



## A comprehensive analysis of academic performance, self-confidence, motivation, and communication in calculus courses: Insights from international and local students

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### Abstract

Taiwan's rapid development in education is evidenced by its high ranking in the 2022 PISA assessment, making it an attractive destination for international students. National Dong Hwa University, particularly its Department of Computer Science and Information Engineering (CSIE), has become popular among these students. This study focuses on the impact of integrating local and international students in calculus courses, a required subject, due to the close relationship between mathematics and computer science. The study sampled 14 international and 14 local first-year students, collecting data through questionnaires to assess their self-confidence, communication skills, and motivation. At the same time, academic performance was measured through midterm exam scores. The findings revealed significant differences in academic performance, self-confidence, and communication between local and international students, with p-values of .024\*, .016\*, and .012\*, respectively. Among international students, self-confidence and communication were significantly correlated with academic performance ( $p=.013^*$  and  $p=.026^*$ ), while for local students, a significant relationship was found between scores and communication ( $p=.035^*$ ).

**Keywords:** calculus academic performance; communication; international students; local students; motivation; self-confidence

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## Introduction

The internationalization of education in Taiwan is a multifaceted process influenced by various factors. Studies highlight the importance of factors beyond economic growth, such as tuition costs, visa regulations, and perceptions of educational quality, in attracting international students (Li, 2023). Taiwan's New Southbound Policy emphasizes the psychological dimension to support international students, focusing on optimism and emotional regulation to predict resilient behavior (Radiamoda, 2024). Integrating international students into Taiwan's education system is crucial for addressing challenges like declining birth rates and enhancing the quality of education (Lundegjantsan, 2022). However, promoting English as a medium of instruction (EMI) in Taiwanese higher education institutions faces structural inequalities and institutional logic challenges, potentially widening horizontal inequalities among institutions (Huang, 2024). By continuously optimizing international development strategies, enhancing cross-cultural communication, and fostering equality in education, Taiwan is solidifying its position as a top choice for international students, showcasing a commitment to inclusivity and educational excellence.

Integrating students from diverse linguistic, familial, and national backgrounds in a single class presents significant challenges that impact student characteristics and behaviors. Research emphasizes the importance of exploring the effects of such integration on self-confidence, communication, and motivation (Michala, 2024). Specifically, studies highlight the language-related barriers international students face, affecting their listening comprehension and communication experiences (Diaz, 2024). Additionally, cultural awareness and sensitivity are needed to promote successful language learning among students from different backgrounds (Brainee, 2024). Understanding the dynamics of adjustment, acculturation, language barriers, and motivation is crucial for enhancing the experiences of both international and local students in shared learning environments (Atobatele, 2024). By addressing these factors holistically, educational institutions can create inclusive and supportive environments conducive to academic achievement and personal growth.

Research gaps in this area remain, particularly in understanding how self-confidence, motivation, and communication influence academic outcomes within calculus courses in mixed classrooms (local and international students). Most existing studies either focus on one of these factors or examine students in isolated groups (either local or international) without exploring their interplay in a shared educational environment. More research is needed to explore how the interaction of these psychological and social factors—self-confidence, motivation, and communication—affect academic performance in diverse, multicultural classrooms, particularly in mathematically intensive subjects like calculus. Additionally, while qualitative studies have provided valuable insights into the challenges faced by local and international students, there is a lack of quantitative studies that rigorously assess the relationship between psychological factors (like self-confidence and motivation) and academic performance in calculus courses. Furthermore, the existing research tends to focus on general measures of academic success (e.g., GPA) rather than specific course performance or subject-related assessments. More quantitative research is needed to measure the direct relationship between

self-confidence, motivation, communication, and academic outcomes in highly specialized courses such as calculus.

The research conducted at National Dong Hwa University in Taiwan focuses on the impact of internationalization on student characteristics in a mixed classroom environment, particularly in mathematics education (Ramjan, 2024). Multicultural learning, which integrates culture into the learning process, can significantly address challenges related to integrating students from different countries into one classroom (Pangaribuan, 2024). Understanding the experiences of international students transitioning to university mathematics is crucial for providing effective support in a foreign educational setting (Locke, 2023). Furthermore, professional development incorporating intercultural learning can enhance teachers' practices and create a culture of belonging for all students in mathematics and science education (Sorge, 2023). Educators can foster awareness, understanding, and tolerance among students by developing mathematics learning models based on multicultural education, ultimately improving mathematics achievement and creating a conducive learning environment (Masykur, 2023).

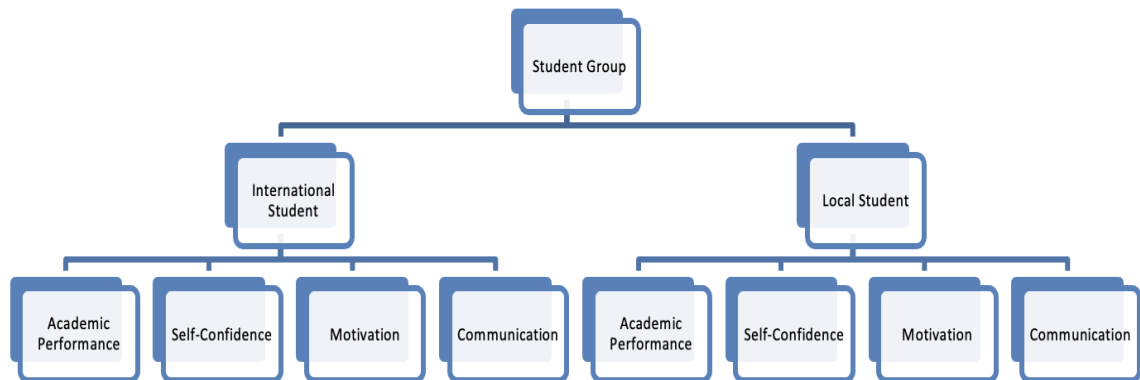
## Methods

This study was conducted among first-year students in the Computer Science & Information Engineering (CSIE) program at Dong Hwa National University. The study's primary focus was on students from diverse academic and cultural backgrounds, including both international and local students. To better understand the diversity of the participants, the study began by collecting detailed participant characteristics through a survey conducted at the beginning of the study. The survey included demographic information such as nationality, previous educational background, language proficiency, and other relevant factors, allowing for a clear profile of the diverse backgrounds of the participants. The students came from 11 different countries.

The decision to focus on first-year students in the CSIE program was made due to the nature of the program itself. Computer science and information engineering are fields that rely heavily on mathematical reasoning, problem-solving, and analytical skills, making courses such as calculus essential for students in the program. Additionally, the CSIE program at Dong Hwa National University is known to attract students from a variety of countries, offering a unique opportunity to study how cultural diversity and different educational experiences can impact academic performance, self-confidence, communication, and motivation in technical courses such as calculus. Given the highly structured and rigorous nature of the program, this setting provides an ideal context to explore the dynamics of integration and the factors that impact local and international students.

The primary objective of this study is to compare the levels of self-confidence, communication skills, motivation, and academic performance in calculus between international and local first-year students enrolled in the Computer Science & Information Engineering (CSIE) program at National Dong Hwa University. The population of this research is the first-year students enrolled in the CSIE program. The sample of this research consist International

Students (14 students) and Local Students (14 students). Purposeful sampling to ensure representation of both international and local students. As a flowchart of the following research design:



**Figure 1.** Flowchart of research design

This study has independent and dependent variables as follows:

1. Independent Variable: Student group (International vs. Local)
2. Dependent Variables:
  - a. Self-confidence in learning calculus (measured by a questionnaire)
  - b. Communication skills in the classroom (measured by a questionnaire)
  - c. Motivation to learn calculus (measured by a questionnaire)
  - d. Academic performance in calculus (measured by midterm exam scores). Academic performance in calculus was measured by midterm exam scores, as midterm exams are a standard, widely accepted method of assessing students' understanding of core concepts and problem-solving abilities at a critical point in the semester, providing an objective measure of their academic progress.

In this research, there were two instruments, namely questionnaires and students' calculus test scores. Questionnaire: A validated questionnaire assessed self-confidence, communication skills, and motivation. The questionnaire used in this research was administered once to assess self-confidence, communication skills, and motivation to learn calculus, with the survey consisting of two parts. The first part collected the demographic characteristics of the respondents (e.g., age, gender, academic background), while the second part focused on the three key aspects that influence student success in learning calculus. The survey was designed in English to ensure clarity and accessibility for the students participating in the research. The questionnaire includes Likert scale items tailored to measure each construct. Academic Performance Data: Midterm exam scores from the calculus course. Each construct was measured using a series of Likert-scale items, which allowed participants to express their level of agreement or disagreement with various statements on a scale (e.g., 1 = Strongly Disagree to 5 = Strongly Agree). Example questions from each section of the questionnaire could include:

1. Self-Confidence in Learning Calculus: "I believe I can successfully solve most calculus problems" (Likert scale: Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree).

2. Communication Skills in Learning Calculus: "I feel comfortable asking questions in class when I don't understand a concept in calculus" (Likert scale: Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree).
3. Motivation to Learning Calculus: "I enjoy solving calculus problems because I find them interesting" (Likert scale: Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree).

The responses to these questions were used to quantitatively assess students' self-reported confidence, communication abilities, and motivation levels in relation to their calculus learning experience. This structure ensures that the questionnaire provides comprehensive insight into the factors that might influence academic performance in calculus, while also allowing for comparisons across different demographic groups.

The research procedure consists of:

1. Recruit participants from the first-year CSIE students, ensuring equal representation of international and local students, and informed consent was obtained from all participants, ensuring adherence to ethical guidelines and university-approved research protocols.
2. Administer the validated questionnaire to all participants via an online survey to assess self-confidence, communication skills, and motivation in learning calculus.
3. Collect the midterm exam scores of the participants from the 2018 calculus course.

The primary instrument for data collection for this study was a validated questionnaire. The questionnaire was designed to assess three key constructs related to students' experiences in calculus: self-confidence, communication skills, and motivation. This conceptual framework explores the key factors influencing student success in learning calculus, focusing on self-confidence, communication skills, motivation, and academic performance. Self-confidence shapes students' belief in their ability to master calculus concepts and solve problems, directly impacting their persistence and engagement. Communication skills enable students to express ideas, seek help, and collaborate, fostering deeper understanding and problem-solving abilities. Intrinsic and extrinsic motivation drives students to invest time and effort in learning calculus, influencing their engagement and performance. Academic performance, measured through midterm exam scores, reflects the cumulative effect of these factors, providing an objective measure of students' conceptual understanding and problem-solving skills. Together, these elements interact to determine how well students succeed in calculus, and by analyzing these components, educators can identify strategies to enhance learning outcomes and improve overall student performance in the subject.

#### 1. Self-Confidence in Learning Calculus

This section of the questionnaire contained items that measured the students' belief in their ability to succeed in calculus. The responses to these items provided a quantitative measure of the students' self-confidence, which is crucial for academic success, especially in challenging subjects like calculus.

#### 2. Communication Skills in the Classroom

This section assessed the students' communication skills within the classroom setting, particularly in the context of learning calculus. These items were designed to evaluate how well students could express their ideas, seek help, and collaborate with peers, which are essential skills for learning complex subjects.

### 3. Motivation to Learn Calculus

The motivation section aimed to capture the students' intrinsic and extrinsic motivation to engage with calculus. The responses provided insights into the factors driving students' engagement and effort in the course, which could influence their overall performance.

### 4. Academic Performance

The second instrument involved in this study was the students' midterm exam scores from the 2018 calculus course. These scores served as an objective measure of each student's academic performance in calculus. The midterm exam was designed to evaluate students' understanding of the fundamental concepts covered in the first half of the course, including problem-solving skills and the ability to apply calculus principles in various contexts.

After data collection, the responses from the questionnaire were quantitatively analyzed to compare the differences between the two student groups (international vs. local). The independent samples t-test was employed to determine whether the two groups had statistically significant differences in self-confidence, communication skills, motivation, and academic performance. This statistical test is appropriate for comparing the means of two independent groups on continuous dependent variables, such as self-confidence, communication skills, and academic performance (measured through calculus test scores). The t-test was chosen because it is designed to assess whether the observed differences between the two groups are statistically significant, essential for understanding how international and local students differ in their learning experiences. For categorical data (e.g., group membership), the independent samples t-test allows for the examination of continuous variables, ensuring that the differences in variables like self-confidence and academic performance between international and local students are evaluated using the correct statistical method. This approach ensures that the data was analyzed appropriately to assess the impact of various factors on students' experiences in learning calculus.

This research was built upon the following hypotheses:

1. **Academic Performance Discrepancy:** There is a significant difference in calculus scores between international and local students at National Dong Hwa University, Taiwan.
2. **Confidence Variation:** International and local students at National Dong Hwa University differ significantly in their levels of self-confidence in learning calculus.
3. **Communication Differences:** There is a noticeable difference in communication skills between international and local students at National Dong Hwa University.
4. **Motivational Distinction:** The level of motivation to learn calculus differs significantly between international and local students at National Dong Hwa University.
5. **Interrelationship Among Variables:** There is a significant relationship between self-confidence, communication skills, motivation, and calculus scores among both international and local students at National Dong Hwa University.

These hypotheses aim to uncover the distinct educational experiences and outcomes of international versus local students in the same academic environment, offering insights into how cultural and linguistic diversity may influence learning in a calculus course.

## Results

This research findings provide answers to the initial hypothesis proposed at the start of the study:

### First hypothesis (academic performance)

**Table 1.** Comparison of score

Group	n	<i>p</i>
International Students	14	.024*
Local Students	14	

$p < .05^*$   $p < .01^{**}$

The results of the first hypothesis revealed a significant difference in calculus scores between international and local students at National Dong Hwa University, with a p-value of .024\*, indicating that the observed difference is unlikely due to chance. Local students generally outperformed their international counterparts, which may be attributed to factors such as greater language proficiency, familiarity with the educational system, and fewer cultural adjustment challenges faced by local students. These findings suggest the need for targeted interventions, including language support and cultural orientation programs, to assist international students in overcoming barriers to academic success. Overall, this significant performance gap highlights the importance of developing strategies to create a more equitable learning environment for all students.

### Second hypothesis (self-confidence)

**Table 2.** Comparison of self-confidence

Group	n	<i>p</i>
International Students	14	.016*
Local Students	14	

$p < .05^*$   $p < .01^{**}$

The results of the second hypothesis indicated a significant difference in self-confidence levels between international and local students at National Dong Hwa University, with a p-value of .016\*. This finding suggests that local students exhibited higher self-confidence in their ability to succeed in calculus compared to their international peers. Factors contributing to this disparity may include language barriers, cultural differences, and a lack of familiarity with the academic environment among international students, which can undermine their confidence. This highlights the importance of implementing supportive measures, such as confidence-building workshops and mentorship programs, to enhance the self-confidence of international students and facilitate their academic success. Overall, addressing these self-confidence issues is crucial for improving the educational experiences and outcomes of all students.

**Third hypothesis (communication skills)****Table 3.** Comparison of communication

Group	n	<i>p</i>
International Students	14	.012*
Local Students	14	

*p*<.05\* *p*<.01\*\*

The results of the third hypothesis demonstrated a significant difference in communication skills between international and local students at National Dong Hwa University, with a *p*-value of .012\*. This finding indicates that local students generally possess stronger communication skills in the context of learning calculus compared to their international counterparts. Contributing factors may include greater fluency in the language of instruction and more familiarity with the local academic culture, which can enhance their ability to articulate ideas and collaborate effectively in group settings. This disparity emphasizes the need for targeted interventions, such as cross-cultural communication training and collaborative learning opportunities, to help international students improve their communication skills. By fostering better communication, educational institutions can create a more inclusive environment that supports the academic success of all students.

**Fourth hypothesis (motivation)****Table 4.** Comparison of motivation

Group	n	<i>p</i>
International Students	14	.225
Local Students	14	

*p*<.05\* *p*<.01\*\*

The results of the fourth hypothesis indicated no significant difference in motivation to learn calculus between international and local students at National Dong Hwa University, with a *p*-value of .225. This finding suggests that both groups exhibit similar levels of intrinsic and extrinsic motivation towards their calculus studies, despite the observed differences in academic performance and self-confidence. The lack of disparity may imply that factors influencing motivation, such as personal interest in mathematics or future career aspirations, are relatively consistent across both student populations. However, this underscores the importance of continuing to engage and motivate all students, as fostering a strong motivation can still play a critical role in enhancing their overall academic experience and outcomes, particularly in challenging subjects like calculus.

**Fifth hypothesis (interrelationship among variables)****Table 5.** Relationship between students' behavior and score

Group	Self-Confidence	Motivation	Communication
International Students	.013*	.246	.026*
Local Students	.110	.322	.035*

*p*<.05\* *p*<.01\*\*



The results of the fifth hypothesis revealed significant correlations between self-confidence, communication skills, and academic performance among international students, with p-values of .013\* for self-confidence and .026\* for communication skills, indicating that both factors positively influence their calculus scores. In contrast, only communication skills showed a significant relationship with academic performance for local students, at a p-value of .035\*, while self-confidence did not demonstrate a notable effect. While enhancing self-confidence and communication is crucial for the academic success of international students, local students may primarily benefit from improved communication skills to perform well academically. These findings highlight the importance of tailored interventions that address the specific needs of each student group, fostering both self-confidence and communication skills to enhance overall learning outcomes in calculus courses.

The results substantiate the first three hypotheses, indicating significant differences between international and local students' academic performance, self-confidence, and communication skills. However, there was no significant difference in motivation levels. Furthermore, the interrelationship analysis revealed that self-confidence and communication positively correlate with academic performance among international students, while only communication had a significant relationship with local students. These findings underscore the complexities of integrating international and local students in calculus courses and the varying factors influencing their academic experiences.

## Discussion

There are significant differences in various aspects between international and local students in Taiwan. For instance, international students displayed lower susceptibility but higher anxiety levels compared to local students (Ahorsu, 2021). Additionally, prediction models for academic performance showed varying results for international, local, and students with disabilities, with different algorithms outperforming others based on the student group (Huynh-Cam, 2022). Moreover, a study on online learning behavior revealed positive relationships between Taiwanese and international students' intention to use online learning platforms, with percentages varying between the two groups (Lundegjantsan, 2022). Furthermore, research on cross-cultural adaptation of international students in Taiwan emphasized the importance of cultural intelligence in addressing adaptation challenges, suggesting a focus area for universities dealing with international students (Lawrence, 2011). The study's results, which involved 384 international students, showed that cultural intelligence significantly positively impacts cross-cultural adaptability. It emphasizes that students with high cultural intelligence can better navigate challenges in different cultural environments. Considering these findings, it is recommended that National Dong Hwa University in Taiwan implement tailored support programs focusing on cultural intelligence and mental health to enhance the learning outcomes and overall experience of international and local students.

The significant difference in self-confidence between international and local students at National Dong Hwa University in Taiwan, as indicated by a p-value of .016\*, suggests a noteworthy disparity that warrants attention (Ahorsu, 2021). International students may face

unique challenges, such as language barriers and cultural differences, impacting their self-confidence levels compared to local students. It is recommended that the university implement tailored support programs focusing on enhancing international students' practical skills and confidence, particularly in areas where they feel less confident, such as performing clinical procedures (Gazibara, 2019). Additionally, promoting cross-cultural communication and cultural intelligence among students and faculty could help bridge the gap and create a more inclusive and supportive learning environment for all students (Lawrence, 2011). Cultural intelligence plays an important role in students' ability to adapt to new socio-cultural environments, helping them overcome adaptation challenges. (Rahmawati, 2018)

Based on the data indicating a significant difference in communication skills between international and local students at National Dong Hwa University in Taiwan, it is recommended to implement targeted cross-cultural communication training programs for both groups (Kittot, 2022). These programs should focus on enhancing intercultural communication competence, which has been shown to positively impact academic performance among international students (Kittot, 2022). Additionally, creating a cross-culturally tolerant environment within the university campus can greatly enhance students' cross-cultural competence, leading to better communication skills and mutual understanding between international and local students (Chen, 2015). By promoting cultural intelligence, self-efficacy, and cross-cultural communication skills, universities can facilitate smoother cross-cultural adaptation for international students in Taiwan, ultimately fostering a more inclusive and supportive academic environment (Lawrence, 2011).

Based on the data showing no significant difference in motivation between international and local students at National Dong Hwa University in Taiwan (Fan, 2011; Ching, 2014), it is recommended to implement cross-cultural workshops and activities to foster interaction and understanding between the two student groups. These workshops can include cultural exchange events, language exchange programs, and collaborative projects to enhance cross-cultural communication and adaptation (Lawrence, 2011). Additionally, providing mental health support services tailored to the specific needs of international students, who may face higher levels of anxiety and stress (Ahorsu, 2021; Ching, 2014) can contribute to their overall well-being and academic success. By creating a supportive and inclusive environment, the university can promote a sense of belonging and facilitate a positive academic experience for all students.

The data from the various research papers highlights the importance of self-confidence and communication for international students compared to local students. Specifically, the findings indicate that self-confidence and communication significantly impact international students' learning outcomes, with p-values of .013\* and .026\*, respectively. On the other hand, for local students, only communication shows a significant relationship with learning outcomes, with a p-value of .035\*. At the same time, self-confidence does not significantly affect their academic performance (Olutola, 2023). Interventions focusing on enhancing self-confidence and communication skills could be particularly beneficial for international students to improve their academic achievements and overall learning experience. In contrast, for local students, emphasis on communication skills may be more crucial for academic success (Olutola, 2023).

## Conclusion

The findings of this study reveal significant differences in scores, self-confidence, and communication skills between international and local students at National Dong Hwa University. These disparities underscore the importance of paying close attention to these key components, as they directly influence student outcomes. The differences in academic performance between international and local students, particularly among first-year students, highlight the need for educators and policymakers to explore effective solutions for fostering a more inclusive and supportive learning environment. As Taiwan continues to welcome international students, the resulting multicultural dynamics within classrooms necessitate thoughtful educational strategies. Both teachers and education policymakers must work together to design systems that cater to the needs of both international and local students, recognizing the challenges they face, including cultural adjustment and academic shock.

The study further indicates that self-confidence and communication skills are strongly correlated with academic performance among international students. Students who scored higher in calculus also demonstrated higher self-confidence, while those with lower scores exhibited reduced confidence. Additionally, the communication skills of local students were found to significantly impact their academic performance, suggesting that communication plays a crucial role in student success. In light of these findings, educators must prioritize the development of effective communication strategies within the classroom to enhance student engagement and performance. Furthermore, building and maintaining students' confidence should be a key focus, particularly among international students, as it is closely linked to their academic achievements. By addressing these areas, educational institutions can better support the diverse needs of their student populations and help ensure academic success for all.

Despite the valuable insights gained from this study, there are a few limitations that should be noted. First, the sample size of 28 students (14 international and 14 local) was intentionally chosen for this exploratory analysis, given the specific context of the research and the nature of the student population at National Dong Hwa University. While the sample size is relatively small, it allows for an in-depth understanding of the differences between international and local students in the specific setting of the CSIE program. Additionally, the use of midterm exam scores as the sole measure of academic performance provides a snapshot of students' progress at a critical point in the semester, but future research could benefit from considering multiple assessment points (e.g., final exam scores or overall course grades) to capture a more comprehensive picture of academic achievement. The focus on self-confidence, communication, and motivation was deliberate to examine key psychological and interpersonal factors, yet other variables, such as prior academic experience or social integration, could provide valuable insights into the broader context of student success. Moreover, the cross-sectional design offers valuable insights into students' experiences at a particular moment, and longitudinal studies could help track how these factors evolve over time. Lastly, while self-reported data introduces the possibility of response biases, it remains an effective method for understanding students' perceptions and experiences. Future research could complement these self-reports with objective measures to further enrich the findings.

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## Conflicts of Interest

Authors have no competing interests. In addition, the writers have addressed ethical concerns like plagiarism, misconduct, data fabrication and falsification, double publishing and submission, and redundancy

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## Author Contributions

**Ramadoni:** Conceptualization, writing—original draft, methodology, formal analysis, editing, investigation and visualization; **Tai Chien Kao:** formal analysis, editing, and investigation; **Hafizah Delyana:** Supervision, validation, formal analysis, Writing—review & editing, visualization; **Anna Cesaria:** Writing—review & editing, and visualization. **Arie Purwa Kusuma:** Writing—review & editing.

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