching setting and answer questions about their learning objectives and classroom needs and are presented with a selection of projects to choose from. Each project page provides session plans and a comprehensive list of materials that can be digitally downloaded or printed, an introduction video that addresses learning objectives and ways to adapt the project for learning needs. Blog/forum for each project provides a space for teachers to share how they have implemented projects and ask advice for how to integrate and adapt. Completion of project results in a follow up session with PLT for feedback, review and advice for teaching, supported by an online feedback form for use by the experience team in understanding classroom interests and needs. The online platform suggests other projects to move on to as well as Scitech Incursions that could support areas of learning.

EXCHANGES

- Sharing of experience and education knowledge between Metro and Rural teachers.
- Scitech shares educational resources and guidance with teachers.
- The forum provides an opportunity for Scitech to understand the experiences and needs of teachers and their communities.

COMMUNITY PARTNERSHIP

The idea for a community partnership would allow SciTech and industry to connect and discuss an opportunity for regional schools to gain experience working on a project for industry using STEM skills. This would allow the regional schools to give the students real-life practice using STEM skills and give industry partners incentive to fund these projects since the students can work on a project for them. The project would then fund the students to be able to travel to an industry site for a day and understand the project better. After a period of time when the students finish working on the project, a case study can be compiled that is given to SciTech. The industry partnership will benefit because the students are working for them on a problem. The students will benefit because they will utilise STEM skills during the project. SciTech will benefit from industry funding and having proof via the case study that they are providing skills to these regional schools that often get left out.



Scitech + industry reach out to regional high schools

School accepts offer and is sent rescources from scitech

Students are introduced to project

Project facilitated with an industry field trip

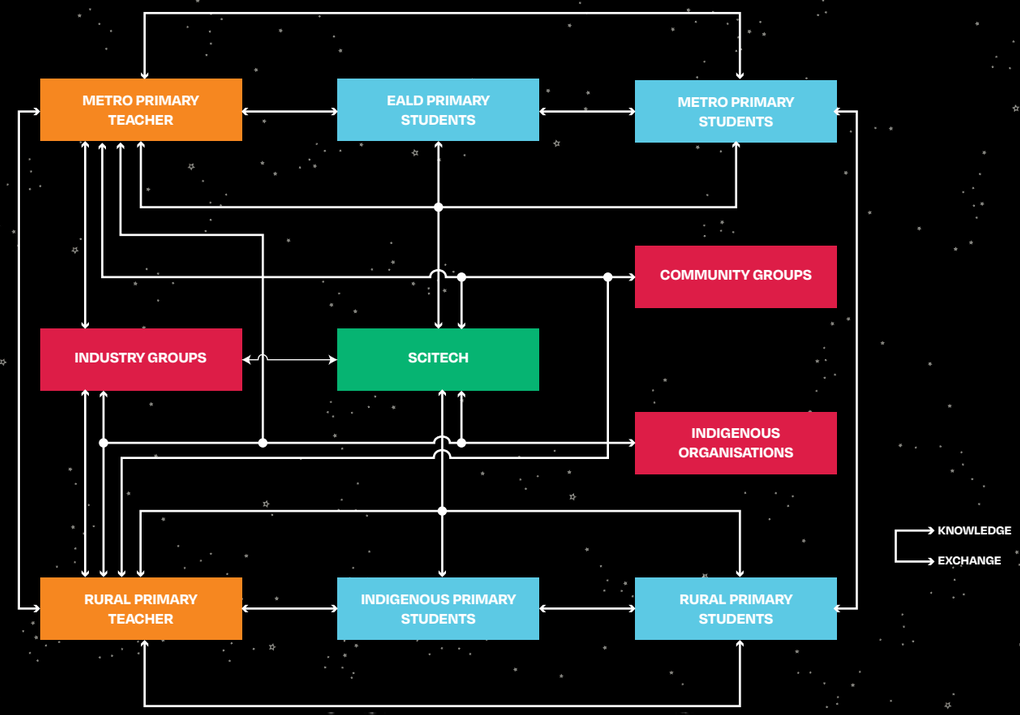
Student use STEM skills to problem solve

Send final case study to Scitech

Figure 57: "Community Partnership Storyboard"

EXCHANGES

- Sharing of industry or community knowledge between partner, Scitech and community.
- Communities share with industry partner how their experiences shape understanding and exploration of a problem specific to their context.
- Industry partner provides skills, resources and knowledge to Scitech and the community.
- Scitech shares educational resources and knowledge with the community.

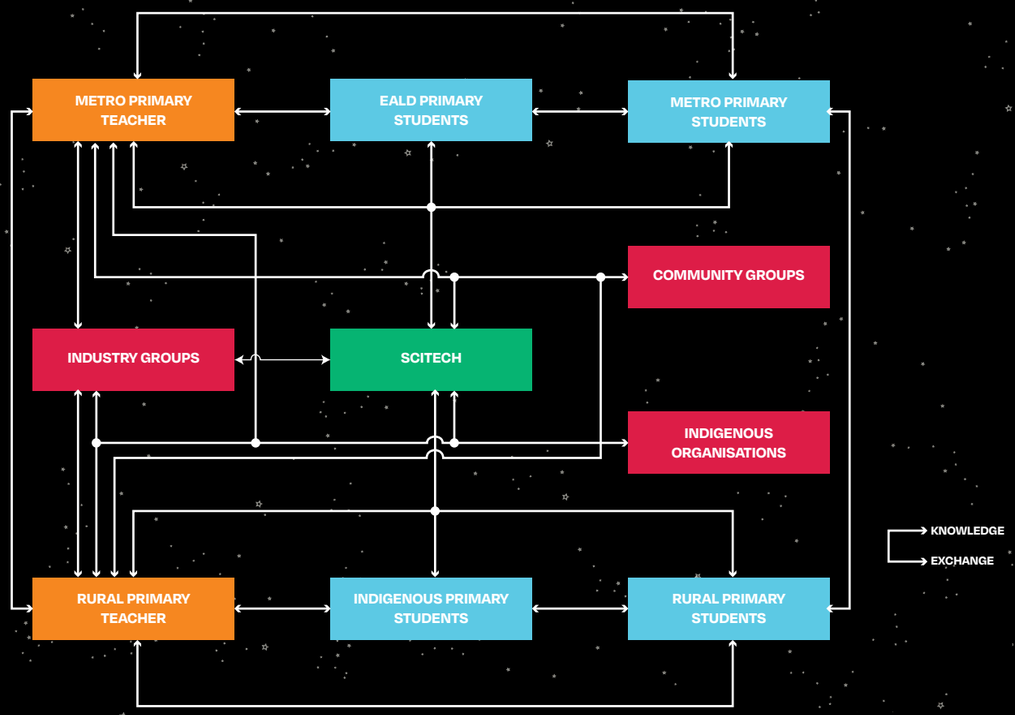


EXPERIENCE MEASURE

Currently, Scitech's main measure of experience is through the achievement of KPIs with the aim of reporting to funding partners. We understand that these measures are required to document financials and secure backing for the delivery of programs. We have also noted that these measurement tools are quantitative in nature and miss the opportunity to measure the qualitative impact programs are having on the experiences of stakeholders. To gain a clearer understanding of the way in which current programs and the future service system will influence the lives of those impacted as well as the landscape of STEM, industry, and educational contexts, it is important to implement tools that aim to measure growth and change by way of participation, perception, collaboration, and opportunity. We are interested in the impact the system will have on all stakeholders over an extended period and know that a human-centred approach to reporting will be required to do so.

This new way to measure experiences is something that we will need to investigate alongside Scitech in the next phase of this project, aligning the aim of the project with the outcomes measured. Taking a qualitative approach to measuring impact rather than relying on numbers can be daunting to organisations that are used to immediate indicators of success. We believe that a combination of experience measures are required to assess and modify the system to facilitate these future-ready learning experiences.

As a starting point, we wanted to revisit our core actor groups and envision the experiences they may have as a result of the new service system.



"I HAVE THE OPPORTUNITY TO CREATE ALONGSIDE SCITECH, PROGRAMS WHICH MEET MY TEACHING NEEDS AS WELL AS THE LEARNING AND CULTURAL NEEDS OF MY STUDENTS. I HAVE NEVER FELT MORE CONFIDENT IN ENGAGING MY STUDENTS WITH EXPERIENCES WHICH WILL INSPIRE OUR COLLECTIVE FUTURE!"

- Remote Primary School Teacher

"WE HAVE THE OPPORTUNITY TO WALK HAND IN HAND WITH OUR COMMUNITIES AND HELP THEM TO NUTURE THE FUTURE FOCUSED SKILLS OF THE NEXT GENERATION TO BUILD A WORLD IN WHICH WE ALL THRIVE. DIVERSE KNOWLEDGE RESULTS IN RICHER INNOVATIVE POTENTIAL!"

- Outreach Team Member

"AS HOLDERS OF CULTURAL KNOWLEDGE AND EXPERTISE, WE HAVE THE OPPORTUNITY TO WORK ALONGSIDE SCITECH AND OUR LOCAL EDUCATORS TO EMPOWER STUDENTS TO HARNESS THEIR UNIQUE CULTURAL PERSPECTIVES IN THEIR LEARNING JOURNEYS!"

- Community Leader

"I GET TO JOIN IN WITH SUPER EXCITING PROJECTS WITH SCITECH AT SCHOOL. WE EXPLORE QUESTIONS WE FIND IN OUR COMMUNITY AND I GET TO SHARE THINGS I LEARNED WITH MY AUNTIES ON COUNTRY WHICH MAKES ME FEEL REALLY IMPORTANT AND LIKE I BELONG AT SCHOOL!"

- Indigenous Primary School Student

Figure 58: "Future Persona Experiences"

VALUE PROPOSITION

Although at this stage, we are proposing the experience of the service system rather than the finalised outputs and touch-points used in its delivery, we can still discuss the value provided for the impacted stakeholders. Based on the research and ideation phases, we have identified opportunities to add value to core actors' experiences. We hope to empower all Western Australians to construct a better world by preparing them with 21st century skills. We wish to bridge the cultural gap between diverse communities by establishing a sustained network of mutual knowledge exchange. We hope to give communities previously barred by economic, societal and/or physical barriers the opportunity to access future-ready learning experiences by co-designing programs with them. As a result, this service system will contribute to a future in which stakeholders are empowered with the skills, confidence and knowledge to innovate solutions to challenges posed by a fast-changing global environment.

OUTCOMES

THERE ARE FOUR PROPOSED OUTCOMES FOR THIS PROJECT:

1. **AN INNOVATIVE WAY TO REMOTELY DELIVER FUTURE-READY LEARNING EXPERIENCES BEYOND PERTH METRO REGIONS**
2. **TO CREATE A CULTURALLY RESPONSIVE SYSTEM**
3. **A PARTNERSHIP BETWEEN EDUCATORS AND SCITECH**
4. **TO DECREASE BARRIERS WITHIN WESTERN AUSTRALIA, ALLOWING CHILDREN TO ACCESS FUTURE-READY EDUCATION MORE FREELY**

IMPACT AND SUSTAINABILITY

When thinking about the future change that this project can bring, it's important to consider how it will adapt over time as well as the impact that comes with the inevitable growth. We realise that implementation of this service system hinges on the development of relationships with communities; a process that requires patience, commitment and attention. We also know that the implementation of a sustainable system requires shared ownership with the communities that will allow it to be nurtured and developed over time. Therefore, it was crucial that we think about this project over an extended timeline. Although we intend to begin with a focus on Primary School contexts, we have examined the desired growth and impact of the project at three key milestones: 1-2 years, 5 years, and 10 years. This has allowed us to consider ways in which to scale the system to impact a broader range of stakeholders and support students throughout the entirety of their educational journey from primary school through to industry. The intention is that the impact students will have in the industry will be fed back into the system as their role as stakeholders changes, supporting reciprocal and infinite cycles of knowledge exchange that will nurture the innovative capacities of generations to come.

1-2 YRS

AREA OF GROWTH

Launch of system with primary schools

IMPACT:

Increasing capacity of teachers
↳ Increased cross-curricular engagement

Co-creation with diverse communities and Scitech
↳ Increasing cultural competency of Scitech

Students and communities offer cultural knowledge and connect learning to their environment
↳ Students are inspired learners
Empowered sense of identity and belonging

5 YRS

AREA OF GROWTH

Expansion into Secondary Schools, continuing to support students on their learning journey

This phase will require more targeted research into the unique needs of the secondary school context

IMPACT:

Confidence of secondary school students to engage with traditional STEM subjects.

Increased in the amount of students willing to study futher
↳ Students going into tertiary education/ vocational training
Breaking barriers to participation through inclusive education

Communities engaging and supporting their students.

10 YRS

AREA OF GROWTH

Building stronger ties with local industry to support local implementation of sytem

Students initially involved will be able to give back to the system and their communities through education and innovation

IMPACT:

Pool of knowledge in industry expanded due to diverse participation leading to greater innovative capacity
↳ Sharing back with Scitech and communities
Challenging industry stereotypes by breaking barriers to participation as a result of increased representation
Development of more sustainable and inclusive innovations

Figure 59: "Impact Tunnel"

07 WHAT HAPPENS NEXT?

REQUEST FOR FEEDBACK

After a long semester of work, we are eager to hear the thoughts of the Scitech staff. It is important for us to know that we have addressed your concerns, and appropriately explained our process and conclusions. Hearing your perspectives on our questions that didn't directly suit the needs of our problem statements will benefit our further research.

We have been thorough in ensuring that any content included in this document has been sufficiently supported by our research.

If there are any aspects of this document that have concerned you, or you need additional information/ clarification, do not hesitate to make us aware. Your feedback is valuable to us and will help to inform the continuation of the process over the next semester.

THE NEED FOR CO-DESIGN

Our research has revealed that co-design is a priority moving forward. It is important that the people who have the most stake in SciTech's operations and services are included in the design process. Co-designing is integral to the design thinking process and we wish to work together with the core actors for an outcome that benefits their future experience.

The interview process has shown that there are limits to what we can achieve alone. This is simply a result of these stakeholders having experiences and expertise that we do not. While interviewing them has been invaluable, giving these stakeholders the opportunity to collaborate will present even more opportunities to effectively address SciTech's goals.

Moving forward, we aim to create and strengthen connections to people within the various stakeholder groups and support their participation in the process. This includes:

- Indigenous Communities and Elders
- Rural and Remote Communities
- Primary and High School Students
- Scitech Employees

Indigenous communities are of particular priority. This is a group that has traditionally been excluded from discussion of how Australia can shape its future, and the team has been hyper-aware of this reality all throughout this initial design process. We aim to facilitate contact in order to lay the foundation of trust and collaboration with indigenous communities as soon as possible. This will bring the voices of these communities to the forefront.

The team also intends to overcome the barrier of physical distance regarding rural and remote communities in the next stage of this project. With the right resources, the team is prepared to go to these communities to understand their needs and perspectives.

We are also eager to collaborate with the staff of Scitech itself. Through our interview process, we have discovered a plethora of accomplished individuals, all with their own experiences and skills that give them a unique approach and perspective to their roles. Collaboration with staff that have proven to be dedicated and eager to shape the future of SciTech will be essential to this project moving forward.

Figure 60: "Proposal Presentation"

UP NEXT

Please take the next month to review the supplied proposal and supply feedback for us to continue with. We would like to begin the second phase of the project in the last week of July 2021, upon commencement of Semester Two. This phase will mark transition into the second diamond of the Design Thinking process, involving prototyping, testing and evaluation.

Under the guidance of our supervisors, Erica Ormsby and Eko Pam, we would like to collaborate with Scitech on a strategy to facilitate co-design with staff and key stakeholders. This will enable us to establish a strong foundation for this phase of work.

THANKYOU

We would like to take the opportunity to thank the Scitech Staff who have dedicated their valuable time to assist with this project; their insight and support has been invaluable. We would also like to thank Erica Ormsby and Eko Pam for their guidance and leadership throughout this process. Without their dedication and mentorship, the work we have carried out would not be possible.

REFERENCES

LITERATURE REVIEW

Al-Kodmany, K. (2001). Visualization Tools and Methods for Participatory Planning and Design. Journal Of Urban Technology, 8(2), 1-37. https://doi.org/10.1080/106307301316904772

Allen, J. (2012). Stained Glass and the Culture of the Spectacle, 1780-1862. Visual Culture In Britain, 13(1), 1-23. https://doi.org/10.1080/14714787.2012.641778

Avgerinou, M., & Pettersson, R. (2011). Toward a Cohesive Theory of Visual Literacy. Journal Of Visual Literacy, 30(2), 1-19. https://doi.org/10.1080/23796529.2011.11674687

Bleakley, A. (2005). Stories as data, data as stories: making sense of narrative inquiry in clinical education. Medical Education, 39(5), 534-540. https://doi.org/10.1111/j.1365-2929.2005.02126.x

Bederson, B., & Shneiderman, B. (2003). The Craft of Information Visualization (1st ed.). Elsevier Science & Technology.

Brown, T. (2021). What is Design Thinking. Design Thinking Defined. IDEO. https://designthinking.ideo.com/#:~:text=For%20IDEO%2C%20design%20thinking%20is%20a%20way%20to,established%20one%2C%20and%20with%20that%20comes%20interest%20

Browne, C. (2020). What Is an Empathy Map? A Comprehensive Guide for UX Designers. https://careerfoundry.com/en/blog/ux-design/what-is-an-empathy-map/

Bulmer, S., & Buchanan-Oliver, M. (2006). Visual Rhetoric and Global Advertising Imagery. Journal Of Marketing Communications, 12(1), 49-61. https://doi.org/10.1080/13527260500289142

Carlgren, L., Elmquist, M., & Rauth, I. (2016). The Challenges of Using Design Thinking in Industry - Experiences from Five Large Firms. Creativity And Innovation Management, 25(3), 344-362. https://doi.org/10.1111/caim.12176

Carmel-Gilfilen, C., & Portillo, M. (2015). Designing with empathy: Humanizing narratives for inspired healthcare experiences. HERD: Health Environments Research & Design Journal, 9(2), 130-146. https://doi.org/10.1177/1937586715592633

Celikoglu, O., Krippendorff, K., & Ogut, S. (2020). Inviting ethnographic conversations to inspire design: Towards a design research method. The Design Journal, 23(1), 133-152. https://doi.org/10.1080/14606925.2019.1693209

Cho, I., Park, H., & Choi, J. (2011). The impact of diversity of innovation channels on innovation performance in service firms. Service Business, 5(3), 277-294. https://doi.org/10.1007/s11628-011-0114-x

Cho, I., Park, H., & Kim, J. (2012). The moderating effect of innovation protection mechanisms on the competitiveness of service firms. Service Business, 6(3), 369-386. https://doi.org/10.1007/s11628-012-0140-3

Clandinin, D., & Connelley, F. (2000). Narrative design: Experience and story in qualitative research (1st ed.). Jossey-Bass Publishers

Connelly, F., & Clandinin, D. (1990). Stories of experience and narrative inquiry. Educational Researcher, 19(5), 2-14. https://doi.org/10.3102/0013189x019005002

Crevani, L., Palm, K., & Schilling, A. (2011). Innovation management in service firms: a research agenda. Service Business, 5(2), 177-193. https://doi.org/10.1007/s11628-011-0109-7

Crouch, C., & Pearce, J. (2012). Doing research in design (pp. 103-120). Bloomsbury.

Csordas, T., Dole, C., Tran, A., Strickland, M., & Storck, M. (2009). Ways of Asking, Ways of Telling. Culture, Medicine, And Psychiatry, 34(1), 29-55. https://doi.org/10.1007/s11013-009-9160-4

Dam, R., & Siang, T. (2019). Design thinking: a quick overview. Analysis & Policy Observatory. Retrieved 2 June 2021, from https://www.interaction-design.org/literature/article/design-thinking-a-quick-overview.

Denscombe, M. (2014). The good research guide: For small-scale social research projects (5th ed.). McGraw Hill.

Dyer, G. (1982). Advertising As Communication (Studies in culture and communication). Routledge.

Engbretsen, M., & Kennedy, H. (2020). Data visualization in society. Amsterdam University Press.

Ersoy, A. (2018). Why Design Thinking is failing and what we should be doing differently.. UX Collective. https://uxdesign.cc/why-design-thinking-is-failing-and-what-we-should-be-doing-differently-c8842f843b44.

Erwig, M., Smeltzer, K., & Wang, X. (2017). What is a visual language? Journal Of Visual Languages & Computing, 38, 9-17. https://doi.org/10.1016/j.jvlc.2016.10.005

Fearon, K. (2019). 'Have you ever talked to any women with Turner syndrome?' Using universal design and photo elicitation interviews in research with women with mild cognitive impairment. Methodological Innovations, 12(2). https://doi.org/10.1177/2059799119841933

Friendly, M. (2009). Milestones in the history of thematic cartography, statistical graphics, and data visualization. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.190.9498&rep=rep1&type=pdf.

Friis Dam, R., & Yu Siang, T. (2021). 5 Stages in the Design Thinking Process. The Interaction Design Foundation. from https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process.

Gasparini, A., & Chasanidou, D. (2016). Understanding the role of design thinking methods and tools in innovation process. In The International Society for Professional Innovation Management. https://www-proquest-com.libproxy.murdoch.edu.au/docview/1803692420?accountid=12629&pq-origsite=summon.

Gibbons, S. (2018,). Empathy Mapping: The First Step in Design Thinking. https://www.nngroup.com/articles/empathy-mapping/

Given, L. (2008). The Sage encyclopedia of qualitative research methods. SAGE Publications.

Grochowska, M. (2015). Importance of visualization in design thinking.https://sidlaurea.com/2015/10/02/importance-of-visualization-in-design-thinking/

Hampshire, K., Iqbal, N., Blell, M., & Simpson, B. (2012). The interview as narrative ethnography: Seeking and shaping connections in qualitative research. International Journal Of Social Research Methodology, 17(3), 215-231. https://doi.org/10.1080/13645579.2012.729405

Hepworth, K. (2014). History, power, and visual communication artefacts. Rethinking History, 20(2), 280-302. https://doi.org/10.1080/13642529.2014.932079

IDEO. (2019). Change By Design. https://www.ideo.com/post/change-by-design

Kelcher, J. (2021). The Best Visual Storytelling Examples (Infographic). https://www.brafton.com.au/blog/distribution/how-to-enthrall-your-audience-with-visual-storytelling/

Kernbach, S., & Svetina Nabergoj, A. (2018). Visual Design Thinking: Understanding the Role of Knowledge Visualization in the Design Thinking Process. 2018 22Nd International Conference Information Visualisation (IV), 2-3. https://doi.org/10.1109/iv.2018.00068

Kueh, C. (2019). Learnings from the First Wave of Design Methods Movement: 3 Missing Pieces in the current Design Practice.. Linkedin.com. https://www.linkedin.com/pulse/learnings-from-first-wave-design-methods-movement-3-kueh-phd-/

Leifer, L., & Meinel, C. (2019). Design Thinking Research: Looking Further: Design Thinking Beyond Solution-Fixation. Potsdam, Germany. Stanford, USA: Springer, Cham.

Liedtka, J., & Ogilvie, T. (2011). Designing for Growth (pp. 9-11). Columbia University Press.

McCandless, D. (2010). The Beauty of Data Visualization. TED Global 2010. TEDX Talks.

Mootee, I. (2013). Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School (pp. 16, 59). John Wiley & Sons.

Ormsby, E. (2021). Session 1 - What is Visual Data. GRD Research Methods for Innovation. Perth: Murdoch University.

Owen, J., & Westoby, P. (2012). The structure of dialogic practice within developmental work. Community Development, 43(3), 306-319. https://doi.org/10.1080/15575330.2011.632093

Parrish, P. (2006). Design as storytelling. Techtrends, 50(4), 72-82. https://doi.org/10.1007/s11528-006-0072-7

Penin, L. (2018). An introduction to service design: Designing the invisible (pp. 208-215). Bloomsbury.

Polaine, A., Løvlie, L., Reason, B., & Thackara, J. (2013). Service design: From insight to inspiration (1st ed.). Rosenfeld Media.

Pollastri, S. (2012). Visualization tools for service design. 8-35. https://www.slideshare.net/seremiru/visualization-tools-for-service-design

Quesenbery, W., & Brooks, K. (2010). Storytelling for user experience: Crafting stories for better design (1st ed.). Rosenfeld Media.

Roofthooft, W. (2010). Customer equity: a creative tool for SMEs in the services industry. Service Business, 4(1), 37-48. https://doi.org/10.1007/s11628-009-0082-6

Rosling, H. (2006). The best stats you've ever seen. TEDX | The best stats you've ever seen. Monterey, CA: TED Talks.

Sadiku, M. N., Shadare, A. E., Musa, S. M., & Akujuobi, C. M. (2016). DATA VISUALIZATION. International Journal of Engineering Research And Advanced Technology (IJERAT), Volume. 02 Issue.12.

Segelström, F. (2013). Stakeholder engagement for service design: How service designers identify and communicate insights. Linköping University Electronic Press.

Stickdorn, M., & Schneider, J. (2011). This is service design thinking: Basics, tools, cases. BIS Publishers.

Tether, B. (2005). Do Services Innovate (Differently)? Insights from the European Inn barometer Survey. Industry & Innovation, 12(2), 153-184. https://doi.org/10.1080/13662710500087891

Toco, T. (2018). 7 examples of Data Visualization. https://toucantoco.com/blog/en/7-examples-of-data-visualization/

Todd, L. (2020). Using infographic design & data visualization in service of important causes. https://killervisualstrategies.com/blog/infographic-design-data-visualization-in-service-of-important-causes.html

Tufte, E., Steele, J., Smith, J., & Thorp, J. (2013). The Art of Data Visualization. The Art of Data Visualization | Off Book | PBS Digital Studios. Kornhaber Brown.

Wilson, C. (2014). Interview Techniques for UX Practitioners : A User-Centred Design Method. Elsevier Science & Technology.

Wroblewski, L. (2005). | A Difference of Design. Lukew.com. Retrieved 1 June 2021, from https://www.lukew.com/ff/entry.asp?205.

GENERAL REFERENCES

Australia. Department of Education and Training. (2015). ATSIHEAC background paper: Indigenous science, technology, engineering, and mathematics (STEM). https://www.dese.gov.au/download/2986/indigenous-participation-science-technology-engineering-and-mathematics-disciplines/4171/document/docx

Australian Curriculum Council. (2020). Why is STEM important? National-stem-education-resources-toolkit/introductorymaterial/why-stem-important? https://www.dese.gov.au/australian-curriculum/

Australian Curriculum, Assessment and Reporting Authority (ACARA). 2021. STEM. https://www.australiancurriculum.edu.au/

Department of Education. (2021). What is STEM? - Department of Education. Department of Education. Retrieved 2 June 2021, from https://www.education.wa.edu.au/what-is-stem.

Department of Industry, Science, Energy and Resources. (2021). Science, technology, engineering and mathematics (STEM). Department of Industry, Science, Energy and Resources. Retrieved 2 June 2021, from https://www.industry.gov.au/policies-and-initiatives/science-technology-engineering-and-mathematics-stem.

Education Coalitian. (2019). About STEM. http://www.stemedcoalition.org/.

Education Council. (2019). STEM School Education Interventions. Synthesis Report. http://www.educationcouncil.edu.au/site/DefaultSite/filesystem/documents/Reports%20and%20publications/Publications/STEM%20Education%20Initiatives%20Synthesis%20Report.pdf

Gibson, R., & Ewing, R. (2020). Transforming the curriculum through the arts (2nd ed.). Springer International Publishing.

Dawson, E. (2014). "Not Designed for Us": How Science Museums and Science Centers Socially Exclude Low-Income, Minority Ethnic Groups. Science Education, 98(6), 981–1008. https://doi.org/10.1002/sce.21133

Giles, Danielle. 2021. "Inspiring Young People To Invent Their Future". Presentation, Murdoch University, 2021

Government of Western Australia (2021). What is STEM? https://www.education.wa.edu.au/what-isstem#:~:text=What%20is%20STEM?%20STEM%20is%20an%20approach%20to,mathematics.%20Through%20STEM,%20students%20develop%20key%20skills%20including

Government of Western Australia. (2019). "Driving STEM skills in Western Australia": Future jobs, future skills. https://www.wa.gov.au/government/publications/future-jobs-future-skills

Ife, J. (2010). Principles and dimensions of community development. In J. Ife, Human rights from below; achieving rights through community development (pp. 29-66). Cambridge University Press.

Kenton, W. (2021, January 4). What is Ideation? Retrieved from Ideation: https://www.investopedia.com/terms/i/ideation.asp

Khine, M. S., & Areepattamannil, S. (Eds.). (2019). STEAM education: Theory and practice (1st ed.). Springer International Publishing.

Lewrick, M., Link, P., & Leifer, L. (2020). The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods.

Our Story | About Scitech. (2021). Scitech. https://www.scitech.org.au/about/.

Penin, L. (2018). An introduction to service design (1st ed.). Bloomsbury Publishing.

Pwc. (2016). "Making STEM a primary priority": Practical steps to improve the quality of science and mathematics teaching in Australian Primary schools. https://www.pwc.com.au/pdf/making-stem-a-primary-priority.pdf

Scitech. (2018). 2018-2021 New Scitech Strategy. https://www.scitech.org.au/wp-content/uploads/2019/10/ENP-3577-A4-Strategy-Booklet-reprint-digital.pdf

Scitech. (2018). Scitech 2018 – 2021 business plan https://www.scitech.org.au/wp-content/uploads/2019/09/Scitech-2018-to-2021-Business-Plan-Digital-V1.1P.compressed.pdfStem

Scitech. (2021). What is STEM and Why Does It Matter? | Scitech. Scitech. Retrieved 2 June 2021, from https://www.scitech.org.au/about/why-stem-matters/.

Stickdorn, M., & Schneider, J. (2011). This is service design thinking. John Wiley & Sons Inc.

The Atlantic Monthly Group. (2019). The New Science of Rural Education. https://www.theatlantic.com/sponsored/chevron-stemeducation/the-science-of-rural-education/207/.

The Centre for Inclusive Design. (2019). The benefit of designing for everyone. https://centreforinclusivedesign.org.au/wp-content/uploads/2020/04/inclusive-design-report-digital-160519.