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Impact of a Voluntary Extracurricular Research Program on Engineering Students' Sense of Belonging: An Exploratory Case Study*

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In this paper, we present results of our exploratory study to explain students' experiences with the Icarus program. The program's goal was to provide students with a different space to develop sense of belonging. The research design is an exploratory case study. Data were collected quantitatively using a survey and qualitatively using semi-structured interviews. Results showed that students' primary motivation to join the Icarus program was to apply theory from class into real-world engineering problems and to work and engage with peers. In addition, students' experiences with Icarus aligned with the constructs desired for promoting sense of belonging. The program helped solve one of the issues in the School, an improvement in academics and student interactions. Students' experience with the program was positive, and they reported how it improved issues related to their academic program, their relationships with mentors, and their perceptions of inclusion.

Keywords: sense of belonging; motivation; extracurricular program; voluntary research

1. Introduction

The engineering field is expected to solve complex engineering problems with exceptional performance. Consequently, engineering education research has traditionally been exploring ways to make engineering classrooms more effective in developing the required future engineering graduates. One challenge has been regarding students' motivation in the classroom and the lack of participation and interaction with academics [1, 2–7]. Part of effectively developing an engineering identity is to be able to understand the complexities of the workforce and establish interactions with mentors (e.g., engineering professors). Sense of belonging has been directly linked to desirable academic outcomes, including persistence, self-efficacy, and perceptions of technical competence [8–10]. Sense of belonging refers to the positive behaviours and motivation resulting from meaningful interactions with others to satisfy the need to belong and develop interpersonal bonds [11, 12]. Research suggests that developing sense of belonging in engineering programmes has focused on the students' connectedness to the campus, the university community, or institutional facilities (e.g., research laboratories) [13, 14].

According to Allendoerfe [8] sense of belonging can be developed in non-traditional environments for students (e.g., an extracurricular program). In addition, informal spaces can help students establish connections with academics and mentors for non-academic reasons to develop mentor and role model relationships and to provide with not required informal learning opportunities [15]. Furthermore, a considerable portion of student learning occurs in these informal settings, particularly in out-of-the-classroom activities [16, 17].

In order to provide students with these opportunities, experiential learning has recently gained more traction in the engineering education field [18–20]. Experiential learning initiatives have been developed to provide students with authentic experiences to obtain learning gains, develop professional skills, increase students' sense of belonging, promote critical thinking, and prepare students for the workforce. Some of these initiatives include study abroad experiences, industry placements, service learning, and hands-on laboratories, among others. For example, in the Australasian engineering context, there has been a focus on integrating industry engagement so students can participate in industry placement experiences which have been proven to have a positive impact on students' learning outcomes and employability [21], and enhance different types of students' capital

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(i.e., human, social, psychological) [22]. Similarly, several undergraduate engineering programs are incorporating humanitarian engineering experiences, targeted to have the students contextualize their engineering learning in societal problems [23, 24]. Although these initiatives provide different benefits, they are not always accessible to all students and do not impact students-academics interactions. Furthermore, there is a gap in the literature around the impact of these experiences on sense of belonging. Sense of belonging is important because students who feel they belong are more motivated and invested in their courses and engineering programs.

According to the Australian Government of Education and Training, in their Higher Education Funding report [25], one of the main sources of funding for universities in Australia is through the enrolment of students. Therefore, there has been a tendency for universities in previous years to increase enrolment numbers, resulting in very high student-to-academic ratios [26]. As a consequence of high numbers, students enrolled in engineering programs at top universities in Australia face challenges in developing the required interactions and experiences that promote sense of belonging. Furthermore, the higher education system is structured to limit student-academic and peer-to-peer interactions. In addition, in Australia, digital recording and streaming of lectures has become a standard component of the resources provided to students through learning management sites [27], which has had an impact on the decrease of student attendance to class, which ultimately negatively impact interaction with their peers and professors. Finally, multiple incentives for academic buy-out of teaching are provided by a combination of a research-driven culture and multiple government programs that explicitly fund full academic buy-out. The ensemble of these characteristics represents a challenge for developing a student's sense of belonging.

In the particular case of the School of Civil Engineering at The University of Queensland (UQ) in Australia, there were serious issues regarding students' sense of belonging, perceived by the lack of interaction with academics and class participation. Furthermore, student/staff ratios were very high; hence academics' efforts to interact with students were complicated to implement widely. For example, a traditional learning experience for civil engineering students at UQ was to register for courses, submit assignments and participate in exams and any other types of evaluations; class attendance was really low, and students did not traditionally interact with the academics, not even when they did attend class. In addition, most students had a part-time job that often became the priority, and beyond their courses, students did not engage with the School in any other way. There were no extracurricular programs in the School, and students did not participate in many extracurricular programs offered by the university.

To find ways to address these problems, and provide students with a space to develop sense of belonging and engage with their peers through an extracurricular experience, the School of Civil Engineering in 2015 created the Icarus program. Icarus is a voluntary, project-based, research program where students engage with peers in small projects directed by academic mentors to establish a small class atmosphere that promotes outside-of-classroom interactions, expands learning beyond the classroom, and provides mentoring and role-model relationships. The program's initial goal was to increase the sense of belonging in engineering students regarding their civil engineering education to translate into more classroom participation and better student-academic interactions.

The purpose of this paper is to present preliminary results from an exploratory study about the implementation of Icarus, as an extracurricular program to improve sense of belonging., The program's goal was to provide students with a different space to develop the competencies and skills desired while simultaneously forming their identity as engineers. Icarus is an innovative solution since the School of Civil Engineering had not previously offered a structured extracurricular voluntary research experience in the past. The purpose of this study was to understand students' initial experiences participating in the Icarus program. More specifically, we address the following questions:

RQ1: Why do students decide to join a voluntary research program?
RQ2: How do students describe their experience with the Icarus program?

To answer the research questions, we collected data quantitatively using a survey and qualitatively using semi-structured interviews with participants from the first cohort of students enrolled in the Icarus program. We asked about their motivation to participate in the program and their experiences with it. Our overarching goal was to identify if the program impacted the students' sense of belonging and report on the initial experiences creating a new voluntary extra-curricular program.

2. Theoretical Background

Sense of belonging gained presence in education to understand the integration of students with their respective academic programs (or departments)

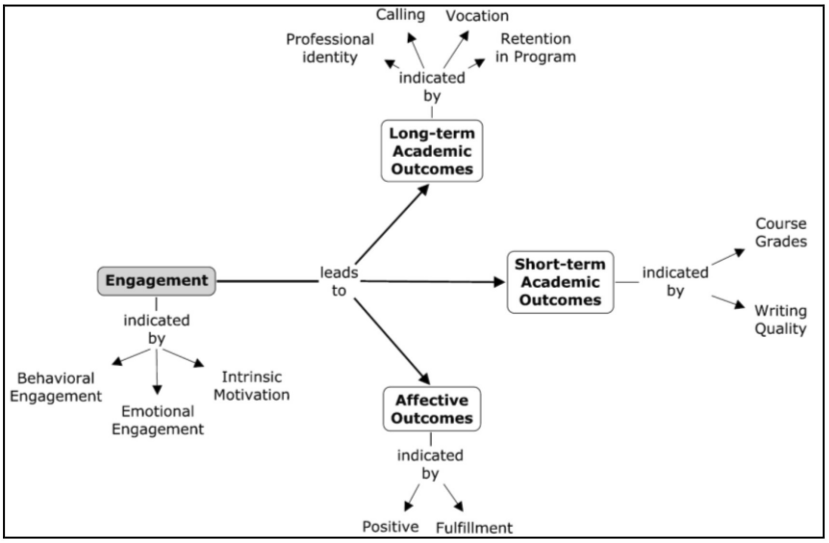

Fig. 1. Floyd-Smith et al. [42] model of outcomes of students' engagement.

and how different contextual characteristics had an influence in this integration [28, 29]. Sense of belonging within the context of higher education has been traditionally explained from two different perspectives that usually are not perceived as interacting; those are social and academic belonging [13, 30, 31]. Academic belonging is conceptualized as an institutional commitment that shows an interest in developing students' interactions with academics, peers, and staff [32, 33]. Research in engineering education around belongingness has focused on explaining the concept from a perception of inclusion of traditionally marginalized students. However, focusing on the relationships between academics and students is less prevalent in the literature [34]. In a study about sense of belonging in education, Allen et al. [35] identified that students' belonging is influenced by the relationships between the students and the teacher, the relationships developed with peers, and the students' perceptions of the academic institution. Similarly, Hoffman et al. [13] identified support from teachers, empathetic relationships with academics, and peer support as the most relevant aspects in developing a sense of belonging.

More recently, sense of belonging has also been a factor supporting inclusion in higher education [36, 37]. In several studies, sense of belonging has been part of research around diversity and inclusion, especially in students that have been identified to have less sense of belonging and to take more time to adapt and engage with their programs because of their higher uncertainty about how their interactions and behaviours will be seen, especially by academics [32, 38, 39]. In addition, sense of belonging is important in engineering because it increases student engagement which can translate into desirable learning outcomes, such as critical thinking and high academic performance [40, 41]. Thus, the Icarus program was implemented to engage students with their academic program and institution to increase their sense of belonging and expect better student engagement.

Floyd-Smith et al. [42] argued that developing a sense of belonging leads to students' engagement. Hence, it is also essential to have a community where students can participate and interact with others. Their model is presented in Fig. 1.

According to Floyd-Smith et al. [42], when students feel they belong, they will also demonstrate intrinsic motivation. This engagement will lead to short-term and long-term positive academic outcomes. The Icarus program was structured with this theoretical framework in mind. The expectation was that students participating in Icarus would have a sense of belonging with their engineering program and with the academics in the program – an outstanding issue in the School of civil engineering for years, but not to the expense of their academic coursework. Icarus emphasized the value of the alignment between the research project offered and the coursework students were enrolled in. We hypothesized that students would develop short-term academic outcomes, like improving their critical thinking, problem-solving, and research skills; by developing productive relationships with their peers and mentors; and having positive results in the classes in which they were enrolled. Some of the long-term academic outcomes that we expected to develop were having students becoming engaged professional engineers able to successfully finish their engineering program and effectively adapt to their next step, that being their first professional engineering job, or the decision to

continue their education in a higher research degree (i.e., graduate education).

We also considered it important to develop sense of belonging because the School of Civil Engineering was having a very difficult time recruiting students to consider research career tracks; furthermore, there was a need in the country to motivate more students to complete a higher degree by research [25]. Therefore, the Icarus program was developed to let the students guide how they worked and have complete control over their involvement and participation. An important aspect is that the focus was completely removed from outcomes regarding the students. We encouraged academics to put projects that resulted in positive research outcomes for them (thus, projects had to be very well thought out). In contrast, students were not required to achieve or deliver anything; it was their own initiative. A successful project was not one that delivered outcomes but one that delivered sense of belonging.

On the impact of extracurricular activities on undergraduate students, there is research supporting the notion that out-of-the-classroom learning experiences promote students' engagement with their academic programs, among other positive outcomes [1, 10, 43]. Wilson et al. [1] explain that when student participation in extracurricular activities is voluntary, students have higher levels of "academic conscientiousness" (p. 627), which the authors define as a willingness to raise their academic standards; this includes how they perform in the classroom, understand class materials, but also is related to how they conduct research and help and interact with classmates. We considered that Icarus students participating in voluntary research projects would obtain these positive outcomes.

Allendoerfer et al. [8] explain that providing students with opportunities to belong help them overcome some of the needs they face during their time in college and provide "the most return of investment for engagement in academic endeavours" (p. 512). The authors suggested that the most important part of providing sense of belonging and engagement are activities that enable students to receive family-like support, such as (Allendoerfer et al., [8], p.531):

- Formal cohorts of incoming students in classroom and/or labs.
- Living/learning communities, such as an engineering residence.
- Design teams/lab partners, scaffolded for success concerning the team relationships as well as the project goals.
- Weekly informal gatherings with academics, staff, and students for non-academic reasons (e.g., departmental tea, lunches in the dining halls, etc.).
- Academically-related clubs, with space to meet and 'hang out' to facilitate community.

The Icarus program was designed to provide several of these activities. Students members of the program considered themselves as being in an Icarus "cohort." The program also provided scaffolding for general academic success through building team relationships and project goals while they participated in the voluntary research projects and in cross-project activities that highlighted the social aspect of the program. These social aspects provided students with informal spaces to interact with academic mentors and peers in non-academic settings (e.g., end-of-semester BBQs). In addition, the Icarus program had a room available for the students to facilitate community interactions. These factors align with the criteria proposed by Allendoerfe et al. [6] to provide the family-like environment that students need to become engaged and feel they belong.

In the following section, we provide a complete description of the Icarus program, an innovative engineering education initiative to promote sense of belonging, engagement, and self-directed learning in engineering students.

3. The Icarus Program

The Icarus Program was developed as a pilot engagement program in the School of Civil Engineering at the University of Queensland (UQ). Students in the program participated voluntarily in research projects led by mentors who are part of the academic staff in the School. The Icarus Program was developed with three primary goals:

- to boost undergraduate student interest and experience in diverse and interdisciplinary projects;
- to foster close collaboration between academic mentors and small groups of students, and
- to leverage this engagement to elevate student learning pathways, student career outcomes, and UQ's national and international reputation for producing the leaders of tomorrow.

The Icarus program was created on several premises:

1. Research programs proposed for Icarus had to be an integral part of the academic research program. Therefore, it could not be perceived as another task; rather, it had to lead to a productive activity that had value on its own.
2. The objective of the research program had to be aligned with the second-year core courses'

learning outcomes in such a way that the research experience contributed to students learning. Ideally, a student could choose only to follow the Icarus learning path and still be assessed for the required learning outcomes of the second-year core classes.

3. It had to be voluntary and by application so that we could monitor enrolment.
4. Admission to the program had to be assessed based on the application process and not based on any other indicator (such as GPA). Thus, motivation was a primary selection criterion.

The program officially started in the first semester of 2015 with four projects across structural, environmental, and transport civil engineering streams. For the initial semester, 60 students were enrolled in the program. Students were in the second year of civil engineering. However, it was the first year in the civil major, since the first-year courses are non-discipline-specific engineering classes. Students committed 2 to 4 hours per week of work and active contribution to the research project, supervised by an academic mentor. However, the project was intentionally non-structured, so students had to decide and direct how to engage and learn from it. During the first semester, students had 24/7 access to a student-run design studio space and the opportunity to work closely with project mentors in small settings and collaborate with motivated peers. In addition, mentors tried to make students apply the knowledge they were acquiring in the second-year classes (structures, environmental, and transport). Hence, there was an intentional overlap of learning outcomes. As a result, students, through the research projects, were acquiring the learning desired for the courses.

The program was developed to complement academic's teaching and research efforts and students' curricular and extracurricular time. The program allows students and academics to spend more time together on diverse and small-cohort projects to generate a sense of belonging for the students in the discipline and minimize the barriers and power distance between students and academics. In addition, from a research and educational perspective, the program has been identified as a supplement to the civil learning material with civil research and extended non-civil learning material. By the end of semester 1, 2016, just three semesters after its initial pilot, the Icarus program had grown considerably. It had 144 students working on 39 different projects. These 144 students included most of the 60 initial students and about 84 new students. Although we did not keep track of students' participation and engagement, most students decided to stay in Icarus for more than one semester and continue with their projects. There were no limits regarding the amount of time a student could participate in the program. In addition, from having six mentors in the initial semester, Icarus had 24 academics serving as mentors for the students in the following areas: environmental, geotechnical, computational mechanics, hydraulics, fire safety, structures, transport, wind, construction management, entrepreneurship, and architecture. There were also several industry-sponsored projects where students had the chance to conduct research, interact with academics, and participate in real-world research solving problems for these companies. In Fig. 2, it is possible to perceive part of the growth of the Icarus program over its first three semesters.

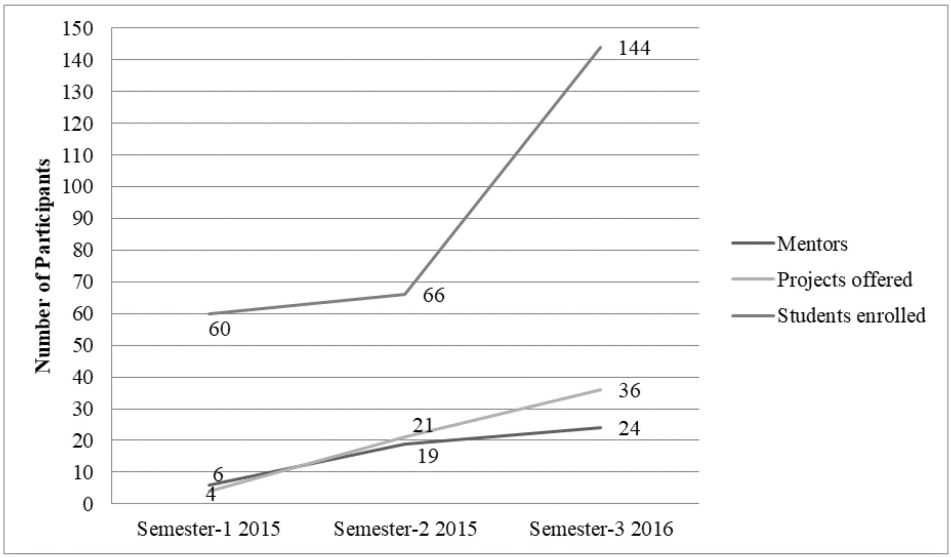

Fig. 2. Icarus program growth in 3 semesters.

To contextualize the scope and range of Icarus projects, we want to describe in this paper some of the projects and their impact in different areas of academia and industry. ''The Turbidity Challenge'' project is an excellent example from the research perspective. The project aimed to analyse and develop a low-cost turbidity monitoring network to address critical issues in coastal management.

The students were involved in the completion of the largest and most comprehensive survey of Moreton Bay sediments to date; 220 sites were sampled over a 1500 km2 area in a 3-month field campaign, with all students participating in both the fieldwork and laboratory analysis. Results from this project were included in the Health Waterways Ecosystem Health Report Card for 2015, which assesses the health of waterways across the entire South East Queensland region. Furthermore, the team was announced as finalist in the Healthy Waterways Awards 2016 People's Choice Awards. Students who participated in this project have continued their engagement for three consecutive semesters. Icarus students that participated in this project were included in all the field trips realized by the research team, and the research lab covered all of their travel costs.

Some other projects demonstrated an alignment of learning outcomes between the project and class perspective. ''The Station Simulation'' project was proposed to use virtual technologies to simulate a Bus Rapid Transit (BRT) and find operation scenarios that could reduce or remove peak hour congestion. The project allowed the students to use state-of-the-art simulation software tools to solve a complex local problem. In a small team, students created and analysed factory, bank, toll booth, airport, and train station models with 2D/3D model animations and learned basic Discrete-Event Simulation (DES) and Agent-Based Simulation (ABS) modelling skills. Students re-created the Cultural Centre Busway Station located in Brisbane, Australia as a virtual BRT station simulation model. The students presented their preliminary study results at the 2015 Australian Transport Research Forum (ATRF), under the title ''An agent-based simulation model to evaluate a real-time passenger information system in a Bus Rapid Transit station.'' The Station Simulation team won the runner-up for the David Willis Best Poster award.

From an international engagement perspective, the ''The TOMMbot'' project was a joint research investigation by the School of Civil Engineering at UQ and the Motion Structures Laboratory at Tianjin University in China. The project aimed to build structural ''transformers'' and determine suitable uses. In brief, it aimed to achieve this with a hybrid origami mechanism that functions as a large, transformable sheet. Students participating in this project were expected to develop creative, user-centered design and rapid prototyping skills to generate TOMMbot application ideas and build basic prototypes. Consequently, students employed ideation design methods to find applications of the morphing origami technology. They used this to develop a morphing shelter application that was entered into the Road Side Rest Area Design Competition. Their design entry was selected as a Runner-Up. Students successfully prototyped a full-scale morphing shelter and an experimental-scale deployable shelter. Furthermore, the students visited the Motion Structures Laboratory at Tianjin University in July 2015. They worked with Tianjin University graduate students on morphing and rigid origami structures.

Some Icarus projects have also been developed based on industry engagement. For example, one project is trying to improve the CityCat ferry service operations in Brisbane by creating a demand-based scheduling system that can increase the level of ferry transport serviceability. This project was developed in conjunction with the Brisbane City Council. Also, several projects have been developed with Brisbane airport to improve the understanding of the experience of both the general public and specific groups (particularly families and passengers with limited mobility and disabilities). In particular, the projects focus on supporting the continuous improvement of BAC's central security and passenger processing and the Disability Access Facilitation Plan (DAFP) to a 'world's best' standard of customer experience.

It is important to mention that students could participate in the program and the research projects for as long as they wanted; some students decided to stay one semester, and some decided to remain in Icarus permanently. Similarly, some projects were offered for a limited period (e.g., a semester), and others continued over several years. Although we needed to be more actively keeping track of attendance, Academics reported on how impressed they were by the student's commitment to the projects. There were never complaints of students abandoning their research responsibilities with the projects. While they were not active every week, they were present and fulfilled all the responsibilities they had with the projects.

In addition to the research projects, Icarus offered students and mentors several social activities throughout the semester. Despite having two academics supporting everything in the program, students decided to create a student management committee that is in charge of the organization, administration, and control of the program. Stu-

dents in the management committee developed a sense of autonomy and commitment to Icarus, with the goal of growing it sustainably over time with the support of the School of Civil Engineering.

The Chair of the student management committee became a full member of the Industry Advisory Board by petition of the external members of the Board. Furthermore, from a community-building perspective, it is important to highlight that most students enrolled in the program to try it for one semester, and the majority have decided not to leave; some of them expressed that they would continue engaging with Icarus projects until the time they graduate, because of the value they find in the program for their identity development as engineers.

Unfortunately, the Icarus program has been affected in the previous years, and its continuation has been challenging. In 2017, two academics responsible for the program transitioned into different roles outside UQ. Hence, the program was put on hold while decisions were made about its transition. In 2019, the program opened projects again for students and had great acceptance among Civil Engineering students. However, the COVID-19 Pandemic in 2020 impacted several projects, and they could not continue as expected. Currently, the program is offering only a few projects. Therefore, it is on hold while students are navigating all the different priorities and challenges of going through the pandemic and returning to in-person education.

4. Methods

To address the research questions, we used a case study approach to examine students' experiences after participating in the Icarus program. A case study approach allowed us to use different sources of data to explore these experiences in depth bounded to the participation in the program [44, 45]. A case study approach is also appropriate because we were interested in obtaining preliminary information about the program. Hence, we focused on the process (students' experiences) rather than the outcomes (e.g., learning gains). Furthermore, students' experiences are uniquely tied to voluntary participation in the program, supporting that the phenomenon under study cannot be separated from the bounded context [44]. Our case is the Icarus Program, described in the previous section, where we collected preliminary data quantitatively and qualitatively. Since our research aimed to understand students' initial reactions to the program rather than evaluate its impact, our data were from the program's first semester in 2016. We were not interested in claiming causalities but rather in getting a sense of the students' perceptions at that point. We also discuss this in more detail in our limitations section.

4.1 Quantitative Data

For research question one, we analysed students' application form to participate in Icarus. In addition, responses to the open-ended question "Why did you decide to participate in the Icarus Program?" were quantified to identify the reasons students had to participate. The study secured ethical clearance from the Human Research Ethics Office at UQ, approved under the number 2016001501.

The sample of Icarus students consisted of 49 engineering students enrolled in their second year, most from civil engineering, with some students participating in mechanical and chemical engineering. The sample represented 76.5% of the initial cohort of the Icarus program. All the participants were part of an Icarus project. In the sample, 52% were male, and 48% were female, 78% were domestic students, and 12% were international.

In addition to the preliminary data from the survey, we collected qualitative data by doing semi-structured interviews with students participating in the program.

4.2 Qualitative Data

To answer our second research question, which focused on understanding overall students' experiences with the program, qualitative methods that provide rich descriptions were appropriate [46, 47]. Therefore, we used thematic analysis methods [48, 49] to investigate students' experiences after participating for one semester in the Icarus program. Data were collected from semi-structured interviews with 12 undergraduate civil engineering students at the University of Queensland in Australia in 2016. Specifically, interviews were conducted with participating students at the end of the semester when they participated in the Icarus program for the first time.

4.3 Thematic Analysis

Thematic analysis is defined by Braun and Clarke [48] as a method of identifying, analysing, and reporting patterns within qualitative data. According to Robson and McCartan [50], thematic analysis is a generic qualitative method not linked to any particular theoretical perspective. Since we were interested in identifying, analysing, and reporting the patterns of the interview data, the use of thematic analysis was appropriate for this data. Robson and McCartan [50] suggest that thematic analysis can be used to better understand "experiences, meanings and the reality of participants" (p. 474). In addition, thematic analysis seeks to describe patterns across qualitative data to understand a phenomenon in question [49]. For example,

Table 1. Codebook

Theme	Sub-theme/Code	Definition
Academic Program	Icarus vs. Lecture	Comparison of how the Icarus program learning outcomes and settings compare to the learning outcomes and settings of lectures
	Teamwork	Perceptions of how the program developed the ability to collaborate with others that were not acquired in traditional learning settings
	Motivation to join the program	Students' reasons for joining the Icarus program as a complement of their formal civil engineering education
	Becoming an engineer	Students' perceptions on how participating in the Icarus program they were developing their identity as a practicing engineer
Mentorship Relationships	Changing perceptions of academics	Students' initial negative perceptions about academics changed after participating in the Icarus program
	Impact on lecture participation	Students' interest to attend and participate in Lecture after socializing with their professors in the Icarus projects
	Understanding of academia as a career path	Deep understanding of the meaning of taking the academic path as civil engineer which involves research, teaching, service, and student mentorship
Inclusion and diversity	Peer relationships	Students' relationship with other civil engineering students beyond course traditional interactions
	Cohort feeling	Participation an academic unit that identify itself as the Icarus Cohort that shares similar interests and motivations
	Sense of belonging	Increased feelings of identification and belonging to the University of Queensland, and the School of Civil Engineering after participating in the Icarus program
	Reinforcing being good enough for engineering	Students overcoming fears of not being good enough for an engineering career and feeling capable of doing engineering work

the phenomenon studied is students' experiences after participating in the Icarus Program.

4.4 Participants

The participants of this study were civil engineering undergraduate students that participated in the Icarus program voluntarily. Participants were 12 students, four were female, and eight were male. All the participants were in their second year of civil engineering. Participants were invited to participate voluntarily in the interview, and there was no compensation for participation. It is important to note that the Icarus program had 51% female enrolment and 43% international students enrolment, which is non-typical of the civil engineering population.

4.5 Data Collection and Analysis

Data were collected using semi-structured interviews. The interview protocol was informed by the theoretical frameworks of sense of belonging Allendoerfe et al. [8] and extracurricular support best practices [51]. The first version of the interview protocol was piloted with four graduate students. The interviews were conducted in a private location. A consent form was developed and read to the students before the interview started. After discussing the consent form, the students signed it, and the interviewer started audio recording the interview. Interviews lasted between 45 minutes to 55. There were no interviews that went further than 55 minutes.

Data were analysed using a thematic analysis approach. The analysis process was inductive, and the themes and codes emerged from the interaction of the researchers with the data [50]. A codebook was developed based on the comparison of the codes and the themes. Table 1 shows information about the first level of codes and the themes that emerged from the data. The themes represent the main topics that were designed when developing the interview protocol. During the analysis, there were more levels of sub-codes, and every time a new code or theme emerged. The authors returned to the transcripts already coded to ensure new codes and themes were included in the initial analysis. During this inductive process, several memos were taken into consideration when developing and establishing the relationships networks between themes and the connection between the data, the research question, and the theoretical considerations.

During the data collection, we took several notes and memos and returned to the original transcripts several times to revise the information. Following thematic analysis procedures [49, 50], we transcribed most of the recordings to increase familiarization with the data. Pseudonyms were used to ensure the anonymity of the participants, and some information, like names of courses, professors, and Icarus projects, were changed. Notes taken during the interview were included when analysing the data to facilitate the development of memos.

The MaxQDA software was used to code the interview line by line. Robson and McCartan [50] recommend the use of a qualitative data analysis

software to have a single organized data storage location, to have quick and easy access to the coding system, to make sure there is a consistent coding scheme, and to be able to analyse differences, similarities and relationships between the codes developed.

Codes were developed, and two researchers compared initial codes and agreed on the coding system. Once all parts of the data were coded, codes were grouped based on their similarities into themes. To maintain trustworthiness, two researchers independently coded all the interviews and grouped the codes into the themes developed. Using MaxQDA, it was possible to establish inter-rater reliability by having a visual representation of the codes.

Finally, data were integrated and interpreted [50] so that patterns were identified in the data to describe the phenomenon. The connection between themes can be seen in Fig. 4, where a visual representation of the story that emerged from the data analysis is presented. These emerging themes aligned with the constructs around sense of belonging explained in detail in the Theoretical background section. The results section includes detailed information about the interpretation of the findings.

4.6 Limitations

There are several limitations to our study. First, the interviews were conducted by one of the program's creators. The possible biases were recognized, and efforts, such as team discussions with the research team, were made to reduce the potential impact.

Second, our data reports back to 2016 and focuses on students that were very active in the program missing the voices of the students that were less engaged or dropped out of the program since we were not actively keeping track of them. Several challenges had impacted the Icarus program since then, including the leaders of the program leaving UQ, the program having to close its operations for two years, and then again having to stop when it reopened in 2019 due to the COVID-19 pandemic. Although our intention with this paper is to present the initial students' experiences, these experiences might not represent all the student population that has participated in the program, so we suggest caution when making inferences about our results.

Finally, our work focused on the lenses of belongingness constructs. We recognize the limitation of understanding other potential impacts of an extracurricular program like Icarus.

5. Results

5.1 Quantitative Results

The first research question aimed to understand students' motivation to join and invest their time in a voluntary research project. Table 2 summarizes the responses from the 49 students. Then, in the discussion section, we elaborate more on these results.

It is important to mention that these results challenged our original intention of alignment

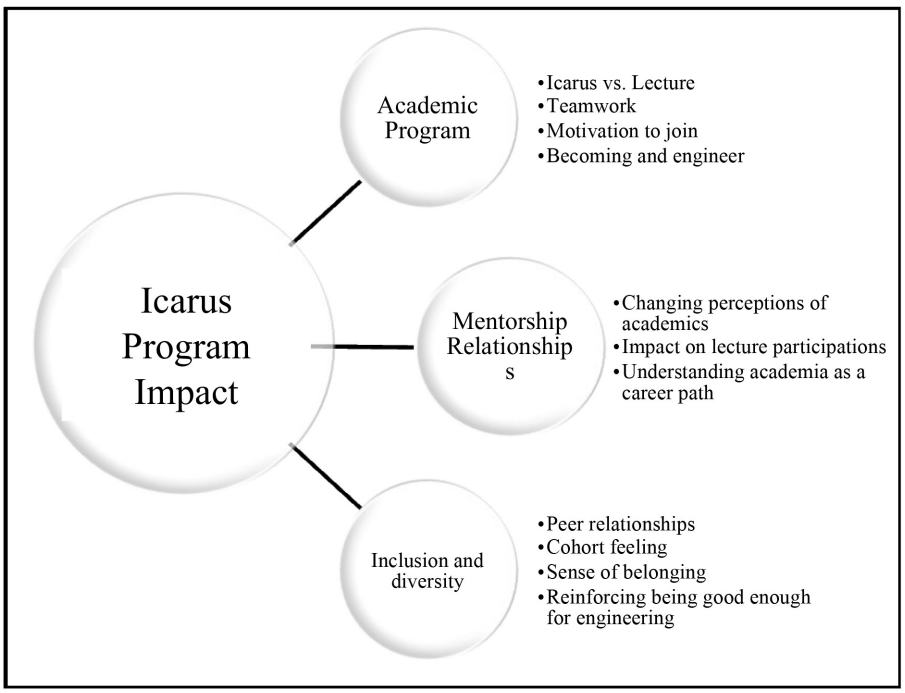

Fig. 3. Themes network.

Table 2. Students' motivation to join the Icarus program

Why would you like to join the Icarus program?	%
Apply theory from class into engineering real world issues	27.88%
Work and engage with peers	15.93%
Expand interest on specific technical topic	14.60%
Better understand the engineering profession	8.41%
Get to know academic mentors	6.64%
Develop teamwork and interpersonal skills	6.19%
Enhance engineering skills	4.87%
Have hands-on experience	3.10%
Engage in a research / Understand research practices	2.65%
Develop problem-solving skills	2.21%
Participate in extracurricular activities	2.21%
Knowledge beyond the grades	1.77%
Engage in innovative engineering research	1.33%
Enhance resume	1.33%
Have fun	0.88%

with core courses. We thought this would be an element of value that would encourage the students to participate, but it did not register in the survey.

Other things seemed to matter more to them. However, many academic mentors still saw value in connecting the projects offered to the relevant topics students are learning in their classes, which also matches the first option of the students of applying what they are learning in the classroom in a real situation.

5.2 Qualitative Results

Investigating students' perceptions of their overall experience in the Icarus program helped us understand the program's relevance regarding engagement and sense of belonging. The following sections describe the main themes identified in our results.

5.2.1 Academic Program

Students revealed several aspects of the Icarus program that complemented what they learned in lectures. Initially, students reported that through the Icarus program, they were able to complement the knowledge that they received in lectures. In addition, students perceived Icarus as a motivator to go to the university, which directly implies higher attendance to Lectures. Two students commented:

> "I learned why we learn in the lecture. I mean, I learned why things are being taught to students. If I wouldn't do Icarus I would be in the lecture or listening to the lecture and thinking yes this is going to be in the final exam. Yes, alright I will just study for the final exam. Since I was in Icarus with Mentor 1, I knew why actually people actually build the roundabout and why people would have the roundabout." [I#4Female]

> "I actually had a connection with the reality and the lecturer, and it was my – it was a good thing actually – motivating, making that kind of connection – they would actually try to always make us learn, but the Icarus program actually triggered more so that I can connect with reality and I actually knew why they teach this, and I wanted to learn more out of this." [I#12International]

In addition, students commented on how being in Icarus changed their perceptions about teamwork. Initially, they had the perception that teamwork was something they needed to do because it was a program requirement, but they didn't see the benefit of doing it. However, after seeing how working in teams with others to be able to achieve the Icarus projects, they realized the importance of understanding how to collaborate with others. Additionally, they changed their negative perception about teamwork, as an international student explained: "I generally when I'm particularly working on an assignment, I like to work by myself because then I can concentrate but, having a voice input was a new rewarding experience." [I#1]. Furthermore, the international students recognized that Icarus represented a new opportunity to demonstrate to other students that their perception was important to find alternative ways to solve problems. For example, student # 11 (International) explained: "I think part of the reason the station simulation group did very well was because our demographic was a little bit different than the typical, I mean we had 2 international students and we were encouraged to provide our perceptions."

In addition, students felt that by joining Icarus, they had a competitive advantage in comparison to other students. One student explained: "So that's actually why I joined Icarus, hoping that I'd have an advantage compared to other students who didn't. So that I can potentially get into the field that I want which is really difficult specially if you are a woman." [I#6Female]

Finally, students recognized Icarus as being an important part of them to become an engineer, a feeling that they haven't felt so far in their traditional lectures. As Interviewer #5 explained:

> "I was actually the person who wants to get that degree – that's it, but as I moved on to this kind of atmosphere, they actually gave me the feelings that I should be here with a reason, and because I was in Icarus I found that reason, too. I actually – I am here to learn things and to be a civil engineer – I knew what kind of attitude and perspective I needed to have. I actually learned that kind of thing from students and mentor. So yeah, it's a lot."

5.2.2 Mentorship Relationships

One of the aspects of the Icarus program that has had a positive impact on the students is the improvement of the relationships between students

and academics. Consequently, students felt that their academic experience improved by having better relationships with the academics at the School of Civil Engineering. Students explained that they initially had negative perceptions about their professors. However, the perceptions changed after participating in the program. Also, knowing their professors made students feel more engaged in lectures and encouraged to participate. Interviewer #8 (Female) explained: ''. . . so I asked some questions to Mentor 1, which was quite unusual for me, because I'm not that kind of enthusiastic student, but yeah I wasn't at all, Icarus made me realize that I actually can ask questions.''

In addition, a significant aspect of the program was to let the students understand what civil engineering is about, and the understanding that becoming a practicing engineer is not the only option. Some students recognized that they now understand the academic path better and are considering a path in research that was not something they would have considered otherwise. Two students commented:

> ''I know what engineering really is. I think it shows me what engineers in the workplace do but not only in the field but also in the research path. Working in projects like this or even just the lecturers, just seeing what they do every day is great. If I did it – if I wasn't sure about engineering and I got to know and it's not my thing, then I'd quit it. It's just good knowing what you're studying for, and all the possible options you have in the future kind of thing. That's what I got from Icarus. So pretty much what the profession do and that I can be one of them someday.'' [I#9]

> ''No. I mean, maybe I was too scared actually, because the other day I asked mentor 1 about what he was like in the industry, and why did you choose to do teaching – professor? He told me about some things, and then he was a totally different person, actually. He still wanted to give me some strategy and the way to go there, and be in the industry field and he told me about that, and he was more like not a mentor but just a brother. He was a really more than a mentor.'' [I#6Female]

5.2.3 Perceptions of Inclusion

One of the most important and unexpected findings of the data collected was the impact of the Icarus program on inclusion and diversity. Marginalized students reported how the program made them feel, and how they use the program to have a voice in the School of Civil Engineering. It also encouraged them to be successful in their engineering career. In addition, students explained how they were able, for the first time to develop relationships with other students:

> ''Because now, I've gotten to know people from engineering from outside my circle because I'm often with groups, with projects groups, often they have. . . well I think we are on to form long-lasting friendships with them and also it could be because before Icarus I didn't have that kind of bonding experience.'' [I#10Female]

> ''. . . we also sometimes ask for each other's help, not only on Icarus space work but also on other stuff outside of Icarus. Sometimes that happens – we meet up pretty much at this time on this day at the Icarus room, and lets us do this [coursework] together.'' [I#12International]

In addition, students explained that by being part of the Icarus program, they developed a ''Cohort feeling,'' usually in civil engineering, there are so many students in the lectures that students are not able to bond and have that. However, students felt that Icarus provided a cohort for them, they consider themselves as part of the Icarus family. As International student #11 commented: ''After the exam we had a party and all the Icarus students went to the city and grabbed a beer. Yeah, it was good fun. I mean, yeah I think those people in the group are going to be really good friends until I graduate, I think they actually are the first real friends I have had since I arrived to Australia''.

Furthermore, the explained that the Icarus cohort shared the same motivations and interests as engineers

> ''I keep saying self-motivations. Yes, and as I said, if I were in the first year of engineering, I actually was sitting in the lecture room for getting the degree – for getting credit, but as I do Icarus, with Mentor 1 and everyone in the Icarus project, I actually felt that all these people at least - these people knew what they want to do, and these people aren't here to just to learn something in the university, they –like me- are here to change the world, to have a voice, to care about what a good engineer needs to be.'' [I#10Female]

> ''Like as I was saying, everyone was closed in the first few weeks so I didn't know anyone. Now, I know them really well as people. Most importantly I feel confident that I can talk to other people and I can make friends that are different than me.'' [I#9]

Finally, the Icarus program helped students to reinforce that they are good enough to do engineering. Several of them expressed how before Icarus they didn't feel they belong; they were demotivated to come to campus and unsure about engineering being the right choice. However, the Icarus program provided that missing piece in their academic program that reinforced them to continue with their studies. As some students commented:

> ''At some point I did not really feel like doing university, I didn't – it stepped up the amount of effort required, and I'd gone through all of school courses. Sort of just sat without having to try very - fairly well in grades and stuff. Then Icarus happened and my motivation came back.'' [I#6Female]

> ''I feel like I wasn't ready enough as an engineer, I guess that was my perception. However, the students that are gaining the most [from Icarus] aren't necessa-

> rily the students who will go and meet the lecturers on their own. The benefit is for students like me, we are scared, we don't feel we belong, I to be honest hated coming to Uni." [I#7International]

The reinforcement helped especially female engineering students who had perceived barriers to be a successful engineer in a male-dominated field. Female student #4 explained:

> "It also [The Icarus program] made me more confident . . . Because I just – I can talk to people a bit more clearly now, openly – not as before. Okay, I used to think that as an international woman in engineering, my voice didn't matter; I was scared of talking to my lecturer, now I feel he is my mentor [laughs]. But – yeah it'll help me be confident as well because I have been able to probe in the lab that my knowledge as good as anyone else's."

Another female student (#10) also commented:

> "Umm, one of the interesting things I got out of it, was sort of confirmed like what I had experienced in engineering is not true. Like many women in these occupations find that there's a significant barrier of them being a woman in a man's world. But I haven't found that. That's probably because my participation in Icarus. Like I don't think, oh I'm a female so I can't do it. That will never affect me anymore because, guess what? I did it."

6. Discussion

Results from the data collected helped us to better understand students' initial perceptions of their experiences with Icarus. When students were asked about why they wanted to join an extracurricular program that offered them the option to use their spare time to participate in a voluntary research project, students expressed that they were motivated to participate because they wanted to apply the theoretical knowledge obtained in the classroom into real engineering situations. This aligns with the perceived need for students to belong to their engineering program [42]. Furthermore, having an opportunity to do engineering technical research, can make a significant impact on how students view themselves, and their perceptions of being able to succeed in professional practice. The second most cited reason students provided was the need to have a cohort-like experience and get to know their peers, something more difficult to achieve in their large engineering lectures. The need to interact with other engineering students to develop professional relationships can also be related to the theory of self-belonging proposed by Allendoerfe et al. [8] and Wilson et al. [1], explained previously. Peer belonging has been identified as having a positive impact on career decision-making (including considering graduate education), and persistence in engineering [52].

Another reason the students provided for their interest in participating in Icarus was the opportunity to explore and work on a research project on a chosen topic. Students wanted to understand a specific engineering topic better, and the opportunity to conduct research on it motivated them to spend some time engaged in the voluntary program. Faber et al. [53] highlight the importance of providing students with research opportunities that expose students to discovery, dissemination, societal impact, and self-regulation which overall has a positive impact on students' development. Previous research [54–56] has focused on the role of mentors in developing engineering students' skills and knowledge to conduct research but in those contexts, the student is always formally hired to conduct research either as an assistantship or as part of research credits, our study explores a space that had not been studied that is voluntary research where mentors also work voluntarily.

Overall, the Icarus program has shown to be very successful in the school of civil engineering. Students participating in the program were very engaged with the program, the research they conducted, and their interactions with the academics in the School. Icarus has been shown to be part of the solution to the problem of the structure of higher education systems, especially in engineering, where students enrol in large classes and have minimal interaction with their peers and their instructors. Students participating in Icarus have reported that they not only know and engage better with their academics but also engage more in their classes because they have been able to get to know some of the school's academics outside the classrooms. It has been demonstrated the importance of student-teacher interactions as a significant predictor of engagement, reading performance, and retention [57]. Furthermore, a nurturing academic environment where academics provide a supportive and caring relationship promotes student success [58]. In engineering, specifically, Vogt [59] reported the importance of academics-students relationships as it has a positive effect on self-efficacy, academic confidence, self-regulated learning, and GPA. These relationships can provide the required engagement that overall impacts effort, persistence, and the development of critical thinking, some of the most desired outcomes in engineering programs. We consider the Icarus program promotes these academic-students relationships in an efficient and practical way and students reported on this. Furthermore, our previous research [60] also confirmed that academics participating had the same perceptions. The Icarus projects were developed by academic mentors who spent time mentoring the students, letting them have hands-on research

experience and the opportunity to make mistakes and learn from the experience. Results describe how students could compare their traditional education and the added value that the Icarus program provided them, which directly impacted how they learned and their motivation to engage in their courses and with their professors.

Finally, results explained the Icarus program's positive impact on improving inclusion and diversity in the School of Civil Engineering. Students felt they belonged to the program and the university for the first time and felt encouraged to have a voice, to speak up, and to demonstrate that their work is valuable and important for the field. Although this was not the intention of the program when created, we consider this to be one of the most important outcomes as we consider it really important for universities to provide spaces where all students can feel included. The program's goal of building community really had an impact on those students who felt their voices were usually not heard.

The goal of this paper was to present the initial perceptions of the students participating in the Icarus program and describe the program in detail. Results suggest that understanding the importance of this type of program to students and why it enables academic engagement for both students and mentors, can allow educators to encourage and support participation in these types of programs from inside the classroom. It is important to institutionalize Icarus as a successful program in the School of Civil Engineering as it is helping with students' sense of belonging in terms of relationships with academics and peers, better institutional perceptions, and perceptions of inclusion. In addition, the program gave students in the School an option to participate in an extracurricular activity and learn more about an engineering topic they care about.

The findings provide implications for practice regarding how to design better extracurricular programs with a lens in mind (i.e., sense of belonging) that allow hands-on application, promotes more collaboration, and enables students to develop positive relationships with Academics. The Icarus program is voluntary and does not reward students with credit or any other type of compensation. However, it has had a remarkable positive impact on the School of Civil Engineering. Academics have also seen the benefit of investing their time in mentoring students. They realized that not only students are more engaged in their courses, but they were also able to execute several minor research projects they didn't have the time to conduct.

7. Conclusions

The exploratory study presented preliminary results about the implementation of Icarus with the overarching goal of understanding how the program promoted sense of belonging based on students' initial experiences participating in it. We collected and analysed different sources of data to be able to answer our research questions. In terms of why students joined the program, we could identify 15 reasons provided by the students. The most salient reasons discussed were highly related to sense of belonging but also, in our opinion, to complement some of the things students might be missing from their formal learning environments. For example, students expressed that they wanted to be able to apply what they learned in their courses to real research projects. Having the opportunity to participate in real research was a really good complement to their theoretical courses.

Similarly, students mentioned expanding interest in specific technical topics. The other aspect students mentioned as important when joining the program was finding opportunities to engage with peers. Our results suggest that the university needs to provide students with more opportunities to develop peer interactions which are important for sense of belonging and professional development.

Our second research question related to how students described their experiences with the Icarus program. The experience was overall perceived as positive and as an excellent way for students to complement what they were learning in their classes; having a program that engages students in real research also resulted in becoming a significant factor for student engagement, and the program proved to be effective in helping students develop their technical and professional skills and their engineering identity. Other aspects very salient in our study were students recognizing the importance of the program to create mentorship relationships (both with academics and peer-to-peer mentorship) and the program's impact on students feeling included at their institution. Although we did not intentionally develop the program expecting these outcomes, we consider the impact of Icarus to be very positive for engineering students, mentors, and academics and a great initiative to promote sense of belonging.

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