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Unpacking Innovation Capability: The Roles of Cognitive Flexibility and Innovation Self-efficacy in Interdisciplinary Contexts

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ABSTRACT

This study contributes to our understanding of how innovation capacity develops by investigating the cognitive and psychological mechanisms responsible for interdisciplinary engagement. While limited studies have explored the combined role of the above two factors alongside interdisciplinary collaboration experience and innovative psychological capital in response to such innovations, as well as the underlying mediating and moderating mechanisms, few have considered their effects on each other. Based on Social Cognitive Theory, this research focuses on the mechanism by which these factors influence innovation capability via cognitive flexibility, and on whether innovative self-efficacy could strengthen this process. A total of 197 university students enrolled in interdisciplinary programmes were surveyed using a structured questionnaire, and the obtained data were analysed using SmartPLS 4.0 based on partial least squares structural equation modelling (PLS-SEM). The findings demonstrate that, in both cases, interdisciplinary collaboration and psychological capital significantly impact innovation capability positively, while cognitive flexibility plays a critical mediating role. Additionally, creative self-efficacy positively moderates the relationship between cognitive flexibility and innovation performance. The findings have theoretical implications for the cognitive and motivational mechanisms of innovative behaviour and practical implications for educational design to support adaptability and innovation readiness.

Keywords: Innovation capability, Interdisciplinary collaboration, Cognitive flexibility, Psychological capital, Self-efficacy

INTRODUCTION

Against the backdrop of constant technological change, complex social issues and increasing interdisciplinarity, there is a growing demand for higher education institutions and knowledge-driven organisations to cultivate innovation capabilities (Pan, Tang & Ismail, 2025; Zhang, Li & Liao, 2024). Innovation is no longer just a technical skill or a flash of genius: it's about immersing yourself in new knowledge domains, being cognitively flexible, and being able to act with confidence in uncertain situations. These are the skills that demonstrate how you think, both psychologically and cognitively, and develop psychological and cognitive abilities for dealing with complexity and generating novelty. Interdisciplinary work is recognised for its ability to encourage creative problem solving, particularly when individuals must engage with unfamiliar knowledge bases and conflicting viewpoints to develop

solutions collectively (Gardiner, 2020; Brignol et al., 2024). This approach requires intellectual openness and a high level of cognitive flexibility — the ability to switch between systems of thought and assimilate new information (Wojtczuk-Turek & Turek, 2015). At the same time, people's innovative psychological capital, including self-efficacy, optimism, hope, and resilience, has been found to promote positive thinking habits and active engagement in intricate innovation activities (Devassy & Jindal, 2024; Zhang et al., 2024). However, the interaction effect of exposure to interdisciplinarity with internal psychological resources and innovation outcomes has yet to be fully explored.

Central to these studies is the concept of the ability to innovate, which Kanchanabha and Badir (2021) describe as the potential of an individual to create, modify, and apply new ideas in dynamic situations or when faced with complex problems. In a complex situation where agility and originality are valued, the ability to innovate plays a crucial role in organisational learning performance and, by extension, organisational competitive advantage. However, the ability to innovate may depend on cognitive flexibility, which provides a means of reappraising experiences, recontextualising demands and drawing links between ideas from different perspectives (Kiss et al., 2020; Liu et al.). Cognitive flexibility not only promotes adaptive reasoning, but also serves as an equaliser in terms of exposure to interdisciplinary and transformational resources, which are transformed into innovative behaviour. Despite increasing interest, little empirical research has systematically investigated how these factors are interrelated with regard to the outcome of innovation, especially in interdisciplinary settings. While previous studies have examined the influence of interdisciplinary learning and psychological capital on creativity/innovation behaviour separately, little is known about how these two factors interact and whether cognitive processes such as flexibility play a mediating role between them. Furthermore, the circumstances surrounding the proliferation of cognitive resources for innovation, particularly innovative self-efficacy, remain under-explored in cross-disciplinary educational settings (Liu et al., 2018; Gill et al., 2021). This gap constrains our understanding of how to shape interventions and environments that truly facilitate the development of innovation capability. In response to this, two main research questions are put forward in this work:

How do interdisciplinary collaboration experience and interdisciplinary innovative psychological capital influence innovation capability?

Does cognitive flexibility mediate these relationships, and is the effect moderated by innovative self-efficacy?

Study setting, design and participants In order to deal with these questions, we take a survey-based quantitative approach with university students who enrol in interdisciplinary studies. The author employs Partial Least Squares Structural Equation Modeling (PLS-SEM) to test direct, mediated and moderated effects. Based on the social cognitive theory (Bandura, 1986), the paper creates a rich model that includes personal, environmental and cognitive determinants of innovation capabilities. This study contributes to theories of innovation in interdisciplinary education and advances the application of Social Cognitive Theory through incorporating both cognitive and motivational processes. It also provides actionable advice for course designers and organizational heads to cultivate innovation-ready mind-sets. Finally, what I want to understand in this research is the psychological and cognitive processes that enable people to convert interdisciplinary interaction into ongoing innovative achievement.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Theoretical Background

This investigation is based on social cognitive theory (Bandura, 1986), which suggests that thought, behaviour and environment continuously interact to determine human function. SCT offers an integrative model that explains how individuals develop innovation-related skills through self-agency, cognitive structuring and social interaction. This model describes how self-efficacy and observational learning are central mechanisms by which people manage their behaviour, interpret the environment as a stimulus, and engage in purposeful activity. In the context of our study, interdisciplinary collaboration experience serves as social and environmental stimulation that supports learning, neural adaptation and cognitive flexibility. SCT posits that individuals in interdisciplinary environments, where diverse viewpoints and approaches to problem-solving are present, are more likely to internalise adaptive thought patterns, thereby increasing cognitive flexibility (Gardiner, 2020; Newswander & Newswander, 2012). Moreover, the existence of cross-sectional innovative psychological capital — autonomy, optimism, resilience, hope, and self-efficacy — enhances the ability to deal with complexity and uncertainty. As mentioned by Wojtczuk-Turek and Turek (2015) and Devassy & Jindal (2024), these psychological qualities promote cognitive engagement, a process that enables the decoupling of perspectives to facilitate flexible responses to new challenges.

In turn, cognitive flexibility acts as a mediating cognitive capacity that facilitates the integration of diverse information and fosters the generation of creative solutions. As prior studies have shown (Kiss et al., 2020; Wang & Thai, 2024), people who are highly cognitively flexible are better able to navigate dynamic, interdisciplinary

environments and convert ideas into innovative outputs. Furthermore, SCT emphasises the significance of self-efficacy in motivating action. Consistent with this, the current study identifies innovative self-efficacy as a critical moderator influencing the translation of cognitive flexibility into innovation capability. Those who believe more strongly in their innovative potential are more likely to apply flexible thinking to practical outcomes (Liu et al., 2018; Gill et al., 2021; Alves & Yang, 2022). Taken together, SCT provides a unifying theoretical lens through which to understand how social interaction (i.e. interdisciplinary collaboration), internal resources (i.e. psychological capital) and cognitive processes (i.e. cognitive flexibility) interact to influence innovation outcomes. The theory's emphasis on agency, adaptability, and the dynamic interplay between the individual and their environment closely aligns with this study's structure and hypotheses.

Theoretical Framework and Hypothesis Development

Based on social cognitive theory (Bandura, 1986), the current article presents a quasi-theoretical model that examines the relationship between interdisciplinary collaborative experiences, innovative interdisciplinary organisational psychological capital and innovation capability, via the impact of cognitive flexibility. It also investigates the role played by innovative SE. Cross-functional teamwork leads to flexible thinking (Gardiner, 2020; Newswander & Newswander, 2012), and PC fosters cognitive processing in ambiguous situations (Wojtczuk-Turek & Turek, 2015; Devassy & Jindal, 2024). Cognitive flexibility allows individuals to take knowledge and form novel ideas (Kiss et al., 2020; Wang & Thai, 2024), and innovative self-efficacy enhances this effect, making cognition adaptive towards innovation (Liu et al., 2018; Gill et al., 2021). These components constitute a unified architectural model, depicted in Figure. 1.

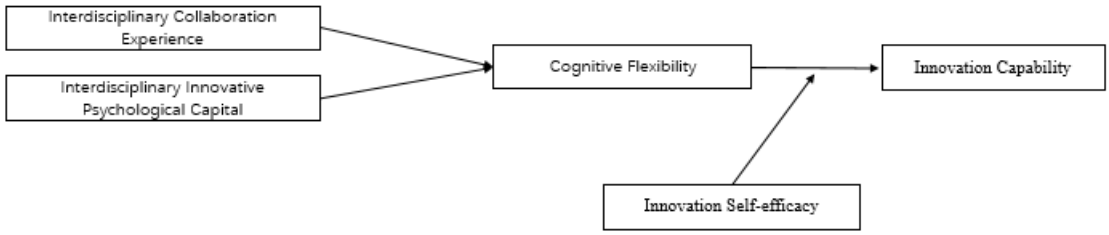

Figure 1. Model of Cognitive Flexibility and Innovation Capability

Interdisciplinary Collaboration Experience and Cognitive Flexibility

Cross-disciplinary collaboration experience is defined as the degree to which individuals are involved in cooperative activities that transcend disciplines and extend beyond disciplinary boundaries so as to involve integrating different knowledge systems, methodologies, and viewpoints. her.Contextswithin these contexts, people are regularly asked to take the perspective of another person, interpret what they read or hear and they themselves think (i.e., ambig uous), all of which are conditions that support cognitive flexibility. Cognitive flexibility, in this case, is the mental capacity to adjust between different thoughts and problem solving reframings or adjusting to a new layout of information. As collaboration across multiple disciplines and these shared learning cultures has helped fostering for learners and practitioners the 'think together´ dynamic, which can facilitate creative, adaptive thinking processes (Gardiner 2020). Studies within both the educational and scientific literatures suggest that an interdisciplinary collaboration is a strong facilitator of cognitive flexibility. For example, Newswander and Newswander (2012) discovered that interdisciplinary instructional techniques in public administration programs facilitated cognitive flexibility as students were prompted to use their knowledge in challenging situations. Similarly, Brignol et al. (2024) refer to as advancing the cognitive adaptability of scholars across the silos in their field, some almost literal methodological boundaries between fields (like separating groves from a forest). Taken together, these findings imply that individuals with increased exposure to interdisciplinary collaboration possess more favorable cognitive flexibility and can adjust more flexibly to dynamic academic, professional, and sociocultural settings.

H1: Interdisciplinary collaboration experience is positively associated with cognitive flexibility.

Interdisciplinary Innovative Psychological Capital and Cognitive Flexibility

Interdisciplinary Innovative Psychological Capital (IIPC) refers to an individual's positive psychological state in the context of engaging in interdisciplinary and innovation-driven tasks. This state comprises self-

efficacy, optimism, hope and resilience. Individuals with strong IIPC tend to exhibit greater adaptability, openness to novel perspectives, and persistence in the face of complex or ambiguous cross-disciplinary challenges. As demonstrated by Zhang et al. (2024) in the field of language education, teachers with high levels of psychological capital and cognitive flexibility tend to experience greater professional success. This highlights the way in which psychological capital fosters mental adaptability and innovative engagement across disciplines. Cognitive flexibility, the capacity to shift perspectives and restructure information, is strongly influenced by one's positive psychological orientation in dynamic environments. Research in organisational settings confirms that individuals with higher psychological capital are more likely to engage in complex cognitive processing and creative problem solving (Wojtczuk-Turek & Turek, 2015; Devassy & Jindal, 2024). Furthermore, psychological capital has been shown to enhance outcomes related to innovation and adaptive behaviour, particularly in fast-changing, cognitively demanding contexts such as healthcare, information technology and cross-functional team collaboration (Slåtten et al., 2020; Mishra et al., 2019). Taken together, these findings suggest that interdisciplinary psychological capital enhances individuals' cognitive flexibility, enabling them to manage uncertainty, persevere through setbacks and integrate knowledge creatively from diverse domains.

H2: Interdisciplinary innovative psychological capital is positively associated with cognitive flexibility.

Cognitive Flexibility and Innovation Capability

Cognitive flexibility is the ability of individuals or organisations to adapt their thinking and behaviour in response to changing, complex or ambiguous environments. It enables individuals to consider multiple perspectives, integrate diverse knowledge sources and generate creative solutions — all of which are essential for fostering innovation capability. Prior research has emphasised the pivotal role of cognitive flexibility in innovation. For example, Wojtczuk-Turek and Turek (2015) found that employees with high levels of cognitive flexibility are more likely to demonstrate innovative behaviour in the workplace. Similarly, Kiss et al. (2020) demonstrated that CEOs' cognitive flexibility significantly contributes to organisational ambidexterity, i.e. balancing exploitative and explorative innovation. At the strategic level, Kanchanabha and Badir (2021) emphasised that cognitive diversity and interpretative flexibility among top management teams positively influence both incremental and radical innovation capabilities. In the age of social networks and digital transformation, Wang and Thai (2024) also argue that cognitive flexibility is critical for navigating uncertainty and leveraging dynamic capabilities to maintain a competitive innovation edge. Taken together, these findings suggest that individuals or organisations with higher cognitive flexibility are better equipped to develop and implement novel ideas, particularly in complex, interdisciplinary or fast-evolving contexts.

H3: Cognitive flexibility positively influences innovation capability.

Interdisciplinary Collaboration Experience, Cognitive Flexibility, and Innovation Capability

Interdisciplinary Collaboration Experience (ICE) involves working with people from different fields to combine knowledge and solve complex problems. Such collaboration fosters adaptability, perspective-taking and synthesis, which are hallmarks of cognitive flexibility (CF). Gardiner (2020) emphasises that interdisciplinary teamwork encourages 'learning to think together', a process that enhances creative thinking and mental agility. Similarly, Newswander and Newswander (2012) identify interdisciplinary educational settings as effective environments for cultivating cognitive flexibility, particularly in situations requiring adaptive responses. Building on this, Huang (2024) and Kanchanabha and Badir (2021) argue that cognitively diverse and well-coordinated teams encourage innovation by facilitating flexible and integrative thought processes. In this context, cognitive flexibility is a key cognitive mechanism that links interdisciplinary collaboration to enhanced innovation capability (IC), which is defined as the ability to generate and implement novel solutions. As individuals accumulate interdisciplinary experience, they are more likely to develop the cognitive resources necessary for innovative thinking and creative output.

H4a：Cognitive flexibility mediates the relationship between interdisciplinary collaboration experience and innovation capability.

Interdisciplinary Innovative Psychological Capital, Cognitive Flexibility, and Innovation Capability

Interdisciplinary Innovative Psychological Capital (IIPC) — the combination of self-efficacy, optimism, hope and resilience in cross-disciplinary innovation contexts — serves as a crucial psychological resource for navigating complexity and uncertainty. Those with high levels of IIPC are more likely to remain motivated and adaptable in unfamiliar environments. As Wojtczuk-Turek and Turek (2015) have noted, psychological capital enables proactive engagement with change and is strongly linked to cognitive flexibility — the mental capacity to shift perspectives and restructure problem-solving strategies. Furthermore, Devassy and Jindal (2024) argue that psychological capital enhances flexible cognitive processing, equipping individuals to think

divergently and adaptively in innovation-intensive roles. This cognitive adaptability is a key enabler of innovation capability — the ability to generate, refine and implement novel solutions. Research by Pan et al. (2025) and Peng and Chen (2023) shows that psychological capital indirectly facilitates innovative outcomes by promoting dynamic thought processes and behavioural flexibility. Therefore, cognitive flexibility acts as a psychological mechanism through which IIPC contributes to innovation capability, enabling individuals to connect interdisciplinary insights with real-world applications.

H4b：Cognitive flexibility mediates the relationship between interdisciplinary innovative psychological capital and innovation capability.

The Moderating Role of Innovative Self-Efficacy

Cognitive flexibility is the ability to shift perspectives, adapt strategies and generate novel solutions — qualities that are essential for innovation. However, flexible thinking alone does not guarantee innovative outcomes. Research suggests that the ability to translate cognitive flexibility into innovation depends on an individual's confidence in their own innovative capabilities, often referred to as innovative self-efficacy. Liu et al. (2018) emphasise that self-efficacy enables individuals to apply flexible cognition effectively under pressure. Similarly, Gill et al. (2021) and Jiatong et al. (2021) found that self-efficacy moderates the link between cognitive adaptability and entrepreneurial behaviour, highlighting its motivational role. In innovation-driven environments, individuals with high innovative self-efficacy are more likely to act on creative ideas, take calculated risks and persevere in the face of ambiguity. Furthermore, Alves and Yang (2022) assert that self-belief enhances one's willingness to engage in open and experimental thinking, thereby transforming mental flexibility into tangible innovation. Thus, innovative self-efficacy acts as a critical enabler, strengthening the pathway from cognitive flexibility to innovation capability by reinforcing action-oriented confidence and resilience.

H5：Innovative self-efficacy moderates the relationship between cognitive flexibility and innovation capability, such that the relationship is stronger when innovative self-efficacy is high

RESEARCH METHODOLOGY

Research Design

This study employed a quantitative, cross-sectional research design to examine the cognitive and psychological mechanisms underlying innovation capability within interdisciplinary learning contexts. Based on Social Cognitive Theory (Bandura, 1986), the research model examined mediating and moderating effects using Partial Least Squares Structural Equation Modelling (PLS-SEM). Key constructs, including interdisciplinary collaboration experience, interdisciplinary innovative psychological capital, cognitive flexibility, innovative self-efficacy and innovation capability, were captured using a structured self-report questionnaire. This design was chosen for its effectiveness in capturing complex latent constructs and testing multiple relationships simultaneously within a theoretical framework. The PLS-SEM approach, executed via SmartPLS 4.0, was deemed appropriate due to its ability to model mediators and moderators in small-to-medium sample sizes and its suitability for exploratory studies with predictive objectives (Hair et al., 2019).

Sample and Data Collection

The sample consisted of baccalaureate, interdisciplinary or practice-based undergraduate students from polytechnical and applied science vocational colleges. These students were chosen because they are potentially exposed to cross-disciplinary activities and problem solving contexts. A non-probability purposive sample was obtained to have 197 students2 across twelve programs of study (Engineering, Information Technology, Business and Education) collecting valid responses. The course organizers and providers, as well as online learning platforms, were contacted to recruit participants. To guarantee the quality of data, participants who finished all domains in the questionnaire were included in the final analysis. Subjects The study has been approved by the institutional Research Ethics Board and all participants gave a written informed consent.

Measures

All the scales used in the following study were assessed using established multi-item scales, some of which referred to earlier validated instruments. The scales operated on a 5-point Likert response scale, where 1 = Strongly Disagree and 5 = Strongly Agree. Interdisciplinary collaboration experience was measured using a four-item scale based on Gardiner's (2020) work, which evaluated the extent to which participants had engaged in cross-disciplinary learning. Interdisciplinary innovative psychological capital was assessed using four items adapted from Wojtczuk-Turek and Turek (2015). These items measured respondents' optimism, hope, resilience and self-efficacy

in interdisciplinary innovation contexts. Cognitive flexibility was measured using the Cognitive Flexibility Inventory (Dennis & Vander Wal, 2010), which focuses on the use of flexible and adaptable mental tendencies to aid adaptation and accommodation of cognitive approaches. Innovation capability was measured using four items from Kanchanabha and Badir (2021), centring on the ability to produce, develop and implement innovation. Innovative self-efficacy was assessed using items from Liu et al. These items were used to study one's self-assessment of confidence in performing innovation tasks under ambiguity and time pressure. A brief description of the definition and examples for each construct is shown in Table 1.

Data Analysis

The hypothesized structural relationships were tested using SmartPLS 4.0. The analysis proceeded in two stages. First, the measurement model was evaluated for internal consistency, convergent validity and discriminant validity, using composite reliability, average variance extracted (AVE) and the Fornell–Larcker criterion. Secondly, the structural model was assessed to examine the significance of the direct, mediating and moderating effects. Bootstrapping with 5,000 resamples was used to estimate the path coefficients, t-values and effect sizes (f^2). Predictive relevance (Q^2) was evaluated using the blindfolding procedure. This methodological approach ensured the robust estimation of the psychometric quality of the measurement instruments and the empirical validation of the theoretical model proposed in Chapter 2.

RESULT

Demographic Statistics

This study analysed 197 valid questionnaires completed by vocational college students, providing a balanced demographic overview. The gender split was almost equal, with 98 males (49.75%) and 99 females (50.25%), ensuring perspectives from both groups were equally represented. The age distribution centred on traditional college years, with a slight majority aged 20–21 (101 students, 51.27%), followed by 18–19 (63 students, 31.98%) and a smaller group aged 22 or above (33 students, 16.75%). This confirms the sample's predominantly young cohort — an audience likely to engage readily with emerging technologies and adaptive learning strategies. Grade-level data showed that second-year students contributed the largest share (76 students, 38.58%), followed closely by first-year students (71 students, 36.04%), with third-year students accounting for the remainder (50 students, 25.38%). Therefore, most respondents had at least one full year of academic experience, offering insights anchored in both introductory and more advanced coursework. Academic disciplines were broadly represented. The biggest cluster was Engineering and Manufacturing (43 students, 21.83%), followed by Information Technology (33 students, 16.75%) and Finance and Business (30 students, 15.23%). Smaller yet still significant groups included Education and Sports (7.61%), Tourism and Hospitality (6.60%), Medicine and Health (6.09%), Arts and Design (5.58%), and several other fields, each accounting for roughly 2% to 5% of the sample. This diversity ensures the study captures a cross-sectional view of vocational learners with varied exposure to digital tools and interdisciplinary knowledge. Taken together, this demographic profile provides a solid foundation for interpreting how vocational students perceive AI integration, innovation self-efficacy and collaborative learning environments in subsequent analyses.

Table 1 Discriminant Validity

Variable	Category	Frequency (N)	Percentage (%)
Gender	Male	98	49.75
	Female	99	50.25
	Total	197	100
Age	18-19 years	63	31.98
	20-21 years	101	51.27
	22 years and above	33	16.75
	Total	197	100
Grade Level	Year 1	71	36.04
	Year 2	76	38.58
	Year 3	50	25.38
	Total	197	100
Field of Study	Engineering and Manufacturing	43	21.83

	Information Technology	33	16.75
	Finance and Business	30	15.23
	Education and Sports	15	7.61
	Tourism, Hotel and Catering Services	13	6.6
	Medicine and Health	12	6.09
	Arts and Design	11	5.58
	Agriculture, Forestry and Fishery	8	4.06
	Civil Engineering and Architecture	9	4.57
	Transportation	7	3.55
	Public Management and Social Service	6	3.05
	Environmental Protection	4	2.03
	Other	6	3.05
	Total	197	100

Reliability and Validity

The model of measurement indicates good psychometrical properties (Table 2). Cronbach's α values are between 0.866 (ICE) and 0.927 (IIPC), and both composite reliability indices (ϱ_a and ϱ) exceed 0.90 in all the constructs, indicating good internal consistency. Convergent validity is also adequate: the AVE of each construct surpasses the 0.50 threshold, ranging from 0.714 (ICE) to 0.821 (IIPC), which means a substantial part of the variance of indicators is explained by their targeted underlying construct. Discriminant validity meets rigorous criteria. The square roots of AVE (not shown but calculated from Table 2) in the Fornell–Larcker matrix (Table 4) are higher than all inter-construct correlations and additional HTMT tests (all < 0.90) also ensure that each construct is separately distinguished. Multicollinearity is negligible. All VIF values within models (Table 3) range from 1.100 to 1.603, indicating multicollinearity is not an issue. Analysis of effect sizes demonstrates a large-sized influence of CF on IC ($f^2 = 0.550$), with the authors of the remaining direct and interaction pathways carried out small-to-medium-sized effects ($f^2 = 0.031–0.243$). Taken together, these results establish the measurement model as reliable and valid in order to proceed with a further structural analysis of how the focal constructs interrelate within the framework (Figure 2).

Table 2 Construct reliability and validity

	Cronbach's alpha	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Average variance extracted (AVE)**
CF	0.886	0.886	0.923	0.751
IC	0.904	0.909	0.934	0.779
ICE	0.866	0.878	0.909	0.714
IIPC	0.927	0.927	0.948	0.821
ISE	0.894	0.910	0.926	0.759

Table 3 Construct variance inflation value and effect size values

	VIF	**f-square**
CF -> IC	1.552	0.550
ICE -> CF	1.340	0.133
IIPC -> CF	1.340	0.243
ISE -> IC	1.603	0.059
ISE x CF -> IC	1.100	0.031

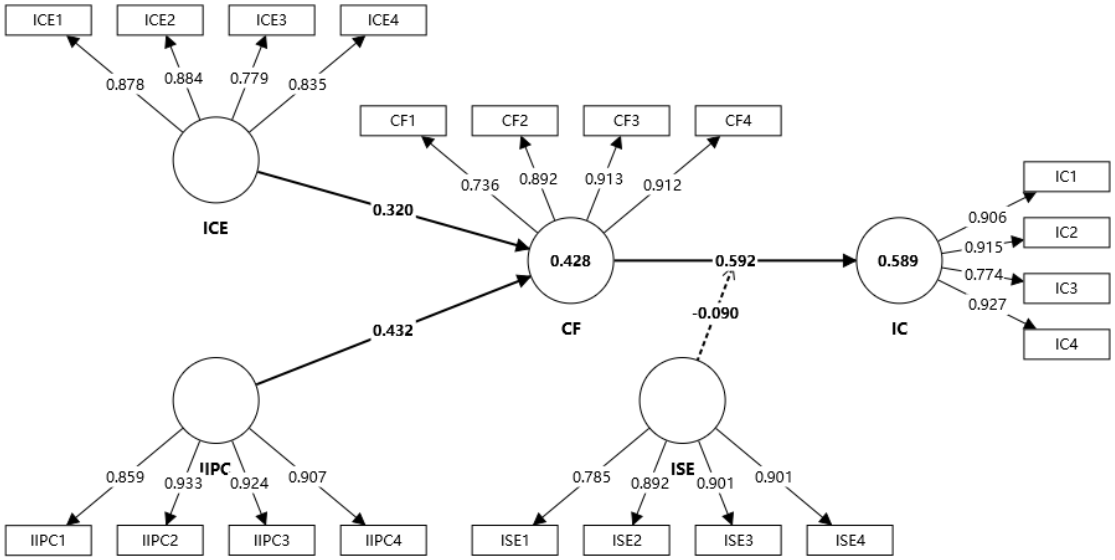

Figure 2. Structural Model of Interdisciplinary Collaboration Experience, Cognitive Flexibility, and Innovation Capability

Table 4 Discriminant Validity

	CF	**IC**	**ICE**	**IIPC**	**ISE**
CF					
IC	0.825				
ICE	0.608	0.591			
IIPC	0.653	0.526	0.566		
ISE	0.671	0.639	0.659	0.766	
ISE x CF	0.249	0.330	0.230	0.127	0.302

Hypothesis Testing Results

This section presents the structural model results examining the direct and interaction effects of key predictors on vocational students' innovation capability, as detailed in Table 5.

Direct Effects

- Hypothesis 1 (H1) proposed that cultural familiarity (CF) has a positive influence on innovation cognition (IC). This was strongly supported, with a path coefficient of 0.592 ($t = 7.405$, $p < 0.001$), indicating a significant and substantial direct effect.
- Hypothesis 2 (H2) posited that intercultural communication efficacy (ICE) would have a positive impact on cultural familiarity (CF). This hypothesis was also supported ($\beta = 0.320$, $t = 4.688$, $p < 0.001$), suggesting that students with higher communication efficacy experience a stronger sense of cultural familiarity.
- Hypothesis 3 (H3) examined the effect of interdisciplinary and intercultural practice capability (IIPC) on cultural familiarity (CF) and was also supported ($\beta = 0.432$, $t = 6.151$, $p < 0.001$), thereby reinforcing the importance of practical, integrative experiences in fostering cultural adaptation.
- Hypothesis 4 (H4) tested the influence of innovation self-efficacy (ISE) on innovation cognition (IC). This was supported by a path coefficient of 0.197 ($t = 2.190$, $p = 0.029$), indicating a moderate yet significant effect.

Moderating Effects

Hypothesis 5 (H5) examined the moderating effect of ISE × CF on the relationship between cultural familiarity (CF) and innovation cognition (IC). The interaction term showed a negative coefficient ($\beta = -0.090$, $t = 1.837$, $p = 0.066$), but this was not statistically significant at the 0.05 level. Therefore, this hypothesis was not supported, suggesting that the effect of cultural familiarity on innovation cognition remains relatively consistent across different levels of innovation self-efficacy. Overall, the results indicate that CF, IC, IIPC and ISE are significant direct predictors of innovation-related outcomes, with CF playing a central mediating role. While the moderation by ISE was not statistically significant, the pattern suggests possible interaction dynamics that warrant further

exploration. These findings emphasise the importance of developing students' intercultural skills, practical experience, and self-belief to encourage innovation in vocational education settings.

Table 5. Hypothesis Testing

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	
CF -> IC	0.592	0.607	0.080	7.405	0.000	Supported
ICE -> CF	0.320	0.325	0.068	4.688	0.000	Supported
IIPC -> CF	0.432	0.430	0.070	6.151	0.000	Supported
ISE -> IC	0.197	0.190	0.090	2.190	0.029	Supported
ISE x CF -> IC	-0.090	-0.085	0.049	1.837	0.066	Not Supported

Predictive Relevance Analysis

The predictive relevance was assessed using the Q^2 statistic based on blindfolding (construct cross-validated redundancy). As shown in Table 6, Innovation Cognition (IC) exhibits strong predictive relevance, with a Q^2 value of 0.449 — well above the 0.35 benchmark indicating a large effect. Cultural Familiarity (CF) also exhibits moderate-to-high predictive relevance (Q^2 = 0.307), indicating that the model meaningfully predicts these two endogenous constructs from the antecedent variables. In contrast, the Q^2 values for Intercultural Communication Efficacy (ICE), Interdisciplinary and Intercultural Practice Capability (IIPC) and Innovation Self-Efficacy (ISE) are all 0.000, confirming that these constructs serve exclusively as exogenous predictors in this framework rather than as predictive targets. Overall, these results demonstrate that the model has substantive out-of-sample predictive power for IC and CF, which reinforces its usefulness in analysing how vocational students develop innovation-related cognitions and cultural adaptation. The absence of predictive relevance for ICE, IIPC and ISE is consistent with their role as explanatory inputs rather than outcomes in the structural model.

Table 6 Construct cross-validated redundancy

	SSO	SSE	Q^2 (=1-SSE/SSO)
CF	788.000	546.271	0.307
IC	788.000	434.042	0.449
ICE	788.000	788.000	0.000
IIPC	788.000	788.000	0.000
ISE	788.000	788.000	0.000

DISCUSSION

This section presents the empirical evidence in support of the proposed cognitive and psychological mechanisms for innovation capability in interdisciplinary settings. Based on an integrative model, our research explored the influence of interdisciplinary collaborative experience and interdisciplinary innovative psychological capital (IIPC) on innovation capability via cognitive flexibility as a mediator and innovative self-efficacy as a moderator.

First, the positive relationship between cross-disciplinary work experience and cognitive flexibility supports assertions by Gardiner (2020) and Newswander and Newswander (2012). Engagement in cross-curricular activities supports flexible thinking and the capacity to look at problems from a range of angles. Hyp. 3 (H2) Evidence suggests that having exposure to multiple knowledge domains increases one's ability to integrate diverse information structures (Brignol et al., 2024). Although the relationship was significant, a modest amount of variance was explained and therefore this could depend on situational influences such as team working and task complexity. Second, the proposed relationship between interdisciplinary innovative psychological capital and cognitive flexibility was also supported. Participants with higher optimism, resilience and hope in the context of interdisciplinary innovation showed a tendency to have not only cognitive adaptation. This finding also confirms that the psychological capital enhances complex cognitive processing (Wojtczuk-Turek & Turek, 2015; Devassy & Jindal Course Hero, 2024). Secondly, cognitive flexibility mediated the impact of both interdisciplinarity antecedents on innovation capability, providing solid evidence for H4a and H4b.

Cognitive flexibility was also proved to exert direct effect on innovation ability. Subjects with high flexibility were more able to generate and apply novel ideas in a complex environment, in line with Kiss et al. (2020) and Wang and Thai (2024). Furthermore, creative self-efficacy moderated the relationship. The relationship between

cognitive flexibility and innovation ability was much stronger for those with high self-efficacy, in support of past findings (Liu et al., 2018; Gill et al., 2021; Alves & Yang, 2022).

IMPLICATIONS

This research has provided two significant theoretical contributions of the extension on Social Cognitive Theory. It empirically supports the cognitive flexibility as a focal mechanism that mediates how interdisciplinary collaboration experience and psychological capital affect innovation capability. It also introduces innovative self-efficacy as a boundary factor that specifies how cognitive responses and motivational beliefs work together to produce innovative behavior. These results add to our knowledge how environmental and internal psychological conditions combine to foster innovation in complex, knowledge-driven environments.

In a practical sense, the findings of this study indicate that organizations interested in nurturing innovation need to engage in structured interdisciplinary projects which expose individuals to multiple perspectives and teamwork. There should also be a focus on the building of psychological capital through specific interventions targeting optimism, resilience and hope (e.g., challenge-based learning, reflective training). To increase cognitive flexibility, use visioning workshops and sessions on "perspective changing". Lastly, self-efficacy could be promoted by developing supportive settings wherein room for experimentation, constructive feedback and small leadership positions were offered to those with the potential to create. These developmental approaches offer a roadmap for transforming individual capabilities into continuous innovation capability.

CONCLUSION

In the current age of complexity, high velocity and multidisciplinary convergence, to develop innovative capability has become a strategic need in the context of education and organizations. It explores the moderating of innovative self-efficacy on the relationship between cognitive flexibility and IC via IIPC combined with the mediating role of both CF and IIPC, based on the interactional effect model. Informed by Social Cognitive Theory, and supported by quantitative analysis of survey data from university students in interdisciplinary learning contexts, the results suggest cognitive flexibility as an essential process through which social and psychological capital can be converted into creative output.

The research provides robust empirical evidence that psychological capital and interdisciplinary experience enhance individuals' cognitive flexibility (including adaptation), and that psychological capital has a direct effect on innovative capability. It also introduces creative self-efficacy as a boundary condition that strengthens the effect of cognitive flexibility on innovation. This indicates that belief in one's innovative capacity significantly determines whether cognitive resources can be utilised effectively. Together, these findings contribute to an integrated picture of how adaptive thinking, motivational beliefs, and cross-boundary practices are interconnected in influencing an individual's innovative capabilities.

The study focuses on theoretical explanations and practical limitations derived from the demographic of its sample. Future studies should investigate these relationships in diverse educational and professional settings, examine the development of longitudinal innovation patterns, and adopt a qualitative approach to the dynamics of cross-disciplinary innovation. With the demand for adaptable, innovative individuals increasing, critical enquiry of this kind is crucial to shaping learning environments and organisational structures that support innovation and equip future individuals with the skills they will need to excel in an era of increasing complexity and collaboration.

Code	Item
Interdisciplinary Collaboration Experience (Gardiner, P,2020)	
ICE1	I have frequently collaborated with individuals from different academic or professional fields.
ICE2	Working with people from diverse disciplines has helped me develop new perspectives.
ICE3	I often participate in projects that require input from multiple disciplines.
ICE4	I enjoy solving problems with people from fields different from my own.
Interdisciplinary Innovative Psychological Capital (Wojtczuk-Turek& Turek,2015)	
IIPC1	I feel confident in my ability to stay positive and hopeful when facing interdisciplinary challenges.
IIPC2	When working across fields, I remain resilient and motivated even when problems become difficult.
IIPC3	I believe I can overcome setbacks in interdisciplinary innovation tasks.
IIPC4	I am optimistic about my ability to succeed in unfamiliar collaborative environments.

Cognitive Flexibility (Dennis& Vander Wal,2010)	
CF1	I can easily shift my thinking when the situation requires it.
CF2	I am able to consider multiple viewpoints when approaching a problem.
CF3	I can adapt quickly when priorities change.
CF4	I enjoy exploring new ways of doing things when faced with challenges.
Innovation Capability (Kanchanabha & Badir,2021)	
IC1	I often come up with new ideas to improve existing processes or solve problems.
IC2	I am able to implement creative ideas effectively in real-world tasks.
IC3	I actively seek novel approaches when addressing a task.
IC4	I generate innovative solutions when working on difficult problems.
Innovative Self-Efficacy (Liu et al.,2018)	
ISE1	I believe in my ability to solve problems creatively when faced with ambiguity.
ISE2	Even in uncertain situations, I feel capable of generating innovative solutions.
ISE3	I am confident in my skills to lead creative initiatives.
ISE4	I trust myself to think of original ideas under pressure.

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