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Student Perception on Project-Based Learning in E-Sports Using CDIO Framework

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ABSTRACT

This study investigates student perceptions of project-based learning (PBL) in an e-sports co-curricular course delivered using the Conceive–Design–Implement–Operate (CDIO) framework at three Malaysian polytechnics. A total of 44 students participated in the pilot study during the 2024/2025 academic session. Data were collected through a structured questionnaire adapted from Li Chen et al. (2022), which was validated for reliability (Cronbach's alpha values ranged from 0.778 to 0.906 across different phases). Descriptive analysis was conducted using SPSS to examine students' experiences in each CDIO phase, as well as their collaboration and communication skills. Findings indicate that students generally had a clear understanding of project objectives, applied creativity in design, engaged actively in implementation, and perceived their projects as successful and improvable. The findings indicate that CDIO-based PBL has the potential to enhance both technical and soft skills in e-sports education but with limited sample size and dependence on self-reported data, restrict the extent of results to be generalized. The study highlights the potential of CDIO to guide the development of structured e-sports curricula in three institutions at Politeknik Malaysian while calling for further large-scale and inferential research.

1.0 Introduction

Electronic sports is now one of the fast-growing sectors in Malaysia which experiencing similar growth trends seen in global digital entertainment, tech, and youth trend. The local industry is expected going over RM1 billion by 2025, making Malaysia e-sports as important area for building talent and innovations. E-sport requires a mix of many skills such as teamwork, digital skills, strategy and media, thus making it important for nurturing essential 21st-century competencies. Accordingly, Ministry of Youth and Sports in Malaysia has launch National E-sports Development Plan (2020–2025) to create a better path for training and education hence making it more professional.

In line with national objectives, some TVET institutions are already starting to offer an e-sports as co-curricular subjects. Since 2024, three institutions within Politeknik Malaysia namely

Politeknik Mersing (PMJ), Politeknik Tuanku Sultanah Bahiyah (PTSB) and Politeknik Sultan Abdul Halim Muadzam Shah (POLIMAS) has successfully run e-sports course using Conceive–Design–Implement–Operate (CDIO) framework. CDIO frameworks were pioneered in engineering education, provides more organized methods that fit well with project-based learning (PBL) and may support the practical nature of e-sports.

1.1 Problem Statement

Despite efforts to incorporate e-sports into technical and vocational education (TVET), its pedagogical application remains underdeveloped and inconsistent. Many institutions still do not have a proper outcome-based or standardized teaching method that follow education best practices (Hamari & Sjöblom, 2022; Teo et al., 2023). The CDIO framework that is commonly used in engineering education has shown to be effective for project-based and interdisciplinary learning, focusing on solving real-world issues and ongoing reflection (Crawley et al., 2021). However, using this model in co-curricular or non-mainstream area such as e-sports remains limited, especially in Malaysian TVET settings.

A lack of empirical studies on student perceptions and learning outcomes in e-sports courses grounded in CDIO methodology further compounds this gap (Chong et al., 2023). Thus, this study intends to examine students' experience in adapting CDIO framework for project-based learning in their co-curricular e-sports course which may help standardize curriculum design in e-sports education.

1.2 Research Objective

The aim of this research is as stated below:

i. To examine current trends in e-sports education in Malaysia

ii. To analyse students experience in adapting CDIO framework for project-based learning in co-curricular e-sports course.

1.3 Research Significant

This research is crucial for educators who seek a direction on student enthusiasm and learning experience in adapting CDIO framework to design a better co-curricular e-sports courses to support ongoing improvement of Malaysia's TVET curriculum. It also promoting project-based learning which a critical aspect of teamwork in employment sphere is. By providing empirical data on students perceiving within a CDIO-based e-sports course at three institutions within Politeknik Malaysia, a replicable model for integrating digital co-curricular activities that support national agendas for digital economy growth and talent development may be emerge.

1.4 Research Scope

The research scope is as stated below:

i. Corresponding with student experience in adapting CDIO framework for project-based learning in co-curricular e-sports course at three institutions within Politeknik Malaysia.
ii. Forty-four students from Politeknik Mersing (PMJ), Politeknik Tuanku Sultanah Bahiyah (PTSB), and Politeknik Sultan Abdul Halim Muadzam Shah (POLIMAS) in Session 2 2024/2025 were involved in this study.
iii. The study was managed quantitatively via information gathered from the questionnaire given to the respondents, which are the students.
iv. The scope of the sport will be limited to e-sports only.
v. Students taking the co-curricular e-sports course at Politeknik Malaysia must carry out an e-sports event based on the CDIO framework.

2.0 Literature Review

E-sport program in higher education was reported with high student satisfaction and engagement when a structured curriculum models were applied (Jenny et al., 2021). A conceptualized e-sport are described as a digital learning space with authentic, relevant, and motivating educational experiences (Witkowski et al., 2021). National Sports Institute (ISN) is working hard to integrate e-sports into educational curricula by cooperating with Ministry of Education to promote e-sport as part of co-curricular activities in schools (Syed Omar S.F, 2025). Having students' motivations to engage with e-sports programs will be able to bring up potential of curricular integration to leverage student interest for educational outcomes (Abdullah et al., 2024). However, many challenges found in inconsistency of instructional approaches in implementing e-sports curricula in Malaysian TVET institutions (Teo et al., 2023).

Syahril et al. (2022) who investigated the effectiveness of project-based learning in Malaysian vocational programs has identifying significant gains in the "4Cs" skills which are communication, collaboration, creativity, critical thinking. Improvements in student engagement and practical competency aligned with industry standards was seen when evaluating PBL approaches in Malaysian polytechnics (Rohanai et al., 2020). A systematic framework for delivering PBL in e-sports training programs was proposed to demonstrate project-centric tasks for promoting critical thinking and teamwork in students (Chang et al., 2024).

A review exploring on e-sports projects supporting the development of 21st-century skills like leadership, communication, and digital literacy were conducted with positive outcome in contributing to the student skills and career development. (Kwan, 2025). The foundational theory of the CDIO framework aligned with experiential and project-based pedagogy were proposed by Crawley et al., 2021. However, there are some constraints of integrating CDIO in higher education curricula and its adaptability to non-engineering contexts such as e-sports (Padua et al., 2024). Yusoff et al. (2024) studied work-based learning self-efficacy among Malaysian TVET students, noting that practical, structured learning experiences improve confidence and readiness for employment. To the best of the author's knowledge, no standardized framework has yet been proposed for an e-sports education curriculum. Nonetheless, CDIO framework were implemented for co-curricular e-sport course at three institutions within Politeknik Malaysia during Session 2 2024/2025.

3.0 Methodology

Forty-four students majority males from Politeknik Mersing (PMJ), Politeknik Tuanku Sultanah Bahiyah (PTSB) and Politeknik Sultan Abdul Halim Muadzam Shah (POLIMAS) during Session 2 2024/2025 were involved in this pilot study. Pilot studies are used to evaluate the adequacy of planned methods and procedures (Polit & Beck, 2017). Pilot studies can be based on quantitative and/or qualitative methods. (Van T et al., 2002). The respondents selected are students who enrolled in co-curricular e-sports course at Politeknik Malaysia. Questionnaire was used as a survey instrument mechanism with descriptive research methods. Li Chen et al., (2022) questionnaire are adapted and distributed to the students. The assurance of confidentiality in addition of obtaining precise information from respondents is the upper hand of using questionnaire (Ary, Jacob, and Razarieh, 1990).

CDIO model has been used as a research methodology in project-based learning in an e-sports co-curricular subject. Consistent application of CDIO phases, especially through project-based learning has positively influenced students' readiness for the workplace (Bhattacharyya et al., 2025). Students outside of the engineering field who were exposed to CDIO-based instruction exhibited improved clinical thinking, higher engagement and stronger practical skills (He et al., 2024). Nevertheless, given that the study relies on respondents self-reported perceptions, it is important to note that such responses may not accurately reflect actual learning gains. Self-

report measures are subject to biases where respondents may interpret questions differently or respond in socially favourable ways (Lira et al., 2022).

Part A in the questions contains respondents' details and Part B of the questions contains basic e-sport background information. Meanwhile, Part C until Part F contains statement related with CDIO framework. Whereas Part G and Part H contain statements associated with communication/collaboration skill and skill development. The last part, which is Part I, is an open feedback question. Part C consists of four statements specifically related to the Conceive Phase, while Part D includes four different statements focusing on the Design Phase. Similarly, Part E includes four statements related to the Implement phase, while Part F comprises three statements focusing on the Operate phase. Communication and collaboration skills in Part G also contains 3 statements. Using SPSS version 27, the reliability coefficient using Cronbach's alpha standard for Part C was $\alpha = 0.878$, Part D with value $\alpha = 0.906$, Part E with value $\alpha = 0.778$, Part F with value $\alpha = 0.822$ and last one Part G with value $\alpha = 0.896$. Cronbach's alpha values demonstrate a satisfactory level of internal consistency among the responses. Likert Scale from scale one to five are used in the questionnaire to determine the analysis interpretation. Scale will interpret an answer choice as Strongly Disagree (SD), Disagree (D), Not Sure (NS), Agree (A) and Strongly Agree (SA) as per Schedule 1 below.

Schedule 1: Likert Scale

Scale	Interpretation
1	Strongly Disagree
2	Disagree
3	Not Sure
4	Agree
5	Strongly Agree

The data collected were analysed using the mean and standard deviation. A high mean score indicates a strong tendency toward that item, while a moderate mean score reflects a moderate tendency. Conversely, a low mean score suggests a weak tendency. The interpretation of the mean scores was conducted according to the scale outlined in Schedule 2, adapted from Landell (1997).

Schedule 2: Mean Value Interpretation Scale

Group	Range	Tendency Level
1	1.00 – 2.33	Low
2	2.34 – 3.67	Moderate
3	3.68 – 5.00	High

4.0 Discussion Of Analysis And Findings

From the data, analysis obtained using descriptive methods where students experience towards problem-based learning in e-sports co-curricular subjects using CDIO framework were analysed. Results from analysis showed that 38 (86.4%) respondents are male students and 6 (13.6%) respondents are female student. Meanwhile, 36 (81.8%) respondents are at age of 19 years old and below and 8 (18.2) respondents are at age of 20 to 29 years old. Whereas 38 (86.4%) are Malay, 3 (6.8%) are Indian, 1 (2.3%) is Chinese and the balance 2 (4.6%) are Sarawak Native. Politeknik Mersing accounted for 27 respondents (61.4%), followed by Politeknik Tuanku Sultanah Bahiyah with 9 respondents (20.5%), and Politeknik Sultan Abdul Halim Muadzam Shah with 8 respondents (18.2%).

Schedule 3: Student's Experience in Conceive Phase

No	Item Conceive Phase	Mean Value	Dev. Std
1	I clearly understood the project objectives at the beginning.	4.18	0.8147
2	I was able to identify relevant problems or needs in the e-sports field.	4.16	0.6800
3	The project topic matched my interests in e-sports or gaming.	4.32	0.8003
4	I felt confident sharing my ideas during the ideation phase.	4.18	0.8428

Based on the results from Schedule 3 above, majority of respondents agreed that they clearly understood the project objectives (M=4.18). Most also agreed that they were able to identify problems or needs within the e-sports field (M=4.16). Additionally, respondents felt that the project topic aligned with their personal interest in e-sports (M=4.32). During the Conceive phase of the CDIO framework, respondents also reported feeling confident in sharing their ideas (M=4.18). These findings suggest that respondents able to execute PBL with clearance, motivation and confidence.

Schedule 4: Student's Experience in Design Phase

No	Item Design Phase	Mean Value	Dev. Std
1	My team organized tasks and responsibilities effectively.	4.20	0.7947
2	We used design tools effectively in planning the project.	4.25	0.7193
3	Our design decisions reflected real-world e-sports scenarios	4.15	0.7134
4	I applied creativity and innovation in this phase.	4.11	0.7802

According to the findings from Schedule 4, most respondents agreed that their team successfully organized tasks and responsibilities (M=4.20). A majority also agreed they effectively used design tools in project planning (M=4.25). Furthermore, respondents felt that their design decisions aligned with real-world e-sports scenarios (M=4.15). During the Design phase of the CDIO framework, participants also indicated they applied creativity and innovation (M= 4.11). Overall, design phase encouraged structured teamwork and practical creativity among the respondent to work as a team.

Schedule 5: Student's Experience in Implementation Phase

No	**Item Implementation Phase**	**Mean Value**	**Dev. Std**
1	I was actively involved in project development or production.	4.09	0.7721
2	I applied my technical skills effectively (e.g., coding, media tools).	3.95	0.7456
3	I was able to solve problems that emerged during development.	4.00	0.7152
4	Digital tools (e.g., WhatsApp, Discord, and Telegram) supported our implementation.	4.39	0.6893

As indicated by the results in Schedule 5, a significant number of respondents agreed they were actively involved in project development (M=4.09). Most also agreed that they applied their technical skills effectively (M=3.95). Additionally, respondents felt capable of solving problems that arose during the project (M=4.00). During the Implementation phase of the CDIO framework, respondents also reported that digital tools were effectively used to support the program's execution (M=4.39). This phase highlights the roles of digital platforms in supporting project execution.

Schedule 6: Student's Experience in Operation Phase

No	**Item Operation Phase**	**Mean Value**	**Dev. Std**
1	Our project worked as expected during the execution phase.	4.23	0.7108
2	I was involved in evaluating or testing the project results.	4.07	0.6611
3	I could see how the project could be maintained or improved further.	4.32	0.6387

Referring to the outcomes shown in Schedule 6, respondents generally agreed that their project performed as expected during the execution phase (M=4.23). Many also indicated their involvement in evaluating the project outcomes (M=4.07). It was also perceived by respondents that the project had potential for further improvement (M=4.32). Results shown respondents achieved their goals and developed a mindset for continuous improvement in execution the next project.

Schedule 7: Student's Experience in Collaboration & Communication Skill

No	**Item Collaboration & Communication Skill**	**Mean Value**	**Dev. Std**
1	My team collaborated effectively throughout the project.	4.25	0.7193
2	I improved my communication skills during the project.	4.28	0.6942
3	The project-based format encouraged more teamwork than traditional classes.	4.34	0.7134

From the analysis of Schedule 7, a large proportion of respondents acknowledged that their team collaborated effectively throughout the project (M=4.25). It was also widely agreed that their communication skill was improved (M=4.28). They also felt that project-based format encourages more teamwork than traditional class (M=4.34). Overall, the result from this phase reinforces the value of PBL and CDIO approach in building the important soft skills among the respondent.

5.0 Conclusion And Future Research

The analysis indicates that the overall impact of CDIO framework implemented during PBL in co-curricular e-sport course on students' experience is very positive. Most students demonstrated a clear understanding of project objectives and increased confidence in sharing ideas during the Conceive phase. Students are also able to effectively organize tasks and use relevant tools in Design Phase. Students have a strong involvement in project development and problem-solving in Implementation phase. During Operate phase, majority of students perceive their project as successful and have clear potential for future enhancements. Data indicates that CDIO-based PBL approach effectively supported both technical learning and the development of key soft skills such as teamwork and communication in esport course. In summary, this pilot study provides encouraging evidence that a CDIO-based, project-oriented approach can enrich students' experiences in e-sports education. While preliminary, these findings highlight the potential for e-sports to serve as a meaningful and structured learning environment within Malaysian TVET. However, the results should be interpreted cautiously given the sample and method limitations.

Based on the findings, it is proposed to enhance effectiveness of PBL in co-curricular e-sport course by adopting the CDIO framework at these three institutions within Politeknik Malaysia. Also, it is recommended that applications of digital tools such as software and platform to be widely to optimize the execution of student projects during PBL. By far, the most important recommendation is to initiate a participation from a larger sample and includes female and minority students in order to address the gender and ethnic imbalance in the respondents' demographics. It is recommended for institution to offer a mentorship, funding opportunities, or incubation programs to allow students to further develop and refine their projects beyond the classroom setting.

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Author Contributions

Abu Hasan H. B.: Conceptualization, Methodology, Writing- Original Draft Preparation, Validation, Supervision, Writing-Reviewing and Editing; **Yusoff A. Z.**: Conceptualization, Data Provider, Reviewing; **Wan Yahaya W. N. H.**: Conceptualization, Data Provider, Reviewing; **Meidelfi D.:** Writing-Reviewing and Editing.

Conflicts of Interest

The manuscript has not been published elsewhere and is not being considered by other journals. All authors have approved the review, agree with its Submission and declare no conflict of interest in the manuscript.

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