

# **Fostering Competitive PhD Talent Through Interdisciplinary Graduate Education: A Case Study From a Japanese National University**

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## **Abstract**

In Japan, doctoral enrollment has been declining due to financial pressures and uncertain career paths. Limited demand from primary employers, including universities and industry, contributes significantly to the mismatch between PhD graduates and available opportunities. Beyond expertise, doctoral graduates require the ability to identify and address societal challenges, integrate knowledge across disciplines, and act proactively to succeed across diverse career paths. This paper elaborates on a university-wide interdisciplinary graduate program implemented at a Japanese national university, targeting graduate students through diverse offerings and events aimed at fostering competitive PhD talent by bridging academia and society. Our case study showcases the background and design of this well-rounded education, reviews implementation outcomes over the past decade, and evaluates its impact on cultivating interdisciplinary talent within Japan's higher education context. This program offers a variety of components designed to address social challenges and explore diverse career pathways across academia, industry, and government. Key initiatives include original interdisciplinary courses, project-based learning opportunities, group and individual practical activities, career development seminars, sustained career workshops, and interdisciplinary innovation retreats. These efforts not only enhance the employability of doctoral graduates and foster competitive PhD talent capable of adapting to the rapidly evolving demands of society and industry, but also strengthen connections among academia, industry, community, and government, thereby fostering a dynamic ecosystem in which knowledge creation, social innovation, and practical solutions can flourish. By combining diverse perspectives and resources, we aim to foster competitive talent and generate broader societal impact, while offering actionable insights for other HEIs.

*Keywords:* competitive PhD talent, interdisciplinary graduate education, integration of knowledge with society, career paths, Japanese university

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## Introduction

The concept of a competitive PhD requires careful definition and reconsideration in light of changing academic and professional landscapes. Equally important is the question of how doctoral education can effectively foster graduates who are able to thrive in diverse and dynamic career environments. This paper addresses these issues by examining the definition of a competitive PhD and exploring strategies for cultivating such doctoral graduates.

In many countries, the number of PhD graduates now exceeds the number of available academic positions, rendering access to professorships increasingly competitive (OECD, 2024). As a result, universities are under growing pressure to reconsider the purpose and structure of doctoral education and to ensure that graduates are equipped with knowledge and skills applicable to a broad range of career pathways beyond academia (OECD, 2021). The reform of doctoral education has therefore become a central topic in higher education research (Nerad, 2020). Scholars have highlighted the diversification of doctoral candidates' motivations, which range from intellectual curiosity and personal development to more pragmatic, career-oriented goals (Gardner, 2008; Guerin et al., 2015; Horta et al., 2024; Skakni, 2018). These changing motivations further underscore the need to align doctoral training with evolving professional landscapes.

In the Japanese context, doctoral education has been characterized by a strong research-oriented culture that often overshadows teaching and learning components within PhD programs (Kimura & Yoneda, 2011). Moreover, the narrow specialization of doctoral research may reduce graduates' attractiveness to industry employers, raising concerns about employability outside academia. Consequently, increasing attention has been paid to skills development and the transferability of doctoral competencies (Jackson & Michelson, 2015; Mantai & Marrone, 2022). The value of the PhD has been examined not only in terms of disciplinary expertise but also in relation to the acquisition of transferable skills and their applicability across diverse professional contexts (Edge & Munro, 2015; Haapakorpi, 2017; Hayter & Parker, 2019).

Graduate employability is of critical importance to professions and industries, many of which are facing significant talent shortages that constrain organizational and sector-wide productivity. Beyond economic contributions, higher education institutions are also expected to cultivate socially responsible and globally engaged citizens (Bennett, 2019). Within this context, interdisciplinary research has been recognized as particularly beneficial for doctoral and higher-degree students. Engaging in interdisciplinary inquiry broadens intellectual perspectives, fosters versatile skill development, and prepares graduates for diverse career trajectories (Rana et al., 2025; Vanstone et al., 2013). Employers likewise value the integrative thinking and problem-solving capacities associated with interdisciplinary training (Miller & Boix-Mansilla, 2004).

In addition to formal academic training, extra- and co-curricular activities play an important role in enhancing employability. Such activities contribute to the expansion of social and professional networks, support career planning, and facilitate the development of transferable skills (Buckley & Lee, 2021; Dickinson et al., 2021; Jackson & Bridgstock, 2021; Jackson & Cameron, 2025; Jackson & Tomlinson, 2022). At the same time, attention must be given to doctoral students' well-being. A substantial body of research has reported high levels of stress (Kernan et al., 2011; Virtanen et al., 2017; Wyatt & Oswalt, 2013), mental health concerns such as depression (Hyun et al., 2006; Pallos et al., 2005), and even physical health symptoms

(Juniper et al., 2012; Kernan et al., 2011; Pallos et al., 2005) among doctoral students. These findings highlight the importance of adopting a holistic approach to doctoral education that integrates employability, skills development, interdisciplinary engagement, and student well-being.

### PhD Education in Japan's Higher Education Context

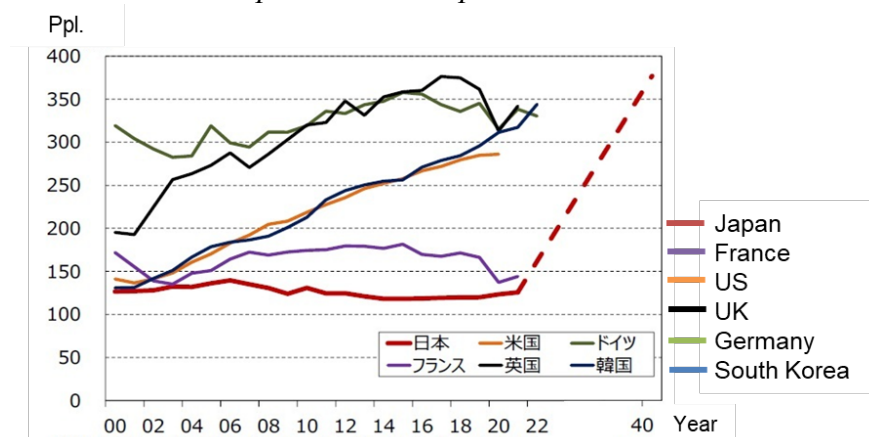
In Japan, the number of individuals pursuing doctoral degrees has shown a long-term decline. Although enrollment in doctoral programs has exhibited a modest recovery over the past two years, the overall trend between 2003 and 2022 remained downward (Shuji Kawagishi, 2025). Within this context, academic careers have become less attractive due to uncertain professional prospects (Arimoto et al., 2019), a factor that may discourage highly capable students from advancing to doctoral study. The long-standing instability of academic career pathways in Japan has also been noted as influencing doctoral candidates' motivations and progression decisions (Yoshioka-Kobayashi & Shibayama, 2023). One contributing factor to the decline appears to be intensifying competition for academic positions alongside the widespread prevalence of fixed-term and precarious contracts at Japanese universities (Huang, 2024).

**Figure 1**  
*Number of Students Enrolling in Doctoral Programs*



Source: Shuji Kawagishi, 2025

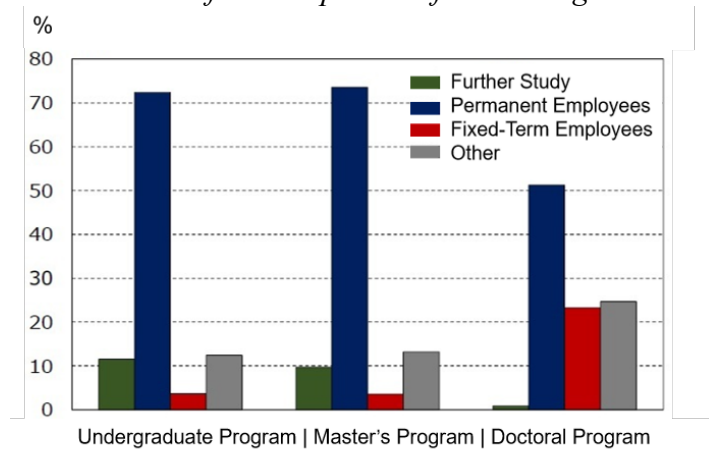
**Figure 2**  
*Doctorate Holders per Million People*



Source: Shuji Kawagishi, 2025

Financial considerations further compound this situation. Students' economic circumstances during their studies, combined with uncertainty regarding future career trajectories, constitute major deterrents to doctoral enrollment. Moreover, compared with graduates holding undergraduate or master's degrees, doctoral degree holders face a substantially higher incidence of fixed-term employment, reinforcing perceptions of instability associated with the PhD pathway (Shuji Kawagishi, 2025). Together, these structural and economic factors help explain the sustained decline in doctoral participation in Japan.

**Figure 3**  
*Career Paths After Completion of Each Program*



Source: Shuji Kawagishi, 2025

Admission to doctoral programs typically prioritizes applicants' disciplinary foundations, research competence, critical thinking abilities, and strong research motivation. While these attributes remain essential for undertaking advanced scholarly work, they are no longer sufficient to ensure that graduates can successfully navigate increasingly diverse and competitive career landscapes after completing their PhDs. The evolving expectations placed upon doctoral degree holders, both within and beyond academia, require a broader set of competencies, including transferable skills, professional adaptability, and career self-management capacities.

This situation raises a fundamental question for doctoral education: what should doctoral training entail in order to prepare candidates more effectively for their future trajectories? More specifically, how do particular components of doctoral programs contribute to the development of essential skills and to the strengthening of graduates' self-efficacy regarding their career pathways? Addressing these questions is crucial for rethinking the design and purpose of contemporary doctoral education.

### Case Study

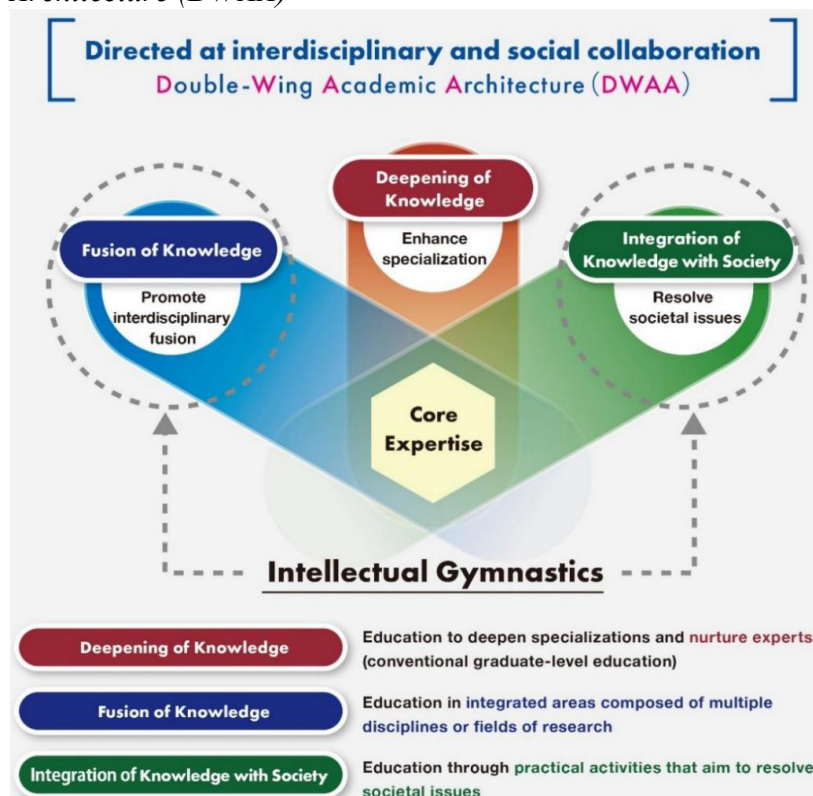
This study is guided by two central research questions. First, it seeks to identify the skills and competencies that enable PhD graduates to remain competitive in contemporary labor markets across both academic and non-academic sectors. Second, it examines how doctoral education and training processes can effectively cultivate such competitiveness, with particular attention to program structures, learning experiences, and developmental opportunities that support the formation of well-rounded, adaptable researchers. Together, these questions aim to clarify not only what makes a PhD graduate competitive, but also how doctoral programs can systematically foster the capacities required for sustainable and successful career trajectories.

## Program Framework and Core Skills for Competitive PhD Graduates

Since 2021, the University of Osaka has been promoting the Double-Wing Academic Architecture (DWAA), an advanced graduate education system focused on interdisciplinary and social collaboration. Its goal is to nurture doctoral professionals who can create social innovations across many fields, not limited to academia. DWAA is composed of three areas: Deepening of Knowledge, Fusion of Knowledge, and Integration of Knowledge with Society. In addition to developing expert knowledge, the system expands education in two new directions predicated on the acquisition of core expertise. Graduate degree holders are expected to tackle problems with flexibility and a broad worldview, collaborate with diverse stakeholders, and leverage their core expertise as they more broadly and deeply apply their graduate school education.

**Figure 4**

*Structure of Graduate Education at the University of Osaka—Double-Wing Academic Architecture (DWAA)*



Source: <https://itgp.osaka-u.ac.jp/en/systems/dwaa/>

The Cross-Boundary Innovation Program (CBI Program), launched in 2012, is a comprehensive interdisciplinary graduate initiative designed to address complex social challenges through cross-sector collaboration. The program brings together graduate students and faculty members from all graduate schools of the University of Osaka under the unifying theme of solving societal issues. It offers coursework and project-based learning opportunities to students from both the humanities and the sciences, thereby fostering dialogue and cooperation across disciplinary boundaries. Through these activities, the program seeks to cultivate a new type of doctoral talent capable of contributing beyond narrow areas of specialization and prepared for diverse career pathways in academia, industry, and government. The CBI Program operates in conjunction with the Fellowship for Integration of Knowledge with Society, a fellowship scheme provided by the Japan Science and Technology Agency

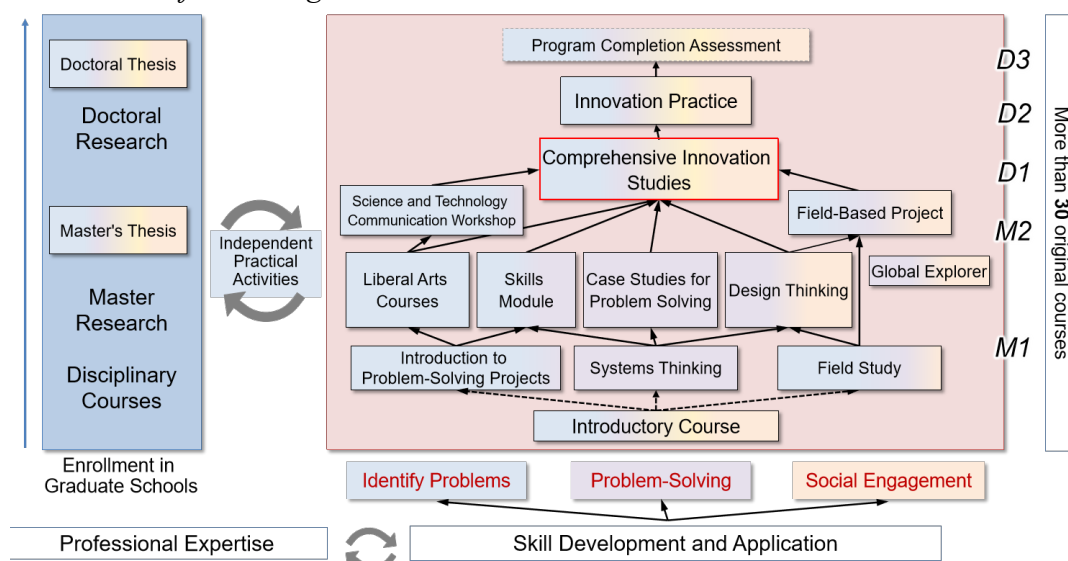
(JST). This fellowship supports doctoral students in integrating scientific expertise with societal knowledge by providing research grants and financial assistance. Together, these initiatives promote interdisciplinary competence, social engagement, and practical problem-solving skills, enabling doctoral candidates to pursue innovative research while developing capacities applicable to a broad range of professional contexts.

**Table 1**  
*Student Affiliations (2012–2025 AY)*

Graduate School	Number	Percentage
Human Sciences	42	20.00%
Engineering	38	18.00%
Humanities	33	15.70%
Medicine	21	10.00%
Sciences	18	8.60%
International Public Policy	10	5.10%
Biosciences	10	4.70%
Pharmaceutical Sciences	10	4.70%
Informatics	8	3.80%
Engineering Science	7	3.30%
Law and Politics	6	2.90%
Economics	5	2.30%
Dentistry	2	0.90%
	210	100%

From 2012 to the 2025 academic year, more than 200 graduate students from all graduate schools have participated in the program, covering a wide range of disciplines, including Human Sciences, Engineering, Humanities, Medicine, Sciences, International Public Policy, Biosciences, Pharmaceutical Sciences, Informatics, Law and Politics, Engineering Science, Economics, and Dentistry. Faculty members from all graduate schools, with diverse backgrounds, are also involved in program management and teaching.

**Figure 5**  
*Curriculum of CBI Program*

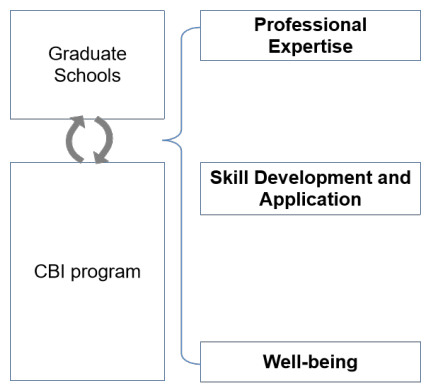


Source: <https://www.cbi.osaka-u.ac.jp/teaching/feature/>

The program offers more than 30 original courses, long-term project-based learning opportunities, and a combination of group and independent activities. Through these components, students develop competencies in problem identification and problem solving, as well as the capacity for meaningful social engagement. By working beyond the boundaries of their own specializations, participants are encouraged to cultivate innovative and integrative thinking. Key features of the program include workshops and project-based learning initiatives that bring together students from diverse academic backgrounds and different stages of study, enabling constructive dialogue and collaborative learning. In addition, overseas experiences and collaborative projects with companies and government agencies provide opportunities for students to address real-world social issues in practical contexts.

While students primarily acquire advanced disciplinary knowledge within their respective graduate schools, the CBI program places particular emphasis on transferable skill development and real-world application. Through sustained participation, students strengthen their ability to identify complex challenges, design and implement solutions, and engage effectively with society. At the same time, interdisciplinary collaboration throughout the program further promotes innovative thinking by encouraging students to transcend traditional academic boundaries.

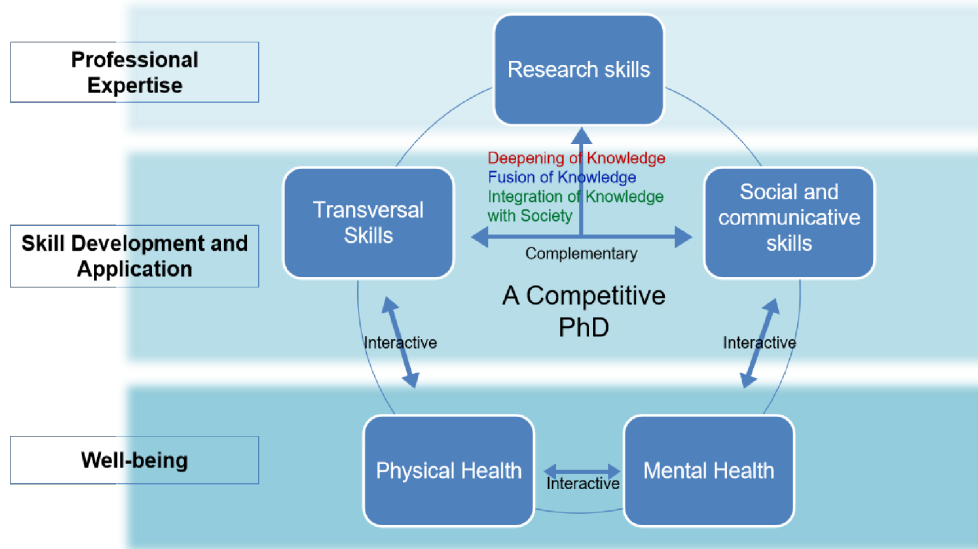
**Figure 6**  
*Skills Contributing to Competitive PhD Graduates*



In terms of skill development and practical application, the program provides students with opportunities not only to acquire knowledge but also to apply what they have learned through practice and real-world engagement. Emphasis is placed on experiential learning, whereby students perform tasks, participate in authentic activities, and develop competencies through hands-on experience. In this sense, learning occurs through doing, and skills are cultivated through repeated practice in practical contexts.

Alongside the development of professional expertise and transferable skills, the program also places strong emphasis on students' physical and mental well-being. These three dimensions, disciplinary knowledge, practical competence, and well-being, are regarded as mutually reinforcing foundations for sustainable development. Together, they enable students to respond to real-world challenges both reactively and proactively, while enhancing their capacity to adapt to the uncertainties of a rapidly changing global environment.

**Figure 7**  
*Interactive and Complementary Functions of Skills in Developing a Competitive PhD Graduate*



These three core elements were further organized into five key components within the program framework. Physical and mental well-being constitute the foundational layer, upon which all other competencies are built. Rather than functioning independently, these skills interact dynamically and complement one another, collectively contributing to the development of a competitive and resilient PhD graduate equipped for diverse professional contexts.

Given that most doctoral students encounter significant academic and personal challenges during their studies, physical and mental strength is regarded as essential for sustaining long-term engagement and success. A strong foundation in well-being supports students' capacity to recover from setbacks, maintain motivation, and demonstrate resilience in the face of uncertainty. In this way, well-being not only underpins academic achievement but also enhances adaptability and long-term professional growth.

### **Cultivating Competitiveness Through Doctoral Education and Training Processes**

To address the second research question—how to foster competitive PhD graduates—this study draws attention to the role of structured learning experiences beyond conventional disciplinary training. Previous research has demonstrated that extra- and co-curricular activities enhance graduate employability by expanding social and professional networks, supporting career planning (Jackson & Bridgstock, 2021; Jackson & Tomlinson, 2022), and facilitating the development of transferable skills (Buckley & Lee, 2021; Dickinson et al., 2021; Jackson & Cameron, 2025). These findings suggest that doctoral education should extend beyond formal coursework and research supervision to incorporate broader developmental opportunities.

**Table 2***A Staged Interdisciplinary Graduate Education Model*

	<b>Curricular programs</b>	<b>Co-curricular programs</b>	<b>Extra-curricular programs</b>
Individual Work	e.g. Interdisciplinary course, PBL courses	e.g. Brownbag Seminar, Forum (Domestic / International (Joint International and Interdisciplinary Forum) ), Overseas Travel Support	e.g. Cross-Boundary Practical Activities, Career Development Seminars
Group Work	e.g. Field Project, Comprehensive Innovation Studies (PBL)		e.g. Group work support, Cross-Boundary Practical Activities, Career Development Seminars, Life-Skill Training Camp
Upgraded Individual Work	e.g. Independent Practical Activities (Innovation Practice)		

In this context, we have developed a staged interdisciplinary graduate education model that systematically integrates curricular, co-curricular, and extra-curricular components. The model is organized into three progressive phases, individual work, group work, and upgraded individual work. Across these phases, students engage in diverse project-based learning courses and activities designed to cultivate interdisciplinary collaboration, practical problem-solving abilities, and reflective integration of learning outcomes. This staged structure enables students to gradually expand their competencies, first by strengthening individual expertise, then by engaging in collaborative inquiry, and finally by refining and advancing their individual capacities at a higher level of integration.

### **Applied Practices in the CBI Program**

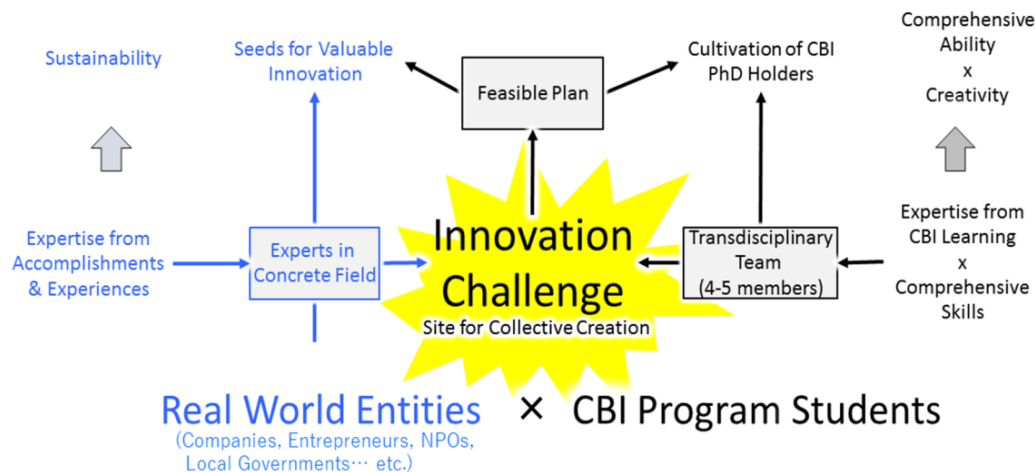
In the following sections, we introduce several practical cases to demonstrate the concrete implementation of the staged interdisciplinary graduate education model.

#### ***Project-Based Learning (PBL) Courses***

As a core component of the program, Project-Based Learning (PBL) courses integrate both individual and group work across curricular and co-curricular settings. A representative initiative is the long-term PBL course *Comprehensive Innovation Studies*, which extends over approximately ten months and is designed to promote sustained engagement with complex societal challenges.

In this course, interdisciplinary teams composed of students from the humanities and the sciences collaborate to address real-world social issues. Through continuous communication and iterative collaboration with diverse stakeholders, including community members, industry partners, and public-sector representatives, students engage in problem identification, needs analysis, solution design, and proposal development. The extended duration of the project allows participants to refine their ideas through feedback and reflection, thereby strengthening both analytical rigor and practical applicability. The overall objective is to develop feasible and socially meaningful solutions that demonstrate the capacity of doctoral students to contribute constructively to society beyond the boundaries of their respective disciplines.

**Figure 8**  
*Comprehensive Innovation Studies*



### ***Life-Skill Training Camp***

As part of the extra-curricular component of the program, the “Life-Skill Training Camp” is designed to strengthen students’ foundational competencies for personal and professional resilience. Life skills are defined as the abilities required to deal constructively and effectively with the demands and challenges of everyday life (WHO, 1997). These include decision-making, problem-solving, creative and critical thinking, effective communication, interpersonal skills, self-awareness, empathy, coping with emotions, and coping with stress.

Research on elite athletes suggests that they possess highly developed life skills that enable them to withstand negative external influences, positively reframe challenges, and push beyond perceived physical and psychological limits. Drawing on these athlete-developed competencies, the CBI program incorporates residential, sport-based training designed to foster life skill acquisition and strengthen team building. Through structured physical activities, reflective exercises, and collaborative tasks, students enhance resilience, emotional regulation, communication, and mutual trust. In this way, the program situates life skill development as a practical and embodied process that supports both individual growth and collective cohesion.

### ***Career Development Seminars***

The Career Development Seminars constitute an important extra-curricular component of the program, combining individual reflection with group-based learning activities. These seminars are designed to enhance doctoral students’ preparedness for diverse career pathways by strengthening transferable skills and informed decision-making capacities. In particular, students develop the ability to analyze and integrate perspectives from multiple sectors, thereby supporting flexible and strategic career planning in rapidly changing professional environments.

A strengths-based approach is emphasized throughout the seminars. Participants are guided to reflect on their individual strengths, core values, and long-term career aspirations as doctoral candidates operating within an interdisciplinary context. This process of structured self-assessment supports greater self-awareness and clearer professional direction. In addition, the seminars provide foundational knowledge of labour laws and workplace-related issues, including employment conditions and risks such as overwork, thereby equipping students with essential awareness for sustainable career development.

Given the increasing globalization of career trajectories, the seminars also address international career pathways. Particular emphasis is placed on cross-cultural understanding and effective communication, enabling students to navigate diverse professional contexts and to contribute successfully within the global community.

### ***Independent Practical Activities (Innovation Practice)***

Independent Practical Activities, referred to as Innovation Practice, represent the upgraded individual phase of the program. These activities are student-designed projects that integrate co-curricular and extra-curricular learning, enabling participants to extend and apply their academic and professional competencies in authentic social contexts. Under faculty guidance, students design and implement projects that translate their interdisciplinary learning into concrete forms of social engagement.

Through initiatives such as volunteering, internships, collaborative research, and field-based projects, students actively apply acquired knowledge and skills in real-world settings. These experiences promote independent initiative, practical problem-solving, and reflective learning, while reinforcing the connection between doctoral education and societal needs. Since 2015, more than 70 students have participated in this initiative, collaborating with universities, research institutes, NPOs, companies, and government agencies. This sustained engagement demonstrates the program's commitment to experiential learning and to fostering socially responsive and professionally competitive PhD graduates.

### **Career Paths of Graduates**

The career trajectories of program graduates indicate positive outcomes in terms of doctoral employability. Over half of the graduates, 51%, entered employment in the private sector. This proportion is substantially higher than the national average for PhD holders in Japan, which stands at 34% according to a 2023 Cabinet Office survey. Notably, many of these graduates pursued non-research positions, including general administrative and strategic roles, suggesting that they were able to transfer their doctoral competencies beyond narrowly defined research functions.

At the same time, strong outcomes were also observed among those who pursued academic careers. Of the 22 students who expressed the intention to enter academia, 18 (81.8%) secured full-time positions as university faculty members or researchers. The remaining four graduates are active as Japan Society for the Promotion of Science Postdoctoral Fellows, part-time researchers, or in comparable research-oriented roles. These results indicate that the program supports diverse career aspirations while maintaining strong academic competitiveness.

Doctoral employability has been conceptualized as the combination of knowledge, skills, attributes, social resources, and personal agency that enables doctorate holders to obtain, sustain, and advance in meaningful work, whether inside or outside academia (Jackson & Michelson, 2015; Pham, 2023). From this perspective, the outcomes of the program suggest that it has effectively fostered competitive and adaptable PhD graduates capable of navigating multiple professional pathways. In this sense, the program's integrated and staged educational model has demonstrably contributed to enhancing doctoral employability.

## **Challenges**

Despite its positive outcomes, the program faces several challenges. First, integrating multiple disciplines into a coherent educational framework renders curriculum design inherently complex. Continuous adjustments are required to balance disciplinary depth with interdisciplinary breadth, ensure internal coherence across courses and activities, and respond effectively to evolving student needs and societal demands. Maintaining this balance remains an ongoing process of refinement and coordination.

Second, evaluating interdisciplinary learning presents methodological and pedagogical difficulties. Assessment must capture not only disciplinary knowledge acquisition but also the development of cross-cutting competencies such as critical thinking, integrative analysis, and collaborative skills. Designing valid and reliable evaluation mechanisms for such multidimensional learning outcomes is demanding. Accordingly, continuous improvement depends heavily on systematic feedback and iterative revision of teaching and learning activities.

Students themselves encounter practical and academic challenges throughout the program. Managing interdisciplinary projects alongside the rigorous demands of their primary doctoral research requires careful time and workload management. In addition, collaboration with peers from diverse academic backgrounds can present communication barriers, differences in epistemological assumptions, and contrasting methodological approaches. While such tensions may initially create difficulties, they also constitute valuable opportunities for interdisciplinary dialogue, mutual learning, and personal development.

Furthermore, broader structural and psychological challenges facing doctoral students must be acknowledged. Existing research has consistently reported high levels of stress (Kernan et al., 2011; Virtanen et al., 2017; Wyatt & Oswald, 2013), mental health concerns such as depression (Hyun et al., 2006; Pallos et al., 2005), and significant physical health symptoms including upper respiratory infections (Juniper et al., 2012; Kernan et al., 2011; Pallos et al., 2005). In their social and personal lives, doctoral students also frequently report difficulties in maintaining relationships (Dabney & Tai, 2013; Wellington & Sikes, 2006) and participating in social activities (Juniper et al., 2012; Longfield et al., 2006), often due to limited time, financial constraints, and reduced motivation. These findings underscore the importance of sustaining institutional support systems that address not only academic development but also students' overall well-being.

## **Conclusion and Future Directions**

There is a growing recognition of the need for specialized training and educational programs tailored to interdisciplinary research skills. Such training should extend beyond technical competencies to encompass emotional, social, cultural, and contextual dimensions of research practice (Menken & Keestra, 2016; Rana et al., 2025). Interdisciplinary doctoral education therefore requires a holistic approach that integrates cognitive development with interpersonal awareness and contextual sensitivity.

In response to these demands, we have implemented follow-up interviews with students to monitor their academic and professional development over time. In addition, several new initiatives have been launched to strengthen support for students' physical and mental well-being. As Sverdlik et al. (2018) argue, understanding doctoral students' physical,

psychological, and emotional well-being is essential for fully capturing the complexities and challenges of graduate education. Systematic attention to these dimensions allows institutions to design more responsive and sustainable support mechanisms.

Looking ahead, future efforts may focus on expanding initiatives that promote cross-cultural interaction and global learning opportunities. As interdisciplinary research within doctoral studies continues to evolve, academic institutions must adapt by enhancing their structural and pedagogical support systems. This may include establishing additional interdisciplinary platforms, integrating collaborative methodologies more explicitly into curricula, and providing targeted funding schemes, while simultaneously cultivating a culture that values collaboration and mutual learning (Lyall et al., 2013; Rana et al., 2025; Sun et al., 2021b; Vienni-Baptista et al., 2023).

At present, our program operates with a comprehensive support system that includes faculty and staff guidance, dedicated classrooms and interaction spaces, diverse course offerings and activity opportunities, collaboration with multiple external stakeholders, and financial grants. However, sustaining continuous and long-term support remains both a crucial component and an ongoing challenge. Ensuring the durability and adaptability of this support structure will be central to the program's future development and its continued contribution to fostering competitive and resilient PhD graduates.

### **Limitations and Future Work**

This study is mainly a case description of a single program and therefore does not provide a fully systematic or comparative evaluation of implementation processes and outcomes. While the findings offer meaningful insights into program design and graduate trajectories, the descriptive nature of the study limits the generalizability of the conclusions.

Empirical evaluation remains limited, particularly in terms of comprehensive data collection, longitudinal tracking, and advanced analytical procedures. A more rigorous evidence base is needed to assess the effectiveness of the program in fostering interdisciplinary competencies, transferable skills, and long-term career development.

Future research will focus on establishing structured assessment frameworks and employing mixed-methods evaluation approaches. By integrating quantitative indicators with qualitative data, subsequent studies aim to strengthen the empirical foundation of the program and provide a more nuanced understanding of its impact on doctoral education and employability.

### **Declaration of Generative AI and AI-Assisted Technologies in the Writing Process**

During the preparation of this manuscript, the authors used ChatGPT solely for proofreading and refining language, including correcting grammar, spelling, and rephrasing for clarity and accuracy. Apart from Grammarly, no other AI or AI-assisted tools were used to generate content. All ideas, study design, procedures, findings, analyses, and discussions are original and derived from the careful and systematic conduct of the research.

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