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Outcomes of Interdisciplinary Graduate Education - A Case Study from a Japanese University-

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Abstract

Interdisciplinary graduate education has become increasingly important in addressing complex global challenges that transcend traditional disciplinary boundaries. This study examines the outcomes of such education programs through the lens of Tomlinson's Graduate Capital Model, which encompasses human, social, cultural, identity, and psychological capitals. Focusing on a case study at a Japanese national university, qualitative data were collected through semi-structured interviews and free-form questionnaire with program graduates. Using KH Coder for quantitative text analysis, the results revealed that interdisciplinary education strengthens graduates' academic, social, and personal development. It broadens knowledge and skills by combining ideas and methods from different fields, improving research ability, employability, and adaptability. Collaborative learning across disciplines helps students build professional networks and appreciate diverse academic and workplace cultures. These experiences also shape their professional identity, foster career flexibility, and build confidence and resilience. Overall, interdisciplinary learning fosters well-rounded development by cultivating both expertise and transferable skills essential for lifelong learning and success.

Keywords: Interdisciplinary, graduate education, qualitative, quantitative text analysis, Japan

1 Introduction

1.1 The International Context of Interdisciplinary Education: Historical Origins from the 1950s to the SDGs era

The notion of interdisciplinary education emerged in the post-World War II era, when rapid scientific and technological progress called for new forms of knowledge integration across disciplines. In the 1950s and 1960s, the rise of systems theory, cybernetics, and social science collaborations, along with reports such as "*General Education in a Free Society"* [1], laid the groundwork for integrating liberal and scientific inquiry in higher education [2]. The period also witnessed the first institutional experiments in "interdisciplinary studies" and "area studies," which sought to understand global issues beyond disciplinary boundaries, particularly in the United States and Europe.

Contemporary societies face complex and multifarious challenges, as underscored by the Sustainable Development Goals (SDGs). Addressing these challenges transcends the scope of unidimensional approaches; rather, it necessitates the cultivation of advanced capabilities that enable a comprehensive perspective [3]. The global community now recognizes that

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tackling "wicked problems," such as climate change, global health, and digital transformation, require collaboration across disciplinary, institutional, and cultural boundaries [4] [5].

Universities and other higher education institutions bear a significant responsibility: they are the epicenters of pioneering research and the crucibles for educating the forthcoming generation of scholars and professionals. A retrospective analysis from educational offerings to course structures indicates an escalating demand and interest in interdisciplinary and transdisciplinary approaches to education [6]. Over the past two decades, such approaches have become central to developing competencies for knowledge co-creation and societal engagement, particularly in graduate programs designed to bridge research and practice [7] [8] [9].

1.2 From Quantitative Expansion to Interdisciplinary Innovation: Graduate Education Reform in Japan

The development of graduate education in Japan has been closely intertwined with postwar reforms in the higher education system. With the establishment of the new university system in 1948, the graduate school system was officially introduced in 1950. It succeeded the research training functions of the prewar universities while establishing a new degree structure. During this early period, graduate schools were primarily designed to train a small number of elite researchers, placing greater emphasis on research activities than on structured educational programs. Subsequently, in 1974, the "*Standards for the Establishment of Graduate Schools"* were enacted, providing a legal and institutional framework that clarified and systematized graduate education nation-wide.

In the latter half of the 1980s, amid socioeconomic transformations and the growth of knowledge-intensive industries, the expansion of graduate education emerged as a major policy agenda. Two important reports by the University Council - "*The Flexibility of the Graduate School System"* [10] and "*Quantitative Expansion of Graduate Schools"* [11] - explicitly positioned the enhancement of graduate education as a national priority. These reports set a concrete goal of doubling the number of graduate students from approximately 100,000 in 1991 to 200,000 by the year 2000. This policy goal was largely achieved, marking a significant shift in the role of graduate schools from institutions primarily focused on training researchers to those expected to cultivate diverse professional talents and respond to the broader needs of society.

Following this quantitative expansion, the 2000s witnessed growing attention to the qualitative enhancement of graduate education. Two key policy documents - "*Graduate Education for a New Era"* [12] and "*Graduate Education in a Globalized Society*" [13] - issued by the Central Council for Education emphasized qualitative improvement and international competitiveness as the twin pillars of graduate education reform. Building upon these recommendations, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) formulated the "*Policy Guidelines for the Promotion of Graduate School Education"* in 2006 [14]. These guidelines were positioned as a strategic framework for constructing internationally competitive graduate programs and served as a catalyst for promoting educational reforms emphasizing industry–academia–government collaboration and international partnerships.

Building on these foundations, the "Doctoral Program Leading Initiatives" were launched in 2011, reinforcing the commitment to develop global leaders capable of operating seamlessly across industry, academia, and government sectors. By 2013, this initiative had successfully implemented 62 such programs [15]. Moreover, the "Excellence Graduate School Program," introduced in the 2018 academic year, aims to foster doctoral candidates who are poised to become global leaders. This program is dedicated to advancing the creation and application of new knowledge, addressing and resolving societal challenges, and driving innovation [16].

1.3 Purpose and Research Questions

The purpose of this qualitative study is to examine how graduates from interdisciplinary programs make sense of and articulate their employability in relation to Tomlinson's Graduate Capital Model. Specifically, the study seeks to understand how human, social, cultural, identity, and psychological capitals are developed and integrated through interdisciplinary learning experiences, and how these contribute to graduates' perceptions of their career preparedness and professional trajectories.

In alignment with this purpose, the study seeks to answer the following research questions:

1. How do graduates describe the knowledge, skills, and competencies gained through interdisciplinary learning?
2. In what ways do interdisciplinary learning environments shape graduates' professional relationships and networks?
3. How do graduates interpret the influence of interdisciplinary education on their understanding of different disciplinary and professional cultures?
4. How does interdisciplinary education contribute to graduates' formation of professional identity and sense of belonging in the workplace or academia?
5. How do graduates reflect on their confidence, resilience, and adaptability as outcomes of interdisciplinary study?

2 Theoretical Framework

The issue of graduate employability in the contemporary labor market requires a theoretical framework extending beyond conventional, skills-based approaches. This study adopts the Tomlinson's Graduate Capital Model to provide a comprehensive, socio-psychological lens for understanding the outcomes of interdisciplinary graduate education [17]. However, as the participants have not yet entered the labour market, the analysis focuses on the core layer of five forms of capital and their related key resources (Figure 1). The "application and utility in the labour market" component is therefore omitted, as it pertains to post-graduation outcomes beyond the present research scope.

Graduate Capital is defined as a set of keys, interactive resources that graduates accumulate and deploy to gain advantages in their career journeys. Moving beyond simplistic reliance on academic degrees or formal qualifications, this model offers a multi-faceted analysis of career formation. This model arose partially as a critique of the over-emphasis on neoliberal Human Capital approaches. It is comprised of five interconnected forms of capital: Human, Social, Cultural, Identity, and Psychological.

The five capitals provide a robust architecture for capturing the breadth of graduate development, particularly within an interdisciplinary context.

- **Human Capital**: This involves the technical knowledge, specialized expertise, and career-building skills acquired through formal education. These resources reflect the 'hard skills' required for career construction. For interdisciplinary graduates, this manifests as comprehensive and integrative expertise.
- **Social Capital**: This is the resource embedded in networks, contacts, and relationships. It facilitates access to opportunities and 'insider knowledge' of jobs. This also includes activities that strengthen ties. Interdisciplinary programs foster broad, cross-disciplinary professional networks.
- **Cultural Capital**: This includes culturally valued knowledge, embodied behaviors, and dispositions that aid in navigating and integrating into specific professional fields. It encompasses distinction and symbolic value, leading to differentiation. A key outcome of interdisciplinary learning is greater openness to diverse epistemologies.
- **Identity Capital**: This is a graduate's personal investment in their professional self-concept, articulated through compelling employability narratives. This involves the formation of professional identity and personal engagement with work. Interdisciplinary graduates often form a hybrid professional identity bridging multiple fields.
- **Psychological Capital**: Comprising positive psychological resources such as resilience, self-efficacy, and adaptability, this capital is crucial for proactively managing career challenges and setbacks. The demanding nature of interdisciplinary studies enhances graduates' heightened adaptability and resilience.

The synergistic relationship among these five capitals demonstrates that career preparedness is a complex, accumulative process rather than a linear acquisition of skills. This multi-faceted perspective is essential for fully evaluating educational efficacy.

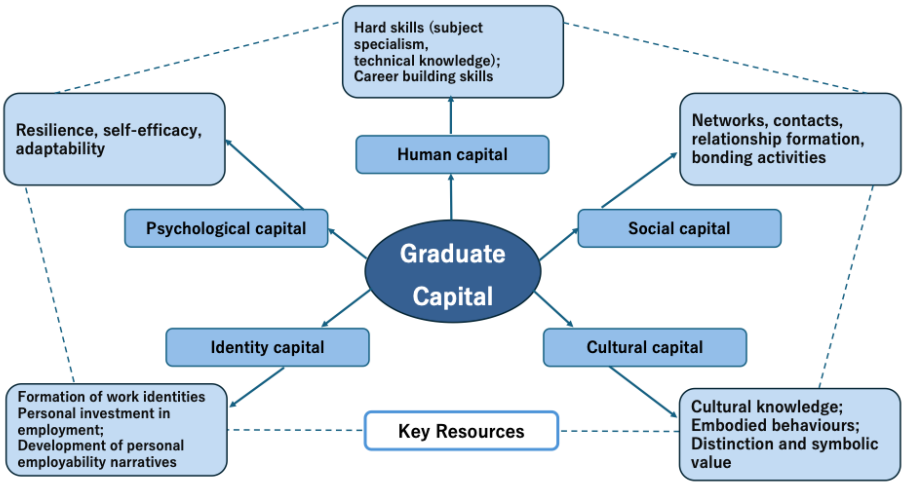

Figure 1: The conceptual framework adapted from the Graduate Capital Model.

3 Methodology

3.1 Research Design

This study employs a qualitative case study design to explore the experiences of graduates from interdisciplinary graduate programs. The aim is to understand how their educational experiences influenced their career trajectories and personal growth. A qualitative approach was selected as it allows for the exploration of complex, context-dependent phenomena that cannot be captured through quantitative measures. By focusing on the case from a Japanese university, the research provides in-depth insights into the relationship between higher education and employability outcomes. Semi-structured interviews and free-form questionnaire served as the primary method of data collection, while thematic analysis, guided by the Graduate Capital Model, provided a structured lens for interpretation.

3.2 Case Context

This section shows a prominent Japanese university running two distinctive interdisciplinary education schemes: the Graduate Minor Program and the Graduate Program for Advanced Interdisciplinary Studies. Both are crafted to accommodate a wide spectrum of academic interests, offering students an integrated and intellectually stimulating learning experience organized around specific academic themes. The principal difference between the two programs is as follows: the Graduate Minor Program demands over 14 credits, while the Advanced Interdisciplinary Studies Program more than 5 credits.

The university offers 22 Graduate Minor Programs and 51 Advanced Interdisciplinary Studies Programs in 2025, reflecting a strong commitment to comprehensive graduate education. Since their launch in 2008, these programs have expanded from 14 to 73, accompanied by a steady rise in applicants—over 10,000 students so far in total. Although recent years have seen a decline due to the COVID-19 pandemic, the programs continue to attract motivated students. Graduates receive an official certificate of completion, symbolizing not only their academic achievement but also their dedication to interdisciplinary learning and research excellence.

These programs are grounded in a student-oriented pedagogical philosophy, allowing each participant to design an academic pathway suited to their own intellectual goals. This flexibility enhances engagement with contemporary interdisciplinary issues and promotes the synthesis of knowledge across diverse academic fields, thereby enriching the applicability of academic inquiry to contemporary societal challenges. A defining characteristic of both programs is the collaborative learning environment they foster. Students, faculty members, and researchers from multiple disciplines come together to exchange perspectives, generating a dynamic community of inquiry and creativity. Such collaboration cultivates critical thinking and enriches participants' academic experiences.

3.3 Participants

The participants in this study were graduates from the program with diverse disciplinary backgrounds. A total of 35 graduates responded to the free-form questionnaire, including 21 males and 14 females. Among them, 25 were master's program graduates and 10 were doctoral program graduates, representing 18 from the humanities and social sciences and 17 from science and engineering fields.

In addition, 12 of these graduates participated in group interviews to provide more detailed insights into their educational experiences and career transitions. The interview participants included 6 males and 6 females, with 10 from the master's program and 2 from the doctoral program. In terms of academic background, 4 participants were from the humanities and social sciences, while 8 were from science and engineering disciplines.

3.4 Data Collection

The qualitative data for this study were collected in 2023 and 2024 through group interviews and free-form questionnaire conducted in Japanese with graduates of these programs. The group interviews aimed to capture participants' shared reflections on their educational experiences, career transitions, and personal growth. The free-form questionnaire provided additional individual perspectives and allowed participants to express their experiences in their own words. Interviews were audio-recorded and transcribed verbatim, while questionnaire responses were compiled and anonymized for analysis.

3.5 Data Analysis

The qualitative data were analyzed using KH Coder3 for text mining and thematic exploration. Word frequency and co-occurrence analyses were conducted to identify key patterns in participants' responses. The findings were interpreted through the lens of the Graduate Capital Model, to understand how graduates developed employability and personal growth through their educational experiences. Meaningless expressions were removed as forced exclusion words. Next, words or phrases that were intended to be extracted as single units (e.g., "shakaijin" [working adult]) were specified as forced inclusion words.

Category 1		Category 2		Category 3		Category 4	
research	研究	knowledge	知識	opportunity	機会	student(s)	学生
class(es)	授業	field	分野	talk	お話	discussion	ディスカッション
myself	自分	acquire	得る	impression	印象	make	作る
program	プログラム	perspective	視点	see	見る	group	グループ
teacher	先生	study	勉強	listen	聞く		
learn	学ぶ	in the future	今後	understanding	理解		
take	取る	content(s)	内容	leave	残る		
attend	受講	other	別	enter	入る		
		be useful	役立つ				
		medical	医療				
		technology	技術				
		topic	テーマ				
		broaden	広がる				
		have	持つ				
Category 5		**Category 6**		**Category 7**		**Category 8**	
medical device(s)	医療機器	in reality	実際	career	キャリア	major	専門
development	開発	society	社会	get a job	就職	teaching	教育
company	企業	take	受ける	relation	関係	university	大学
make use of	活かす	many	多い	job	仕事		
working adult	社会人	go out	出る	theater	劇場		
		deal with	扱う	conduct	行う		
		use	使う				
		issue	問題				

Figure 2: Eight categories and their keywords derived from the co-occurrence network analysis (Japanese terms and English translations)

Subsequently, out of a total of 12,027 extracted words, 3,990 were used for analysis. The unit of analysis was set to the sentence, and a co-occurrence network analysis was performed. Regarding the selection of words based on frequency, the minimum occurrence threshold was set to eight, and the number of co-occurrence relationships displayed was limited to 80. As a result of the co-occurrence network analysis, eight categories were generated (Figure 2). The extracted words within each category were analyzed using Key Word in Context (KWIC), and the categories were subsequently named (Figure 3).

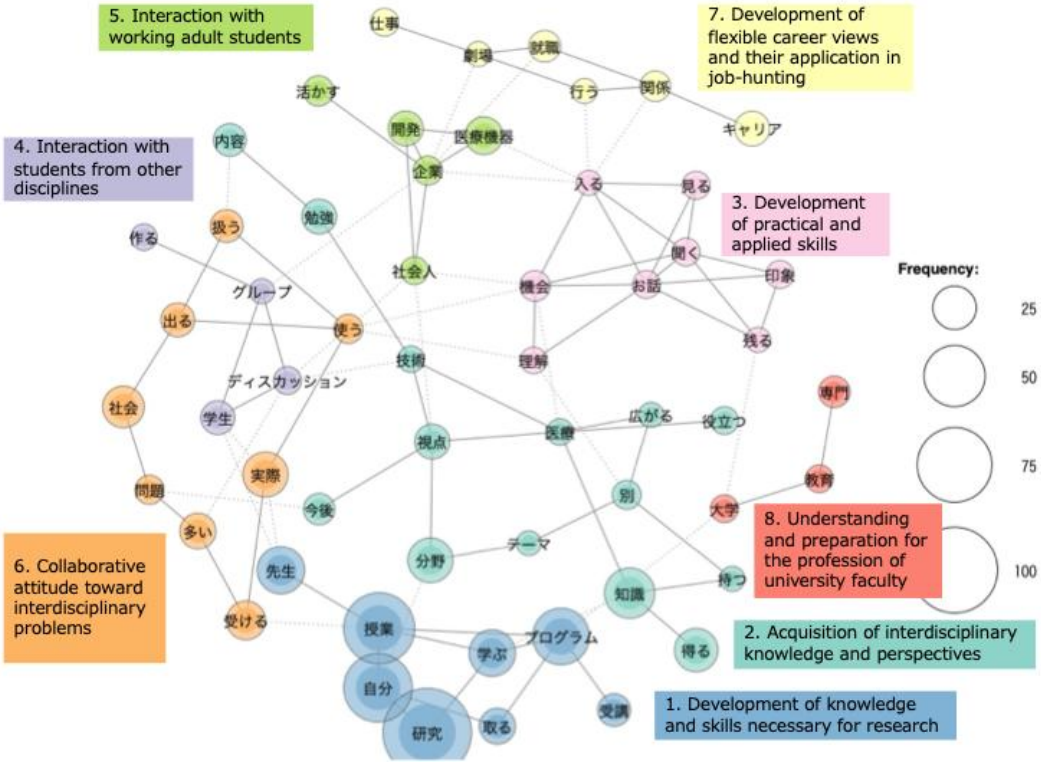

Figure 3: Co-occurrence network with eight named categories

4 Findings

4.1 (Category 1) Development of Knowledge and Skills Necessary for Research

Words such as "myself," "research," "learn," and "take" were closely interconnected, illustrating students' emphasis on personal agency and active learning in their research development.

> "My research theme is deeply connected to adjacent fields, and studying in faculties and graduate schools specializing in those fields has been invaluable and directly applicable to my research." (Humanities, master's student (M))

Many students intentionally enrolled in interdisciplinary programs to acquire the knowledge necessary to advance their research. Their narratives demonstrate that these courses not only provided expertise directly relevant to their projects but also fostered broader competencies that enriched their research processes. Beyond the accumulation of *human capital* (knowledge and

skills), students also developed *psychological capital*—such as initiative, perseverance, and a proactive attitude toward challenges.

> "I believe research is all about taking action. Those who take initiative can grow beyond their current abilities. The determination I developed in other fields now helps me push forward when I hesitate." (Information Science, doctoral student (D))

4.2 (Category 2) Acquisition of Interdisciplinary Knowledge and Perspectives

Words such as "knowledge," "acquire," "have," "other," "field," "broaden" and "perspective" were closely interconnected, reflecting students' recognition of the value of learning across disciplinary boundaries. These terms appeared in statements such as:

> "I was able to acquire knowledge different from my own field of specialization" (Humanities, M).

> "By broadening my knowledge and perspectives, I was able to deepen my understanding of others' knowledge" (Social Sciences, M).

These narratives suggest that students accumulated *human capital* through their participation in interdisciplinary programs—particularly in the form of new knowledge and perspectives drawn from other fields. Such capital was perceived as directly relevant to both academic research and future employment. For example:

> "I incorporated the knowledge and methods learned in the courses 'Language Statistics' and 'Fundamentals of Digital Humanities' into my research, presented at a young researchers' forum, and received an encouragement award." (Humanities, M)

> "Regarding employment, I feel that having prerequisite knowledge of financial and economic systems finally allowed me to stand at the starting line." (Engineering, M)

Even when the knowledge gained did not directly contribute to their theses, students noted that the broad knowledge and experience acquired through interdisciplinary learning functioned indirectly as a foundation supporting their research. For instance:

> "Although it does not explicitly appear in my thesis, the knowledge and experience I gained have become indispensable support for my research." (Humanities, M)

> "The knowledge I acquired has helped me understand prior studies." (Engineering, M)

4.3 (Category 3) Development of Practical and Applied Skills

Words such as "talk," "listen," "enter," "see," "opportunity," "understand," and "impression" were closely interconnected, reflecting students' emphasis on experiential learning and exposure to real-world practices.

Students frequently recounted episodes that left a lasting impression on them. These experiences often involved exposure to perspectives, practices, and forms of knowledge that were difficult to obtain through regular coursework or laboratory research but became accessible

through participation in the program. Such encounters enabled students to develop practical and applied skills that complemented and extended their academic learning, bridging the gap between theory and practice.

> "What I found valuable in the Medical Device Design course was learning about risk management and operational aspects, which are rarely taught in academic settings. It was a great opportunity to acquire knowledge necessary for social implementation." (Medicine, M)

> "Listening to professionals with practical experience—whose viewpoints are rarely accessible in academia—was an invaluable opportunity." (Engineering, M)

4.4 (Category 4) Interaction with Students from Other Disciplines

Words such as "group," "discussion," "students," and "make" were closely interconnected, highlighting the significance of collaborative learning across disciplinary boundaries. Many interdisciplinary programs are open to students from diverse academic backgrounds, where active group discussions are a core component of the learning process.

Through collaboration and dialogue with peers from other specializations, students developed *social capital*—networks and relationships that facilitated the exchange of ideas and mutual understanding. This interaction enabled them to encounter diverse perspectives and cultivate the ability to approach problems from multiple angles.

> "In the programs I took, discussions were emphasized. There were students from engineering, medicine, and the humanities, each offering unique perspectives. Through discussions on the same topic, I learned how people in different fields think and was able to broaden my perspective." (Social Sciences, M)

4.5 (Category 5) Interaction with Working Adult Students

Words such as "working adult," "company," "medical device," and "development" were closely interconnected, emphasizing the value of interaction with professionals engaged in real-world practice.

The *social capital* cultivated through interdisciplinary programs extended beyond exchanges among students from different academic fields to include networks with working adult students. These interactions provided opportunities for participants to gain practical insights and understandings of industry and institutional contexts. Such experiences helped students bridge the gap between academic study and professional practice, equipping them with perspectives beneficial for their future careers.

> "I was impressed by how different the perspectives of working professionals were. Through group work with them, I learned about the differences between academic research and corporate R&D, including considerations such as cost, time constraints, and commercialization." (Life Sciences, M)

4.6 (Category 6) Collaborative Attitude toward Interdisciplinary Problems

Words such as "society," "deal with," "issue," and "in reality" were closely interconnected, reflecting students' growing awareness of the societal relevance and complexity of interdisciplinary challenges.

"I came to understand the importance and difficulty of interdisciplinary research. Future research will inevitably require collaboration with people from other fields and even outside academia." (Human Sciences, M)

"Through this course, I began to hope that I could work as part of a team to solve social issues, building on my background as a medical researcher." (Medicine, D)

These narratives show that students not only recognized the significance and challenges of interdisciplinary research but also developed a collaborative mindset toward addressing complex social issues. Through these experiences, they cultivated *cultural capital* by learning to appreciate diverse perspectives, respect different approaches to knowledge, and engage in cooperative problem-solving across disciplinary and institutional boundaries.

4.7 (Category 7) Development of Flexible Career Views and Their Application in Job-hunting

Words such as "career," "relation," "job," and "conduct" were closely interconnected, reflecting students' evolving understanding of career possibilities and professional identity. These connections were evident in comments such as:

"Speaking of my career, I plan to join a think tank. When I entered graduate school, I was determined to become a psychologist and work in the field. Through my studies, however, I began to see various career options." (Human Sciences, M)

"For example, there are development engineers, material jobs, and positions assessing whether medical devices can actually be used. I became interested in those jobs and felt that this awareness helped me during job hunting." (Life Sciences, M)

These narratives indicate that *identity capital* was cultivated through participation in the interdisciplinary program. By engaging with diverse disciplines and professional cultures, students were able to reassess their career trajectories, broaden their awareness of potential pathways, and approach job hunting with greater flexibility and self-directedness.

4.8 (Category 8) Understanding and Preparation for the Profession of University Faculty

Words such as "university" and "teaching" were connected by solid lines. This group primarily consisted of narratives concerning experiences in the Future University Faculty Development Program:

"I was able to reconfirm what the job of a university faculty member entails—not only research, but also education and social engagement, each contributing to the role in different ways." (Information Science, D)

For graduate students, becoming a university faculty member represents one possible career path. Through participation in this program, students deepened their understanding of the mul-

tifaceted nature of the academic profession, including responsibilities related to teaching, research, and social contribution. In doing so, they developed *identity capital* associated with the competencies, values, and perspectives required for an academic career.

5 Discussion and Conclusion

The findings indicate that interdisciplinary education plays a significant role in developing graduates' employability by enhancing multiple forms of capital within Tomlinson's framework. Interdisciplinary learning expanded students' human capital by broadening knowledge, analytical perspectives, and technical skills, thereby strengthening research capacity, adaptability, and employability.

Collaborative learning across disciplines fostered social capital through peer interaction, networking, and engagement with industry professionals, providing insights into real-world practices and supporting future career opportunities. Exposure to diverse disciplinary cultures also enriched cultural capital, enabling students to appreciate different epistemological approaches and navigate interdisciplinary and professional contexts with greater flexibility.

Interdisciplinary experiences further contributed to identity capital by encouraging reflection on career pathways and professional roles, leading to more flexible and coherent career orientations. At the same time, students developed psychological capital, including increased confidence, resilience, and openness to uncertainty, which supported proactive learning and career decision-making.

Overall, interdisciplinary education functions as a transformative process that prepares graduates for complex professional environments by integrating skill development with personal and professional growth. However, this study's limited scope and reliance on self-reported data suggest the need for future longitudinal and mixed-method research across diverse contexts to better understand the long-term impacts of interdisciplinary learning on employability.

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