SINGAPORE POLYTECHNIC AND POLIBATAM TRANSNATIONAL COLLABORATIVE STUDENT PROJECT: INITIAL EXPLORATION

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ABSTRACT

This paper describes the insights gained from a transnational learning collaboration of a capstone project between Singapore Polytechnic (SP), School of Mechanical and Aeronautical Engineering (MAE) and Politeknik Negeri Batam, Indonesia or Polibatam (PB). It highlights the constraints and the benefits using framework outlined by Augouri (2023, p.9) for a deeper academic collaboration in an international setting. It emphasises the importance of cross-cultural sensitivities, transdisciplinary coordination and practical learning experiences in institute of higher learning, and how synergies could be forged in an international collaboration. Both institutions involved being members of the CDIO (Conceive, Design, Implement, and Operate) international network, therefore the CDIO Framework lends itself readily to facilitate such cross-border collaboration. The deployment of the CDIO framework and its relevance and the benefits in bringing about the learning outcomes needed to prepare graduates in an interconnected global working environment were discussed. 13 students comprise of 3 nationalities were grouped to observe their collaboration process, guided by faculties from SP and PB. The student teams from both countries aimed to use their domain knowledge to solve the problem faced by a household in a village in Batam, Indonesia.

KEYWORDS

Transnational Collaboration, Transdisciplinary, Capstone Project, CDIO Standards: 5-8

INTRODUCTION

Internationalisation of curriculum has been a common feature in many schools globally for many years. This can be observed by the many students social and cultural exchange programmes before and after the COVID-19 pandemic period. Many Institutes of Higher Learning (IHL) also allow students to gain credit by reading a few courses abroad, usually via credit transfer. Overseas capstone programme is also well documented. Bovill C. et al (2015, p.13) observed that “internationalization are often responding to national and global pressures to maximise knowledge transfer, where knowledge is viewed as a global commodity.”. While the advantages from the learning outcomes are obvious, the resource intensive nature of such learning can be challenging when educators have to work in a different environment culturally. In Singapore recently, there has been a strategic shift from the Singapore’s Ministry of Education (MOE, 2024) with a "70-70" initiative which aims for 70% of local IHL students to have some form of overseas exposure, and 70% of these students to have exposure to ASEAN countries, China or India (ACI). The authors feel that transnational learning fosters collaborative and cross-cultural competence by enabling students to work in multi-disciplinary, transnational teams, engage in international projects, and develop strong communication skills. Innovation and systems thinking are emphasized through design thinking, sustainability integration, and understanding the global impact of engineering solutions. The author also feels that such collaboration affords good opportunity to bring about transdisciplinary learning outcomes among participating students. McPhee *et al* (2018, p.3) described the difference between transdisciplinary, multidisciplinary and interdisciplinary innovation. Transdisciplinary approaches place disciplinary interaction “in an integrated system with a social purpose, resulting in a continuously evolving and adapting practice”. He pointed out that a “by-product of transdisciplinary innovation is that the integrated solution contributes back to the disciplines it drew upon to evolve them, too”. Angouri (2023, p.9) highlighted the benefits of transnational collaboration illustrated in figure 1.

Angouri (2023) noted that: “The complexity of problems faced by modern society requires universities, as generators of new knowledge and educators of the future global citizens, to find ways to transcend national, discipline and linguistic borders in research, innovation, teaching and learning. The changing population demographics, skills gap agenda and geopolitical changes also necessitate a rethink of the types of education and the modalities of the offering that should be available to the citizens of the future”. (p.8)

Attempts were made to link these benefits from the CDIO skillsets perspective and how transnational collaboration can be an effective strategy in bringing out the CDIO skillsets.

In terms of transnational learning collaboration, it is one notch higher and hence resource intensive. The CDIO (Conceive, Design, Implement, Operate) framework lends itself an effective milestones and skillsets for planning and executing transnational collaborations. Due to policy and culture differences, many blind spots have to be uncovered. To forge for a deeper transnational collaboration with as part of curriculum design, a capstone project would be a good start to explore academic and resource requirements and constraints faced by partnering institutes. This will eventually pave the way for a sustainable scaling up of the collaboration.

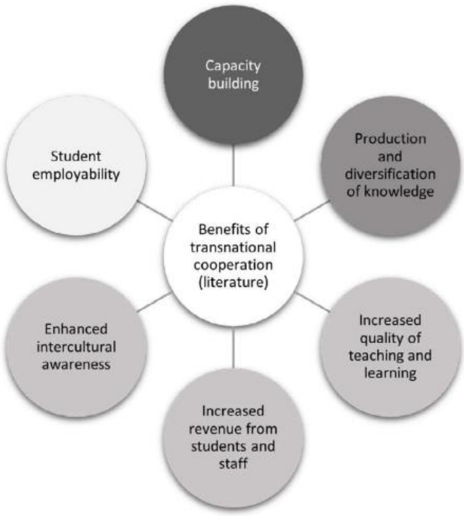


Figure 1: Benefits of transnational collaboration (Angouri 2023, p.9)

BACKGROUND ON JOINT SP-PB CAPSTONE PROJECT

SP is an early adopter and had piloted with CDIO in 2004 to transform its engineering education. This was later expanded to all engineering programs in 2008 with the objective of transforming unmotivated and uninterested first-year engineering students into engineering graduate who are innovators with a social cause. To this end, empathy studies to uncover unmet needs of stakeholders (using Design Thinking) was infused into the C-D stages of the framework. Since then, CDIO has continued to be an important part of education in SP. For examples, Soh (2010, 2011) had demonstrated that the CDIO is a meaningful framework in capstone projects in SP. SP recognizes that key learning outcomes for polytechnic education are to equip students with both technical competencies and global collaboration skills. Given the increasing importance of transnational learning, these outcomes should align with preparing students to work effectively in an interconnected world. Soh et al (2014) for example explored a 2-week transnational programme, engaging multidisciplinary students, using their domain knowledge to solve real-world social issues. However, the geographical distance between institutions posed significant logistical challenges to bring together students from different IHLs for relatively longer periods of time to work together to complete the full CDIO cycle. The advent of technology especially affordable online video conference call now made such endeavours more realizable.

This transnational collaboration with Polibatam (PB) is therefore a renewed effort to execute a transnational program. Both are members of the international CDIO community. A relatively newcomer, PB adopted the CDIO Framework in 2021 as a pilot to enhance the quality of project-based education and learning in the Applied Bachelor of Robotics Engineering Study Program. This initiative was later expanded to 18 study programs at PB. The collaboration between the School of Mechanical and Aeronautical Engineering (MAE) from Singapore Polytechnic (SP) and Polibatam (PB) is a natural fit due to their geographical proximity to one another and an emphasis on project-based learning while teaching relevant disciplinary skills and knowledge.

The SP-PB collaboration aims to provide students with cross-cultural, multidisciplinary and practical learning experiences. The project involves students and staff from both polytechnics working together on a social project to help a household in Batam produce banana chips with improved safety and productivity. The project involves transdisciplinary collaboration involving engineering students from Electronic Engineering, Mechatronic Engineering, Instrumentation Engineering and Aeronautical Engineering.

TRANSNATIONAL PROJECT COLLABORATION FRAMEWORK

The project was divided into four phases: Conceive, Design, Implement, and Operate. As illustrated in Figure 2, both institutions had decided to meet in-person at the end Conceive and Operational phases. Online milestone meetings were set before the project "kick off" and the end of Design phase. MS Team and Zoom were used for online milestone meetings although students often rely on messaging tool such as WhatsApp for communication. Katsumata et al (2020, p.20) observed that "Intercultural telecollaboration projects increase cultural knowledge and skills". Hence, online mode of collaboration can be an economical and effective tool. In a trans-national setting, it is highly possible that divergence of ideals and solutions would occur. The supervisors from both institutions adopted a flexible approach by allowing a possibility of delivering multiple solutions to the stakeholders. From the bold central arrow, as shown in figure 2, attempts were made to guide students to converge (thin arrows) as best as possible at every stage. If divergence (thin arrows) were unavoidable, the team could possibly end up with 2 sets of solutions. By working closing with each other, the team decided at the Implementation stage to deliver one solution, but each group will take care of fabricating different portion of the final product. Throughout the whole process, business students would have to rework their analysis based and marketing plans based on the latest Engineering updates. Design students focus on packaging while the media students came up with good storyline to develop a video documentary of the product creation process. Face-to-face meeting in Indonesia for assembly and delivery, and training were provided to the stakeholder premise.

The project timeline is as shown in Figure 3. While students from both SP and PB started on week 1 by meeting online, actual work from SP students started on week 3 after their examination. Hence, they missed the on-site empathy studies using the Design Thinking process and both teams will do their own ideation separately based on established data points. Occasionally, students communicated remotely (e.g. WhatsApp) to update each other. They meet in-person on week 5 to share their outcomes and to finalise their design direction. Students from SP are progressing with the end of design phase by themselves as BP students are preparing for their mid-semester test from week 8 to week 11.

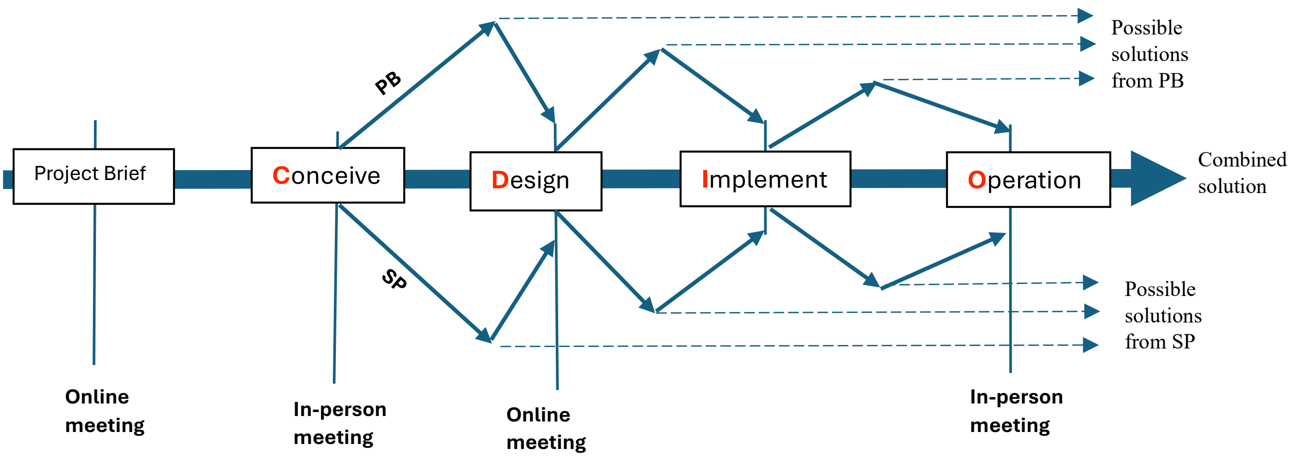


Figure 2: Divergence and convergence of ideas at each project phase

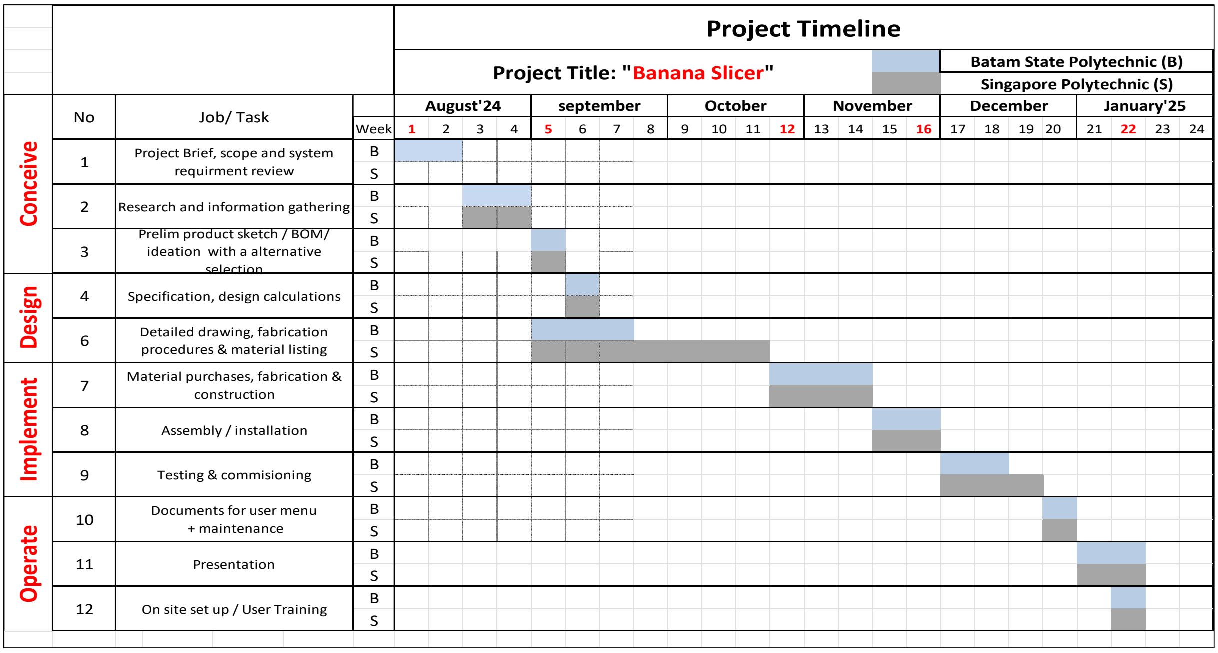


Figure 3: Project timeline of Polibatam

Students' Feedback

Students were asked to provide their views on the benefits of an international collaboration, what went well and what can be further improved on. This is to gain insights from the project, challenges faced and how they were overcome, and the impact of the collaboration on their personal and professional development. The main results are summarized in Table 2, and the major findings discussed.

When asked if they find international collaboration useful for executing their project, all responded positively. The students' feedback highlights the significant benefits of their transnational learning experience. Working with international partners brought innovative ideas, enriched design and functionality, and provided new perspectives, especially in engineering and the CDIO framework. This collaboration improved their cross-cultural communication, teamwork, and problem-solving skills while exposing them to diverse standards and approaches, contributing to their professional development. The experience facilitated valuable knowledge exchange and offered insights into different work cultures and technological approaches. Even initial unsuccessful attempts served as valuable learning experiences, reinforcing the importance of cultural nuances and interpretation.

The students indicate that their collective project faced significant challenges, primarily due to misinformation and technical issues. Additionally, incomplete information and misunderstandings during the conceive stage led to improper tool selection. Delays in budget planning and issues with storage of materials further complicated the project, highlighting the need for better coordination and expertise in future attempts. To improve the flow of the project, students suggested that it is essential to enhance communication within the team, conduct more detailed research on machine requirements, and engage experts to refine the machine's functionality. Testing prototypes early will identify and address issues, while better understanding of materials and tool compatibility through direct surveys will minimize errors.

The most frequently reported challenges in remote international collaboration were language barriers, lack of face-to-face interaction, and time zone differences. Despite these challenges, most students rated communication and overall teamwork effectiveness as 'Well' or 'Very Well', indicating that teams were generally able to overcome barriers and collaborate successfully.

Table 2. Students' feedback on their transnational collaboration

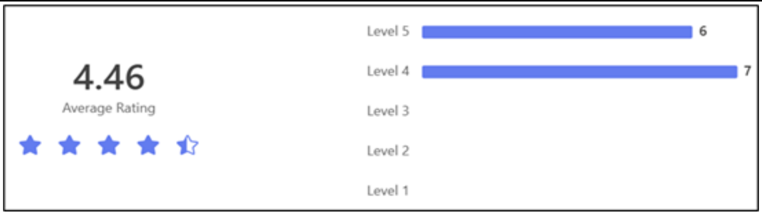
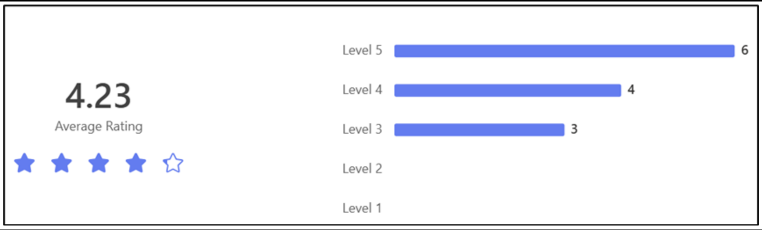
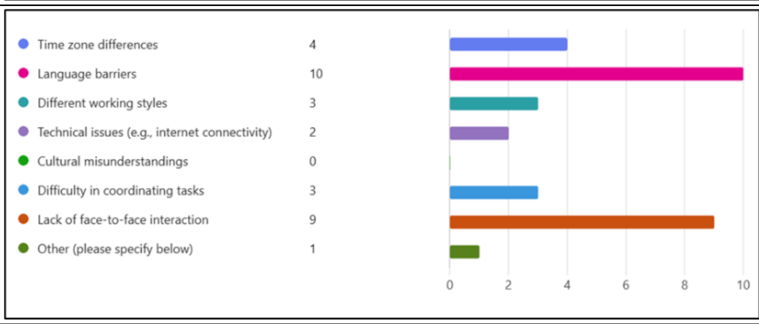
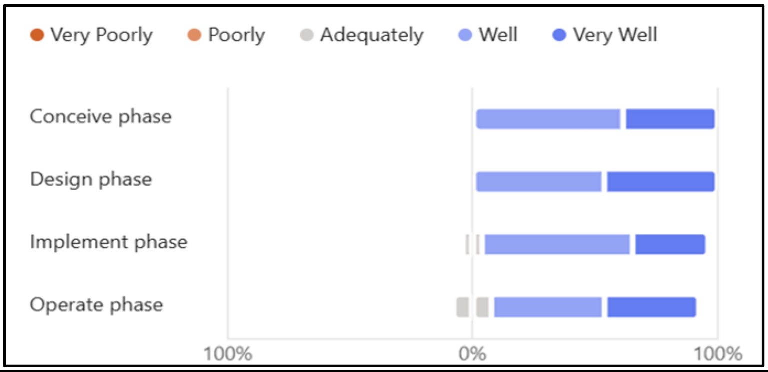
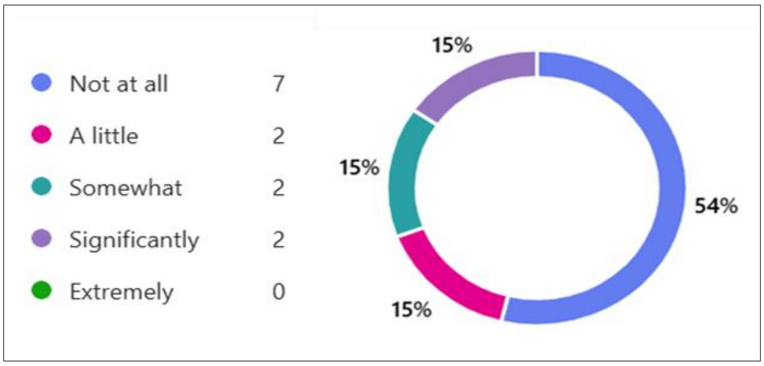
Effectiveness of teamwork between Singapore Polytechnic and Batam state Polytechnic students?	
How effective was the communication among team members during the project?	
Challenges you faced while working remotely with team members from a different country and discipline.	

Table 2 (Cont'd)	
How well did the team collaborate during the different project phases?	
To what extent did cultural differences influence your team's dynamics and project work?	
Suggestions to improve future international and interdisciplinary collaborations?	

LEARNING POINTS FROM FACULTY REFLECTIONS

The transnational project served as a powerful catalyst for both student growth and institutional learning. The collaboration between students from PB and SP has many advantages for students. Students can improve their interpersonal skills, such as teamwork and communication skills. Because this project was conducted by two different institutions coming from different countries, Indonesia and Singapore, communication skills, especially in English, are essential for students and educators.

Transnational capstone project can be resource intensive. A trip from Singapore to Indonesia Batam involved additional budget for ferry tickets, working permit (even for a few hours of physical meeting) and travel insurance. Angouri (2023, p.42) concluded that "true international collaboration is achieved when it is deeply and fully embedded in the daily experience of students and staff. To build on momentum, we need to approach internationalisation with a new holistic approach which must cut across resourcing, careers, administrative/pedagogical support, and infrastructure". Faculty reflections affirmed that transnational collaboration successfully delivers broad academic and professional benefits to both institutions and students, validating the 6 benefits outlined by Angouri (2023).

Capacity Building

The international collaboration between Polibatam and Singapore Polytechnic in the implementation of Project-Based Learning has contributed significantly to capacity building, particularly within Polibatam. Several lecturers and laboratory technicians gained new experiences and insights that can be applied to institutional development at Polibatam.

One notable example is the application of design thinking in the implementation of project-based learning. A sound understanding of design thinking is essential for lecturers, laboratory technicians, and students, as it supports the development of innovative products and services.

In addition, this transnational project has had a positive impact on improving the quality of laboratory equipment and materials. The collaborative initiative created opportunities for laboratories—especially mechanical and electrical laboratories—to acquire new equipment and components. Internally, Polibatam provided institutional support to enhance the capacity of selected laboratories in order to effectively support the collaborative project with Singapore Polytechnic.

Production and Diversification of Knowledge

Working across national borders facilitates a "by-product of transdisciplinary innovation" where solutions contribute back to the original disciplines, evolving them further. By integrating engineering, business, and media disciplines in a transnational setting, students and staff generate new knowledge that transcends linguistic and national borders. This diversification is essential for addressing the complexity of problems faced by modern society.

Increased Quality of Teaching and Learning

The collaborative project contributed to the enhancement of teaching and learning quality for lecturers, laboratory technicians, and students at Polibatam. Polibatam lecturers and laboratory technicians gained valuable knowledge regarding project management practices and idea development through communication and joint project implementation with lecturers and students from Singapore Polytechnic. This collaborative activity also served as a benchmarking reference for Polibatam in the development of curricula within relevant study programs, particularly by providing insights into the implementation of capstone projects in the teaching and learning process.

Furthermore, students from the Electrical Engineering program at Polibatam benefited substantially from collaboration with students from Singapore Polytechnic, who came from a different discipline, namely Mechanical Engineering. Knowledge and exposure to mechanical design and fabrication processes offered new learning experiences for Polibatam students. Improvements in teamwork and communication skills were also evident among Polibatam students as a result of their participation in the collaborative project.

Increased Revenue from Students and Staff

Essentially, lecturers, laboratory technicians, and students from Polibatam did not receive direct financial benefits from the implementation of this collaborative project, as it was specifically designed as a community engagement initiative. The products developed through the project were donated to Micro, Small, and Medium Enterprises (MSMEs) in Batam. Nevertheless, Polibatam lecturers, laboratory technicians, and students gained substantial indirect benefits, including valuable experience, enhanced insights, skill development, and the establishment of new professional networks.

Enhanced Inter-cultural Awareness

The transnational project between Polibatam and Singapore Polytechnic enhanced awareness of the importance of cultural differences brought by lecturers, laboratory technicians, and students from both institutions. Polibatam lecturers, laboratory technicians, and students became more aware of the cultural diversity embodied by their counterparts from Singapore Polytechnic, allowing differences in culture and background to be recognized as natural and non-disruptive to the collaborative process. Such intercultural awareness facilitates students' development of knowledge, perspectives, and skills, particularly in preparation for future opportunities to study, work, or travel abroad in environments characterized by different cultural contexts.

Student Employability

Polibatam students involved in the collaborative project with Singapore Polytechnic gained numerous benefits, including improved English language proficiency, adaptability skills, teamwork, intercultural awareness, and communication competence. Several of the skills developed through participation in this transnational project constitute valuable elements of students' professional portfolios, which can be leveraged when applying for employment after graduation. This is particularly relevant in the context of Batam, where most industries operate as multinational companies with strong international working cultures. Students who are already accustomed to, or have prior experience in, international collaboration are therefore more likely to have enhanced employment opportunities within these industries.

AREAS OF IMPROVEMENT

From the authors' experience supervising this project, the following points are recommended:

- Administrative and Policy support: As highlighted by Angouri (2023), a well-structured policy enables sustainable collaborations in the future. Partnering institutions need to establish comprehensive administrative protocol (e.g. signing of a Memorandum of Cooperation and IP agreements), to streamline the operation of transnational learning projects. Fulfilling national policies such as the 70-70 initiatives and targeting on ASEAN, China and India institutions would provide rationale to push forward the implementation of such learning projects.
- Resource allocation: Transnational collaborations for design and implement experiences are resource intensive. For continual engagements with strategic partners, special funding must be set aside beyond hardware and software development. Expenses for transport, working visas, food and insurance coverage must be considered. In situation where students need to bring fabricated parts overseas for final assembly of the project, it would be good to prepare relevant documents for the custom clearance (see appendix) and to check for any cost incurred.
- Pedagogical Synchronisation: Despite a staggered in academic calendar by 2 weeks and the difference in cultures, both institutions had coped well mainly because both are CDIO collaborators and students were taught the Design Thinking methodology. Future collaborations should emphasise more on the "social" dimension so that

students would understand the purpose of their endeavours and not just fulfil the technical requirements.

CONCLUSION

This transnational capstone collaboration between Singapore Polytechnic (SP) and Politeknik Negeri Batam (PB) demonstrates the potential of international, cross-cultural, and transdisciplinary project-based learning in engineering education. Anchored in the CDIO framework, the project brought together students from diverse nationalities and disciplines to address a real-world problem faced by a household producing banana chips in Batam. With emphasis on empathy studies during the Conceive phase of the project, the team was able to meet the stakeholder's technical expectations. Furthermore, the collaboration succeeded in achieving important learning outcomes related to communication, empathy, teamwork, and iterative problem-solving.

The challenges encountered—including cultural differences, misaligned academic calendars, remote coordination, and technical setbacks—highlight the complexity and resource-intensive nature of such initiatives. Nevertheless, the students gained valuable exposure to global work practices and intercultural collaboration. Faculty reflections affirmed that the project deepened student learning through stakeholder engagement and iterative prototyping and laid the groundwork for sustained partnerships. To scale and sustain such collaborations, future efforts should focus on streamlining administrative processes, aligning academic timelines, and enhancing remote collaboration tools. Ultimately, this model offers a meaningful pathway to prepare graduates for an interconnected and complex global landscape.

ACKNOWLEDGEMENTS

The authors from SP and PB received no financial support for this work.

The GenAI tool Gemini was used in the review of the AREAS of IMPROVEMENT section of this paper. It essentially entails the use of Gemini to “read up” some papers from the author's own manual keywords search of the Internet using Google, whereby Gemini then provide key summaries that are of relevance to this paper. The author then writes this part of the paper using his own words. The prompts used and responses obtained can be found in the LINK.

REFERENCES

Angouri, J. (2023). Transnational Collaboration and Mobility in Higher Education: Looking Back – Looking Forward. The Guild Insight Paper No.4, Intensive Universities and Bern Open Publishing. https://www.the-guild.eu/publications/insight-papers/the-guild_insight-paper_transnational-collaboration_june-2023.pdf

Bovill, C., Jordan, L. and Watters, N. (2015). Transnational approaches to teaching and learning in higher education: challenges and possible guiding principles. *Teaching in Higher Education, 2015*

Vol. 20, No. 1, 12–23, http://dx.doi.org/10.1080/13562517.2014.945162

Katsumata, E., & Guo, S.C. (2020). Intercultural Learning Through a Telecollaboration. Project: Video Conferences and Presentations Between Taiwanese and Japanese University Students. *The Aoyama Journal of International Politics*, Economics and Communication, No. 105.

Koster, J.N. (2012). HYPERION: A Follow the Sun Design Experience. *Proceedings of the 8th International CDIO Conference*, Queensland University of Technology, Brisbane.

McPhee, C., Bliemel, M. & van der Bijl-Brouwer, M. (2018). Editorial: Transdisciplinary Innovation. Technology Innovation Management Review, Vol. 8, issue 8.

MOE (2024). Parliamentary replies: Disruption in overseas exposure programme. https://www.moe.gov.sg/news/parliamentary-replies/20210224-disruption-in-overseas-exposure-programme.

Soh, K.F, (2010). CDIO as a Meaningful Framework for Final Year Aerospace Projects, *Proceedings to the 4th International Symposium on Advances in Technology Education (ISATE)*, Kagoshima, Kanazawa Institute of Technology.

Soh, K.F. (2011). An Observational Study of Infusing Design Thinking into the CDIO framework. *Proceedings of the 7th International CDIO Conference,* Copenhagen, Denmark: Technical University of Denmark.

Soh, K.F. & Kristian, N. (2014). Promoting Sustainable and Social responsible Mindset Through A Transnational Programme Using The CDIO Framework. *Proceedings of the 10th International CDIO Conference*, Universitat Politècnica de Catalunya, Barcelona, Spain.

BIOGRAPHICAL INFORMATION

Hendawan Soebhakti is an Assistant Professor in Robotics Engineering Technology and Expert Staff to the Vice Director for Academic Affairs at Politeknik Negeri Batam. He is a lead driver of Project-Based Learning (PBL) and the CDIO framework, overseeing the institutional CDIO Taskforce. His pedagogical interests include robotics for STEM education, while his research focuses on autonomous mobile robots and industrial automation.

Muhammad Arifin is the Coordinator of the Electronics Manufacturing Engineering Study Program at Politeknik Negeri Batam. He leads the curriculum development team and the institutional CDIO Taskforce, guiding multidisciplinary departments in the adoption of CDIO and Outcome-Based Education. His work focuses on aligning engineering education with institutional strategy and industrial standards.

Nanta Fakih Prebianto is the Coordinator of the Electronics Engineering Technology Study Program at Politeknik Negeri Batam. Drawing on his previous experience in the oil and gas sector, he focuses on strengthening the linkage between industry and academia. His pedagogical interests center on implementing CDIO-based learning and promoting Project-Based Learning as a tool for applied research with social impact.

Abdurahman Dwijotomo is a lecturer in the Mechatronics Study Program at Politeknik Negeri Batam. With a Ph.D. from Universiti Teknologi Malaysia, his expertise lies in control systems and automation. His research focuses on the development of Electronic Control Units (ECUs) and SLAM-based navigation systems for autonomous vehicles, integrating advanced automation technology into the engineering curriculum.

Kim-Fai Soh is the Senior Manager for the Teaching and learning unit in the School of Mechanical and Aeronautical Engineering, Singapore Polytechnic. He is also the Programme Chair for Common Engineering. His pedagogical interests include authentic and experiential learning with deep industrial participation and global collaborative learning, fostering real-world experiences that prepare students for the challenges of a globalized engineering landscape.

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Appendix: Document prepared for custom.

KEMENTERIAN PENDIDIKAN TINGGI,
SAINS, DAN TEKNOLOGI
POLITEKNIK NEGERI BATAM
Jalan Ahmad Yani, Batam Centre, Kecamatan Batam Kota, Batam 29461
Telepon +62 778 469856 - 469860, Faksimile +62 778 463620
Laman: www.polibatam.ac.id, Surel: info@polibatam.ac.id

No. 1626/PL29/VII/2025

Batam, 17th July 2025

To:
Mr. Soh Kim Fai
Singapore Polytechnic
Singapore

Subject: **Invitation for Educational Meeting**

Warm greetings,
Politeknik Negeri Batam (Polibatam) is pleased to invite you and group of students from Singapore Polytechnic (SP) to visit Polibatam and attend an educational meeting as detailed below:

Date	: Thursday, 24th July 2025
Time	: 08.00 – End
Place	: BRAIL Lab Polibatam
Agenda	: Educational Meeting on Learning Application
Delegation	: 5 persons

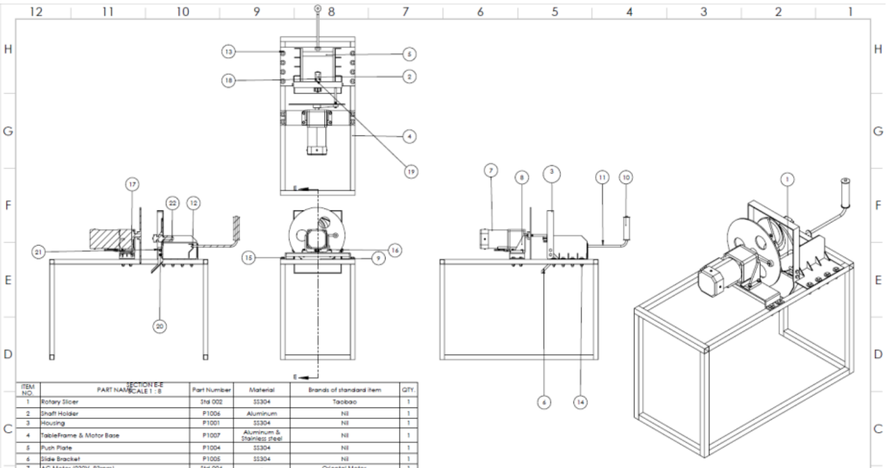
We expect you to bring along the learning equipment (attached here in this letter) for a demonstration, so students can have better understanding on how it works and how it can benefit to their expertise.

If you have any inquiries or further information, please do not hesitate to contact Mr. Muhammad Arifin, Head of Study Program for Electronics Manufacturing of Polibatam, via e-mail: arifin@polibatam.ac.id

We appreciate your understanding and cooperation in this matter.

Yours Sincerely,

Bambang Hendrawan
Director



ITEM NO.	PART NAME	Part Number	Material	Brands of standard item	QTY.
1	Rotary Slicer	Std 002	SS304	Taobao	1
2	Shaft Holder	P1006	Aluminum	Nil	1
3	Housing	P1001	SS304	Nil	1
4	TableFrame & Motor Base	P1007	Aluminum & Stainless steel	Nil	1
5	Push Plate	P1004	SS304	Nil	1
6	Slide Bracket	P1005	SS304	Nil	1
7	AC Motor (230V, 83rpm)	Std 004	-	Oriental Motor	1
8	Motor Bracket	Std 005	Steel	Oriental Motor	1
9	Rotating Disc	P1002	SS304	Nil	1
10	Handle	Std 001	Alluminum Alloy	Nil	1
11	Push Rod	P1003	SS304	Nil	1
12	Hex jam nut, M8 x 1.25	Std 006	Steel	Nil	1
13	B18.22M - Plain washer, 8 mm, regular	Std 007	Steel	Nil	12
14	Hex nut,M8 x 1.25	Std 008	Steel	Nil	12
15	Hex bolt M8 x 1.25 x 45	Std 009	Steel	Nil	12
16	Heavy hex flange screw, M6 x 1.0 x 35	Std 010	Steel	Nil	4
17	Hex flange nut, M6 x 1	Std 011	Steel	Nil	4
18	M3 x 0.5 x 20 Type I Cross Recessed FHMS --20N	Std 012	Steel	Nil	4
19	Hex nut, Style 2, M3 x 0.5 --D-N	Std 013	Steel	Nil	4
20	Hex bolt M8 x 1.25	Std 014	Steel	Nil	4
21	Hex jam nut, M8 x 1.25 --D-N	Std 015	Steel	Nil	4
22	Deep Groove ball bearings 19.035x12.7	Std 003	Steel	SLS	2

Remarks:
1)Bolt size and thread are fixed
2)Length may be adjusted based on assembly requirements