FLEET

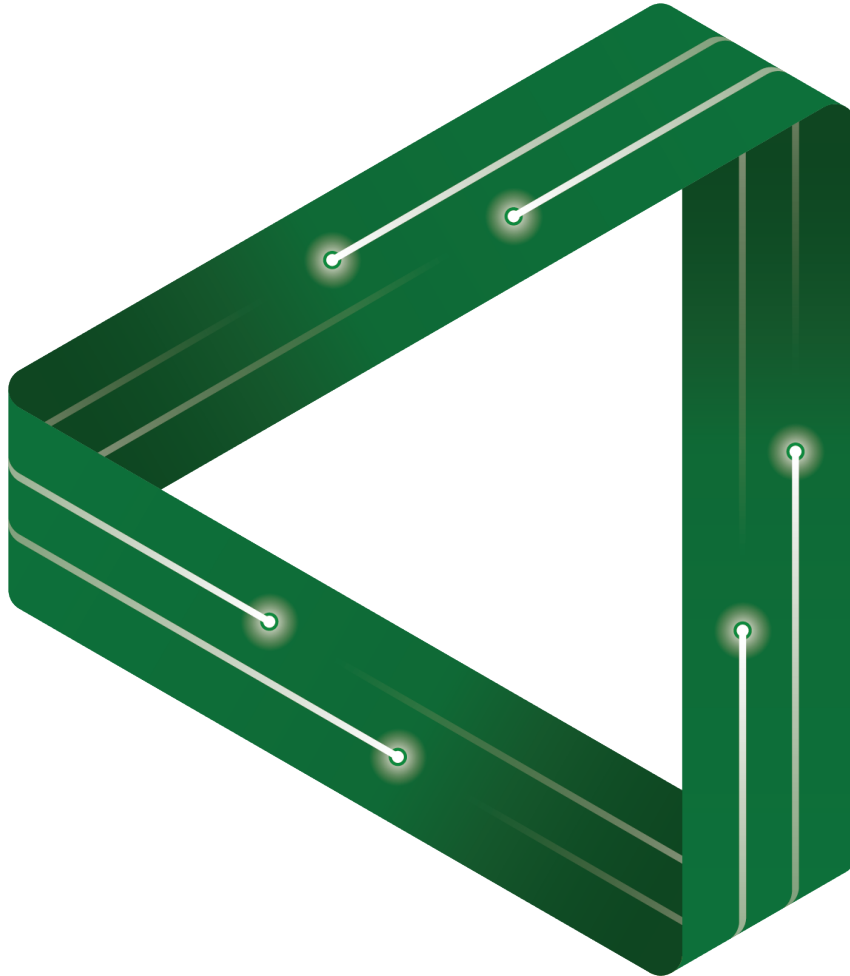**ARC CENTRE OF EXCELLENCE IN FUTURE LOW-ENERGY ELECTRONICS TECHNOLOGIES**

FLEET training evaluation impact report

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Contents

Overview

FLEET's Strategic Plan objectives.

FLEET intends to provide training opportunities to enable FLEET members to become well-rounded researchers in any field of their choice and become the next generation of science leaders.

In FLEET's strategic plan, we define a well-rounded researcher as one that has a high level of the following knowledge and skills:

- The ability to communicate and engage with varied audiences about their research, its meaning and value
- A demonstrated high level of knowledge in their area of specialisation
- An understanding of the value of their research to their field of expertise, the goals of the organisation they work with, and its broader societal implications, for example, for the community, education, equity/diversity, funding, Intellectual Property and policy
- A well-developed professional network to help solve problems and build collaborative research efforts
- Training in a broad range of experimental and theoretical techniques and having a high level of awareness of their skill strengths and weaknesses
- Experience in mentoring and teaching

This report analyses diverse qualitative data sets to understand whether FLEET has met its objective of developing well-rounded researchers and science leaders.

Method: The data used in this report are from semi-structured interviews and the qualitative components extracted from surveys and sources, such as mind maps, collected from the diverse training opportunities FLEET members participated in.

Results: Three core themes emerged from the data: Opportunity, Support and Sense of Community. Each theme is connected and contributes to the narrative of FLEET's attempt to achieve its objective of developing the next generation of science leaders. The core themes examine the opportunities that FLEET enabled to build skills underpinned by diverse support mechanisms and a sense of community that enabled the development of confident, motivated science leaders.

Discussion: FLEET did achieve its objective of developing well-rounded science leaders. The opportunities were only the material and practical components that enabled FLEET to achieve this. Important also was the support that encouraged members and helped them take advantage of the opportunities to develop skills, manage work-life balance and free up time to conduct their research. Crucially, the more abstract concept of Sense of Community strengthened the support and enabled members to connect and work together.

Key findings

- FLEET has developed well-rounded science leaders.
- FLEET members have developed strong communication skills at FLEET, and they place a high value on those skills.
- FLEET members developed a strong and diverse professional network and, crucially, the skills and confidence to build these networks and collaborations.
- FLEET members developed an in-depth understanding of the value of their research toward FLEET's research problems and the broader societal implications of that. FLEET members learned that research and its translation operate in an ecosystem with multiple stakeholders and diverse value sets that affect their research and its potential impact.
- FLEET members developed diverse technical skills at FLEET.
- Formal mentoring programs should continue to be supported because they work for some people for specific outcomes. Informal mentoring had a more powerful impact. Any FLEET

member in a supervisory role for higher degree research students or ECRs acted as an informal mentor, and in this capacity, they were highly effective mentors, especially for students.

- FLEET members developed confidence in their ability to take on leadership roles, develop new research initiatives, and consider translation of their research.
- FLEET has developed scientists (and support staff) with broad research capacity and a socially-enhanced skill base (economic-human capital) highly capable of achieving social and economic impact.

Introduction

Since its beginning in 2017, FLEET has created diverse training opportunities for its members in areas such as equity and diversity, communication, translation and technical skills. FLEET has enabled this through grants to attend conferences, training courses and visits to partner labs. It has also encouraged and provided the opportunity to present posters and seminars at FLEET workshops or monthly FLEET seminars.

Where possible, FLEET has evaluated these training opportunities to understand their impact relative to FLEET's objectives outlined in its Strategic Plan. This report analyses the diverse qualitative data sets from these evaluation reports and additional data from semi-structured interviews and other qualitative methods used at FLEET workshops to understand whether FLEET has met its objective of developing well-rounded researchers and science leaders.

The Australian Research Council require Centres of Excellence to report on their research impact in their final report, as noted in section E (Research Impact) of their final reporting guide. Section E states the following:

Section E. Outline how the completed project has produced (or is expected to produce) significant new knowledge and/or innovative economic, commercial, environmental, social and/or cultural benefits for the Australian and international communities.

The following four points from section E that Centres are to provide details on are most relevant to the outcomes from this report:

- Economic-human capital build-up
- Economic –increased employment
- Social-enhanced skill base
- Research capacity-research training

The next section outlines the method used to gather and analyse the data for this report.

Method

The data collection and analysis in this report are informed by constructivist grounded theory described by Charmaz (2014). In this approach, the researcher is considered a subjective observer and engages in an enquiry process that creates knowledge and truth through interpreted constructions dependent on the social or cultural context where it is experienced (Annells, 1996). In other words, there is no neutral observer; our interpretation of the data is constructed rather than discovered (Charmaz, 2014; Goodrick, 2013; Major, 2017).

The data used in this report are from semi-structured interviews, and the qualitative components extracted from surveys and sources, such as mind maps, were collected from the following and described in more detail below:

- FLEET training grant recipient survey
- Cruxes programs participant surveys (Base and Ascend)
- Mind maps from FLEET workshops

- Logbook from FLEET workshop
- FLEET workshop 2023 Legacy notes
- Mentorloop survey
- FLEET Equity and Diversity survey
- Women in Leadership (WLA) Leading Edge program/Impact, recipient survey

FLEET training grant recipient survey

In 2020, recipients were sent a survey to evaluate the impact of training grants. When the survey was sent, some recipients had completed the training attached to the grant, and others had only partially completed it.

Cruxes program

FLEET members have participated in either the Base or Ascend programs, which were developed to advance members' research towards impact and help them demonstrate the value of their research by exploring questions such as how does research translation work, where do I start with industry engagement and how do I effectively 'sell' the value of my research?

Mind Maps

These consisted of large sheets of butcher paper placed on a wall in the main hall at our 2023 FLEET workshop in Lorne. The map contained the central question: What impact has FLEET had (or is having) on your career? Members were asked to reflect on the question and contribute to the map.

Logbook from FLEET workshop

This book was handed around during meal and conference breaks at FLEET's final workshop at the Gold Coast, December 2023.

FLEET members were asked to reflect on the following statements/questions:

- What comes to mind when you think back on your time at FLEET?
- Describe the value/impact of FLEET for you.

FLEET workshop 2023 Legacy

Members giving presentations at the December 2023 FLEET legacy workshop had to provide one recollection of their time at FLEET. This is a collection of those and other comments collected through observation.

Mentorloop survey

This was a formal survey sent by FLEET to members who had participated in one of the FLEET formal mentoring programs coordinated through the Mentorloop platform. Only three responses were received.

FLEET Equity and Diversity survey

Each year, FLEET surveys members about their experience with equity and diversity within FLEET. We used the qualitative data from the 2023 survey. There was one relevant question with eight responses.

The Equity and Diversity 2023 survey question used in this report was, How have the opportunities offered by FLEET contributed to the development of your career?

Women in Leadership (WLA) Leading Edge program/Impact, recipient survey

FLEET surveyed recipients of its WLA leading edge and Impact programs to understand the impact it had.

Four participants responded to the Impact program survey and seven to the Leading-Edge program survey.

The responses to the following questions were used as data for this report:

- Which specific skills or capabilities have you found most valuable in your career development after completing the program?
- How have these skills contributed to your effectiveness as a leader or manager?
- How have you applied the knowledge and insights gained from the program in real-world work situations?
- In what ways do you believe the skills and capabilities acquired through the program will contribute to your long-term career success?
- Have you observed any tangible outcomes or advancements in your career directly linked to your participation in the program?

Semi-structured interviews

Interviews were conducted over Zoom, in-person or via email. The data from the six interviews conducted via email with alumni, while valuable, lack depth compared to the in-person and Zoom interviews. Where possible, at least one follow-up email with additional questions was sent to email interviewees.

Interviewees were asked the following broad questions: Specific responses were explored further. Often not all these questions were asked because they were part of responses to previous questions.

- Tell me about what things come to mind when you think back on your time at FLEET?
- What has FLEET meant to you, how do you value your time at FLEET?
- What impact has FLEET had on you re: getting you to where you are now or where you aspire to go?

Training specifics (Training is defined as anything from learning technical skills to transferable skills such as ethics, equity/diversity or communication)

- Tell me about your experience with any training at FLEET and its impact on your career – or career path.
- Is there any specific training experience that stood out? Discuss these
- Describe how this training affected your ability in the following:
  - leadership roles
  - ability to communicate with different audiences
- What about IP, and translation training? Tell me about that.
- Tell me about mentoring, formal and informal.

(Formal is defined as being assigned a mentor or mentee under one of the FLEET formal mentoring programs. Informal is the sort of advice or support you seek from friends, peers or colleagues outside of any formal mentoring program.)

Interviewees are de-identified. Interviewees included PhD students (PhD), early-career researchers (ECR), mid-career researchers (MCR), and Chief Investigators or Associate Investigators (CI/AI). See Table 1. In data sources from mind maps and surveys with anonymous respondents, their role in FLEET is unknown, and their quotes are used without any role identification.

Each in-person interview lasted 20-30 minutes. The interviews were recorded and then transcribed. A constructivist inductive analysis was used with three phases of coding: Initial, focused and thematic.

Data was analysed using NVivo.

Table 1 Respondents roles at FLEET and the number of each that participated in the semi-structured interviews

Respondent role	Number interviewed
PhD	8
Early-career researcher (ECR)	6
Mid-career researcher (MCR)	4
Associate Investigator or Chief Investigator (AI/CI)	2

Results

This section examines three core themes from the data: Opportunity, Support and Sense of Community. Each theme is connected and builds on the narrative of FLEET's objective to develop the next generation of science leaders. Figure 1 models the connection between the themes and the objective. The storyline indicates that diverse support mechanisms underpinned the opportunities that FLEET enabled to build skills, and a sense of community enabled the development of confident, motivated science leaders. Each theme, sub-theme and category is examined in detail below.
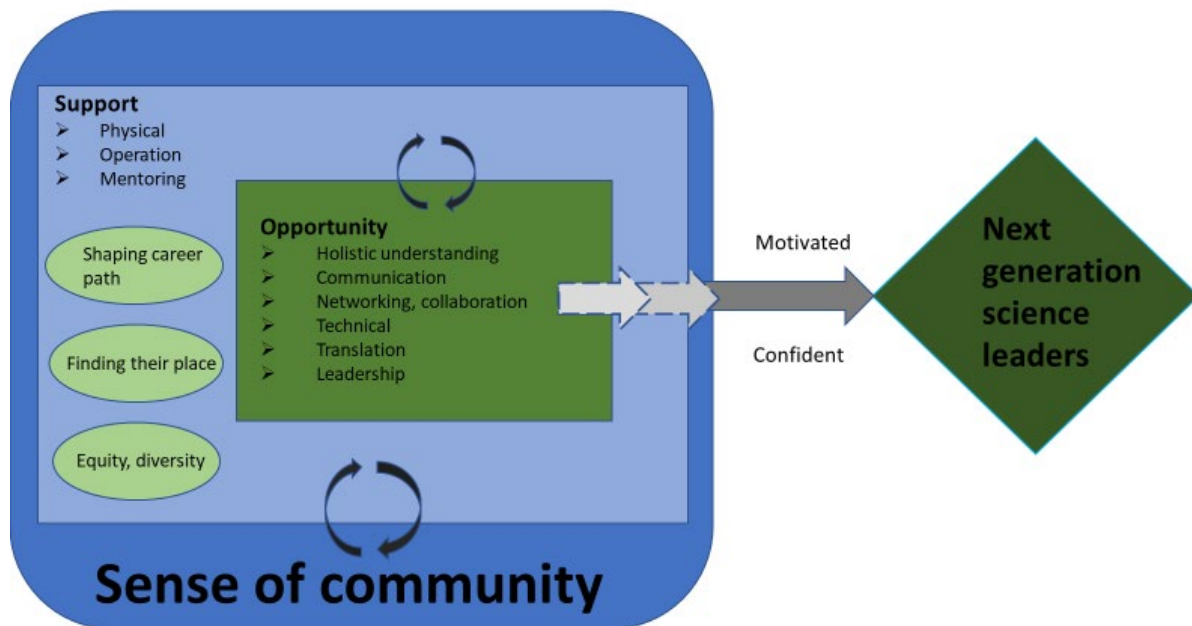
Figure 1 Training impact model that shows the role of the themes and sub-themes in developing the next generation of science leader

The theme of Opportunity is examined first, followed by Support and a Sense of Community. Responses that reflect how respondents developed confidence in themselves and their skills are examined last.

Theme: Opportunity

Throughout all the data respondents describe the immense opportunities they had while at FLEET to broaden their understanding of their craft, build transferable skills and gain a deeper understanding of the ecosystem that their research operates in. This reflects the results from the 2021 FLEET membership survey, where 80% of the survey respondents agreed that they would normally

regularly attend workshops and conferences related to their roles and that they know where to access information about opportunities (FLEET and Leaderskill Group 2021).

In many instances, respondents consider that their opportunities were greater than their peers outside of FLEET or a Centre of Excellence.

Respondents' responses are not necessarily explicit that FLEET has enabled them to become well-rounded, next-generation science leaders, but they strongly indicate that FLEET has produced the opportunity, environment, and support for this to occur. A number of sub-themes specific to different opportunities emerged from the data and enabled the development of skill sets or knowledge relevant to that sub-theme. Table 2 below outlines the sub-themes and the number of files and references coded for each. Each sub-theme is examined in more detail below.

There is an overlap between some of the sub-themes. For example, building communication skills gave some respondents confidence to engage, build networks and start collaborations. Two sub-themes, communication, outreach, and networking, collaboration, emerged as dominant influences on FLEET's objective of developing confident science leaders. Together, the sub-themes generated 39% of files and 53% of responses from the total sub-themes in Opportunity. See Table 2 below. These two sub-themes were each thematically analysed and discussed in greater depth below.

Table 2. Opportunity sub-themes and the number of files and references coded to each sub-theme

Opportunity sub-theme	Files	References
Broad scope	16	31
Holistic understanding	13	35
Communication, outreach	20	85
Networking, collaboration	21	91
Technical	12	23
Translation	8	21
Leadership	9	39
Finding role models	7	12

*Files and references are NVivo categories that refer to the respondent or subject and their coded comments. A file represents the respondent or subject. References refer to the number of comments coded to that file in the theme or sub-theme.

For this report, because of the large and rich data set in the semi-structured interviews, each interviewee represents a single respondent (file). Because of the low number of respondents and responses in the surveys and for ease of analysis, each survey analysed was entered as a single file. Survey responses ranged between 3 and 15. For the mind map and log book data, it was unclear if a respondent made more than one comment. Again, the mind map and log book data each represent a single file, though the references are from numerous different respondents.

Sub-theme: Broad scope

Respondents described broadly how their opportunities were greater in FLEET, but with some focus on the greater opportunity to attend conferences and present posters, general references to career development and access to training workshops.

> MCR: Just the experience of participating in all these things that I hadn't done before that are part of being part of a Centre of Excellence like FLEET, such as extra outreach, extra workshops, mentoring programs…these are things you don't necessarily have exposure to if you are not part of a Centre of Excellence.

PhD: You might attend one, maybe two conferences as a PhD student, unless you are exceptional. With FLEET you start as soon as you begin your PhD program. You are not waiting until your last year when you have some research to show.

PhD: I joined FLEET in my honours so I got to present a poster – in my honours. If I wasn't part of FLEET that would never have happened, and our annual meeting where we get to present posters or talks that is very good practice for us.

ECR: The other memorable thing is that the training was, basically, never ending. You always had the feeling that there was something you could learn – a new analysis technique during a visit to another node, a way to improve your data presentation during an internal seminar, a scientific breakthrough during the workshops. What FLEET did very well (in my opinion) is to constantly enable this transfer of knowledge between people, by organising events and seminars etc.

Sub-theme: Holistic understanding

FLEET members perceived they gained a broadened understanding of their discipline and the research system by becoming aware that research and translation operate in a complex system (an ecosystem) with multiple stakeholders and diverse value sets that affect their research – how it is valued and its potential for translation and impact. FLEET members consider that their diverse training and networking opportunities facilitated this understanding and perspective about research and, indeed, life.

PhD: FLEET has given me a broad perspective of the direction of my research field (which is hard to understand when you enter it!) and how it can be applied to technology to achieve low-energy electronics. It has also shown me the importance of why we are working towards this goal. Working within FLEET for my PhD gave me the feeling I was part of a research effort much bigger than just myself or the research group I was in...I think understanding the landscape and how different areas of physics can be used in technology has been one of the most insightful lessons.

PhD: Every talk, every discussion, every workshop, every presentation, annual conference added something to my knowledge and shaped my way of thinking not just in "science terms" but life in general.

PhD: It [Science Meets Parliament] provided some perspective on the connections between science and government – an important relationship given that it helps drive science.

PhD: I think beyond that we got to interact with not just academics, but with people from industry. I got to go to ANSTO a couple of times and one of those collaborations through FLEET … and that completely pivoted the way I thought about jobs, I'll be completely honest – in a really interesting way.

Cruxes training: To think of the research enterprise as an ecosystem; to be aware that research progress is not linear; it is important to communicate our work effectively.

Sub-theme: Leadership skills

Respondents built leadership skills through formal training, mentoring, or having the opportunity and support to lead. Again, gaining these skills built confidence to apply them and take on leadership roles.

ECR: I learned how to build and maintain collaboration networks and how to be a leader rather than a boss…I had the chance to participate in the "Women Leading Australia" program in 2020, during lockdown. While I had come across part of the content in my own attempt at self-development, the message from this course that the leading style should be tailored and adapted to the people you work with, to allow them to flourish and give their best, really stuck with me. I keep applying this principle in my supervision of graduate and undergraduate students and receive positive feedback about my leading style.

Through different workshops, and opportunities, such as "Science meets Parliament", FLEET has fostered leadership qualities in me.

PhD: I never really took charge of the group. In Uni we had one or two group projects where I stepped up a bit more, but not a lot. In FLEET now doing the ECR committee and stuff, having to …I am feeling more confident in my skills and I am beating the imposter syndrome out a bit and learn to delegate, etc. I am working on my listening skills, because I know I talk a lot. I don't think I would have gotten any of those skills if I had not put myself out there and said to [Op Team member] hey I have these ideas and [they] would say, make these an ECR committee thing and go do stuff.

PhD: I think Innovation is leadership – We did Idea Factory and the Cruxes thing. I think all those sorts of programs develop leadership skills because you are getting broad overviews of how innovation works and that lets you become a leader in spaces like that.

Sub-theme: Technical

Respondents mention or value highly the support for building technical skills such as new experimental techniques, instrumentation operation, or learning how to use Python software.

ECR: I'm applying my analytical and modelling skills to help Defence Australia in decision making around being as well prepared as they can be.

ECR: I learned a new (at that time) experimental technique, STM/S, which I am currently using in my research and teaching to my students… I got impeccable scientific training in terms of data interpretation, scientific writing etc.

PhD: I got to go to the Australian Synchrotron and I got to use their PPMs (Physical Properties and Measurement system) and I got more experience in another type of PPMS – that was another skill set I got to add.

ECR: My postdoc work has made use of a lot of the skills I developed at FLEET, such as material synthesis, characterisation and testing, but being applied to different technologies such as solar cells.

Sub-theme: Translation

Most references coded under this theme are associated with formal training through the FLEET Translation program and participation in the Cruxes Base or Ascend programs. Respondents report that their exposure to the translation process made them think about the impact of their research beyond academia. Members report confidence to not only understand how their research can have an impact but to start taking steps towards translation of their ideas or at least have the confidence and willingness to have a go should the opportunity arise.

PhD: I wouldn't have been able to have worked on this [translation] project without the FLEET translation program and grant. The grant meant I was given the time to

work on the idea without feeling guilty that I should have been doing something else.

Going from ideation to actually believing I can translate my research.

This was probably my biggest takeaway from the Idea Factory. Not the literal results of contacting people…but the act itself. The theory we covered was interesting and useful, but not nearly as good as flipping the switch from "research translation is a cool thing some scientists do" to "I could translate my research." Talking to people is both the first thing you need to do and the thing you need to keep doing continuously, so doing it in the workshop was a big step.

Sub-theme: Finding role models

While an indirect form of skill building, respondents consider they have been lucky to have access to a diverse and large number of role models or scientists who motivate, inspire, and provide direction and insight into work ethic, what a research career, and good leadership look like. This sub-theme is distinct from valued informal mentoring because it lacks direct interaction between the FLEET member and the informal mentor. Respondents' learning, in this instance, is largely observational.

PhD: Especially when you go to networked conferences and there are successful academics, you get a look at what it could be like, or should be like – where people are doing well and what their attitude is towards things.

PhD: We are already in with a bunch of great leaders. But there is definitely lots of opportunity to be thinking about these things and you are effectively being trained as a leader because you are under leaders and you are seeing what good leadership looks like too.

It [FLEET] gave me the opportunity to have so many role models to look up to: [FLEET colleague] with her strength and hard work; [FLEET colleague] with his focussed vision and such an open and down-to-earth personality

I think that is an important thing. You get to see many leaders who can be your role model and represent what kind of leader you want to be in the future when you get to be supervisor or similar.

Sub-theme: Networking, collaboration

Respondents perceived that FLEET succeeded in bringing diverse researchers and industry connections together, enabling opportunities to build networks, meet and connect with people, learn what research is being done by others and build a greater breadth and depth of knowledge. Such connections create opportunities for collaboration and, for some, shape their career path. These opportunities arose through numerous FLEET-organized events where people could connect (workshops, seminars, translation programs, etc), through opportunities to visit other nodes, and funding to attend conferences or events such as Science Meets Parliament and InSTEM. Some respondents noted that FLEET was itself an extensive network that facilitated collaborations. A few respondents also reported that the environment in which the FLEET-based networking operated meant members felt comfortable engaging. This reflects the core theme, Sense of Community. The opportunities that FLEET created in an open and equitable environment enabled respondents to gain the skills and confidence to network and build collaborations, skills that they valued highly and have proved valuable in their post-FLEET careers.

From 91 coded responses and 21 files (see Table 2), the following six categories reflect how the networking and collaborative opportunities contributed towards building confident science leaders:

- Building diverse connections, enabling collaborations

- Breadth and depth of knowledge
- Learning networking skills
- Building confidence
- Shaping career paths
- Sense of community

The six categories are described in more detail below.

Building diverse connections, enabling collaborations

Nearly all respondents made a reference to how they valued the networking opportunities and the opportunity to access a diversity of researchers across FLEET nodes and other partners, opportunities many consider would be unavailable if they were not with FLEET. This enabled respondents to build diverse and extensive networks that, in many instances, initiated new research collaborations. Most of these connections and collaborations are with other researchers, but some include connections and collaborations with industry, such as those established through translation programs.

> ECR: I think the thing I valued the most was being embedded in a broad network of professionals that were more interested in collaborating and building on each other's knowledge rather than competing.

> PhD: Collaboration has been a key ingredient in my post-doc, which has been enabled through the development of these skills during my PhD and FLEET.

> MCR: FLEET has done a good job of bridging the gap between all these squirrels working away on these niche projects across universities. It has brought people together that otherwise may not have been even aware of each other…To meet them, to be aware of what they are doing. I have actively created collaborations based on having been to FLEET conferences where I am suddenly made aware of someone doing something that is very complementary to what I am doing.

> PhD: A lot of career development programs I have been in like Cruxes Innovation and the InStem conference for personal development, and another important thing is that it connected me with people.

> ECR: FLEET helped me to build networks with all other physicists in Condensed Matter Physics across Australia and foster future collaborations.

Breadth and depth of knowledge

This category reflects the responses in the Opportunity sub-theme, Holistic understanding of the research ecosystem. In this instance, respondents discussed how their diversity of connections across disciplines and areas of expertise helped develop new expertise in their own field and a greater depth and breadth of understanding about the big picture that their research fitted into and the functioning of the research ecosystem overall.

> MCR: As a numerical theorist, just seeing the type of work they do, and as an experimentalist I do such and such to get a result, but in terms of digging into the physics and being able to do simulations and to see the connections between this observable in the lab versus …they would be like if we start from the Hamiltonian of the system then we can do these transformations and arrive at a prediction of the observable. It is eye-opening to see how the other half lives.

> PhD: The ability to go interstate and visit other universities on a regular basis with meetings in mind, but also to see all sorts of other research that is being done by

different FLEET nodes. I feel that the networking I achieved with that I would never have achieved without that.

PhD: Where I think FLEET is helpful in this context is that because of all the opportunities you get to – even interact with the other centres like Exciton Science, Climate Extremes, etc, you hear about research that is happening all over the place. Whereas if you were not part of an ARC centre, you would only go to one conference and only meet people in your field and you wouldn't get that breadth of knowledge of what else is out there. Because we get to talk to a lot of people, your options are much wider and you get some inspiration from all the other things that are happening in Australia as well.

PhD: I learn so many skills from FLEET people, for example, [FLEET colleague]. In my first year, they came to [FLEET node] and they showed me their 2D materials transfer technique and it became an expertise of my own as well and then I get to use that skill to contribute to other work as well.

Learning networking skills

Respondents reported that the greater networking opportunities helped them build the skills necessary to network effectively and initiate collaborations with other researchers and industry.

PhD: I think another important skill learnt during my time at FLEET which is proving very useful is the ability to network.

PhD: It [their time at FLEET] helped my connections. It helped me network better and easier.

Building confidence

Respondents reported that having gained the necessary skills at FLEET, they felt more confident to network and initiate collaborations.

Cruxes: It [networking] gave me more confidence to apply for the EQUS/FLEET Translation Program. Also, it helped me with future correspondence with potential research collaborators.

Cruxes: By having a large group of early career researchers, with access to later term professionals, I found I was much more confident in networking than I have been otherwise.

PhD: And through that I develop confidence because you are talking to people from many different levels.

Shaping career paths

New and diverse connections and collaborations have revealed new opportunities for respondents and inspired, motivated, and shaped their career paths.

PhD: FLEET has been key to my growth as a materials scientist. I got to know a lot of brilliant people in the field, and had an opportunity to collaborate with like-minded people with ease.

CI/AI: I have gained a lot from FLEET in terms of the amount of collaborations that I have had and I feel like I have learned a lot because I started working in cold atomic gases prior to FLEET, but during my time at FLEET I started working on new systems like 2D materials and exciton-polaritons that I had not worked in before and this has really come from discussions from people in FLEET – the various CIs and AIs.

PhD: I think beyond that we got to interact with not just academics, but with people from industry. I got to go to ANSTO a couple of times and one of those collaborations through FLEET with [FLEET associate], and that completely pivoted the way I thought about jobs, I'll be completely honest – in a really interesting way.

Sense of community

Reflecting the core theme of Sense of community, respondents suggest that FLEET's creation of an open and equitable environment made members feel comfortable to engage and develop networks and collaborations.

ECR: It [FLEET] fosters an open environment for scientific discussions and active collaborations.

PhD: I got to meet people at UNSW and in QLD, because when you go to conferences and stuff, you get to know each other a little bit, or at least get familiar with who they are so later you can just email them and get a bit of a conversation going with someone you would not otherwise have access to.

Sub-theme: Communication, outreach

From 20 files and 85 references (see Table 2), the following three core categories emerged from the respondents' references relevant to the sub-theme, Communications, outreach:

- Valuing their communication skills
- Applying the communication skills
- Seeing the big sci-comm picture

The three categories are examined in more detail below. Respondents overwhelmingly valued the communication skills they developed and saw them as crucial to their role as a researcher and any existing and future career pathways. Several respondents considered that their skills set them apart from their peers who lacked the opportunities their opportunities.

Further, an NVivo query found that five respondents connected their communication training to their improved confidence, either generally or specifically to areas such as public speaking and the ability to engage diverse audiences, including industry.

PhD: I feel more comfortable talking to people. In undergrad it was mostly class, home and I didn't really talk to anybody, but that was just me. But doing outreach has made me feel more comfortable talking.

ECR: FLEET's science communication program has helped me to enhance my public speaking capability and this, in turn, has boosted my confidence.

Valuing their communication skills

Respondents made general statements that indicated they valued the experience to learn communication skills and become effective communicators of their research to diverse audiences. They reported fond memories of developing these skills through outreach and the simple pleasure of being able to engage people about their research effectively.

ECR: I am very grateful to all FLEET's efforts to incentivise researchers to get engaged with the community through outreach…I love science, and that is why in both my workplaces since FLEET, I've kept doing outreach activities.

PhD: The outreach is good fun, but it helps me develop communication skills, communicating with the general public, finding a way to phrase my research and the research of FLEET in a way that is comprehensible to the general public…Being able to articulate my motivations in a way that makes other people go Ok that is pretty cool. It is a kind of validation.

PhD: I think that you are forced to do outreach hours is a positive. I think doing it forces you into situations where you are engaging with lots of different people. FLEET has done school talks, science week, science meets parliament, laureate things, Idea Factories where you have lots of opportunities to simplify your pitch, communicate at some effective sort of level to a stakeholder. I think implemented well, people doing this stuff I think this is a fantastic training resource. You are thrown in the deep end and you need to learn how to do it and do it well.

I feel that I have the tools to communicate my research better and drive conversations and actions towards impact.

Applying the communication skills

Respondents perceived their communication skills as valuable for specific applications such as grant writing and communicating to scientific peers outside their area of expertise, industry or potential employers.

PhD: Amongst the specific skills I gained are communications skills that I used to win the [name removed] grant and to communicate research in a clear way via publications and presentations.

PhD: I think it is good, especially as I am a teacher now and public speaking is like a job nowadays. Talking in front of diverse audiences is not much of an issue for me.

ECR: [Engaging with researchers outside their specific field of expertise] I think that has helped my communication skills because I can't be too technical. I sort of need to be able to make it edible to these people who have different expertise so it has helped me with my communication skills in that way.

MCR: Every time you are trying to communicate what you are doing. The first page of a grant application is like you start off talking like you are talking to a high school student, and similarly when you are giving a scientific presentation. If it is not your field, the communication is the same.

PhD: That [communication skill] helps me explain what I have been doing to potential employers and what I want to do with my science to potential employers.

Seeing the big Sci Comm picture

Respondents consider how their communication skills are important in a more socio-cultural context to engage and have an impact beyond people's understanding of the science.

PhD: Part of it is that research is a publicly funded endeavour and it is good that the public appreciate what they are funding…At another step it helps people value the contributions I am making… If I am doing some weird abstract thing that nobody cares about, why should I care about it.

CI/AI: I think it is important. If we can get people excited about science then I think it is a good thing, especially nowadays as there is so much negative press about science – with the media, such as antivaxxers.

MCR: [At Science Meets Parliament] Communicating science to someone who makes policy but has an arts background was a different experience because you need to ground it in how it this relevant to society as a whole and why should the government, for example, fund fundamental research – I found the exercise interesting; it was hard, but a good hard. It is kind of the mental gymnastics you

have to do when you are outside academia, for example communicating to a prospective employer who might be doing data science or energy grid work, etc.

MCR: If you don't allow any discussion about any new technology. Like it is an evil word such as nuclear power then you block yourself out from having any progress on that front. And you see this all over the world. You only have your friend or enemy discussions…Hence communicating is getting more and more important, as a researcher – what you are doing and what it means.

The theme, Support, examined next, outlines the elements that enabled respondents to participate and build the necessary skills.

Theme: Support

Respondents refer to diverse forms of support from FLEET that helped them take advantage of the opportunities to develop skills, manage work-life balance and free up time to conduct their research. The following three sub-themes emerged that reflect the types of support provided by FLEET:

- Support: operational framework (8 files / 12 references)
- Support: physical (7 files / 16 references)
- Mentoring

Each sub-theme is examined in more detail below. FLEET put considerable effort into its four mentoring programs and it became a standard exploratory question in the semi-structured interviews to specifically understand the impact of this form of support. Because of the wealth of rich data gathered on the impact of mentoring, it is examined in more detail at the end of this Support section.

The Support theme also enabled respondents to find a sense of place, shape their career path, and better understand equity and diversity. These three categories (Finding their place, Shaping career path, and Equity and diversity) situate themselves within the Support theme as they are not opportunities created by FLEET but emerge from the support provided and the sense of community. They are examined in more detail below.

Support sub-themes

Support: operational framework

Respondents' comments reflect how FLEET's operational framework has encouraged and provided the necessary opportunities, support and organisation to enable participation in professional development, outreach, etc. The organisation can include organising events, flights, or payment of training. Support can include encouragement and mentoring in areas such as career advice or science communication.

At the end of my PhD I explored a fair few options before deciding on taking up this fellowship. And again, here I credit FLEET for the help and guidance provided at this time. I was introduced to a number of contacts who I was able to interview and gain some insight into what the roles I was looking at involved.

… and there are always just so many opportunities and they [op team] are always trying to teach you stuff and help you and if you need anything you know you can just reach out to them and they will try and organize something for you.

We would do no outreach if there wasn't someone like you [OpT] creating the opportunities.

Support: physical

This sub-theme reflects acknowledgement of largely financial support but also research support.

Respondents valued the diverse financial support available, from thesis writing grants, to funding for their research, conducting lab visits at other nodes, attending conferences and professional development courses. Three respondents referenced how the financial support helped manage their family by funding caring responsibilities that enabled them to continue their research.

> FLEET also strongly supported its ECRs. The possibility of accessing small funding for internal collaborations or to extend the PhD duration are some "material" examples.

> A very positive memory of my lockdown time was getting a writing grant from FLEET to help me at the tail end of my PhD. I was off the end of my maternity leave, home-schooling and taking care of a baby and this grant helped to get the assistance to spend the time on writing my thesis and the pending manuscripts.

> My DECRA fellowship ended, but I was working on an experiment that was related to FLEET and that was funded by FLEET so I could continue working on that experiment. For me it is a major thing.

> And more importantly, the funding. If we were not part of FLEET, we would only get $3000 throughout our whole PhD for travel and that is one of the main reasons that, as a PhD student, you would only go to 1-2 conferences because you don't have the funding, whereas FLEET gave us the opportunity by funding us.

Support categories

Category: Equity diversity analysis. 13 files / 26 references

There are two aspects to this category: The first is a perception of an open, non-hierarchical workplace - a sense of belonging and feeling empowered to discuss ideas with anyone from the director to students. The second is respondents report gaining a greater breadth and depth of understanding about equity and diversity in the workplace. In both instances, respondents reported how this has supported their growth as researchers, to become empowered and to be a "voice for change".

> PhD: Every talk, every discussion, every workshop, every presentation, annual conference added something to my knowledge and shaped my way of thinking…About equity and diversity, women's lack of opportunities in STEM and how to be a voice to change that…everything became a part of me and will always stay with me.

> ECR: I attended inSTEM, so that was good. It made me feel supported given the level of concentration going into those sorts of issues. How to improve success for diverse groups in STEM. It made me feel more empowered and supported.

> CI/AI: you know having kids running around and families has created a whole different atmosphere to any other meetings I have experienced and I have loved it. I think it is great. It does create a relaxed atmosphere where people are just talking and you see your colleagues in a different light, not just as a hot shot professor, but as a human being. It does help to break down barriers.

One respondent, however, thought that FLEET was slow to recognise diversity beyond the male-female gender dichotomy. They thought the inclusion of a diversity fellowship that focused on diversity beyond females in STEM was good progress.

> PhD: I did have the impression that in terms of diversity at FLEET, it was a tokenised woman. I was afraid to mention that while I was at FLEET, especially when I first started. It seemed like FLEET's definition of diversity in science was equivalent to supporting the general concept of "woman" in science…They added a new

fellowship for just general diversity which I think was good – instead of just having an exclusively woman one

Category: Finding their place. 5 files / 7 references

Respondents reflect on their time at FLEET as a journey that, through support from FLEET colleagues and their exposure to diverse opportunities and experiences at FLEET, they built confidence in themselves and began to clarify who they are and want to be.

> ECR: I believe that every PhD or ECR will have the moment in their career where they need to decide where to go next. I also had this moment (it was not a short period) and I talked with several senior peers to collect data that helped me decide.

> PhD: I feel like it has had an effect on what I want to do in my life. When I started my PhD, I thought a career for me would be a lecturer and academia. And then doing the work, the with FLEET and the conferences we attend, I have learned that we have so many options after PhD or with a research career. We don't have to restrict ourselves to academia.

> I started as a student, learn and excel to a professional life along the journey of FLEET. The first thing that comes to mind about FLEET is really a school for me that taught me a lot and prepared me to enter into a professional life.

> FLEET for me is a journey of exploring knowledge, knowing myself and becoming a PhD. It tells me I might do something right here.

Category: Shaping career path. 6 files / 12 references

FLEET's support through diverse training, mentoring, networks and outreach exposed respondents to novel career directions and opportunities that helped shape their career direction. Respondents became motivated via role models, discovered unsuspected career opportunities in industry or outreach and science communication, or shifted and refined their research interests.

> ECR: The research training I received definitely shaped my academic interests. Towards the end of my FLEET contract I started applying for competitive fellowships by proposing my original research program/idea, developed by building on what I did at Monash.

> PhD: Especially when you go to networked conferences and there are successful academics, you get a look at what it could be like, or should be like – where people are doing well and what their attitude is towards things….But having those events really does give you an idea of where you can go and what you can do in a way that being at home with one supervisor could never do.

> PhD: I used to be really good at programming and I didn't do it at university because I thought I would find it too easy, but being through one of these facilities with FLEET and interacting with people working on scientific beamlines and doing programming for the beamlines and automated analysis of the data from those beamlines, I have a reignited passion, which is something I might now want to pursue jobwise.

> I love that science communication is actively encouraged and it's massively impacted my career path. I wouldn't have found out how much I enjoy talking to the public, school kids and other scientists without FLEET.

While mentoring fits under the theme of Support, because of the rich data on mentoring, especially from the semi-structured interview, it is examined in some depth next.

Mentoring

FLEET has put considerable effort into its mentoring programs. FLEET has four formal mentoring programs hosted on the Mentorloop platform and involvement in a collaborative mentoring program with other Centres of Excellence, also hosted on Mentorloop.

Nearly all of the data analysed for this section is from the semi-structured interviews. The only other data in this report is from three responses to a survey sent out to members involved in one or more of the four formal FLEET mentor programs (see Table 3). Most of the data is also from the perspective of the mentee.

The following three categories emerged from the responses relevant to mentoring:

- Valued formal mentoring
- Formal mentoring constraints
- Valued informal mentoring

Table 3. Mentoring categories and the numbers of files and references for each.

Category	Numbers of files / references
Valued formal mentoring	10 files / 14 references
Formal mentoring constraints	8 files / 16 references
Valued informal mentoring	14 files / 29 references

From these categories, different sub-categories emerged that describe the perceived value or impact of the mentoring program. Each category and its sub-categories are examined in more detail below.

Formal mentoring is defined as participation as a mentor or mentee in one of FLEET's formal mentoring programs. Informal mentoring is advice or support you seek from friends, peers or colleagues outside of any formal mentoring program.

Category: Valued formal mentoring

Two sub-categories emerged that describe the different types of value FLEET respondents got from the formal mentoring relationship: Practical advice and Moral and emotional support. Responses coded to both categories were approximately equal.

Sub-category: Practical advice: While connections between mentor and mentee were typically infrequent, when they did occur, they were to get help or advice about grant writing, career guidance, or time management. The advice was specific to the mentee's needs at the time and highly valued by the mentee.

> My mentor shared tips and tricks on how to prepare for such a job hunt, how to grow a network in the industry, or how to write a CV. This was especially precious because usually, we don't get such insight from people within the academia.

> I have a formal mentor assigned to me who I tend to only contact rarely if I am going for a promotion or applying for a grant and I want some feedback. It is fairly specific but it has been useful, but I don't meet with them every month.

Sub-category: Moral and emotional support: This category became important during the COVID lockdowns. Three of the four respondents who referred to their formal mentors providing moral or emotional support noted that it occurred and was important during COVID. Mentors acted as an outlet for mentees to talk about any lockdown-related problems they were having and be one of the few connections to their work that wasn't their supervisor.

> Mentee: I could organise a meeting with and go, hey, this is tough. I am sure there was some work-related aspect to it, but it was just nice to see a friendly face that wasn't just my supervisor.

> Mentee: FLEET's mentoring program has been especially useful for me. Not only my mentors have helped me to develop as a scientist, but they have inspired me, and encouraged me during difficult times, such as COVID.

There is a valued role for the formal mentoring program. They work well for some people in terms of getting guidance on things such as grant writing, career pathways, or negotiating the PhD. There was an element of moral support from mentors in the formal mentoring program, but this seemed restricted, for the most part, to the lockdown period during COVID.

The value of formal mentoring is reflected in the Mentorloop platform evaluation of the relationship quality (Mentoring Quality Score), which achieved a score of 4.63/5. This is above the Mentorloop benchmark, but it is based on a low number of people (N=9 from 94 participants and 49 mentor-mentee relationships) who have entered a rating and should not be considered indicative of the program's overall impact. It does, however, indicate that there are some positive outcomes for those few mentor-mentees with an active relationship.

However, for an almost equal number involved in the formal mentoring program that perceived some form of value, a similar number perceived constraints that led to an ineffective mentor-mentee relationship. See below.

Category: Formal mentoring constraints

Two sub-categories, *Struggling to connect* and *Uncomfortable, forced* describe the different perceived constraints to an effective formal mentor-mentee relationship.

Sub-category: Struggling to connect: About half of the files and responses specifically mentioned that they found it difficult to meet with their mentor or mentee. Mentors and mentees rarely, and sometimes never, met. Their relationship struggled to get started and had minimal if any, impact.

> Mentee: I signed up for it [FLEET mentoring program] and it didn't work out. My mentor was someone in Italy and I emailed them a few times and never got a response and it stopped there. I signed up for this other [Mentorloop] cross-centre of excellence. I am unsure if I am using the app wrong, but I have given up trying to contact people…The other ones [through Mentorloop] were just ghosts.

> Mentor: I am on the Mentorloop program. I haven't been a mentor for many people simply because the people that have been assigned to me don't contact me or whatever.

> Mentee: I had a formal mentor, but similar to [FLEET colleague], we only caught up a few times. I think formal mentorships are quite difficult to tap. Unless you are super motivated and have a list of questions that you want to work through with somebody and force them to meet up with you.

> Mentee: I was assigned [FLEET member] as a mentor. We met up once or twice – COVID didn't help – but we didn't really click. He is an experimentalist and his field has nothing to do with mine…it was awkward.

Sub-category: Uncomfortable, forced: The following category might help explain why mentors and mentees struggled to connect. Respondents suggested that their mentor-mentee relationships felt forced and unnatural. There was a lack of personal connection and common ground. Some perceived a level of intimidation or suggested that their introverted nature affected their willingness to begin or forge a relationship. If a meeting did occur, it was because mentees, at least, felt obliged to do so. Any conversation, as noted above already, felt awkward. Two people noted a lack of anything in common as a reason for this. As noted, no practical outcome was recorded from these meetings.

Mentee: I feel like to be a good mentor, it is not easy. It might be like here are some things you might like to talk through or discuss as topics we can meet up and chat about those, but that is quite formalized and rarely people are so formalized when trying to catch up with someone.

Mentee: To be honest I think to randomly allocate a different mentor [in the mentorloop program] didn't actually work or was effective because I feel like to have a mentor that person should be someone that you really admire and respect or are really passionate about their career path and have something you really want to learn from them. I think that this is what keeps the mentor-menteeship going. It doesn't mean that the person that you got allocated is bad, but it that you don't have much in common and you don't know them enough to think about what can I get from them.

Mentee: With the formal mentoring program, if I was to choose someone, I wanted a woman who was a theorist. And there wasn't actually a lot of options. One of my PhD supervisors was on the network – who is a woman and a theorist, but there wasn't a lot of other options. There were a few experimentalists. I think there are some unique challenges for theory students. I am also a bit introverted, which is also maybe why I didn't pursue the formal avenue as much as other people.

Two respondents noted time constraints as reasons for not meeting up regularly.

Neither mentors or mentees are overly motivated to initiate meetings. Mentors are just busy... mentees are probably a bit intimidated? Don't think they need it? Perhaps there needs to be some level of compulsion - mentees need to submit a paragraph on their last meeting every six months. But if there are no consequences - probably no one will do it!

Category: Valued informal mentoring

The number of files and references in this category is considerably higher compared to other mentoring categories, and all references indicate that informal mentoring is highly valued and effective. See Table 3. This suggests that this mentoring needs to be recognised and supported as much as possible. The strong sense of community within FLEET has likely played a role in enabling this. It has facilitated the formation of friendships and trusted/respected peer relationships that enable informal mentoring.

I met her again at SMP, so it is not like I knew them a lot, but because we are part of FLEET it was easy to say I am comfortable enough to get in touch with this person and ask them about what I need.

I can send [anyone in Ops team], or whoever [in FLEET], and know that you guys are really supportive – it feels like a mentor-type situation, being able to chat to you guys about different things.

This reflects the core theme, Sense of Community, that underpins and supports the impact of FLEET training.

Two sub-categories emerged that describe the main drivers of this positive impact: Supervisors as key mentors and Connecting with peers.

Sub-category: Supervisors and key mentors: Respondents considered their supervisors and team leaders crucial and effective mentors. This was especially relevant to students. One respondent mentioned that the operations team plays a crucial mentor role for them. Respondents indicated

they developed a rapport based on trust and respect with supervisors or team leaders who also acted as role models and as inspiration.

> CI/AI: …that is kind of moulding your behaviour because you are not necessarily modelling yourself after your mentor but if there are qualities of your mentor that you like – professional qualities – you absorb those qualities if you interact with them on a regular basis and you guide your thinking and behaviour based on that. Before I came to Monash I shared an office with my group leader for 18 years, although we never said he was my mentor, I thought of him as a mentor because we shared an office.

> ECR: Definitely, my supervisors are all in FLEET as well. I get significant mentoring from them that is excellent. And I would say that I have had so many experiences of informal mentoring that has been really beneficial emotionally and academically.

> PhD: I would like to mention my supervisor here. They have been so supportive throughout my journey and still are. They always go an extra step to support their students...They keep a friendly and relaxed environment that proves conducive to learning.

Sub-category: Connecting with peers: Friendship, openness, trust, respect, sharing, and helping are all qualities that respondents considered enabled them to connect with peers for various forms of support. This support came in the form of emotional support, career advice, grant writing, technical advice about their research, and simply brainstorming ideas.

Because of this connection, respondents felt more able to open up and discuss problems. The informal mentoring was not planned; it happened spontaneously through friendship and connection.

> PhD: It took a search of a good few months to get a job that I really liked. I would like to mention here a combined discussion by women in FLEET [names removed] helped me a lot as they had mentioned that time after PhD gets a little tough in terms of defining your career path and growth.

> PhD: I worked with [PhD student] a lot and he was lovely. We bounced ideas off each other a lot and we talked a lot. I talked a lot also to [another PhD student] and he was lovely and we bounced ideas off each other a lot too. It wasn't so much mentor-mentee. I saw them as equals. It was just like social support, someone else to talk to about problems you were going through, but it was also people who knew a lot about the stuff you were working on and they could provide advice from their perspective and give different perspectives and solutions. It was that sort of dynamic relationship…I could let guards down and we could talk more casually and more efficiently, I guess.

> ECR: I regularly touch base with a more senior post-doc who is also a woman and we are great friends, but our conversations more often than not turn out to be more of a mentoring bent where she mentors me and I really get a lot out of that.

> PhD: It was raised that mentoring can be in many forms. It doesn't have to be a formal mentor-mentee relationship, but anyone can be your mentor – your friends, supervisor or sister, etc. I kind of like that idea and it felt right. I thought that will change my perspective on mentor-mentee relationships.

Conclusion

Formal mentoring programs should continue to be supported because they work for some people

for specific outcomes. Informal mentoring, at FLEET at least, had a more powerful impact. Although it occurs organically, serious consideration should be given to its support to enable it to flourish. Evidence shows that the sense of community was important in enabling this.

Any formal mentoring, however, comes with a financial and resource cost that needs to be considered. To optimise these programs and address resource constraints, several strategies can be implemented for future initiatives:

1. Implement a tiered mentorship approach: offering varying levels of mentorship based on individual needs
2. Use technology to streamline matching processes using platforms that use algorithms to pair mentors and mentees based on skills, goals and compatibility
3. Establish clear program objectives and metrics to assess effectiveness and optimise resource use
4. Comprehensive training: provide training for both mentors and mentees to enhance the quality and productivity of the mentoring relationship
5. Implement regular check-ins and feedback mechanisms to ensure the program remains on track and allow continuous improvement.

Sense of community – 12 files / 44 responses

The theme, Sense of Community, pervades all the other themes, and it plays a crucial role in strengthening the support and the ability to connect and work together. Respondents report a sense of belonging and being connected and part of a "FLEET family" where they feel safe, welcome and supported.

The following four sub-themes emerged from the 12 files and 44 responses

- Recognition
- Connected
- Falling walls
- Building friendships

They are examined in more detail below.

Recognition

Respondents perceived, within FLEET, a sense of community – a sense of belonging to a family and feeling accepted.

> PhD: A lot of it is the sense of community, and feeling accepted.

> The physics family where you fit in. Sense of community at FLEET is much larger than at single university. Physics is usually a bit isolating at a single university.

> So I have all these connections within FLEET and elsewhere. FLEET is like a big family so these connections are easy to make.

> CI/AI: The collaborations, in Australia and internationally, FLEET has made all that possible and that has created a real sense of community.

> Every member of FLEET has treated me with such incredible kindness and acceptance. Such a welcoming environment and community is difficult to foster, but FLEET absolutely has succeeded.

Connected

Respondents felt connected to other FLEET members. For instance, respondents report they never felt they were cold calling FLEET colleagues even if they had never spoken with them before. Respondents knew that this connection would also mean they would get a response and the necessary support from their FLEET colleagues. FLEET was a safe space where members felt comfortable engaging and sharing ideas with anyone. Throughout the themes, respondents report their positive experience with family-friendly policies at events that contributed to an open, welcoming environment and facilitated connections between FLEET members.

> ECR: There are very few communities that can give you a sense of belonging. I think FLEET has done this very successfully. I somehow feel connected with other FLEETers and I think this will continue even after FLEET has dissolved.

> PhD: I think the sense of community comes from knowing that there is this – even though we are all in different nodes…I just knew I could always email say, [FLEET colleague] or [FLEET colleague] and there are always just so many opportunities and they are always trying to teach you stuff and help you and if you need anything you know you can just reach out to them and they will try and organize something for you…That was the thing about FLEET and what I meant about the sense of community, you know those people exist, you don't have to know them, but people respond to you because you are part of FLEET and that was the thing I enjoyed about FLEET – because we are part of FLEET we are going to help each other.

> CI/AI: You can talk to others and just because they are FLEET they will be receptive…There is collegiality because you are in the same organization. They don't fear or see you as competition…I think it is actually a good thing to be open.

> PhD: I contacted them and because we were part of FLEET we were able to do everything really quickly. I feel it was a network, we are all part of the same goal.

> CI/AI: I think it is not so much the training, but it is just the environment – all the various meetings that we have had where we have gone to Lorne and elsewhere, and taken ourselves out of our usual confines and really talk with people who do different things.

> Safe space

Falling walls

Respondents feel comfortable approaching any FLEET member, from a PhD to a Professor/CI. FLEET is considered a safe space to speak your mind and share ideas regardless of position.

> CI/AI: I think the meeting and so on that we have had – you know having kids running around and families has created a whole different atmosphere to any other meetings I have experienced and I have loved it. I think it is great. It does create a relaxed atmosphere where people are just talking and you see your colleagues in a different light, not just as a hot shot professor, but as a human being. It does help to break down barriers.

> PhD: We get to meet people who are successful in their field and you get to talk to them because you are part of the same centre. It makes you feel they are less mysterious, less higher up. You don't put them up on a pedestal and then be afraid to approach them.

> PhD: I don't think going to a FLEET meeting is any different sort of conference in this context because these networks are doing things throughout the year. So you have

familiarity like through newsletters, anecdotal emails that go out and you respond to them but you actually know the person before you get through correspondence. So you are much less afraid. I think that is a big barrier breaker.

Building friendships

The sense of community facilitated respondents' ability to forge long-lasting friendships with FLEET colleagues, friendships that have helped support members along their journey, acting as informal mentors and confidants. Further benefits of such friendships for respondents include emotional support, greater well-being and enjoyment at work, and a sense of finding one's "tribe".

I just feel like I made a lot of friendships through FLEET. It is as simple as that, I think. These friendships were very positive socially and mentally…They increased my enjoyment of work and I am sure that helps in a lot of ways, broadly speaking.

FLEET was all about the friends we made along the way.

Again, this theme reflects what emerged from the 2021 FLEET membership survey, where 91% of survey respondents believe that they are treated with respect at work and that FLEET fosters a diverse, inclusive and flexible working environment that is free from discrimination, and 88% of respondents believe that the FLEET Leadership teams are building a collaborative Centre where members share ideas and information, and open, honest communication is generally encouraged (FLEET and Leaderskill Group 2021).

Confidence

Throughout the themes, respondents (14 files) refer to their growing confidence during their time with FLEET. This confidence is developed through outreach, communication through presentations such as seminars and posters, specific training in areas such as leadership and through the Cruxes workshops, or opportunities such as participation in Science Meets Parliament. The outcomes have been greater confidence to take on leadership roles, network and initiate collaborations, develop new research initiatives, consider translation of their research, and communicate their research to diverse audiences.

PhD: With that training, I am not as hesitant anymore to embark on a completely new research direction, and I'm more confident about my own expertise and knowledge.

ECR: I prepared well to talk about our work to other scientists, MPs and anyone relevant. This whole process made me more confident. I am not afraid to go to a stranger and start a discussion.

ECR: FLEET's "science communication" program has helped me to enhance my public speaking capability and this, in turn, has boosted my confidence.

Cruxes: I think everyone participating came out with good contacts, good experience, and more confidence that they could produce impact.

Mind Maps: A comfortable collaborative environment, build confidence

CI/AI: I am more confident now that I can take up a different topic, learn how to work with it and make significant contributions in another field or sub-field of physics.

ECR: giving presentations of necessity builds confidence. The more times you present something the more you feel like, hey I actually understand what I am presenting.

> PhD: If I wasn't a part of FLEET I wouldn't get to do that a lot. And right now where I am working [at CSIRO] I have to do that communication part and presentation – communicate my work to people and FLEET helped me develop the confidence to do that, through this program.

> PhD: You don't put them up on a pedestal and then be afraid to approach them. Then when I go to an international conference outside of FLEET, I feel more confident to talk to a more senior academic because I have interacted with such people at FLEET.

> PhD: …it is exponential the more times you do this. You just become so much more confident and natural. And you like trusted me to give those two [JMSS] talk with two weeks' notice and it was like – yeh, no sweat.

Confidence in leadership was especially prevalent among participants of the WLA leadership program.

> Confidence - that I have the ability to be an effective leader. To be myself. That others will view me as a competent leader.

> I have an enhanced level of confidence and feedback in the short time since commencing my role has been very positive with regard to my leadership and management style.

> And overall, it did make me more confident in taking on a more leadership role. Feeling confident in being in such a role, being able to address conflict and being responsible for others. I just became a team leader two weeks ago.

Next, we examine further what these results mean and whether FLEET has indeed achieved its objective of developing well-rounded science leaders.

Discussion

FLEET did achieve its objective of developing well-rounded science leaders. This section examines what enabled FLEET to achieve this.

FLEET provided diverse training opportunities to enable FLEET members to become well-rounded researchers and science leaders in any field of their choice. These opportunities were only the material and practical components, however, that enabled FLEET to achieve its objective. Important also was the support that encouraged members and helped them take advantage of the opportunities to develop skills, manage work-life balance and free up time to conduct their research. Crucially, the more abstract Sense of community strengthened the support and enabled members to connect and work together. This sense of belonging and being connected, supported and part of a "FLEET family" enabled a safe space for free and open dialogue; it facilitated networking and collaboration and helped build friendships that further supported members along their journey where friends acted as informal mentors and confidants.

FLEET defines a well-rounded researcher as one with the following knowledge and skills:

- The ability to communicate and engage with varied audiences about their research, its meaning and value
- A demonstrated high level of knowledge in their area of specialisation
- An understanding of the value of their research to their field of expertise, the goals of the organisation they work with, and its broader societal implications, for example, for the community, education, equity/diversity, funding, Intellectual Property and policy

- A well-developed professional network to help solve problems and build collaborative research efforts
- Training in a broad range of experimental and theoretical techniques and having a high level of awareness of their skill strengths and weaknesses
- Experience in mentoring and teaching

The results from the diverse data sets analysed for this report strongly suggest that FLEET members developed high knowledge and skills in each area. The criterion of teaching was not assessed in any of the surveys or interviews, but a large proportion of FLEET members taught undergraduate courses, supervised higher degree research students and participated in outreach where they developed communication and public engagement skills.

The outcomes of each criterion are examined below. Two core outcomes were FLEET members' development of a professional network and well-developed communication and engagement skills.

Communication

Respondents perceived that they developed strong communication skills at FLEET and placed a high value on those skills. They saw them as crucial to their role as a researcher and any existing and future career pathways.

> PhD: Amongst the specific skills I gained, as I mentioned above, are communications skills that I used to win the [name removed] grant and to communicate research in a clear way via publications and presentations.

FLEET members' experience in developing their communication skills helped foster an understanding of the bigger picture role of their research in society and the value of engaging diverse audiences in a dialogue about the value of their research.

> PhD: Part of it is that research is a publicly funded endeavour and it is good that the public appreciate what they are funding…At another step it helps people value the contributions I am making… If I am doing some weird abstract thing that nobody cares about, why should I care about it.

Professional networks and collaboration

FLEET members developed a strong and diverse professional network and, crucially, the skills and confidence to build these networks and collaborations.

It was noted and valued that FLEET was an important network in itself to build connections and collaborations. These connections also revealed new opportunities for FLEET members, inspired, motivated, shaped career paths, and helped develop new expertise in members' own field and a greater depth and breadth of understanding of the research ecosystem.

Value of their research and broader societal implications

FLEET members developed a strong understanding of the value of their research toward FLEET's research problems and the broader societal implications of that. FLEET members learned that research and its translation operate in an ecosystem with multiple stakeholders and diverse value sets that affect their research and its potential impact.

> PhD: FLEET has given me a broad perspective of the direction of my research field (which is hard to understand when you enter it!) and how it can be applied to technology to achieve low-energy electronics. It has also shown me the importance of why we are working towards this goal. Working within FLEET for my PhD gave me the feeling I was part of a research effort much bigger than just myself or the research group I was in…I think understanding the landscape and how different

areas of physics can be used in technology has been one of the most insightful lessons.

PhD: Every talk, every discussion, every workshop, every presentation, annual conference added something to my knowledge and shaped my way of thinking not just in "science terms" but life in general.

Specialised knowledge and technical skills

Respondents developed diverse technical skills at FLEET and valued those skills highly. These included new experimental techniques, instrumentation operation, and learning how to use Python software. Their awareness and confidence in their skills are apparent in their application in their post-FLEET roles.

ECR: I learned a new (at that time) experimental technique, STM/S, which I am currently using in my research and teaching to my students… I got impeccable scientific training in terms of data interpretation, scientific writing etc.

ECR: My postdoc work has made use of a lot of the skills I developed at FLEET, such as material synthesis, characterisation and testing, but being applied to different technologies such as solar cells.

Mentoring

Any FLEET member in a supervisory role for higher degree research students or ECRs acted as a mentor, and in this capacity, they were highly effective mentors, especially for students.

ECR: Definitely, my supervisors are all in FLEET as well. I get significant mentoring from them that is excellent. And I would say that I have had so many experiences of informal mentoring that has been really beneficial emotionally and academically.

PhD: I would like to mention my supervisor here. They have been so supportive throughout my journey and still are. They always go an extra step to support their students...They keep a friendly and relaxed environment that proves conducive to learning.

It was informal mentoring, where potentially all FLEET members had a role supporting their FLEET colleagues with everything from technical and career advice to emotional support.

Support

The support theme had three elements: physical support, the operational support framework, and mentoring.

The physical and operational support enabled FLEET members to access the training, but it also had an important role in their growth as researchers who became empowered to be a "voice for change"; they became confident in themselves and who they are and want to be; and it helped shape their career direction.

The data revealed two different mentoring stories: one about a formal mentoring program that worked for some but was ineffective for others, and the other about highly effective informal mentoring.

As noted, formal mentoring programs should continue to be supported because they are effective for some people for specific outcomes. The informal mentoring experience in FLEET suggests that other Centres should seriously consider supporting an environment that enables it to flourish. In FLEET, the sense of community was a strong enabler of the success of informal mentoring.

Sense of community

The sense of community was the organism that nurtured and enabled FLEET members to engage, connect, learn and become motivated and confident science leaders.

What has enabled the achievement of FLEET objectives?

The opportunities underpinned by the support and sense of community enabled FLEET to achieve its objective of well-rounded, confident and motivated science leaders. But as noted, it is the support framework that includes mentoring and the sense of community that was crucial to whether the opportunities provided were capitalised on and effective in their own specific objectives, such as building knowledge and technical, translation or communication skills. Finding role models was a more abstract or indirect opportunity, but it was important in inspiring and motivating FLEET members and helping them define and achieve their goals.

Impact

It is difficult to definitively claim from this data alone that we have achieved the relevant ARC-required impacts. We can, however, state with some confidence that FLEET has developed scientists (and support staff) with broad research capacity and a socially enhanced skill base (economic-human capital) that is highly capable of achieving social and economic impact.

This comes in the form of productive (new knowledge), well-connected, motivated and confident science leaders with highly developed research and translation skills, deep insight into the value and social implications of their research, and their ability to have constructive dialogue about this with diverse audiences that will help build the social and cultural capital required for valued and trusted scientific research in Australia.

Limitations

Coding was done by the author, Jason Major, FLEET's Education and Training Coordinator. No intercoder reliability testing was done to check the author's coding reliability. This runs the risk of misinterpreting some of the data and its meaning.

There were only two CI-AIs interviewed, which gives a limited perspective of senior FLEET members, though it is known that many senior members contributed to the mind maps, legacy notes and logbooks from the FLEET workshops.

Given that the author is a FLEET member and the outreach coordinator, there is potential bias in the questioning in semi-structured interviews and data analysis, especially where relevant to outreach, where a positive outcome would be considered to reflect well on the author's role. I, the author, made some personal reflections to examine and understand how biases and preconceptions might influence the construction of what is happening. Part of this was understanding my philosophical constructivist position and continual questioning during data collection and analysis of how my perspective could bias my research. Bearing that the data was interpreted through a constructivist and, therefore, subjective lens, I am comfortable with the philosophical lens through which I viewed and interpreted what was happening in the context of this research.
All interviewees in the semi-structured interviews knew of the author's role as outreach coordinator and, therefore, may have unconsciously (or consciously) provided responses they thought the author would want to hear relevant to his role. While this limitation needs to be recognized, the fact that similar responses about outreach were received from other sources gives some rigour to the conclusions drawn about the impact of outreach.

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