A Preliminary Investigation into Theory-Practice Barriers in Sino-New Zealand Undergraduate Computing Education

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Abstract: This paper investigates the barriers hindering the effective transition from theoretical knowledge to practical application in a Sino-New Zealand double-degree undergraduate computing programme. In this unique educational setting, students study at a campus in China but complete both Chinese and New Zealand courses taught jointly by lecturers from both countries. Through a questionnaire administered to these students, we identify critical obstacles such as insufficient foundational knowledge, language barriers, cultural and pedagogical differences, and difficulties adapting to distinct educational systems. Our analysis reveals that these barriers significantly affect students' academic performance, engagement, and skill development. Based on the findings, we propose targeted interventions, including specialized bridging courses, enhanced language support, refined teaching methods, and improved resource allocation.

1 INTRODUCTION

Imagine a student enrolled in a cooperative double-degree programme hosted on a Chinese campus, where the curriculum integrates both Chinese and New Zealand (NZ) courses. In their first year, students primarily focus on their literature and arts major. Starting in their second year, they transition to studying computing alongside their major courses. Lecturers from both countries contribute to the program, offering distinct pedagogical approaches, educational philosophies, and linguistic perspectives. This unique arrangement blends a literature-based foundation with a computing major, equipping students with interdisciplinary skills while exposing them to diverse academic systems. Successfully addressing the transition from theoretical concepts to practical computing skills is critical to ensuring students achieve both academic success and professional competency. This transition is not only essential for mastering complex computing concepts but also for developing the practical skills necessary for professional careers in a rapidly evolving technological landscape.

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Bridging the gap between theory and practice has become increasingly critical in computing education, particularly in programs that incorporate both cultural and educational diversity. For this study, "technology" refers to tools and systems such as Internet of Things (IoT) devices, automation systems, and the technical skills necessary for programming, data analysis, and problem-solving. Computing education demands mastering complex theoretical concepts through hands-on experimentation and application. Although computing concepts are universal, the transition from theory to practice is complicated by bilingual instruction, differences in pedagogical styles, and students' non-technical backgrounds.

To address these challenges, this research investigates the barriers faced by students in Electronics and IoT, Automation and Embedded Systems courses within the Sino-NZ cooperative program. By examining how these barriers impact educational quality and student outcomes, the study seeks to provide actionable, evidence-based solutions for enhancing learning and teaching practices. The insights gained will benefit not only this program but also similar cross-cultural and interdisciplinary educational initiatives.

Our research question is: *"What barriers hinder the effective transition from theoretical knowledge to practical skills in computing education within*

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the Sino-NZ double-degree programme at our University?"

The remainder of this paper is structured as follows: Section 2 reviews existing research and identifies gaps relevant to this study. Section 3 details the research methodology, including survey design, data analysis techniques, and study limitations. Section 4 presents the results, focusing on the learning challenges and barriers identified, students' experiences and resources, and their interests and career aspirations. Section 5 proposes solutions for overcoming these barriers. Finally, Section 6 concludes the study and suggests directions for future research.

2 RELATED WORK

Research on bridging theory-practice gaps in computing education spans three key areas: applying theoretical knowledge to practice, identifying theory-practice barriers, and developing methods to bridge these gaps.

The first area focuses on applying knowledge from theory to practice, encompassing studies on undergraduate computing courses (Eckerdal et al., 2024; King, 2021; Nascimento et al., 2019), teacher's practices (King, 2021; Randi and Corno, 2007; Bouzguenda, 2013; Zyad, 2016; Tedre and Pajunen, 2022; Yılmaz et al., 2016; Cateté et al., 2020), and secondary school education (Hayes and Overland, 2023; Samarasekara et al., 2024). These studies highlight the importance of bridging theoretical concepts with practical skills, emphasizing hands-on experiences to reinforce learning outcomes in computing curricula. For example, Eckerdal et al. (2024) demonstrates how project-based learning significantly improves students' ability to translate abstract concepts into practical solutions, while Hayes and Overland (2023) explores inclusive approaches in secondary schools that foster early computational thinking.

The second area examines the barriers that impede effective learning and application. Challenges include those faced by women in computer science education (Scragg and Smith, 1998; Bock et al., 2013; Kordaki and Berdousis, 2020), broader student learning obstacles (Pappas et al., 2017; Schulte and Knobelsdorf, 2007), and pedagogical issues from the teacher's perspective (Belland, 2009; Aflalo, 2014; Gretter et al., 2019; Zyad, 2016). Additionally, barriers in coding bootcamps (Thayer and Ko, 2017; Thayer, 2020) and high school education (Wang and Hejazi Moghadam, 2017; Samarasekara et al., 2022) further highlight structural and systemic challenges. For instance, Thayer and Ko (2017) analyze how inadequate preparation and lack of mentorship hinder the success of bootcamp graduates, while Schulte and Knobelsdorf (2007) address the role of student attitudes in learning efficacy.

The third area explores solutions to bridge theory-practice gaps, such as computing education projects (Gelonch-Bosch et al., 2017; Martin, 2004; Giacaman and De Ruvo, 2018), curriculum revisions (Young, 2003; Janse van Rensburg, 2020), and AI-driven tools (Murtaza et al., 2024). For example, Giacaman and De Ruvo (2018) propose a novel project-based learning framework that integrates real-world scenarios, while Murtaza et al. (2024) discuss the application of generative AI in personalizing computing education. These approaches highlight innovative ways to adapt teaching strategies and foster experiential learning.

While existing studies offer valuable insights, they rarely capture the unique dynamics of cross-cultural, double-degree programs like the Sino-New Zealand arrangement.

3 RESEARCH METHOD

3.1 Survey Design and Data Collection

To investigate the learning challenges and barriers faced by students in courses that integrate both theoretical and practical tasks, we designed a structured questionnaire targeting students in the Sino-New Zealand educational programme. The questionnaire consisted of 20 multiple-choice questions and 2 open-ended questions, organized into four main sections: (1) *Demographic Information*, (2) *Learning Challenges and Barriers*, (3) *Students' Experiences and Resources* and (4) *Final Remarks*.

Most questions employed a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree," with an option to skip questions to ensure participant comfort. Open-ended questions were included to capture nuanced feedback and suggestions beyond the scope of the predefined questions.

Before distribution, a pilot test was conducted with six participants from the target population to refine the questionnaire. Feedback from the pilot led to clarifying ambiguous terms, incorporating concrete examples, and streamlining the survey to minimize completion time without sacrificing data quality.

Participants were drawn from one major within the 2021 cohort of the Sino-New Zealand double-degree programme. The majority of participants had a background in literature and arts, reflecting limited exposure to science courses in high school. Data were collected using *Jinshuju* (Jinshuju, 2024), a Chinese online survey platform comparable to SurveyMonkey or Qualtrics. Out of 83 initial submissions, 76 valid responses were analyzed after excluding one incomplete submission and six pilot test responses.

The survey was administered in Chinese to accommodate participants' language preferences. The first author later translated responses into English to facilitate analysis. A complete translated version of the survey is provided at https://github.com/TravisDai/CSEDU_appendix.

3.2 Data Analysis

The collected data were analyzed using both quantitative and qualitative methods:

Quantitative Analysis. Multiple-choice responses were exported to Excel and analyzed using Python to generate visualizations such as bar charts. This analysis revealed patterns and trends, identifying prevalent barriers and their impact on students.

Qualitative Analysis. Open-ended responses were reviewed for typographical errors and irrelevant content before coding. An iterative coding process was used to categorize responses into themes, focusing on common ideas and suggestions.

To ensure reliability, the initial analysis conducted by the first author was independently reviewed by other authors. Discrepancies were discussed and resolved through consensus. This collaborative approach enhanced the robustness of the findings by combining quantitative trends with in-depth qualitative insights.

3.3 Study Limitations

This study has several limitations that may affect the generalizability of its findings:

Participant Demographics. All participants were from a single major within the Sino-New Zealand programme and predominantly had literature and arts backgrounds.

Survey Scope. The questionnaire concentrated on student learning challenges, barriers, and experiences, without exploring broader perspectives such as faculty insights or institutional factors, which could provide additional context.

Translation Bias. Responses were translated into English by the first author, which could introduce bias despite careful attention to accuracy.

Sample Size and Diversity. The relatively small sample size and lack of demographic diversity limit the ability to generalize findings.

4 RESULTS

4.1 Learning Challenges and Barriers

The first part of the questionnaire explored the difficulty in understanding theoretical concepts, challenges in applying theoretical knowledge to practical tasks, barriers in the theory-to-practice transition, and their impacts.

4.1.1 Difficulty in Understanding Theoretical Concepts

All 76 participants rated the difficulty of understanding theoretical concepts in their computing courses. A significant majority (96.1%) found these concepts challenging (see Table 1). This indicates that many students struggle with theoretical aspects, suggesting a need for interventions to make theoretical material more accessible.

Table 1: Perceived Challenging Levels in Understanding and Applying Theory.

Difficulty Level	Understanding Concepts (N=76)	Applying Theory (N=76)
Very Easy	1 (1.3%)	1 (1.3%)
Easy	2 (2.6%)	2 (2.6%)
Moderate	24 (31.6%)	16 (21.1%)
Difficult	31 (40.8%)	35 (46.1%)
Very Difficult	18 (23.7%)	22 (28.9%)

4.1.2 Challenges in Applying Theoretical Knowledge to Practical Tasks

Participants were also asked about the challenging level of applying theoretical knowledge to practical tasks in their computing courses. Most students (96.1%) reported challenges in this area (see Table 1). This underscores a significant issue in the practical application of theoretical concepts within computing courses.

4.1.3 Three Barriers in the Transition from Theory to Practice

To understand the barriers students face, participants were asked to choose three barriers they believe have the worst impact on their computing courses. Eleven barrier options were provided, along with three open-ended entries for additional barriers. All 76 participants responded to this question. The top three barriers identified were: **(1) Insufficient prior knowledge of key computing concepts**; **(2) Language barriers to understanding course materials**; **(3) Difficulty grasping abstract theoretical concepts** (see Fig. 1).

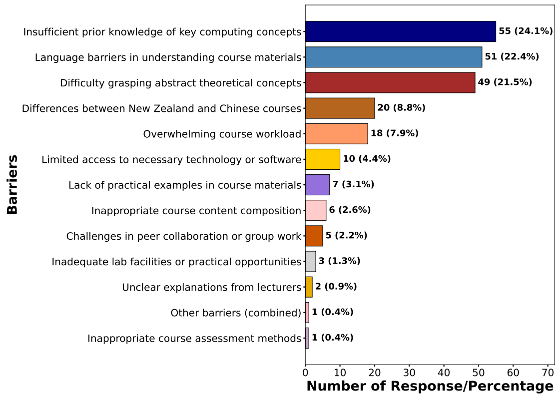

Figure 1: Barriers Distribution in Theory-to-practice Transition by Participants.

Other notable barriers included differences between NZ and Chinese courses, overwhelming course workload, and limited access to necessary technology or software. These findings highlight the complexity of the barriers and their relevance to the research question, suggesting a need for comprehensive and interconnected strategies to address these challenges.

4.1.4 Impact of Identified Barriers

Participants were asked to quantify the impact of the identified barriers on their studies. From Fig. 2, we know that insufficient prior knowledge and language barriers were reported to have moderate to severe impacts by most respondents, with some experiencing extreme difficulties. In contrast, differences between NZ and Chinese courses were seen as having slight to moderate impacts, indicating a less severe overall effect. Limited access to necessary technology or software showed varied impacts, emphasizing the importance of providing adequate technological resources to support learning.

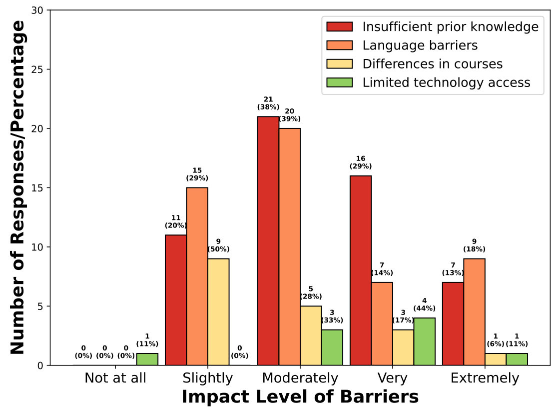

Figure 2: Impact Distribution of Barriers.

4.2 Students' Experiences and Resources

The second part of the questionnaire explored participants' experiences of the resources provided, as well as their overall engagement. We aimed to understand how their previous educational background, the resources provided, and their engagement influenced their current learning experiences in computing courses.

4.2.1 Prior Knowledge

All 76 participants responded to the question about their computing experience level before entering their current courses. The vast majority (94.8%) reported having little or no prior computing knowledge (see Table 2). Only a small fraction rated their prior knowledge as "Intermediate" or "Expert." When asked about the extent to which their previous computing experience helped them perform well in their courses, 53.9% of participants responded. Of these, most found their prior experience helpful to some degree, while a small number felt it was not helpful at all (see Table 3).

Table 2: Distribution of Computing Experience Levels.

Experience Level	Responses (N=76)
No Experience	35 (46.1%)
Beginner	37 (48.7%)
Intermediate	3 (3.9%)
Expert	1 (1.3%)

Table 3: Helpfulness of Prior Computing Experience.

Helpfulness Level	Responses (N=41)
Not at all	3 (7.3%)
Slightly	19 (46.3%)
Moderately	13 (31.7%)
Very	4 (9.8%)
Extremely	2 (4.9%)

4.2.2 Engagement and Its Impact

All 76 participants responded to the question about their level of engagement in computing courses. The majority reported being engaged to some extent, with 93.4% indicating some level of engagement and only 6.6% stating they were "minimal" engaged (see Table 4). When asked whether their level of engagement affects their learning and helps overcome learning barriers, most participants agreed, with 60.5% expressing agreement and 32.4% holding a neutral perspective (see Table 5). Only a small percentage (7%) disagreed.

Table 4: Student Engagement Level in Computing Courses.

Engagement Level	Responses (N=76)
Not at all	5 (6.6%)
Slightly	16 (21.1%)
Moderately	41 (53.9%)
Very	8 (10.5%)
Extremely	6 (7.9%)

Table 5: Impact of Engagement on Learning.

Agreement Level	Responses (N=74)
Strongly Disagree	2 (2.8%)
Disagree	3 (4.2%)
Neutral	23 (32.4%)
Agree	41 (57.7%)
Strongly Agree	2 (2.8%)

4.2.3 Support from Lecturer and Teaching Assistant

Participants were asked about the extent to which support from lecturers and teaching assistants (TA) helped them overcome barriers. All 76 participants responded, with 90.8% indicating that the support was helpful to some degree, and only 9.2% stating they gained no help (see Table 6). These results indicate that support from lecturer and TA plays a crucial role in helping students overcome barriers in their computing courses. The majority found the support at least somewhat helpful, highlighting the importance of accessible and supportive instructors.

Table 6: Helpfulness of Lecturer and TA Support.

Helpfulness Level	Responses (N=76)
Not at all	7 (9.2%)
Slightly	20 (26.3%)
Moderately	36 (47.4%)
Very	11 (14.5%)
Extremely	2 (2.6%)

4.2.4 Impact of the Transition from Chinese to New Zealand Educational Systems

All 76 participants responded to the question about how various cultural teaching methodologies, such as independent learning versus rote memorization-based approaches, influence their learning experiences and outcomes. Responses revealed three distinct viewpoints: 55.3% perceived the transition as having a negative impact on their learning experience, 21.1% reported no impact, and 23.7% perceived a positive impact (see Table 7).

Table 7: Impact of Transition from Chinese to NZ Education System.

Impact Level	Responses (N=76)
Negative	13 (17.1%)
Slightly Negative	29 (38.2%)
None	16 (21.1%)
Slightly Positive	16 (21.1%)
Positive	2 (2.6%)

4.2.5 Advice on Improving Courses

In their open-ended responses, students offered several suggestions for enhancing the courses. Key themes emerged, including:

Emphasize English Proficiency and Fundamental Knowledge. Students (N=7) express language and technical barriers in their study. Two students advised, "We need to enhance our English and computer background, then carry out relevant practice."

Strengthen the Explanation of Technical Terms/Knowledge in Lecture and Provide More Demonstrations in Lab. Students (N=6) request more explanations with examples to help them understand these abstract concepts and need more demonstrations of how to use IoT components. One mentioned: "Lecturers could focus more on the practical aspects of courses and present theory more interestingly and understandably".

Provide In-Time Translation in Class and After-Class Videos to Help Students Better Understand. Students (N=3) request in-time translation and more videos to help them learn and understand. One stated: "Increase the range of available after-class videos and translations to help students better understand the material".

4.3 Interest and Career Aspiration

The third part of the questionnaire explored participants' interests and career aspirations. We aim to understand how these factors influenced their current learning experiences in computing courses.

4.3.1 Interest in Computing Field

Participants were asked about their interest in the computing/computer science field. As shown in Table 8, a significant portion (43.4%) remained neutral, neither agreeing nor disagreeing, while 39.5% expressed a lack of interest in computing. Only 17.1% indicated that they are interested in computing. These findings suggest that many students are indifferent or uninterested in computing, with only a minority expressing interest.

Table 8: Interest Distribution in Computing Field.

Interest Level	Responses (N=76)
Strongly Disagree	7 (9.2%)
Disagree	23 (30.3%)
Neutral	33 (43.4%)
Agree	11 (14.5%)
Strongly Agree	2 (2.6%)

4.3.2 Career Aspiration

For students who did not disagree with the statement regarding their interest in computing, we further examined the alignment between their career aspirations and interests. As illustrated in Table 9, the majority (69.6%) neither agreed nor disagreed, indicating a neutral stance, while 26% agreed that their career aspirations align with their interests. Only a small portion disagreed. This suggests that while some students have a clear alignment between their career goals and interests, the majority remain undecided or neutral.

Table 9: Career Aspirations and Family Influence.

Response	Aspirations Align (N=46)	Family Influence (N=29)
Strongly Disagree	0 (0.0%)	1 (3.4%)
Disagree	2 (4.3%)	7 (24.1%)
Neutral	32 (69.6%)	15 (51.7%)
Agree	10 (21.7%)	3 (10.3%)
Strongly Agree	2 (4.3%)	3 (10.3%)

For students who disagreed with the statement regarding their interest in computing, we explored whether parents, relatives, and friends influence their career aspirations. As shown in Table 9, over half (51.7%) neither agreed nor disagreed, 27.5% disagreed, and 20.6% agreed that their career aspirations are affected by family and friends. This suggests that while external factors influence some students in their career decisions, many remain neutral or unaffected.

4.3.3 Motivation Related to Career

Participants whose career aspirations align with their interests were asked whether a career in computing motivates them and eases overcoming course barriers. As shown in Table 10, over half (54.4%) agreed, 43.5% were neutral, and a few disagreed. This suggests that alignment between career goals and interests is a significant motivator, though the substantial neutral response implies other factors also influence motivation.

Participants influenced by parents, relatives, or friends were asked whether pursuing a non-computing career adds difficulty to engaging with the course. Table 10 shows that half agreed, 32.1% were neutral, and a small fraction disagreed, indicating that external influences may complicate engagement with computing courses.

Table 10: Career Motivation and Difficulty in Course due to Non-computing Career.

Response	Motivation from Career (N=46)	Difficulty in Course (N=28)
Strongly Disagree	0 (0.0%)	2 (7.1%)
Disagree	1 (2.2%)	3 (10.7%)
Neutral	20 (43.5%)	9 (32.1%)
Agree	20 (43.5%)	11 (39.3%)
Strongly Agree	5 (10.9%)	3 (10.7%)

4.3.4 Advice on Study Strategy or Study Resources for Junior Students

In their open-ended responses, students offered valuable advice for junior students beginning their computing studies. Key themes emerged, emphasizing the importance of foundational skills and proactive learning approaches.

Maintain Open Communication with Instructors. Students (N=7) emphasized the importance of interacting with teachers. One suggested, "Learn about computer knowledge and strengthen contact with teachers." Building relationships with instructors can provide additional support, clarify doubts, and enhance overall understanding.

Engage Attentively in Class and Practice Regularly. Students (N=7) stressed the need to be attentive during lectures and to engage in consistent practice. One comment encapsulated this sentiment: "Listen carefully in class and practice more." Active participation and regular practice are seen as key to internalizing computing concepts.

Focus on Learning English and Computer Knowledge. Students (N=6) highlighted the necessity of learning English alongside foundational computer knowledge. One advised, "Focus on learning English and computer knowledge." Proficiency in English is crucial, given that much of the computing literature and resources are in this language.

5 PROPOSED SOLUTIONS

To overcome these barriers and support students in their transition from theoretical knowledge to practical skills, a multifaceted approach is essential. Below are detailed solutions supported by evidence from educational research:

1. Enhancing Foundational Knowledge and Language Proficiency
Barriers Addressed: Insufficient prior knowledge, language barriers, difficulty understanding theoretical concepts.

- Implement structured preparatory pathways that integrate bridging courses, language assistance, tutoring, and mentorship programs. These should cover computing fundamentals, technical vocabulary, and bilingual materials, leveraging peer mentorship to address both technical and linguistic challenges (Zyad, 2016).
- Leverage AI-powered tools, such as Large Language Models (LLMs), to provide real-time translation and contextualized computing explanations. Unlike basic translation tools (e.g., Google, Baidu Translate), LLMs handle domain-specific terminology, offer interactive explanations, and reduce the cognitive load of learning technical content in a second language (Molina et al., 2024).
- Establish language assistance programmes, including technical vocabulary courses and bilingual materials. Tailored language support has been linked to reduced academic stress and improved outcomes (Gretter et al., 2019).

2. Bridging Educational Systems and Promoting Cultural Support
Barriers Addressed: Differences in educational systems, cultural differences, language barriers.

- Offer orientation sessions or student exchange programs to acclimate students to differences between NZ and Chinese educational systems. Transition programmes have proven effective for international students (Phillips, 2005).
- Conduct cultural integration workshops to foster mutual understanding between students and educators. Linking these workshops with orientation sessions can provide a cohesive approach to addressing cultural differences, language challenges, and adaptation to different educational systems. Enhancing cultural awareness helps reduce misunderstandings and improve classroom dynamics (Hasker and Harriehausen-Muhlbauer, 2007).
- Organize activities such as *English Corners* to improve language skills and cultural familiarity, promoting active learning (Hayes and Overland, 2023).

3. Fostering Interest in Computing and Career Guidance
Barriers Addressed: Lack of interest in computing, unclear career pathways.

- Provide career counselling services or academic support to align academic content with career goals, which motivates students (Martin, 2004).
- Establish mentorship programmes connecting students with industry professionals/academic scholars to inspire and guide them (Resch and Schrittesser, 2023).
- Highlight diverse computing applications through case studies and real-world examples, which effectively increase engagement (Giacaman and De Ruvo, 2018).

4. Providing Technological Resources and Managing Workload
Barriers Addressed: Limited access to technology, difficulty with practical tasks, overwhelming workload.

- Ensure access to technology and software through computer labs, software licenses, and loaner laptops. Provide user-friendly resource guides to facilitate the effective use of these tools, as they are essential for bridging the theory-practice gap (Thayer and Ko, 2017).
- Design balanced curricula integrating theory and practice while avoiding excessive workloads (Aflalo, 2014).
- Offer time management and study skills workshops that are linked to reduced stress and improved academic outcomes (Reimer, 2019).

5. Adapting Teaching Methods to Increase Engagement
Barriers Addressed: Difficulty understanding theoretical concepts, applying theory to practice, lack of interest in computing.

- Introduce curricular adjustments and instructional strategies that integrate practical exercises and career-oriented learning approaches to enhance student engagement and improve the transition from theory to practice (Drymiotou et al., 2021).
- Implement flipped classrooms to encourage active learning during class time (Eckerdal, 2015).
- Highlight real-world applications of computing to demonstrate relevance and foster interest (Young, 2003).

Grounding these solutions in research ensures their reliability and applicability. Together, they create a supportive learning environment addressing the diverse needs of students and enhancing academic outcomes.

6 CONCLUSIONS AND FUTURE WORK

This study identifies significant barriers to the effective transition from theoretical knowledge to practical skills in the Sino-NZ double-degree computing programme. Key challenges include insufficient foundational knowledge, language barriers, cultural and pedagogical differences, and an overwhelming course workload. Additionally, student interest, motivation, and career aspiration can further exacerbate these challenges. Addressing these issues requires an integrated, multi-faceted approach. Strategies such as preparatory bridging courses, targeted language support, and culturally responsive teaching methods are essential to creating an inclusive and effective learning environment. The proposed interventions include tailored mentorship programmes, balancing theoretical and practical content in the curriculum, and fostering student interest through real-world applications of computing. By implementing these strategies, the programme can better equip students to overcome learning barriers and achieve academic and professional success. Furthermore, these findings offer valuable insights for similar cross-cultural educational initiatives.

Future work should involve collaboration with faculty and administrators to assess the feasibility of integrating support mechanisms, such as supplemental tutorials and mentorship programs, without overburdening the existing curriculum. Longitudinal studies are essential to evaluate the long-term impacts of the proposed interventions on students' academic performance and career trajectories. Comparative analyses with other international cooperative programmes could also identify universal challenges and effective solutions.

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