A Framework for Analysing and Improving Graduate Attributes and Employability in the Blue Economy

R. Cossu, L. Adams, D. Pountney and M. Fleming

Abstract—**The Blue Economy plays an instrumental role in the growing offshore industry. The new and emerging sectors of Australia's Blue Economy require an integrated understanding of technical, environmental and social aspects to support academic and industry career development which needs to be developed further at Australian universities. One of the key goals is therefore to educate a new generation of the Blue Economy workforce with detailed cross-disciplinary knowledge in future Blue Economy industries such as sustainable aquaculture industry, offshore wind and wave energy industry, green hydrogen industry and remote and autonomous technology. This work offers a first look on the potential impact of large industry – university partnerships (exemplified by the Blue Economy CRC on various disciplines and curricula.**

The objective of this project is to analyse and qualify the currently implemented graduate attributes at universities and determine how to improve employability skills. This work will explore the challenges, strategies and considerations to improve educational and engagement programs for university students, researchers and practising workforce. In particular, we want to discuss pathways for collaboration between universities, industry and other partners to build a network that supports the ambitious objective of increasing employability skills for Blue Economy graduates *Keywords*—**Graduate attributes, Employability, University-Industry Partnerships.**

I. Introduction

The Blue Economy (BE) has been defined as "the sustainable industrialisation of the oceans to the benefit of all" [1]. Such a definition makes explicit the links between the marine environment, ecosystems and social aspects. It also subsumes issues related to marine pollution, biodiversity, human and ocean health, as well as balancing demands for energy and food provision. However, it does not explicitly reference the legislative and regulatory issues yet to be resolved in this space. The problems confronting the BE can be characterised as involving system complexity, potential disagreements in how best to use and manage resources (goal conflict) and scarce or uncertain information. These are hallmarks of the *wicked problems* (such as global food security and renewable marine energy) [2] that BE industries seek to address.

In the Australian context, the Blue Economy Cooperative Research Centre (BE CRC) was created to provide solutions to exactly these types of problems. There is also a focus on the economic, health and social benefits that are and could be realised through sustainable development associated with these emerging ocean industries [3]. These industries are likely to be in the area of marine renewable energy (e.g. offshore wave, wind, hydrogen and potentially tidal energy) and offshore aquaculture (finfish such as salmon and tuna, or molluscs like abalone or bivalves such as oysters, mussels and scallops, etc, and currently there is a growing sector of native seaweeds) [4]. The information needs, as well as the political and regulatory environment needed to manage sustainable transitions within this space is also a consideration for the BE CRC

To develop effective solutions to these problems, interdisciplinary collaborations are required. It is these

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concerns that prompted the creation of the Blue Economy Cooperative Research Centre (BE CRC) in 2019. The Blue Economy (BE) brings together the renewable energy, aquaculture sectors and marine engineering sectors. It also includes marine tourism, spatial data analysis, legislative and regulatory frameworks.

The remit of the BE CRC is to develop solutions to the 'wicked problems' of climate change and global food security. It does this through connecting engineers and scientists with interests in renewable energy production and offshore aquaculture. This partnership between government, researchers, and industry is expected to make valuable contributions to innovation, economic activity and future employment growth.

As the BE CRC reaches its five-year milestone, it is timely to explore its potential impact in terms of educational outcomes, the development of graduate attributes and employability. Figure 1 displays the different sectors that have already or are going to shape graduate attributes for the Blue Economy. There have been calls for greater attention to be paid to the training provided to those entering these new industries and workplaces [5][6]. An additional imperative is to elucidate career pathways in these new industries.

The OECD [6] forecasts global value added in ocean economies (largely areas affiliated with the Blue Economy) to grow 30% by 2030, compared to 19% for the global economy more broadly. Employment opportunities are also expected to grow substantially in all ocean economy industries. This suggests the importance of these industries to not only future economic prosperity and food security, but also of the workforce itself in shaping these industries.

There is therefore a need to review the skillsets, and the training opportunities provided to those entering new BE industries [6]. Previous changes to the economy have also required changes to learning methods and activities, curriculum, and teaching.

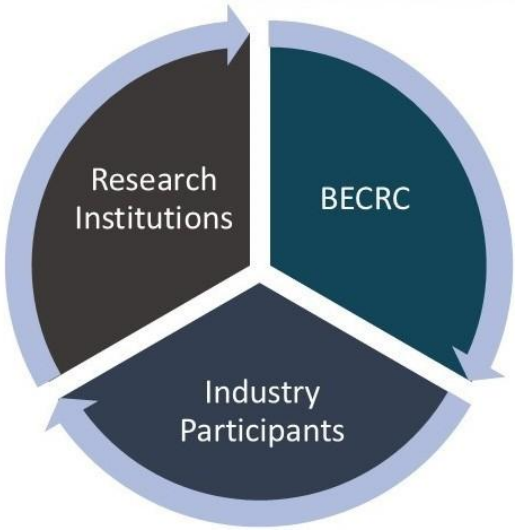

Fig. 1 Structure of the BE CRC and organizations that take part in the education of RHD students

II. Literature Review

A. Previous works

The focus on the impact of large industry- university partnership is not new but to our knowledge has not been done over a larger time frame and across a variety of disciplines.

Manathunga et al. (2009) investigated the relationship between the development of graduate attributes and employment outcomes for PhD graduates. The study focuses on how the skills and attributes acquired during PhD programs—such as critical thinking, problem-solving, and communication—impact career trajectories and employment success. The study highlights that - while PhD graduates often excel in academic and research environments - students may face challenges in translating these skills to non-academic career paths. Through tracking the career progress of PhD alumni, the study identifies a gap between the expectations of employers and the skills PhD graduates possess. Furthermore, the article emphasis the need for PhD programs to integrate professional development components that better prepare graduates for diverse employment opportunities. One potential solution is to align graduate attributes with industry needs and provide career support so that PhD programs can enhance the employment prospects of their graduates and better equip them for varied career paths beyond academia.

A comprehensive review of the attributes expected of doctoral graduates across various disciplines was presented by Senekal et al. (2022). The study systematically examines the definitions and domains of graduate attributes as identified in existing literature and institutional frameworks. These attributes are categorized into several key domains, including research skills, professional skills, and personal qualities. The review reveals that while there is a broad consensus on core research competencies, such as advanced problem-solving and critical thinking, there is considerable variability in the definitions and emphasis placed on professional and personal skills. The findings underscore the need for a more standardized approach to defining and assessing doctoral graduate attributes to better align educational outcomes with the evolving demands of the workforce. By synthesizing current knowledge and highlighting gaps in the literature, this comprehensive review provides valuable insights for institutions seeking to refine their doctoral programs and enhance the employability and overall effectiveness of their graduates.

Another seminal study by Spronken-Smith et al. (2023) examines the perceptions of PhD graduates from humanities, social sciences (HASS), and science disciplines at universities in the United States and New Zealand regarding the development of graduate attributes during their doctoral studies and the application of these attributes in their careers. The research analyzed survey responses from 136 graduates and conducted interviews with 21 participants, revealing that PhD graduates generally felt well-prepared as researchers, but they also expressed concerns about the development of transferable skills such as teamwork, communication, and project management. Graduates across the universities had similar perceptions regarding the application of these attributes in the workplace, highlighting the need for doctoral programs to better support the development of these skills.

The above-mentioned works point to a limited literature on the development and application of doctoral graduate attributes and call for further investigations to provide a more nuanced understanding of the topic. However, the findings have commonalities and suggest that there is a need for greater emphasis on developing a broader range of skills that are applicable in the workplace. The challenge is to assess how well doctoral programs are equipping graduates with the skills needed to succeed in a rapidly evolving knowledge economy. The synthesis is that universities and organizations such as CRCs should take a more proactive role in ensuring that their graduates are truly "employment-ready" and capable of becoming leaders in their fields.

The large presence of industry partners in the BE CRC offers distinct advantages in terms of industry exposure and the development of certain professional skills for PhD students. However, it is essential to investigate and map what the graduate attributes and skills for this emerging Blue Economy industry are and how they align with current education programs at universities (both for undergraduates and graduates).

III. METHODS

Figure 2. Illustrates a structured, multi-year progression of surveys planned within the BE CRC but also outside of it through various activities, with a focus on collaboration between BE CRC universities, industry partners but also external organizations

Successfully conducting surveys across a range of Australian universities necessitates careful planning and a deep understanding of the unique challenges posed by the diversity of institutions and student groups. Addressing these challenges requires a flexible and adaptive approach to survey design, distribution, and data analysis.

While PhD students tend to focus on their individual employability prospects and future career paths, industry discussions are centered on the practical and immediate needs of the labor market, emphasizing the skills and experiences that make graduates job and industry ready. Discussions with industry are more likely to be in the form of structured interviews or focus groups, allowing for a

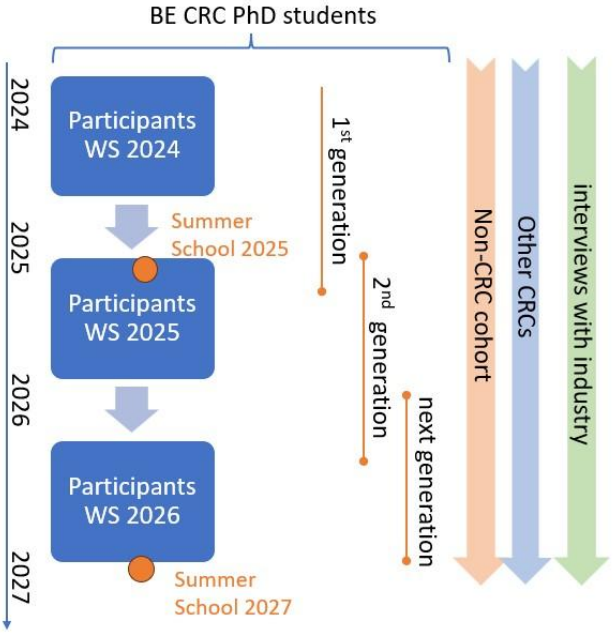

Fig 2 Timeline of the project : Analysing Graduate Attributes and Employability of BECRC RHD students

targeted exploration of specific skill requirements for individual industry sectors, market trends, and hiring challenges.

For interviewing and surveying students about their graduate attributes, the project will draw on several models and methods informed by studies like Senekal et al. (2022) and Spronken-Smith et al. (2023), which – among other methods - include:

1) Survey Design and Questionnaires

a. Structured Surveys: Use structured questionnaires with a mix of closed and open-ended questions. This approach allows for quantitative analysis while also capturing qualitative insights.

b. Likert Scales: Employ Likert scales to gauge students' perceptions of their graduate attributes. This method helps quantify attitudes and opinions on a scale (e.g., strongly agree to strongly disagree).

c. Validated Instruments: Use or adapt validated instruments where possible. For example, the Graduate Skills Assessment Scale (GSAS) or similar tools that measure specific attributes like critical thinking, communication skills, and problem-solving abilities.

2) Interview Methods

a. Semi-Structured Interviews: Conduct semi-structured interviews to allow flexibility in responses while covering core topics. This method provides depth and context to students' views on their graduate attributes.

b. Focus Groups: Organize focus groups to facilitate discussions among students. This method can reveal shared experiences and collective perceptions about graduate attributes.

c. Narrative Interviews: Use narrative interviews to capture detailed personal stories and experiences related to the development of graduate attributes. This method provides rich, qualitative data.

3) Data Analysis

a. Thematic Analysis: For qualitative data from interviews or open-ended survey questions, employ thematic analysis to identify and interpret patterns and themes related to graduate attributes.

b. Quantitative Analysis: Analyze survey data using statistical methods to identify trends, correlations, and differences in perceptions across different student demographics.

c. Mixed Methods: This is an approach to integrate qualitative and quantitative data, providing a comprehensive understanding of students' graduate attributes.

4) Ethical Considerations

Before collecting any data, it is essential to fully inform participants about the study's purpose and how their data will be used, ensuring that informed consent is obtained. Additionally, the confidentiality and anonymity of participants must be safeguarded when reporting results. Finally, it is important to offer participants feedback on the study's findings, highlighting how their contributions will help improve educational practices.

B. Case Studies and Best Practices

This requires a review of the approaches taken by Senekal et al. (2022) and Spronken-Smith et al. (2023) in their surveys, the structure and methodology used, question design, and data analysis techniques to inform our own targeted approach. An example of how this can be used is shown in Figure 3 where a (relatively) simplistic survey among BE CRC students (Cossu et al., 2023) was used to compare more targeted and in-depth survey by Spronken-Smith et al. (2023). This comparison revealed remarkable differences by comparing the BE CRC Engineering students to the non-Engineering and also non-CRC cohort: activities like Teaching development (4 to 2.9), Working in teams (4.36 to 3.2) and especially Research skill development (4.45 to 2.45) are significantly better rated for CRC Engineering students. In addition, Networking, Leadership development and Project

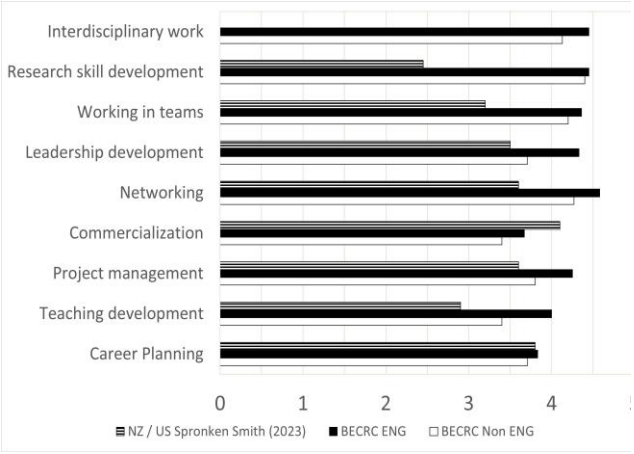

Fig 3 Comparison of Graduate Attributes between Engineering, non-Engineering CRC students and non-CRC students (taken from Cossu et al. (2023). The horizontal axis represents the Likert Scale (from 1 (strongly disagree) to 5 (strongly agree).

management received also much better feedback (>0.5). In contrast, the professional development activity Entrepreneurship & Commercialization has a much better rating from the NZ/US non-CRC cohort. However, the meaningfulness of this study must be considered in the context of comparing a small cohort with a large sample size and by comparing those different methods applied (e.g, Cossu et al. (2023) used only a survey which was not followed up by interviews). The pros and cons of survey methods are discussed above, but it is also imperative to build a broad network that supports longitudinal studies to investigate graduate attributes with consistent sampling and surveying.

C. Networking

Over the life of the BE CRC Project "Analysing Graduate Attributes and Employability of BE CRC RHD students" we aim to measure graduate attributes in students by using a combination of surveys, interviews, self-assessments, and performance evaluations. These tools will help to assess skills such as critical thinking, communication, teamwork, and adaptability (and many more). Surveys will be designed to capture students' self-reported competencies, while interviews and performance evaluations provide deeper insights from both students and educators. By triangulating data from multiple sources, we aim to identify any differences in perceived attribute attainment from PhD graduates within the BE CRC and non-CRC programs. This will likely involve several universities within the BE CRC (University of Tasmania, University of Queensland, University of Western Australia, Griffith University, Auckland University of Technology and MacQuarrie University) but

also other universities that are eager to join this initiative at a later stage.

The project was intentionally designed as a longitudinal approach to offer significant advantages over one-time surveys by tracking the development of graduate attributes over time and with a core cohort of the same students. Long-term studies provide insights into how attributes evolve during a student's academic journey and beyond, offering a clearer picture of the impact of educational interventions. Longitudinal data can highlight trends and long-term outcomes, such as career success or adaptability in the workforce, which one-time surveys might miss. Additionally, including several of the above-mentioned universities in a study makes the findings more representative, as it accounts for the diversity of student populations, educational approaches, and institutional environments. This broad scope enhances the generalizability of the results, allowing for more robust conclusions about the development of graduate attributes across different contexts. For the next months it is envisioned to crystallise a network structure and/or strategy both for universities and industry (Figure 4).

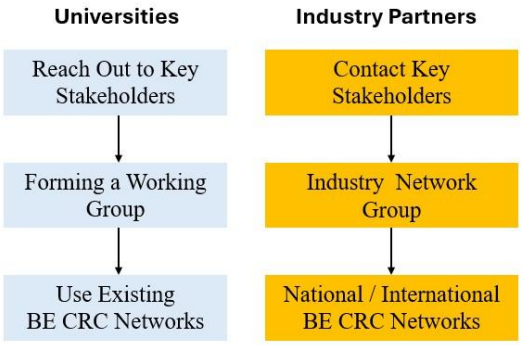

Fig 4 Proposed Network structure between the two streams of Universities (educator, skill developer) and Industry partner (require of skill set)

For surveying graduates, the first step requires to identify and connect with key stakeholders at each university, such as faculty members, department heads, or student affairs offices; starting with existing contacts and leveraging academic networks like conferences or professional associations. Secondly, Working Group can be found to establish a cross-university working group comprising representatives from each participating institution. This group will coordinate the survey process, share responsibilities to ensure consistency. Thirdly, we aim to leverage off an existing inter-university networks and connect with graduate schools, but also undergraduates.

Networking with industry partners for a longitudinal survey on graduate attributes and employability within the Blue Economy CRC framework is a strategic approach that will yield significant benefits. The first milestone would be to identify and contact key stakeholders within over 40 BE CRC industry partners. Establishing a dedicated network group is crucial in this phase, fostering communication and collaboration between educators (graduate Attributes Designer) and industry. This group would be responsible for aligning the survey's objectives with both educational outcomes and industry needs, ensuring the relevance and applicability of the findings.

As the network group becomes established, the next milestone should involve expanding the collaboration to national and international industries, leveraging the CRC's existing connections and seeking new partnerships. This expansion would increase the survey's scope and representativeness, providing a more comprehensive view of how graduate attributes influence employability across different disciplines. Engaging with a broader range of industries would also enhance the survey's impact, offering valuable insights that can inform both academic programs and workforce development strategies on a global scale.

IV. Conclusion

Understanding both graduate and industry perspectives is crucial for universities to successfully align academic training with industry needs. An industry trends overview provides a snapshot of the current and emerging patterns, changes, and developments within the Blue Economy sector.

Apart from innovations and new technologies shaping the industry, the increasing focus on sustainable / environmental practices, corporate social responsibility, and ethical consideration, laws, regulations, and compliance requirements affecting the industry, it is the changes in workforce requirements, skills in demand, and employment patterns, that is the key focus of this initiative.

In a burgeoning industry like harnessing seafood and energy offshore, graduate attributes are likely to evolve significantly to meet the sector's unique current and future demands. This project will therefore document how this change is perceived and provide data and reports to support an analysis of what actions and methods both universities and industries can employ to guarantee the best alignment between skill sets (Graduate attributes and industry needs). In doing so, the study offers a framework for evaluating and improving graduate training across a range of Blue Economy disciplines. While the research is ongoing, early findings point to opportunities for wider curriculum enhancement and coordinated workforce development strategies across Australian institutions. By fostering stronger university–industry linkages, this work

may contribute to shaping a more agile, skilled, and employment-ready ocean economy workforce.

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