



**ENHANCING SECONDARY SCHOOL STUDENTS'
ATTITUDE AND CAREER INTERESTS
TOWARDS STEM THROUGH
ROBOTICS COMPETITION-BASED LEARNING
MODULE**

اونيورسيتي تيكنيكل مليسيا ملاك
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

PANG YEE JIEA

DOCTOR OF PHILOSOPHY

2025



Institute of Technology Management and Entrepreneurship

**ENHANCING SECONDARY SCHOOL STUDENTS' ATTITUDE AND
CAREER INTERESTS TOWARDS STEM THROUGH
ROBOTICS COMPETITION-BASED LEARNING MODULE**

Pang Yee Jiea

Doctor of Philosophy

2025

**ENHANCING SECONDARY SCHOOL STUDENTS' ATTITUDE AND
CAREER INTERESTS TOWARDS STEM THROUGH
ROBOTICS COMPETITION-BASED LEARNING MODULE**

PANG YEE JIEA



**A thesis submitted
in fulfilment of the requirements for the degree of Doctor of Philosophy**

اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

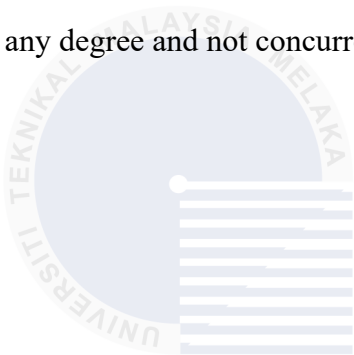
Institute of Technology Management and Entrepreneurship

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2025

DECLARATION

I declare that this thesis entitles Enhancing Secondary School Students' Attitude and Career Interests Towards STEM Through Robotics Competition-based Learning Module is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and not concurrently submitted in candidature of any other degree.



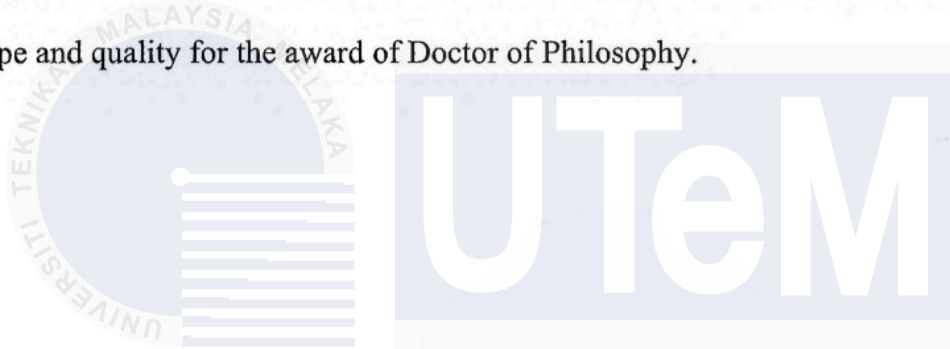
Signature : 

Name : PANG YEE JIEA

Date : 20 JANUARY 2025

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Doctor of Philosophy.



Signature : اونیورسیتی تکنیکل مالیزیا ملاک

Name : PROF. MADYA DR TAY CHOO CHUAN

Date : 18 August 2025

DEDICATION

This project is dedicated to

my beloved husband, Ngan Kwong Song for the unconditional love, sacrifices,

and support,

my beloved parents, Pang Hing Pet and Ong Siew Lan,

for their love and encouragement;

my lovely kids Ngan Cheer You, Ngan Rynn You, Ngan Joan You, and Ngan Elle You,

for their smiles, laughter, and pride in inspiring me to strive for excellence.

ABSTRACT

The persistent decline in secondary school students' enrolment in Science, Technology, Engineering, and Mathematics (STEM), performance, and career interest in STEM fields poses a significant challenge for Malaysia's secondary educational and workforce development goals. Despite national initiatives such as the Malaysia Education Blueprint (2013–2025), the 60:40 Science to Arts Policy, and the National Science, Technology and Innovation Policy (2021–2030), the country continues to face a shortage of STEM-skilled workers. This research addresses these issues by investigating the potential of Robotics Competition-Based Learning (R-CBL) module as an innovative pedagogical intervention to enhance secondary school students' attitudes toward STEM and to foster career interest in related fields. Guided by Constructivist, Constructionist, Social Learning, and Social Cognitive Career Theory (SCCT) perspectives, the study employed a Design and Development Research (DDR) approach structured around the ADDIE instructional model. The research was conducted with Malaysian secondary students participating in the Robot Olympics Malaysia 2019. A mixed-methods design was adopted, combining document analysis, expert validation, pre- and post-surveys using the S-STEM instrument, classroom observations, and focus group interviews. Quantitative data were analysed with SPSS, while qualitative insights were coded thematically to triangulate findings. The results revealed that the R-CBL module significantly improved students' attitudes toward STEM, particularly in terms of motivation, engagement, and confidence. Furthermore, the intervention positively influenced students' perceptions of STEM careers, increasing their interest in pursuing future pathways in engineering, technology, and related disciplines. R-CBL also fostered collaboration, problem-solving, and other 21st-century skills, aligning with national educational priorities and workforce demands. This study contributes theoretically by integrating established learning theories into a robotics competition framework, and practically by demonstrating how R-CBL can bridge the STEM skills gap. The findings provide evidence-based recommendations for policymakers and educators to adopt R-CBL as a scalable, engaging, and effective strategy to strengthen STEM education and STEM career interest among secondary school students.

ABSTRAK

Penurunan enrolmen, prestasi akademik, serta minat kerjaya dalam bidang Sains, Teknologi, Kejuruteraan dan Matematik (STEM) dalam kalangan pelajar sekolah menengah merupakan isu kritikal yang menjejaskan pencapaian sasaran pendidikan negara dan keperluan tenaga kerja berkemahiran tinggi. Walaupun pelbagai dasar telah digariskan, antaranya Pelan Pembangunan Pendidikan Malaysia (PPPM) 2013–2025, Dasar 60:40 Sains kepada Sastera, serta Dasar Sains, Teknologi dan Inovasi Negara (DSTIN) 2021–2030, negara masih belum mencapai tahap keseimbangan yang dihasratkan. Sehubungan itu, kajian ini dijalankan bagi menilai potensi Modul Pembelajaran Berasaskan Pertandingan Robotik (Robotics Competition-Based Learning, R-CBL) sebagai satu pendekatan pedagogi inovatif untuk meningkatkan sikap pelajar terhadap STEM serta menggalakkan kecenderungan mereka terhadap kerjaya dalam bidang ini. Berlandaskan kerangka teori Konstruktivisme, Konstruksionisme, Teori Pembelajaran Sosial, dan Teori Kerjaya Kognitif Sosial (Social Cognitive Career Theory, SCCT), kajian ini menggunakan pendekatan Design and Development Research (DDR) dengan adaptasi model instruksi ADDIE. Subjek kajian melibatkan pelajar sekolah menengah Malaysia yang menyertai Robot Olympics Malaysia 2019. Reka bentuk kaedah campuran diaplikasikan, melibatkan analisis dokumen, pengesahan pakar, soal selidik pra dan pasca menggunakan instrumen S-STEM, pemerhatian berpanduan rubrik, serta temu bual berfokus. Data kuantitatif dianalisis menggunakan perisian SPSS, manakala data kualitatif dianalisis melalui pengekodan tematik untuk tujuan triangulasi. Dapatan kajian menunjukkan bahawa modul pembelajaran R-CBL berkesan dalam meningkatkan motivasi, penglibatan, dan keyakinan pelajar terhadap STEM. Intervensi ini juga mempengaruhi persepsi kerjaya, dengan peningkatan ketara dalam minat terhadap bidang kejuruteraan, teknologi, dan sains gunaan. Selain itu, modul ini turut menyumbang kepada pembangunan kemahiran abad ke-21, termasuk kolaborasi, pemikiran kritis, dan penyelesaian masalah, sejajar dengan aspirasi pendidikan negara. Kajian ini memberikan sumbangan teori melalui pengintegrasian pelbagai teori pembelajaran ke dalam kerangka pertandingan robotik, serta sumbangan praktikal dengan menyediakan bukti empirik bahawa modul R-CBL mampu menjadi strategi berkesan dalam memperkukuh pendidikan STEM dan melahirkan murid sekolah menengah yang minat dalam kerjaya STEM.

ACKNOWLEDGEMENTS

First and foremost, I would like to take this opportunity to express my heartfelt gratitude to my supervisors, Profesor Madya Dr. Tay Choo Chuan, Profesor Madya Dr. Sharifah Sakinah Syed Ahmad, and Profesor Dr. Hanipah Hussin, for their invaluable personal and professional guidance. Their extensive knowledge, thoughtful advice, and constant encouragement have been instrumental in making my doctoral journey a success.

I extend my sincere gratitude to the Ministry of Education Malaysia (KPM), the Department of Education Melaka (JPN Melaka), Faculty of Information and Communication Technology (FTMK) and the Faculty of Electrical Engineering (FKE), Universiti Teknikal Malaysia Melaka (UTeM). Their extensive expertise, insightful guidance, and steadfast encouragement have been pivotal in the successful completion of my doctoral journey. Special thanks to my principal and colleagues at Kolej Tingkatan Enam (Prauniversiti) Tun Fatimah, Melaka, for their understanding, patience, and unwavering moral support throughout this journey.

Last but not least, I extend my heartfelt appreciation to the principal, staffs and students in SMJK Yok Bin for their exceptional assistance and cooperation, which greatly contributed to the successful completion of this research during Robot Olympics Malaysia 2019. The principal's dedication to fostering an environment conducive to research and learning has been truly commendable. Their guidance and willingness to accommodate the requirements of this study have been invaluable, ensuring its smooth progress. This achievement would not have been possible without their exceptional leadership and commitment to excellence.

TABLE OF CONTENTS

	PAGE
DECLARATION APPROVAL DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	viii
LIST OF FIGURES	x
LIST OF APPENDICES	xii
LIST OF ABBREVIATIONS	xiii
LIST OF PUBLICATIONS	xiv
1. INTRODUCTION	1
1.1 Introduction	1
1.2 Research Problem	7
1.3 Research Objectives and Research Questions	14
1.4 Theoretical and Conceptual Framework	18
1.5 Significance of The Research	24
1.5.1 R-CBL in Addressing The STEM Skills Gap	25
1.5.2 R-CBL in Enhancing Positive Attitudes Through Competition	26
1.5.3 R-CBL in Fostering Collaboration and Teamwork	27
1.5.4 R-CBL in Aligning With 21st-Century Skills	28
1.5.5 R-CBL in Informing Educational Policies	29
1.5.6 R-CBL Influencing Students' Interest in STEM Workforce Development	29
1.6 Research Scope and Limitation	31
1.7 Research Approach	33
1.8 Operational Definition	34
1.9 Structure of Thesis	37
1.10 Summary	38
2. Literature Review	41
2.1 Introduction	41
2.2 Systematic Review to Construct Literature Review	42
2.2.1 Step 1: Define The Research Question	43
2.2.2 Step 2: Conduct A Literature Search	44
2.2.3 Step 3: Select Relevant Studies	44
2.2.4 Step 4: Extract and Synthesise Data	45
2.2.5 Step 5: Draw Conclusions and Make Recommendations	45
2.3 Learning Theory	45
2.3.1 Theory of Constructivism	46
2.3.2 Theory of Constructionism	47
2.3.3 Project-Based Learning (PjBL)	49

2.3.4	Social Cognitive Career Theory	50
2.4	Learning Design	52
2.5	Learning Environment	55
2.5.1	Integrated STEM	56
2.5.2	Educational Robotics Competition	57
2.6	Learning Outcomes	62
2.6.1	Attitude Towards STEM	62
2.6.2	STEM Career Interests	65
2.7	Scenario in Malaysia	68
2.7.1	60:40 Policy	69
2.7.2	Malaysia Educational Blueprint 2013-2025	71
2.7.3	National Robotics Roadmap (NRR) 2021-2030	74
2.7.4	National Science, Technology, and Innovation Policy 2021-2030	75
2.7.5	Theoretical and Policy Integration with R-CBL	76
2.8	Bridging the Gap	79
2.9	Summary	83
3.	Methodology	85
3.1	Introduction	85
3.2	Research Design	86
3.2.1	Analysis	90
3.2.2	Design	93
3.2.3	Development	93
3.2.4	Implementation	95
3.2.5	Evaluation	97
3.3	Respondents and Sampling Methods	99
3.3.1	Phase I: Needs Analysis	100
3.3.2	Phase II: Design and Development	100
3.3.3	Phase III: Implementation and Evaluation	103
3.4	Data Collection Procedure	104
3.4.1	Phase I: Needs Analysis	104
3.4.2	Phase II: Design and Development	105
3.4.3	Phase III: Implementation and Evaluation	110
3.5	Research Analysis Method	116
3.5.1	Phase I: Needs Analysis	116
3.5.2	Phase II: Design and Development	117
3.5.3	Phase III: Implementation and Evaluation	118
3.6	Research Methodology Matrix	121
3.7	Summary	122
4.	Data Analysis	124
4.1	Introduction	124
4.2	Research Objective 1	125
4.2.1	Research Question 1	125
4.2.2	Summary of Results for Research Objective 1	145
4.3	Research Objective 2	146
4.3.1	Nominal Group Technique	147
4.3.2	Analysis of Research Question 2	149
4.3.3	Summary of Results for Research Objective 2	163
4.4	Research Objective 3	165

4.4.1 S-STEM Survey	165
4.4.2 Observation on Students' Attitude During Robotics Competition	177
4.4.3 Summary of Results for Research Objective 3	182
4.5 Research Objective 4	183
4.5.1 "Your Future" Survey	184
4.5.2 Semi-Structured Interview	187
4.5.3. Summary of Results for Research Objective 4	196
4.6 Summary	197
5. Discussion, Conclusion and Recommendation	199
5.1 Introduction	199
5.2 Conclusion of Findings	200
5.3 Research Contribution	201
5.3.1 Theoretical Contribution to R-CBL Framework	201
5.3.2 Practical Contribution of R-CBL	206
5.3.3 Methodological Contribution	209
5.3.4 Summary of Contribution	212
5.4 Research Implication	215
5.4.1 Implication Towards Malaysian Integrated STEM Education and Policy	216
5.4.2 Implication Towards Educators	217
5.4.3 Implication Towards Secondary School Students	218
5.4.4 Implication Towards Institutions	220
5.4.5 Summary of Research Implications	221
5.4.6 Interesting Research Findings	
5.5 Research Limitation	223
5.5.1 Impact of Covid-19 Pandemic	224
5.5.2 Short Duration of The Study	226
5.6 Future Research	227
5.6.1 Longitudinal Studies	227
5.6.2 Post-Pandemic Context	228
5.6.3 Integration of New Technologies	229
5.7. Summary	231
5.8. Conclusion	233
REFERENCES	237
APPENDICES	257

LIST OF TABLES

TABLE	TITLE	PAGE
Table1.1	Research Problem and Related Literature Support	16
Table 1.2	Integration of Learning Theories into R-CBL	23
Table 1.3	Research Approach	36
Table 2.1	Comparison of the ADDIE Model with Other ID Models	56
Table 2.2	ADDIE Model Activities	58
Table 2.3	Integrated STEM Education Principles	61
Table 2.4	Policies that Support STEM in Malaysia	73
Table 2.5	Integration of Theories and Policies with RCBL	82
Table 2.6	Comparative Analysis of STEM/RCBL Implementation in Selected Countries	
Table 2.7	Summary of Selected Studies From the Angle of Research Issue	86
Table 3.1	Corresponding ADDIE Stage In DDR	94
Table 3.2	Respondents in the Research Phases	104
Table 3.3	Respondents for Modified NGT in Design and Development Phase	106
Table 3.4	Demographic of Experts in NGT	107
Table 3.5	Respondents Distribution for Phase III	108
Table 3.6	Test Plan for Analysis Phase	109
Table 3.7	Instruments in Questionnaire for Experts	112
Table 3.8	Instructions for Performing a Modified NGT	114
Table 3.9	Test Plan for Assessment Phase	117
Table 3.10	Sample Items from the Three Attitudinal Constructs	117
Table 3.11	Level of Interest Scale	119

Table 3.12	Interpretation Score of Cronbach Alpha	120
Table 3.13	Reliability of S-STEM Survey	123
Table 3.14	Research Methodology Matrix	126
Table 4.1	Matrix of the instructional categories in the module	133
Table 4.2	The Findings of Document Analysis	134
Table 4.3	STEM Educators Needs Survey Demographic Descriptive Statistics	
Table 4.4	Analysis of Need Survey for STEM Educators	138
Table 4.5	Analysis of Need Survey for Students	141
Table 4.6	Five Stages in R-CBL to achieve STEM Literacy	150
Table 4.7	Combined Data on Suitable Content in R-CBL Module	154
Table 4.8	Step for data analysis in Design and Development Phase	155
Table 4.9	Main components of the R-CBL Module by ADDIE Model	157
Table 4.10	The R-CBL Module Matrix	158
Table 4.11	Robotics Project with Integrated KSSM STEM Learning Outcomes	159
Table 4.13	R-CBL Module Outline	163
Table 4.14	Expert feedback and suggestions for improvement	170
Table 4.15	Pre and Post Score for Math Attitude	173
Table 4.16	Paired Samples Statistics for Math Attitude	
Table 4.17	Paired Samples Correlations for Math Attitude	175
Table 4.18	Pre and Post Score for Science Attitude	175
Table 4.19	Paired Samples Statistics for Science Attitude	176
Table 4.20	Paired Samples Correlation for Science Attitude	177
Table 4.21	Pre and Post Score for Engineering and Technology Attitude	178
Table 4.22	Paired Samples Statistics for Engineering and Technology Attitude	179
Table 4.23	Paired Samples Correlations for Engineering and Technology Attitude	180
Table 4.24	Percentage Responses, Mean, and Standard Deviation for Career Interests	190
Table 4.25	Example of Quotes, Codes and Categories for Theme 1	196
Table 4.26	Example of Quotes, Codes and Categories for Theme 2	198
Table 4.27	Example of Quotes, Codes and Categories for Theme 3	200

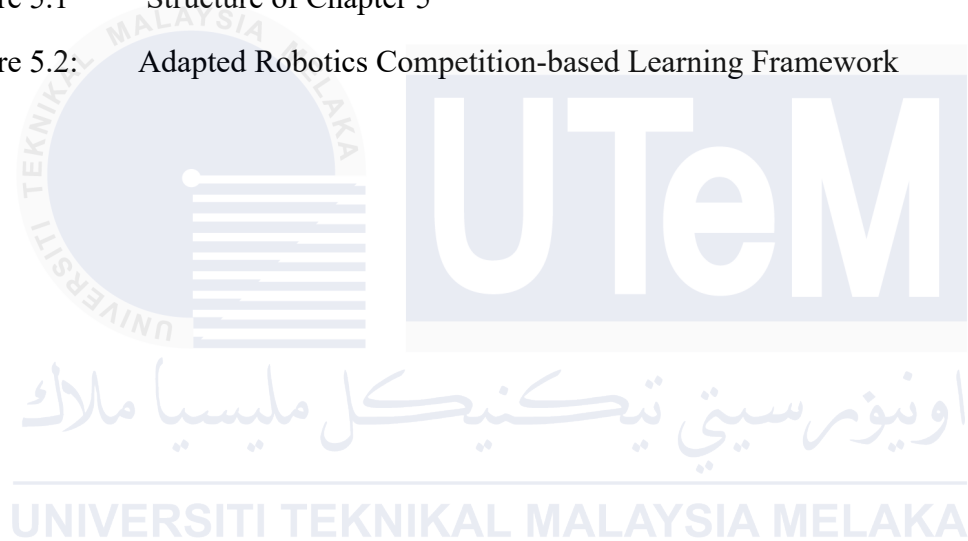
Table 4.28	Coding Scheme for Analyzing Students' Open-ended Responses	201
Table 5.1	Integration of Theories with R-CBL and Supporting Evidence	210
Table 5.2	Summary of Research Contributions	218
Table 5.3	Summary of Contribution through Publication	219
Table 5.4	Summary of Research Implications	226
Table 5.5	Recommendations for Future Research	237



LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 1.1	STEM Education Conceptual Framework	12
Figure 1.2	Student Enrolment in STEM Fields in Malaysia	16
Figure 1.3	Percentage of Students in Vocational Education Year 2016-2021	18
Figure 1.4	Average PISA Scores for Mathematics and Science	20
Figure 1.5	Theoretical Framework for R-CBL	29
Figure 1.6	R-CBL Conceptual Framework	30
Figure 2.1	Structure of Chapter 2	50
Figure 2.2	ADDIE Model by Rosset (1987)	62
Figure 2.3	Social cognitive career theory.	
Figure 3.1	Structure of Chapter 3	94
Figure 3.2	ADDIE Instructional Design Model	97
Figure 3.3	Needs Analysis Framework	100
Figure 3.4	Design and Development Framework	102
Figure 3.5	Implementation Process of R-CBL	103
Figure 3.6	Online Platform for Registration	105
Figure 3.7	Systematic Process in the Design and Development Phase	114
Figure 3.8	Assessment Phase Flow Chart	121
Figure 3.9	Braun & Clarke's Six-phase Framework	127
Figure 4.1	Summary of Chapter 4	134
Figure 4.2	Robotics competition-based learning (R-CBL) Framework	152
Figure 4.3	SUMO Robot Competing Each Other	168
Figure 4.4	Various Syracus Robot Design	168
Figure 4.5	Racing Robot With Large Wheel	169

Figure 4.6	Pick n Mess Robot Completing the Task	170
Figure 4.7	Coding for Autonomous SUMO Robot	171
Figure 4.8	Coding to Remote Control a Robot	172
Figure 4.9	Students were having fun	188
Figure 4.10	Students shows excitement during robotics competition	189
Figure 4.11	Collaboration during robotics competition	189
Figure 4.12	Students encouraged each other	190
Figure 4.13	Students shows confidence during robotics competition	191
Figure 5.1	Structure of Chapter 5	208
Figure 5.2:	Adapted Robotics Competition-based Learning Framework	209



LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	NEEDS SURVEY (STUDENT)	258
B	NEEDS SURVEY (EDUCATOR)	260
C	S-STEM SURVEY	263
D	LIST OF EXPERTS	272
E	R-CBL MODULE	273
F	SEMI-STRUCTURED INTERVIEW	322
G	OBSERVATION RUBRIC	323
H	PERMISSION TO CONDUCT STUDY	324
I	INVITATION TO PARTICIPATE IN ROBOT OLYMPICS MALAYSIA	326

LIST OF ABBREVIATIONS

STEM	Science, Technology, Engineering, Mathematics
R-CBL	Robotics Competition-based Learning
MOE	Ministry of Higher Education
PjBL	Project Based Learning
MEB	Malaysia Education Blueprint
UNESCO	United Nations Educational, Scientific and Cultural Organization
OECD	Organisation for Economic Co-operation and Development
KSSM	Kurikulum Standard Sekolah Menengah
SCCT	Social Cognitive Career Theory
ID	Instructional Design
NGT	Nominal Group Technique

LIST OF PUBLICATIONS

JOURNALS

Jiea, P. Y., Hanipah, H., & Sharifah, S. S. A., 2018. Integrated Robotics STEM Curriculum Towards Industry 4.0. *International Journal of Human and Technology Interaction (IJHaTI)*, 2(2), 17-24.

Jiea, P. Y., Hussin, H. Rosly, R. N. R., & Omar, S. R., 2019. Integrated 21st century Science, Technology, Engineering, Mathematics (STEM) education through robotics project-based learning. *Humanities & Social Sciences Reviews*, 7(2), 204-211.

Jiea, P. Y., Chuan, T. C., Sakinah Syed Ahmad, S., & Thoe, N. K., 2019. Promoting students' interest in STEM education through robotics competition-based learning: case exemplars and the way forward. *Learning Science and Mathematics*, 14, 107-121.

Jiea, P.Y., Hussin, H., Tay, C. C., & Ahmad, S. S. S., 2019. Robotics competition-based learning for 21st century STEM education. *Journal of Human Capital Development (JHCD)*, 12(1), 83-100.

Hoe, L. S., Chuan, T. C. & Hussin, H., Jiea, P. Y., 2019. Enhancing student competencies through digital video production: a Project-based learning framework. *Journal of Business and Social Review in Emerging Economies*, 5(1), 51-62.

Jiea, P. Y., Chuan, T. C., Ahmad, S. S. S., & Thoe, N. K., 2020. Developing Robotics Competition-based Learning Module: A Design and Development Research (DDR) Approach. *Solid State Technology*, 63(1s), 849-859

Jiea, P. Y., Chuan, T. C., Ahmad, S. S. B. S., Thoe, N. K., & Hoe, L. S., 2021. Minecraft Education Edition: The Perspectives of Educators on Game-based Learning Related to STREAM Education. *Learning Science and Mathematics*.

Thoe, N. K., Jamaludin, J., Choong, C., Lay, Y. F., Ong, E. T., Jiea, P. Y., Chin, C. K., 2022. Developing Conceptual and Procedural Knowledge/Skills of Lifelong Learners from Basic to Advance Learning: Exemplars, Challenges and Future Direction. *Dinamika Jurnal Ilmiah Pendidikan Dasar*, 14(1), 22-35.

Khoo, N. K., Ng, K. T., Ong, E. T., & Pang, Y. J., 2023. Design and Development Research on the Module to Manage Noise Exposure: A Case Exemplar Anchored on the OSHEMT Framework. *Journal of Occupational Safety and Health*.

Jiea, P. Y., Lai, N. Y. G., Wong, K. H., Yu, L. J. & Kang, H. S., 2024. Students' Motivation and Feedback on the Learning Potential from a Virtual Minecraft Event Competition. *International Journal of Learning and Teaching*, Vol. 10, No. 1, 202

BOOK CHAPTERS

Ong, E. T., Jiea, P. Y., Talib, C. A., Setiawan, R., Ng, J. H., & Por, F. P., 2023. Industrial Revolution (IR) and Exemplary AR/VR-based Technological Tools in Preventive Health Education: The Past, Present, and Future. in *Immersive Virtual and Augmented Reality in Healthcare* (pp. 1-27). *CRC Press*

Jamaludin, J., Chin, C. K., Lay, Y. F., Ng, K. T., Cyril, N., Jiea, P. Y., & Anggoro, S., 2023 (November). Empowering conceptual and procedural knowledge/skills development in technology-enhanced environment: Challenges and exemplars to promote innovations through digital transformation. in *AIP Conference Proceedings* (Vol. 2954, No. 1). *AIP Publishing*.

CONFERENCES

Hussin, H., Jiea, P. Y., Rosly, R. N. R., & Omar, S. R. , 2017. Integrated 21st Century STEM Education Through Project-based Learning. *International Conference on Religion, Microfinance and Community Empowerment* (ICOMFIN 2017), on 2017, Indonesia.

Jiea, P. Y., Hanipah, H., Chuan, T. C., Hoe, L.S., 2018. Integrated Robotics STEM Curriculum in Meeting the Education 4.0 Challenges". *3rd International Research Conference on Economics, Business and Social Sciences – 3rd IRC 2018-MY* Chapter, Vol 3, Issue 1. eISSN: 2523-1537.

Jiea, P. Y., Hanipah, H., Chuan, T. C., Hoe, L.S., 2018. Malaysia 21st Century S-T-E-M Education Through Robotics Competition-Based Learning. in *27th International Conference on Teaching, Education and Learning* (ICTEL). ISSN 2454-5899

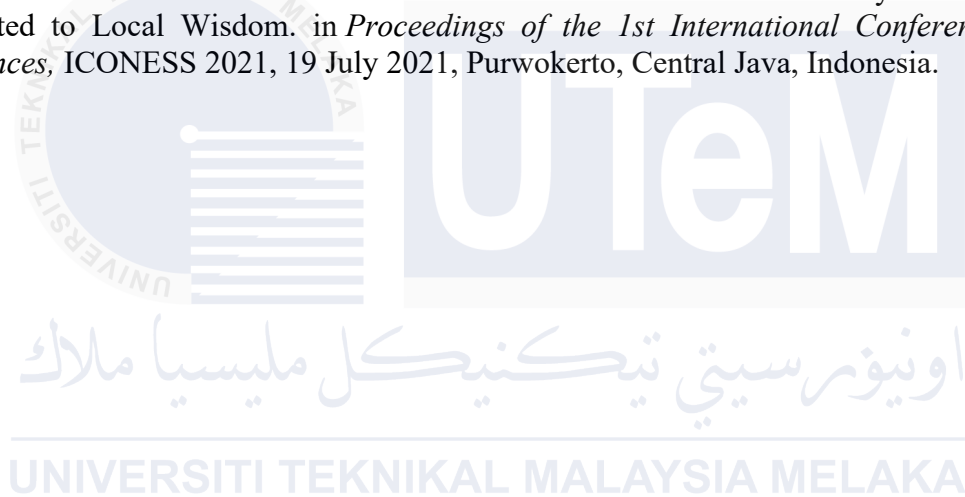
Jiea, P. Y., Chuan, T. C., Sakinah Syed Ahmad, S., & Thoe, N. K., 2021. Using the S-STEM survey to evaluate secondary students' attitude in robotics competition-based learning environment. *International Conference on Science and Mathematics Education* (COSMED21), on 2021, Penang.

PROCEEDINGS

Jiea, P. Y., Hanipah, H., Chuan, T. C., Hoe, L.S., 2017. Robotics Project-based Learning for Sustainability in 21st Century Integrated STEM Education. *Proceeding of Postgraduate Research Seminar in Conjunction with ISORIS 2017*.

Jiea, P. Y., Hanipah, H., Chuan, T. C., Hoe, L.S., 2018. Education 4.0: Trends and Future Perspectives in STEM Teaching and Learning Through Robotics Competition. *Proceedings of Innovative Teaching and Learning Research Day (InTReD'18)*. eISBN 978-967-2145-49-3

Ng, K., Kim, P., Lay, Jiea, P. Y., Ong, E., & Anggoro, S., 2021 (November). Enhancing Essential Skills in Basic Education for Sustainable Future: Case Analysis with Exemplars Related to Local Wisdom. in *Proceedings of the 1st International Conference on Social Sciences, ICONESS 2021*, 19 July 2021, Purwokerto, Central Java, Indonesia.



CHAPTER 1

INTRODUCTION

1.1 Introduction

STEM education, encompassing science, technology, engineering, and mathematics, represents a holistic and interdisciplinary approach to teaching and learning. It aims to connect academic knowledge with practical, real-world applications (Bybee, 2013; English, 2016; Moore, 2021; Dare et al. 2021; Ortiz-Revilla et al., 2022). In Malaysia, the Vision 2020 initiative was launched in 1991 with the goal of transforming the nation into a fully industrialized and developed society. A key aim was to foster a scientific and progressive culture, emphasizing the importance of investment in science and innovation for national advancement. This led to the creation of the Malaysia Education Blueprint (MEB) 2013-2025, developed collaboratively by education experts from UNESCO, the World Bank, the OECD, and six local universities. Feedback was collected from various stakeholders, including principals, teachers, parents, students, and community members across Malaysia. The blueprint's objective is to equip Malaysian children with the skills and knowledge necessary for the 21st century while raising educational standards and expectations for the public and parents. Enhancing STEM education is seen as vital for achieving a high-quality education that meets global standards.

In Malaysia, STEM education is emphasized as a strategic priority to prepare students for the demands of a 21st-century workforce. The Malaysia Education Blueprint (MEB) 2013–2025 outlines this commitment clearly: “To transform Malaysia into a high-income nation, we

need to improve student outcomes and ensure our education system meets the needs of the labour market, particularly in Science, Technology, Engineering and Mathematics (STEM) fields” (Ministry of Education Malaysia, 2013, p. E-7). The blueprint identifies the shortage of STEM talent as a national concern and calls for initiatives to improve enrolment and performance in these fields. It proposes to: (i) Increase the number of students in the STEM stream from 45% to 60% (Ministry of Education Malaysia, 2013, p. E-12); (ii) Enhance teacher capabilities in delivering STEM education; (iii) Improve STEM curriculum relevance; and (iv) Encourage partnerships with the private sector to support STEM learning environments. Similarly, Vision 2020, introduced in 1991, set the foundation for a science-oriented and industrialized society: “Malaysia should establish a scientific and progressive society that is innovative and forward-looking” (Government of Malaysia, 1991, para. 3.7.4). This vision influenced the development of STEM-focused educational reforms, including the introduction of the MEB and the 60:40 Science to Arts Policy.

The 60:40 Science to Arts Policy, first articulated by the Higher Education Planning Committee in 1970, emphasized: “To meet the nation’s need for scientific and technical manpower, a target ratio of 60% science to 40% arts students was set for upper secondary education” (Ministry of Education Malaysia, 1970, as cited in Ali et al., 2021). However, as stated in the National Science, Technology and Innovation Policy (NSTIP) 2021–2030, Malaysia acknowledges the persistent shortage of STEM talent: “STEM enrolment in schools remains low and uneven. STEM interest must be nurtured from the school level” (MOSTI, 2021, p. 18). The Academy of Sciences Malaysia (ASM) also issued a national-level blueprint, the Science Outlook Report 2017, warning: “There is an alarming trend of declining interest and enrolment in STEM fields in secondary and tertiary education” (ASM, 2017, p. 30). These