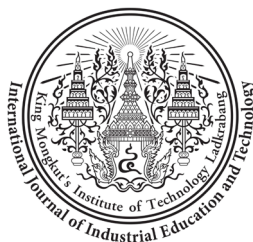




2026

JANUARY - JUNE

8th YEAR 1st EDITION



International Journal of Industrial Education and Technology
ISSN 2673-0448
Vol. 8 No. 1 (January–June) 2026

International Journal of Industrial Education and Technology Editor Board

1. Advisor

Prof. Dr. Pariyaporn Tungkunan
School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang

2. Editor Board

2.1 Editor

Assoc. Prof. Dr. Prasert Kenpankho
School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang

2.2 External Editor Board Committees

Prof. Dr. Edward M. Reeve	Utah State University, U.S.A.
Prof. Dr. Jazlin Ebenezer	College of Education, Wayne State University, U.S.A
Prof. Dr. Michio Hashizume	Kyoto University, Japan
Prof. Woei Hung	University of North Dakota, U.S.A.
Prof. Yamada Shigeru	Waseda University, Japan
Prof. Dr. Act.TLT.Pichai Sodbhiban	(Retired civil servant) Chandrakasem sub-district, Chatuchak district, Bangkok
Prof. Dr. Chaiyong Brahmawong	Bangkokthonburi University
Prof. Dr. Prachyanun Nilsook	King Mongkut's University of Technology North Bangkok
Prof. Dr. Ravewan Chinatrakoon	(Retired civil servant) Bang Phlat sub-district, Bang Phlat district, Bangkok
Prof. Dr. Sirichai Kanjanawasee	Chulalongkorn University
Prof. Dr. Srisak Charmonman	Royal Academy of Great Britain
Prof. Suchat Thaothong	Burapha University
Assoc. Prof. Dr. Chaiwichit Chianchana	King Mongkut's University of Technology North Bangkok
Assoc. Prof. Dr. Charatdao Intratat	King Mongkut's University of Technology Thonburi
Assoc. Prof. Dr. Jirapa Vitayapirak	(Retired civil servant) Saphan Sung sub-district, Saphan Sung district, Bangkok
Assoc. Prof. Dr. Kalayanee Jitgarun	(Retired civil servant) Bang Mod sub-district Thung khru district, Bangkok
Assoc. Prof. Dr. Khajornsak Buaraphan	Mahidol University
Assoc. Prof. Dr. Kumron Sirathanakul	Rajamangala University of Technology Thanyaburi
Assoc. Prof. Dr. Nirat Soodsang	Naresuan University
Assoc. Prof. Dr. Paiboon Kiattikomol	King Mongkut's University of Technology Thonburi
Assoc. Prof. Dr. Pornthap Thanonkeo	Khon Kaen University
Assoc. Prof. Dr. Sreekon Kornratsaten	(Retired civil servant) Ladyao sub-district, Chatuchak district, Bangkok
Assoc. Prof. Dr. Tuanjai Archevapanich	Rajamangala University of Technology Suvarnabhumi, Nonthaburi
Assoc. Prof. Dr. Udomvit Chaisakulkiet	Rajamangala University of Technology Rattanakosin
Assoc. Prof. Attarporn Ridhikerd	(Retired civil servant) Anusawari sub-district, Bang Khen district, Bangkok
Asst. Prof. Dr. Anusit Anmanatarkul	King Mongkut's University of Technology Thonburi
Asst. Prof. Dr. Janpanit Surasin	Burapha University
Asst. Prof. Dr. Pattama Pattanapong	Mahidol University
Asst. Prof. Dr. Petcharat Suriyachai	Prince of Songkla University
Asst. Prof. Dr. Sasitorn Suwannathep	King Mongkut's University of Technology Thonburi
Asst. Prof. Dr. Suchada Katdee	Rajamangala University of Technology Phra Nakhon
Asst. Prof. Dr. Suebpong Prabyai	Ramkhamhaeng University
Asst. Prof. Dr. Thosporn Sangsawang	Rajamangala University of Technology Thanyaburi

Asst. Prof. Dr. Yupin Phasuk
Asst. Prof. Pramote Anunvarapong
Dr. Bundit Prasantree
Dr. Kiattisak Siphimanwat
Dr. Pakorn Prajuabwan
Dr. Saowalak Saengkae
Dr. Somjai Klinngam
Dr. Somporn Seewattanapon

Khon Kaen University
Rajamangala University of Technology Krungthep
Phranakhon Rajabhat University
National Electronics and Computer Technology Center
Kanchanaburi Rajabhat University
Rajamangala University of Technology Krungthep
Phranakhon Rajabhat University
Rajamangala University of Technology Suvarnabhumi

2.3 Internal Editor Board Committees (King Mongkut's Institute of Technology Ladkrabang)

Prof. Dr. Pakkapong Pongsuk,
Asst.Prof. Dr. Somchai Seviset
Asst.Prof. Dr. Somchai Maunsaiyat
Asst.Prof. Dr. Apirath Limmanee
Assoc.Prof. Dr. Pornpimon Chayratsami
Dr. Thadharphut Limapornvanitr

3. Design and Approved Printing (Thai Language Approval)

Asst. Prof. Dr. Ampapan Tuntinakhongul
Asst. Prof. Dr. Jatuporn Anuchai

(English Language Approval)

Asst. Prof. Dr. Ampapan Tuntinakhongul

Cover Design

Dr. Thadharphut Limapornvanitr

Information Technology

Assoc. Prof. Dr. Piya Supavarasuwat
Mr.Mai Charoenthom
Mr.Prayoot Kunthong
Mrs.Jantane Supsaendee

4. Membership Service

Mrs.Jantane Supsaendee

5. Registration Service

Mrs.Jantane Supsaendee

6. Assistant Editor

Mrs.Jantane Supsaendee

Publishing: Two issues per year

The 1st issue for January to June

The 2nd issue for July to December

Submission: Continuously

Scopes

For article acceptance, IJIEET focuses on Educational Technology and Technological Education in five sections follow as

1. Agricultural Education, Environment, and Technology
2. Architecture and Design Technology
3. Educational Technology
4. Engineering and Industrial Technology
5. Space Science and Technology

Selecting speculator for article criteria

Criteria from speculators as follows:

- Article from individual inside institute is speculated by only speculators outside institute.
- Article from individual outside institute is speculated by one speculator inside institute and two speculators outside institute.

Website: <https://www.tci-thaijo.org/index.php/IJIE>

E-mail: journal-enided@kmitl.ac.th

Address: School of Industrial Education and Technology,
King Mongkut's Institute of Technology Ladkrabang
No.1, Soi Chalongkrung 1, Chalongkrung Road,
Ladkrabang, Bangkok, 10520
Tel: 08 6349 6020 or 02 329 8000 ext.3723
Fax: 02 329 8435

Comment, content, and language usages in the article regarding on author's responsibility

Editorial Statement

It is my great pleasure, as Editor-in-Chief of the *International Journal of Industrial Education and Technology (IJIET)*, to present **Volume 8, Issue 1 (2026)**. This issue highlights current research and scholarly discussions in the fields of **Educational Technology** and **Technological Education**. The published works are organized into five thematic areas: **Agricultural Education, Environment and Technology, Architecture and Design Technology, Educational Technology, Engineering and Industrial Technology, and Space Science and Technology**.

IJIET publishes a variety of scholarly contributions, including **review articles, book reviews, and original research articles**. In this issue, the featured review article is entitled “**Cyber Security Measures in Tokyo 2020 Olympic Games: A Case Study**,” while the book review examines “**Agricultural Learning Centers in Schools**.” In addition, this volume contains a collection of high-quality research articles contributed by distinguished scholars and professionals who generously share their research findings, insights, and experiences. I warmly invite our readers to explore the diverse and valuable content presented in this issue. I hope that the articles stimulate new ideas, encourage further research, and contribute to the advancement of knowledge and professional practice in these important fields.

On behalf of the Editorial Board, I would like to express my sincere gratitude to our authors, reviewers, readers, and supporters for their continued trust and contributions to the journal. Your support plays a vital role in maintaining the quality and growth of IJIET. We welcome your comments, feedback, and suggestions regarding this issue and the journal as a whole. Your valuable input will help us continue to improve and better serve the academic and professional communities.

With best regards,

A handwritten signature in blue ink, appearing to read 'P. Ken', with a stylized flourish above the name.

Associate Professor Dr. Prasert Kenpankho, D.Eng.
Editor-in-Chief

International Journal of Industrial Education and Technology (IJIET)

Contents		Page
<i>Review Article</i>		
01	CYBER SECURITY MEASURES IN TOKYO 2020 OLYMPIC GAMES: A CASE STUDY	A1-A4
	Apirath Limmanee	
<i>Book Review</i>		
02	BOOK REVIEW: AGRICULTURAL LEARNING CENTERS IN SCHOOLS	B1-B10
	Authors: Wathana Saduak and Amporn Saduak	
	Pakkapong Pongsuk	
<i>Research Articles</i>		
03	ART, CULTURE, AND TECHNOLOGY: RESEARCH PROCESSES FOR INTELLECTUAL VALUE CREATION AND SUSTAINABILITY IN THE AI ERA	1-12
	Nattaporn Sanguansak, Thanongsak Sovajassatakul, and Kanyarat Sriwisathiyakun	
04	THE ACCEPTANCE OF TECHNOLOGY AFFECTED DIGITAL TRANSFORMATION OF THAI FURNITURE INDUSTRY	13-24
	Krit Taweeponsarn, Chedthida Kusalasaiyanon, and Jutharat Pinthapataya	



	Contents	Page
05	A COMPARISON OF LEARNING ACHIEVEMENT IN MATHEMATICS FOR PRIMARY SCHOOL AMONG FIRST-YEAR UNDERGRADUATE STUDENTS MAJORING IN MATHEMATICS ADMITTED THROUGH DIFFERENT ADMISSION PATHWAYS	25-33
	Thirdsak Kajornboon, Kanchana Boonphak, and Mai Charoentham	
06	THE SPECIFIC CHARACTERISTICS OF TIME AND TEMPERATURE INSIDE A VACUUM GLASS TUBE FOR COOKING RAW INGREDIENTS BY ADJUSTING THE ANGLE OF SOLAR RADIATION AND TYPE OF REFLECTOR	34-54
	Nattakorn Borwornpornmetee, Chawakorn Chanasit, Thanagorn Khuanpanya, Boonchoat Paosawatyanong, and Nathaporn Promros	
07	FACTORS CAUSING DEMOTIVATION IN ENGLISH LANGUAGE LEARNING AMONG AGRICULTURE UNDERGRADUATE STUDENTS	55-68
	Montha Polrak, Napalai Meela, and Charinee Chansri	
08	DEVELOPMENT OF THE DOUBLE P-CE MODEL INTEGRATED WITH CONTEXT-BASED LEARNING TO ENHANCE CRITICAL THINKING FOR 11TH GRADE STUDENTS	69-81
	Pornpat Phusittananan, Sataporn Deeying, and Aungkana Koolnapadol	
09	DEEP LEARNING MODELS FOR EARLY DETECTION OF DEPRESSION FROM SOCIAL MEDIA TEXT	82-92
	Duangporn Janon and Pornpimol Chaiwuttisak	

Contents	Page
10 EFFECTS OF AI-AUGMENTED TAI CHI INSTRUCTION ON PERFORMANCE AND LEARNING OUTCOMES IN SECONDARY VOCATIONAL PHYSICAL EDUCATION Yangyang Sui and Thanawan Phongspatha	93-101

Apirath Limmanee*
apirath.li@kmitl.ac.th*

Department of Engineering Education, School of Industrial Education and Technology,
King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520 Thailand

*Corresponding author E-mail: apirath.li@kmitl.ac.th

Received: June 29, 2026 **Revised:** June 30, 2026 **Accepted:** June 30, 2026

Citation reference:

Limmanee, A. (2026). Cyber security measures in Tokyo 2020 Olympic games: a case study.
International Journal of Industrial Education and Technology, 8(1), A1-A4.

 ABSTRACT

This article reviews the cyber security measures and strategies used in Tokyo 2020 from its official report, an academic article, and some security guidelines. The topic includes basic risk management policies, risk assessment, security working units and personnels, cyber security measures before and during the Games, and conclusion on the success factors.

Keywords: Cyber security, Risk assessment

I. INTRODUCTION

Organizing a gigantic event like Tokyo 2020 Olympic Games requires extremely rigorous planning, especially in terms of risk management. There are several risk categories to be considered, such as the weather, the crowd, the logistics, or even the terrorist attack. There is, however, another kind of risk that is equally, if not more, difficult to manage, the risk of cyber-attacks.

This article reviews the cyber security measures and strategies used in Tokyo 2020 from its official report, an academic article, and some security guidelines. The topic includes basic risk management policies, risk assessment, security working units and personnels, cyber security measures before and during the Games, and conclusion on the success factors.

II. BASIC RISK MANAGEMENT POLICIES

From the official report, there are five basic risk management policies as follows (The Tokyo Organizing Committee of the Olympic and Paralympic Games, 2022).

- 1) Operating the Games Safely
- 2) Completing the Games as Planned
- 3) Preserving the Social Reliability of the Tokyo 2020 Organizing Committee
- 4) Operating the Games through Appropriate Finance
- 5) Achieve the Satisfaction of All Relevant Parties of the Games

III. RISK ASSESSMENT

In the official report of Tokyo 2020, risk assessment for cyber security consists of risk identification and risk evaluation (The Tokyo Organizing Committee of the Olympic and Paralympic Games, 2022). The risk identification part identifies prioritized risks and records them into a risk register. However, to be more precise, risk assessment is defined by ISO/IEC 27000:2018 as consisting of risk identification, risk analysis, and risk evaluation, as shown in Figure 1.

Process	Definition in ISO/IEC 27000:2018 (JIS Q 27000:2019)
Risk Assessment	Overall process of risk identification, risk analysis and risk evaluation
Risk Identification	Process of finding, recognizing and describing risks
Risk Analysis	Process to comprehend the nature of risk and to determine the level of risk
Risk Evaluation	Process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable
Risk Treatment	Process to modify risk

Figure 1: Definitions of key terms

Source: Information-Technology Promotion Agency, Japan (2022, p. 3)

The functional areas of risk management (RSK) proposes the same set of generic attack scenarios for all venues, but they are customizable for each in terms of possibilities of damage and loss. This enables unique identification for each venue while maintaining consistent risk management across all venues.

IV. FORMING SECURITY WORKING UNITS AND PERSONNELS

Several security working units are formed. They coordinate with one another to ensure that the security policies are met (The Tokyo Organizing Committee of the Olympic and Paralympic Games, 2022).

- 1) Security Bureau (SEC) was founded to implement security planning and system considerations at early stages.
- 2) Chief Security Officer (CSO) has jurisdiction over total crisis management for the
- 3) Tokyo 2020 organizing committee.
- 4) Security Operation Center (SOC)
- 5) Technology Operation Center (TOC)
- 6) Security Coordination Center
- 7) Cyber Security Response Coordination Center
- 8) Security Information Center
- 9) Computer Security Incident Response Team (CSIRT)
- 10) Chief Information Security Officer (CISO)

V. CYBER SECURITY MEASURES

Cyber security measures of Tokyo 2020 are divided into two stages, before the Games and during the Games.

A. Before the Games

As preparation before the Games, four types of security measures are taken as follows (The Tokyo Organizing Committee of the Olympic and Paralympic Games, 2022).

- 1) Cyber security exercises: Training, network-based e-Learning training and “awareness training,” are conducted. The awareness training includes training on dealing with targeted email cyber-attacks. For cyber-attacks on critical systems, tabletop exercises are carried out with various simulated scenarios. This involves several participating bureau staff.



- 2) Cooperation with relevant authorities: Those authorities include the Cabinet Secretariat Olympic and Paralympic Games Tokyo 2020 Promotion Management Team, the National Centre of Incident readiness and strategy for cyber security (after “NISC”), and the Tokyo Metropolitan Government Office for Strategic Policy and ICT Promotion. The collected and analyzed information on threats was shared with stakeholders such as the IOC, OBS, marketing partners, and related functional areas.
- 3) Venue cyber security support: The targets of cyber-attacks include not only the information systems (IT) but also the operational technology (OT) such as central monitoring control systems, as well as power and air conditioning monitoring control installed in facilities. Both permanent (legacy) systems and temporary (overlay) systems are protected. Checklists are created to specifically address cyber security concerns.
- 4) Establishing the security operation center (SOC)

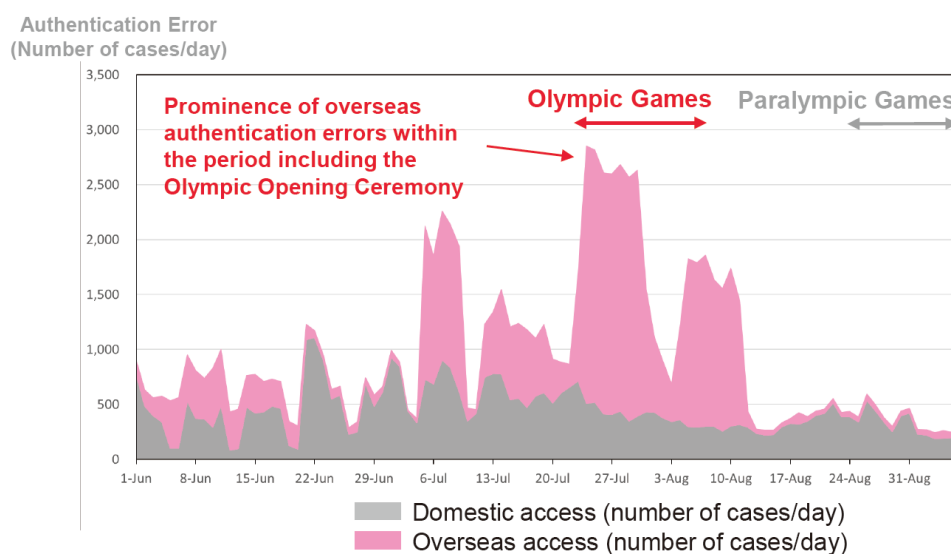


Figure 2: Authentication errors observed in back-office network environments
Source: The Tokyo Organizing Committee of the Olympic and Paralympic Games (2022, p. 267)

B. During the Games

The Security Operation Center (SOC) established within the Technology Operation Center (TOC) is used for monitoring networks and various information systems. It also operated a system of coordination through real-time chains of communication between key broadcasting stakeholders. The SOC also worked to fine-tune security solutions and improve technician proficiency through four field training exercises, two large-scale comprehensive technology training exercises, and three disaster recovery training exercises (The Tokyo Organizing Committee of the Olympic and Paralympic Games, 2022).

The issues observed during the Tokyo 2020 Games includes many cases of authentication errors in back-office environments reported to be password brute force attacks using IP addresses from participating countries as shown in Figure 2. There are also many security incidents on networks including sport networks, back-office networks, and stakeholder networks, as well as on the official website and mobile apps. A total of 450 million security incidents were blocked (The Tokyo Organizing Committee of the Olympic and Paralympic Games, 2022).

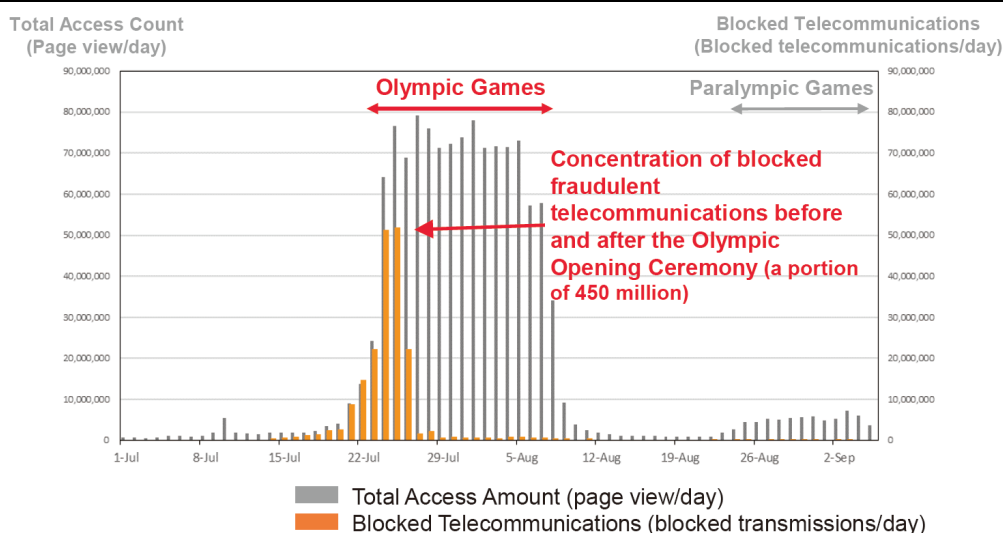


Figure 3: Blocked telecommunication in the server environment of the official website/mobile applications

Source: The Tokyo Organizing Committee of the Olympic and Paralympic Games (2022, p. 267)

VI. CONCLUSION: THE SUCCESS FACTORS

The official report of Tokyo 2020 summarizes a few success factors that make cyber security measures a success, i.e., there is no cyber-attack incident significantly impacting the event. We mention those factors here in terms of action taken, rather than the personnels involved, as follows (The Tokyo Organizing Committee of the Olympic and Paralympic Games, 2022).

- 1) Deployment of cyber security experts as the Internal Staff of the Organizing Committee: These experts are involved in implementation of information security management systems from the start, e.g., establishing necessary regulations and procurement rules.
- 2) Improvement of the architectural design of the information systems and telecommunication networks
- 3) Proactive security measures
- 4) Field training exercises and security audits
- 5) Cooperation with the government and other relevant authorities

REFERENCES

- The Tokyo Organising Committee of the Olympic and Paralympic Games. (2022). *Tokyo 2020 official report: Volume 1*. Olympic World Library. <https://library.olympics.com/Default/doc/SYRACUSE/2954165/tokyo-2020-official-report-the-tokyo-organising-committee-of-the-olympicand-paralympic-games>.
- Information-Technology Promotion Agency, Japan. (2019). *Security Risk Assessment Guide for Industrial Control Systems*. <https://www.ipa.go.jp/icscoe/j5u9nn000000a3y4-att/j5u9nn000000cmcm.pdf>.

The content, as well as the use of language in the article, is the responsibility of the author.



Pakkapong Pounsuk*

pakkapong.po@kmitl.ac.th*

Department of Agricultural Education, School of Industrial Education and Technology,
King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520 Thailand

*Corresponding author E-mail: pakkapong.po@kmitl.ac.th

Received: June 29, 2026 **Revised:** June 30, 2026 **Accepted:** June 30, 2026

Citation reference:

Pakkapong, P. (2026). Agricultural Learning Centers in Schools. **International Journal of Industrial Education and Technology**, 8(1), B1-B10.



 ABSTRACT

This book review critically examines *Agricultural Learning Centers in Schools* by Wathana Saduak and Amporn Saduak, a publication that presents a comprehensive framework for establishing and managing school-based agricultural learning centers. The review evaluates the book's conceptual foundation, pedagogical approaches, organizational structure, practical applications, and contribution to agricultural and industrial education. The analysis is informed by contemporary educational perspectives, including experiential learning, competency-based education, learner-centered pedagogy, and Education for Sustainable Development (ESD). The review finds that the book successfully integrates educational philosophy with practical implementation by presenting agricultural learning centers as authentic learning environments where students develop knowledge, practical competencies, leadership, problem-solving abilities, and environmental responsibility through meaningful learning experiences. Its systematic organization, comprehensive instructional guidance, and emphasis on project-based learning and community participation make the book a valuable resource for teachers, teacher educators, curriculum developers, school administrators, and researchers. Furthermore, the book demonstrates how agricultural learning centers can function as living laboratories that promote sustainable education and lifelong learning. Although future editions could further strengthen the discussion by incorporating recent developments in smart agriculture, precision agriculture, artificial intelligence, digital learning technologies, and international comparative perspectives, these recommendations represent opportunities for future enhancement rather than limitations of the current publication. Overall, the book makes a significant contribution to agricultural teacher education and provides a practical and scholarly reference for developing innovative, competency-based, and sustainable agricultural learning environments within contemporary educational contexts.

Keywords: Agricultural learning centers, School-based agricultural education, Experiential learning, Sustainable education, Agricultural teacher education

I. INTRODUCTION

Agricultural education plays a pivotal role in equipping learners with the knowledge, practical competencies, and professional attitudes required to address the increasingly complex challenges of food security, environmental sustainability, and rural development. In Thailand, agricultural education has continuously evolved in response to changing social, economic, technological, and environmental conditions, requiring educational systems that integrate innovation, experiential learning, and sustainable development (Siriwan, 2014, pp. 45-56; OECD, 2018, pp. 3-6; UNESCO, 2020, pp. iii-5). As education systems increasingly shift from content-based instruction toward competency-based and learner-centered approaches, authentic learning environments have become indispensable for fostering meaningful learning experiences. Among these, school-based agricultural learning centers provide valuable opportunities for students to integrate theoretical knowledge with hands-on practice, thereby enhancing critical thinking, problem-solving, collaboration, and lifelong learning competencies. These characteristics position agricultural learning centers as essential components of Education for Sustainable Development (ESD) and twenty-first-century education (FAO, 2022, pp. iv-vi; UNESCO, 2020, pp. iii-5).

Previous scholarship has further emphasized that meaningful learning occurs when students actively engage with authentic tasks situated in real-world contexts rather than relying solely on classroom-based instruction. Previous studies have consistently emphasized that effective agricultural education should integrate theoretical knowledge, practical experiences, and competency development to prepare learners for professional practice (Poungsuk, 2026, pp. 24-46; Kolb, 2015, pp. 31-50; Roberts & Ball, 2009, pp. 84-90). This perspective is consistent with the long-established philosophy of agricultural education, which recognizes farm work and authentic



agricultural experiences as fundamental components of effective teaching and learning (Siriwan, 1989, pp.133-136). Experiential learning theory proposes that knowledge is created through the transformation of experience, enabling learners to integrate concrete experiences with reflective observation, conceptual understanding, and active experimentation (Kolb, 2015, pp. 31-50). Likewise, school-based agricultural education has increasingly been recognized as an effective pedagogical approach for developing technical competencies, problem-solving skills, leadership, and career readiness through hands-on learning experiences. Recent studies further demonstrate that experiential learning within agricultural education enhances learner engagement, practical competence, and the application of knowledge in authentic educational settings (Banige et al., 2026, pp. 15-33). Moreover, the Education for Sustainable Development (ESD) framework advocates learner-centered, action-oriented, and transformative pedagogies that empower students to address sustainability challenges through participatory and experiential learning (UNESCO, 2020, pp. 13-15). Collectively, these perspectives suggest that agricultural learning centers represent more than instructional facilities; they function as dynamic learning environments where theory, practice, community participation, and sustainable development are meaningfully integrated.

Despite the growing body of literature on experiential learning and agricultural education, relatively few publications provide comprehensive guidance that systematically integrates educational philosophy, instructional design, practical implementation, learner assessment, project-based learning, and academic agricultural activities within a single resource. In this context, *Agricultural Learning Centers in Schools* by Saduak and Saduak (2024, pp. 78-89) makes a valuable contribution by presenting an integrated framework for establishing and managing school-based agricultural learning centers. The book effectively integrates the theoretical foundations of agricultural education with practical strategies for designing learning environments, organizing instructional activities, developing students' practical skills, implementing project-based learning, and promoting agricultural academic activities (Saduak & Saduak, 2024, pp. 90-126). Furthermore, the authors emphasize the role of agricultural learning centers as living laboratories that encourage authentic learning, community participation, and competency development, thereby aligning with contemporary educational paradigms that advocate learner-centered, experiential, and sustainable education (Saduak & Saduak, 2024, pp. 90-139). This perspective is also consistent with previous studies highlighting the transformation of agricultural learning centers into innovative educational environments that support digital learning, lifelong learning, and community engagement in the twenty-first century (Poungsuk, 2018, pp. 1-7).

The purpose of this book review is to critically examine *Agricultural Learning Centers in Schools* by evaluating its conceptual foundation, pedagogical approaches, organizational structure, practical applications, and overall contribution to agricultural and industrial education. The review further discusses the book's strengths, identifies areas for future enhancement, and considers its significance for teachers, teacher educators, curriculum developers, school administrators, and researchers interested in competency-based agricultural education and sustainable learning environments.



II. OVERVIEW AND CRITICAL ANALYSIS OF THE BOOK

1. Overview of the Book

Agricultural Learning Centers in Schools is a comprehensive academic and practical resource that addresses the development and management of agricultural learning centers within school settings. Written by Wathana Saduak and Amporn Saduak, the book presents an integrated framework that combines the philosophy of agricultural education, instructional design, practical skill development, project-based learning, and academic agricultural activities into a coherent educational model. Rather than focusing exclusively on agricultural production, the authors position agricultural learning centers as dynamic educational environments that promote experiential learning, competency development, and community engagement.

The book is systematically organized into seven major sections, beginning with the fundamental concepts of agricultural education and the role of learning resources in schools. It subsequently introduces the theoretical foundations for establishing agricultural learning centers, followed by practical guidance on designing learning spaces, organizing instructional activities, developing students' practical skills, implementing project-based learning, and promoting agricultural academic activities. This logical progression from educational theory to classroom implementation enables readers to understand not only the conceptual rationale behind agricultural learning centers but also the practical procedures required for successful implementation.

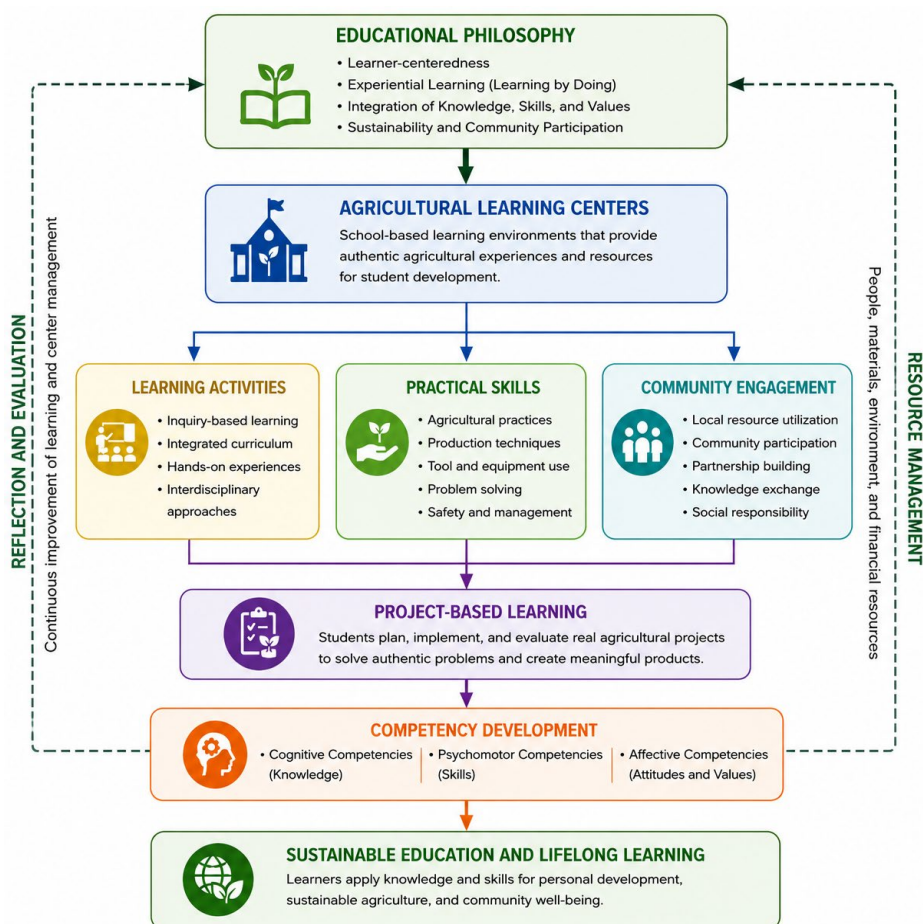


Figure 1: Framework of agricultural learning centers presented in the book
Source: Developed by the reviewer based on Saduak and Saduak (2024, pp. 78-126).

Figure 1 synthesizes the educational framework presented throughout the book. Rather than depicting agricultural learning centers solely as physical facilities, the framework illustrates a holistic educational system that integrates educational philosophy, experiential learning, practical skill development, community engagement, project-based learning, competency development, and sustainable education. The figure also highlights the continuous roles of reflection, evaluation, and resource management in supporting effective learning environments. This conceptual framework demonstrates that agricultural learning centers function as dynamic educational ecosystems rather than isolated instructional resources.

One of the distinguishing characteristics of this book is its successful integration of educational theory with practical experience. Throughout the seven sections, the authors consistently demonstrate how agricultural learning centers can function as "living laboratories," where students actively construct knowledge through observation, experimentation, reflection, and authentic agricultural practice. The book also emphasizes learner-centered instruction, interdisciplinary integration, community participation, and sustainable agricultural development, thereby extending its relevance beyond agricultural education to broader fields of vocational, industrial, and technology education. Consequently, the book serves not only as an instructional guide but also as a practical reference for teachers, school administrators, teacher educators, curriculum developers, and researchers interested in improving experiential and competency-based education.

2. Pedagogical Contributions

To better illustrate the educational value of the book, its major pedagogical contributions can be synthesized into an integrated conceptual framework. Rather than viewing agricultural learning centers merely as physical instructional facilities, the book presents them as learner-centered educational environments that promote experiential learning, project-based instruction, practical skill development, and community participation. These interconnected pedagogical elements collectively support competency-based education and holistic learner development. The conceptual framework is presented in Figure 2.

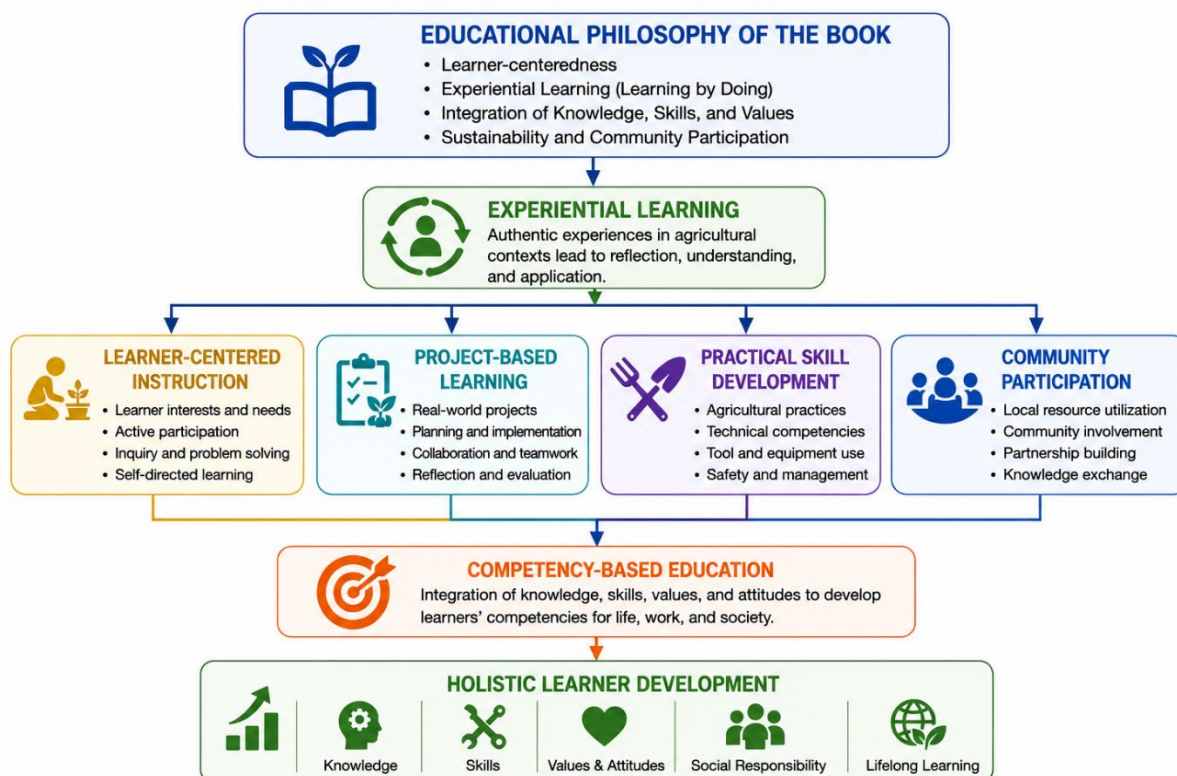


Figure 2: Pedagogical contributions of the book

Source: Developed by the reviewer based on Saduak and Saduak (2024, pp. 90-139).

Figure 2 illustrates the book's major pedagogical contributions by demonstrating how educational philosophy is translated into effective teaching and learning practices within agricultural learning centers. The framework emphasizes experiential learning as the central instructional approach that supports learner-centered instruction, project-based learning, practical skill development, and community participation. Together, these pedagogical components contribute to competency-based education and holistic learner development, reinforcing the book's emphasis on integrating knowledge, skills, values, and lifelong learning within authentic educational settings.

One of the book's most significant contributions lies in its pedagogical perspective on agricultural education. This pedagogical perspective reflects the long-standing principle that agricultural education should integrate practical farm experiences with theoretical instruction to promote meaningful learning and professional competency (Siriwan, 1989, pp. 133-136). Rather than presenting agriculture as a collection of technical production practices, the authors conceptualize agricultural learning centers as educational environments designed to cultivate learners' cognitive, psychomotor, and affective competencies through authentic learning experiences (Saduak & Saduak, 2024, pp. 90-102). This perspective reflects the fundamental principles of experiential learning, where knowledge is constructed through the continuous interaction between experience, reflection, conceptualization, and experimentation (Kolb, 2015, pp. 39-45). Throughout the book, considerable emphasis is placed on learner-centered instruction, practical skill development, project-based learning, and community participation, all of which are recognized as essential characteristics of competency-based education and twenty-first-century learning (Saduak & Saduak, 2024, pp. 90-126; Darling-Hammond et al., 2020, pp. 97-105). Furthermore, the integration of instructional planning, practical activities, learner assessment, and agricultural academic events demonstrates a comprehensive educational model that extends beyond traditional vocational training toward holistic learner development (Saduak & Saduak, 2024, pp. 116-180).

3. Practical Applications

Another notable strength of the book is its strong emphasis on practical implementation. The authors provide systematic guidance for establishing agricultural learning centers, organizing learning resources, planning instructional activities, developing practical skills, implementing project-based learning, and evaluating student performance. These practical recommendations enable readers to translate educational concepts into classroom practice with relative ease. Importantly, the proposed framework is sufficiently flexible to accommodate diverse school contexts, available resources, and community characteristics. Consequently, the book has broad applicability for classroom teachers, teacher educators, school administrators, curriculum developers, and educational policymakers seeking to enhance experiential and competency-based agricultural education. The inclusion of practical examples, instructional procedures, and authentic learning activities further increases the book's value as both a professional reference and an implementation guide for educational institutions.

4. Critical Evaluation

Despite its considerable strengths, several aspects of the book could be further developed in future editions. While the book provides extensive practical guidance for establishing agricultural learning centers, greater discussion of digital technologies, smart agriculture, precision agriculture, artificial intelligence, and data-driven agricultural management would strengthen its relevance to contemporary educational and agricultural contexts. In addition, expanding international perspectives through comparative case studies from other countries would enhance readers' understanding of diverse approaches to school-based agricultural education. Greater attention to evaluating long-term learning outcomes and educational impacts using empirical evidence would also reinforce the book's academic contribution. Nevertheless, these observations do not diminish the overall quality of the publication. Instead, they represent opportunities for



future development of an already comprehensive and highly practical resource. Overall, *Agricultural Learning Centers in Schools* successfully bridges educational theory and classroom practice, making it a valuable contribution to agricultural education, vocational education, and industrial education.

III. DISCUSSION AND EDUCATIONAL IMPLICATIONS

The publication of *Agricultural Learning Centers in Schools* is particularly timely as educational systems worldwide increasingly emphasize competency-based education, authentic assessment, and experiential learning as essential strategies for preparing learners to address complex social, environmental, and technological challenges (Kolb, 2015, pp. 31-50; UNESCO, 2020, pp. 13-15). Contemporary agricultural education extends beyond the acquisition of technical knowledge to encompass the development of critical thinking, collaboration, communication, creativity, and lifelong learning competencies (Poungsuk, 2022, pp. 210-235). In this context, the book illustrates how school-based agricultural learning centers can function as educational ecosystems that integrate classroom instruction, practical experience, community engagement, and sustainable agricultural development into a coherent educational framework (Saduak & Saduak, 2024, pp. 90-139). These characteristics closely reflect current international perspectives on learner-centered and action-oriented education while also supporting educational change through authentic learning, collaborative practice, and continuous professional development, which are recognized as essential elements of sustainable educational improvement (Fullan, 2020, pp. 23-45).

One of the book's most valuable contributions is its ability to bridge the long-standing gap between educational theory and classroom practice. Although experiential learning and learner-centered education have been widely discussed in educational literature, relatively few publications provide comprehensive guidance for translating these theoretical concepts into practical instructional models that can be implemented effectively in school settings (Kolb, 2015, pp. 39-45; Knobloch & Smith, 2024, pp. 304-309). The authors systematically present procedures for designing agricultural learning centers, organizing instructional activities, developing students' practical competencies, implementing project-based learning, and evaluating learning outcomes (Saduak & Saduak, 2024, pp. 90-180). This practical orientation reflects contemporary trends in school-based agricultural education, which advocate authentic and active learning experiences that enable learners to construct knowledge through observation, experimentation, reflection, and application (Kolb, 2015, pp. 40-43; Knobloch & Smith, 2024, pp. 314-319). To further demonstrate the broader significance of the book, its educational implications can be synthesized into a conceptual model that extends beyond agricultural instruction alone. The book illustrates how agricultural learning centers contribute not only to agricultural education but also to vocational and industrial education, community-based learning, and education for sustainable development (Saduak & Saduak, 2024, pp. 90-180). These interconnected educational dimensions collectively support learner competency, innovation, and sustainable community development. The synthesized educational implications are presented in Figure 3.



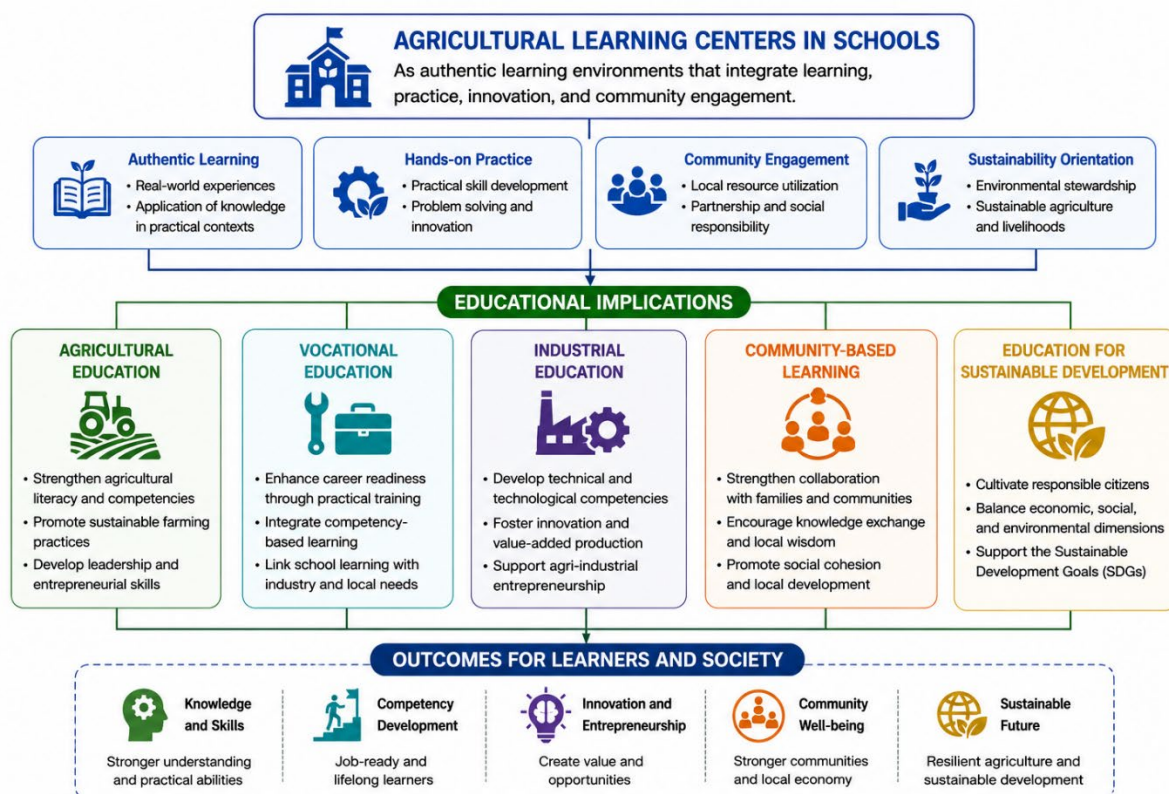


Figure 3: Educational implications for agricultural and industrial education
Source: Developed by the reviewer based on Saduak and Saduak (2024, pp. 78-180).

Figure 3 synthesizes the broader educational implications of the book by illustrating how agricultural learning centers contribute to multiple educational domains. The framework demonstrates that authentic agricultural learning extends beyond technical skill development to strengthen vocational and industrial education, foster community-based learning, and promote Education for Sustainable Development. Collectively, these educational dimensions contribute to competency development, innovation, community well-being, and sustainable societal outcomes.

Furthermore, the educational philosophy embedded throughout the book extends beyond agricultural instruction itself. The proposed learning model encourages learner autonomy, responsibility, teamwork, leadership, environmental stewardship, and community participation—attributes that are central to Education for Sustainable Development (ESD) and competency-based education (UNESCO, 2020, pp. 13-15). By positioning agricultural learning centers as "living laboratories," the authors demonstrate how authentic learning environments can cultivate not only agricultural competencies, but also transferable skills required for sustainable development and responsible citizenship (Saduak & Saduak, 2024, pp. 90-139). This educational perspective is further supported by previous scholarship demonstrating that agricultural learning centers have evolved into innovative learning environments that promote digital learning, community engagement, and lifelong learning in the twenty-first century (Poungsuk, 2018, pp. 1-7). Consequently, the book has relevance not only for agricultural education but also for vocational education, industrial education, technology education, and community-based learning, where experiential and interdisciplinary learning approaches are increasingly encouraged (Poungsuk, 2026, pp. 116-118). This broader educational perspective is consistent with the contemporary direction of Thai agricultural education, which emphasizes authentic learning, community engagement, innovation, and sustainable agricultural development as fundamental principles for preparing future agricultural professionals (Siriwan, 2014, pp. 45-56).

From the reviewer's perspective, this publication represents one of the few comprehensive references that successfully integrate educational philosophy, curriculum implementation, instructional design, agricultural practice, and school management within a single volume. While future editions could be further strengthened by incorporating recent developments in smart agriculture, precision agriculture, digital learning technologies, artificial intelligence, and international comparative case studies, these observations should be viewed as opportunities for future enhancement rather than limitations of the present work. Overall, *Agricultural Learning Centers in Schools* makes a substantial contribution to agricultural teacher education and provides a valuable reference for teachers, teacher educators, school administrators, curriculum developers, and researchers seeking to establish innovative, learner-centered, competency-based, and sustainable agricultural learning environments.

IV. CONCLUSION

Agricultural Learning Centers in Schools is a well-organized and academically valuable publication that successfully integrates educational philosophy, instructional design, agricultural practice, and school management into a coherent framework for agricultural education. The book effectively demonstrates how agricultural learning centers can serve as authentic learning environments that promote experiential learning, competency development, project-based instruction, and sustainable educational practices (Saduak and Saduak, 2024, pp. 90-139). By combining conceptual foundations with practical implementation strategies, the authors provide educators with a comprehensive resource that supports both curriculum development and instructional improvement. This emphasis on innovation, collaboration, and authentic learning also reflects broader perspectives on sustainable educational change and continuous school improvement (Fullan, 2020, pp. 23-45).

From an educational perspective, the book makes a significant contribution by illustrating how agricultural education can extend beyond traditional classroom instruction to foster critical thinking, practical competencies, collaboration, leadership, and environmental responsibility. These educational values are closely aligned with contemporary international priorities in competency-based education, Education for Sustainable Development (ESD), and learner-centered pedagogy (Kolb, 2015, pp. 40-43; UNESCO, 2020, pp. 13-15). Consequently, the publication has relevance not only for agricultural teachers but also for teacher educators, curriculum developers, school administrators, vocational educators, and researchers seeking innovative approaches to authentic and sustainable learning (Poungsuk, 2026, pp. 116-118).

Although future editions could further enrich the discussion by incorporating recent developments in digital learning technologies, smart agriculture, precision agriculture, artificial intelligence, and international comparative perspectives, these recommendations should be viewed as opportunities for expanding an already comprehensive and practical educational resource. The book's emphasis on integrating theory with practice, fostering community participation, and promoting lifelong learning remains one of its most distinctive strengths (Saduak & Saduak, 2024, pp. 90-180). Overall, *Agricultural Learning Centers in Schools* is highly recommended for educators and institutions interested in developing effective school-based agricultural learning environments. Beyond serving as a practical guide, the book contributes meaningfully to the advancement of agricultural teacher education and offers valuable insights that can inform curriculum innovation, instructional improvement, and educational policy. Its publication represents an important contribution to the literature on agricultural education and reinforces the continuing importance of experiential, competency-based, and sustainable learning in preparing future generations for the challenges of agriculture and society.



REFERENCES

- Banige, D., Ikendi, S., Mwenyi, R. M., Somers, R., Asimo, E. A., Kakungulu, B. A., Kitayimbwa, R., & Kabbale, F. G. (2026). Enhancing experiential learning in school-based agricultural education: An exploratory study with agricultural educators in Uganda. *Journal of Agricultural Education*, 67(1), 1-15.
<https://doi.org/10.5032/jae.v67i1.3301>.
- Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science*, 24(2), 97-140.
- Food and Agriculture Organization of the United Nations. (2022). The state of food and agriculture 2022: Leveraging automation in agriculture for transforming agrifood systems. FAO.
- Fullan, M. (2020). Leading in a culture of change (2nd ed.). Jossey-Bass.
- Knobloch, N. A., & Smith, A. R. (2024). Experiential learning in school-based agricultural education. *Journal of Agricultural Education*, 65(1), 303-323.
<https://doi.org/10.5032/jae.v65i1.2527>.
- Kolb, D. A. (2015). Experiential learning: Experience as the source of learning and development (2nd ed.). Pearson.
- Organisation for Economic Co-operation and Development. (2018). The future of education and skills: Education 2030. OECD Publishing.
- Poungsuk, P. (2018). Agricultural learning center and transition to digital society era. *Journal of Industrial Education*, 17(2), 1-7.
- Poungsuk, P. (2022). Agricultural education (3rd ed.). Mean Service Supply.
- Poungsuk, P. (2026). Digital agricultural instructional models. Mean Service Supply.
- Roberts, T. G., & Ball, A. L. (2009). Secondary agricultural science as context for teaching. *Journal of Agricultural Education*, 50(1), 81-91.
- Saduak, W., & Saduak, A. (2024). Agricultural learning centers in schools. Mean Service Supply.
- Siriwan, N. (1989). Farm work: A key strategy in agricultural education. Phonchai Printing Center.
- Siriwan, N. (2014). Miscellany of Thai agricultural education: Essential issues to reconsider. Mean Service Supply.
- UNESCO. (2020). Education for sustainable development: A roadmap. UNESCO Publishing.

The content, as well as the use of language in the article, is the responsibility of the author.



Nattaporn Sanguansak, Thanongsak Sovajassatakul*, and Kanyarat Sriwisathiyakun

65036098@kmitl.ac.th, thanongsak.so@kmitl.ac.th*, and kanyarat.sr@kmitl.ac.th

Department of Industrial Education, School of Industrial Education and Technology,
King Mongkut's Institute of Technology Ladkrabang Thailand, Bangkok 10520 Thailand

*Corresponding author E-mail: thanongsak.so@kmitl.ac.th

Received: January 30, 2026 **Revised:** February 10, 2026 **Accepted:** 27 February 28, 2026

Citation reference:

Sanguansak, N., Sovajassatakul, T., & Sriwisathiyakun, K. (2026). Art, culture, and technology: Research processes for intellectual value creation and sustainability in the AI era. **International Journal of Industrial Education and Technology**, 8(1), 1-12.

 ABSTRACT

This quasi-experimental study aimed to develop and examine the effectiveness of microlearning media (MLM) on the topic “Using Basic Chemical Instruments in Agriculture” for first-year undergraduate students in the Department of Agricultural Education, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang, during the first semester of the 2025 academic year. The sample consisted of 50 students selected through purposive sampling and taught using the one-group pretest–posttest research design. The research instruments included the developed MLM, a media quality evaluation form, a media efficiency evaluation form (E1/E2), and pretest–posttest achievement tests. The overall quality of the MLM was rated at a very good level ($\bar{x} = 4.60$, $SD = 0.39$), with the content quality receiving a very good rating ($\bar{x} = 4.76$, $SD = 0.43$) and the technical quality also rated at a very good level ($\bar{x} = 4.44$, $SD = 0.31$). The media efficiency score was 96.80/84.40, surpassing the standard criterion of 80/80. The comparison of learning achievement before and after using the MLM revealed that the posttest mean score ($\bar{x} = 16.88$, $SD = 2.92$) was significantly higher than the pretest mean score ($\bar{x} = 6.90$, $SD = 1.38$) at the .05 level of significance ($t = 25.24$, $p < .001$). These findings indicate that the developed microlearning media met quality and efficiency standards and effectively enhanced students' understanding and practical knowledge regarding the use of basic chemical instruments in agricultural contexts, demonstrating its potential as a suitable instructional tool for improving learning outcomes in agricultural education.

Keywords: Microlearning media, Basic chemical instruments in agriculture, Learning achievement, Instructional design

I. INTRODUCTION

In the 21st century, technological advancements have profoundly transformed society, the economy, and the education sector. Contemporary educational paradigms emphasize the integration of digital technologies to enhance accessibility, equity, and responsiveness to the diverse needs of learners. The 20-Year National Strategy (2018–2037) and the National Education Plan (2017–2036) recognize digital platforms as a fundamental infrastructure for fostering lifelong learning (Office of the National Economic and Social Development Council, 2018, Online). Additionally, the COVID-19 pandemic further highlighted the critical role of flexible and effective digital learning systems in ensuring educational continuity and quality.

Microlearning represents a pedagogical innovation that addresses the evolving needs of modern learners by presenting information in short, focused segments aimed at promoting rapid comprehension of specific topics (Asha, 2016, Online). This approach aligns with contemporary learning behaviors characterized by reduced attention spans and increased reliance on mobile technologies (Insa-ard, 2021, pp. 45-59) such as smartphones and tablets (Boonmapan et al., 2021, pp. 65-78). Empirical evidence suggests that microlearning not only enhances learner motivation and supports self-directed learning but also integrates seamlessly with social media environments, thereby fostering sustained engagement and continuous learning (Thanomchayathawat et al., 2016, pp. 208–222). Nonetheless, while its flexibility and accessibility offer clear advantages, effective implementation requires thoughtful design to ensure depth of understanding and long-term knowledge retention.

In higher education, particularly in laboratory-based disciplines such as agricultural education, traditional lectures alone are insufficient to develop students' practical understanding. Learners often come from diverse academic backgrounds, and those without a strong foundation in science frequently exhibit limited proficiency in using scientific instruments, leading to operational errors and diminished learning performance (Saikampha, 2021, p. 47). Consequently, the development of microlearning media focused on basic agricultural chemical instruments is essential for enhancing conceptual understanding, improving practical skills, and minimizing procedural errors during laboratory activities.

Therefore, this research aimed to: 1) develop microlearning media on the use of basic chemical instruments in agriculture for undergraduate students; and 2) compare the pre-test and post-test learning achievements of students in the Department of Agricultural Education, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang. Moreover, it intended to address the challenges arising from learners' diverse academic backgrounds and to enhance the effectiveness of practical learning. It was anticipated that the developed media will enable students to acquire accurate knowledge and understanding, minimize errors in the use of scientific instruments, and ultimately improve the quality of graduates by equipping them with the knowledge, skills, and competencies that align with societal needs and professional standards.



II. LITERATURE REVIEW

Technological transformations and evolving learning approaches in the 21st century have rendered traditional education management methods insufficient on their own. In particular, The COVID-19 pandemic has accelerated the adoption of online learning and digital media, which has gained widespread popularity for its ability to effectively address the needs of contemporary learners (Office of the National Economic and Social Development Council, 2018, Online). One learning model that has attracted considerable attention is microlearning, which delivers short, concise, and focused lessons that can be completed within minutes. Empirical studies have demonstrated that microlearning can enhance both academic achievement and self-directed learning skills. For example, Mohammed et al. (2018, pp. 32-38) found that learners engaged in microlearning achieved average outcomes 18 percent higher than those taught via traditional methods. Similarly, Kongsomboon (2019, pp. 51-62) developed microlearning media for vocational students, reporting an efficiency rate exceeding the 90/90 criterion, with students demonstrating significantly higher post-test scores compared to pre-test scores. Consistently, Detphong (2020, pp. 274-282) developed microlearning media on genetics for high school students, and observed that learners not only surpassed standard benchmarks, but also developed positive attitudes toward learning through this approach. Similarly, Jainuri et al. (2025, pp. 630–642) investigated Microlearning effectiveness in higher education: A systematic review and meta-analysis of student retention and learning outcomes. Based on 42 related studies conducted between the years 2020 and 2025, involving 15,673 participants across 18 countries, the findings revealed that microlearning had a significantly positive impact on learning outcomes, particularly regarding knowledge retention. The study reported an effect size as high as 0.74, especially in STEM fields (Science, Technology, Engineering, and Mathematics) when integrated with mobile technologies. Consequently, this research supports the implementation of microlearning as an effective instructional strategy.

An important hypothesis derived from the review of related literature is that instruction utilizing microlearning media has the potential to enhance students' academic achievement and foster essential 21st-century learning skills, including analytical thinking, problem-solving, and self-directed learning. Both domestic and international studies have consistently shown that learners who engage with microlearning media demonstrate statistically significant improvements in post-test scores compared to pre-test scores. In addition, learners have exhibited positive attitudes toward such media, suggesting that learning materials designed to be concise, easily comprehensible, and accessible anytime and anywhere can increase motivation and engagement. Accordingly, within the context of teaching agricultural chemistry courses involving the use of basic scientific instruments, this study hypothesizes that the development of microlearning media on basic agricultural chemical instruments will enable students to achieve higher learning outcomes after instruction than before, while the developed media will meet the established quality and efficiency criteria of 80/80.



III. RESEARCH METHODOLOGY

This study employed a quasi-experimental research design, specifically the one-group pretest–posttest design, to evaluate the effectiveness of the developed microlearning media on the learning achievement of undergraduate students. This design was considered appropriate for authentic educational settings where random assignment of participants is not entirely feasible, while still enabling the researcher to accurately measure changes in learners' performance before and after exposure to the instructional media.

3.1 Conceptual Framework

The conceptual framework of this study centered on the development of microlearning media for the use of basic agricultural chemical instruments among undergraduate students. The independent variable was the microlearning media, which was developed following the ADDIE Model, comprising five phases: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation. The dependent variables included: (1) the quality of the media, assessed in terms of content and technical aspects; (2) the efficiency of the media, measured against the 80/80 (E1/E2) standard criterion; and (3) students' learning.

3.2 Population and Sample

The population for this study consisted of first-year undergraduate students in the Department of Agricultural Education, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang. A simple random sampling method was employed to select a sample of 50 first-year students from the same department, enrolled in the first semester of the 2025 academic year. This group served as the experimental cohort for examining students' learning achievement before and after instruction using the developed microlearning media.

3.3 Research Instruments

The research instruments used in this study were categorized into four types as follows:

3.3.1 Microlearning media on the use of basic agricultural chemical instruments for undergraduate students.

3.3.2 Evaluation form for media quality, completed by experts, assessing both content and technical aspects of the microlearning media.

3.3.3 Efficiency evaluation form (E1/E2) to determine the effectiveness of the microlearning media on the use of basic agricultural chemical instruments for undergraduate students.

3.3.4 4. Achievement test designed to measure students' learning outcomes before and after instruction.

3.4 Development of Microlearning Media on Basic Agricultural Chemical Tools of Undergraduate Students

In the development of the microlearning media, the researcher utilized the ADDIE Model as the guiding framework, as illustrated in Figure 1. The ADDIE Model is a widely recognized approach for designing and developing instructional media, comprising five key phases as follows:



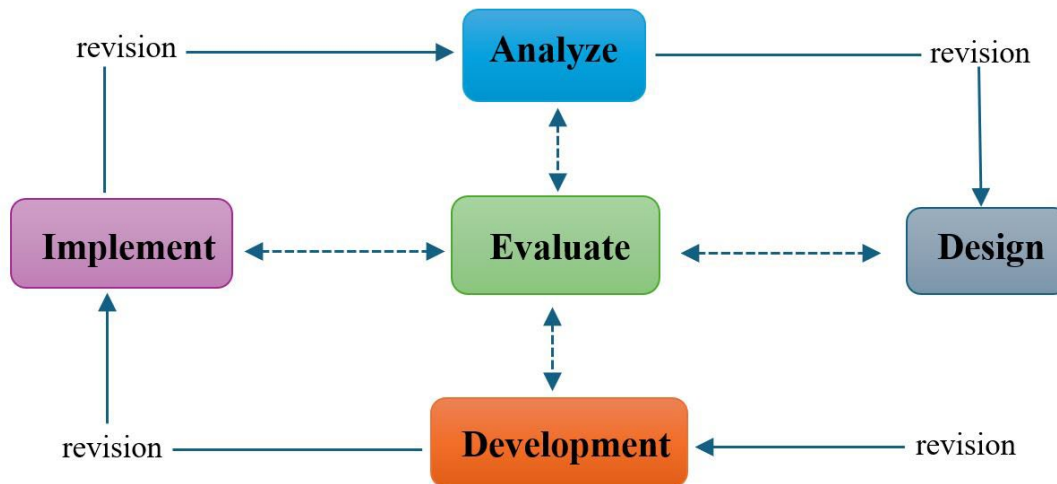


Figure 1: Structure of the ADDIE model

Source: Thienthong (2005, p. 131)

Step 1: Analysis : In this phase, the researcher conducted an analysis of the curriculum and course content for Agricultural Chemistry. The analysis comprised three main components:

1.1 Content Analysis – The structure and scope of the lesson content were examined to identify key concepts and topics appropriate for the development of microlearning materials.

1.2 Learner Analysis – The characteristics of the sample group were analyzed, including their prior knowledge, learning needs, and technological readiness.

1.3 Technology Analysis – The technologies to be employed in the lessons were evaluated, focusing on tools for presenting instructional content, designing learning activities, creating assessments, and collecting learner data.

Step 2: Design : In this phase, the researcher designed the structure of the lessons and learning units for the microlearning media. The design process included the development of a content presentation plan, multimedia elements such as animations and graphics, and alongside the practical worksheets. Additionally, pre-test and post-test assessments, along with practical worksheets, were designed to evaluate students' skills after learning and overall learning outcomes

Step 3: Development : During the development phase, the researcher created the digital microlearning media by integrating text, images, audio, and video to support learners' understanding of the proper use of laboratory instruments. Worksheets and achievement tests were also developed as part of the learning package. The completed media were subsequently reviewed by the research advisor and subject-matter experts to ensure content accuracy and technical appropriateness. Revisions were made based on their feedback and recommendations.

Step 4: Implementation : In this phase, the researcher implemented the developed microlearning media to examine its completeness, clarity, and overall appropriateness prior to making necessary revisions and improvements. Subsequently, the finalized media were administered to a sample group of 50 first-year undergraduate students to evaluate its efficiency based on the 80/80 (E1/E2) standard criteria.

Step 5: Evaluation : In the final phase, the researcher evaluated both the efficiency and quality of the microlearning media by analyzing students' learning achievement before and after the intervention. Additionally, expert evaluations of content and technical quality were reviewed. The findings from these assessments were subsequently used to refine and enhance the instructional media to achieve greater effectiveness.

3.5 Data Collection

The researcher conducted the experiment in accordance with the specified research design using the microlearning media titled "Using Basic Chemical Instruments in Agriculture" which had been reviewed and validated by experts. The experiment was implemented with a sample group of 50 first-year undergraduate students. The data collection process involved the following steps:

3.5.1 The researcher explained the objectives, experimental procedures, and usage of the microlearning media to ensure that participants clearly understood the process.

3.5.2 The participants completed a pre-test to assess their prior knowledge before engaging with the learning media.

3.5.3 The students then participated in the learning activities using the microlearning media, which consisted of five learning units.

3.5.4 Upon completion of the lessons, the participants took a post-test to measure their learning achievement after using the media.

3.5.5 Finally, the researcher collected and verified the accuracy of all data before proceeding with statistical analysis using appropriate methods.

3.6 Data Analysis

3.6.1 The appropriateness and quality of the microlearning media, along with learners' satisfaction, were analyzed using the Mean ($\bar{x}$) and Standard Deviation (SD). The interpretation of the mean scores followed a five-level rating scale (Leekitwattana, 2016, p. 172), as shown below:

Mean scores between 4.50–5.00 indicate the highest level of quality.

Mean scores between 3.50–4.49 indicate a high level of quality.

Mean scores between 2.50–3.49 indicate a moderate level of quality.

Mean scores between 1.50–2.49 indicate a low level of quality.

Mean scores between 1.00–1.49 indicate the lowest level of quality, suggesting that improvement is needed.

3.6.2 The efficiency of the microlearning media was evaluated using the E1/E2 (80/80) efficiency criterion, which measures the instructional effectiveness of the developed media.

3.6.3 The comparison of students' learning achievement before and after using the microlearning media was conducted using the Dependent Samples t-test (Paired Samples t-test) to determine whether the difference between pre-test and post-test scores was statistically significant at the .05 level.



IV. RESULTS

Based on the implementation of this research, the findings from the data analysis can be summarized as follows:

4.1 Results of the quality evaluation of the microlearning media on using basic chemical instruments in agriculture for undergraduate students are presented as follows.

The microlearning media titled “Using Basic Chemical Instruments in Agriculture” for undergraduate students encompassed concise instructional content outlining operational principles, instrument usage procedures, practical worksheets, and corresponding pre-test and post-test assessments. The instructional design emphasized self-directed learning, facilitated through the Google Classroom platform, which supports both desktop and mobile access. This approach enables learners to engage in flexible, continuous learning at their own pace, anytime and anywhere, as illustrated in Figures 2–5.

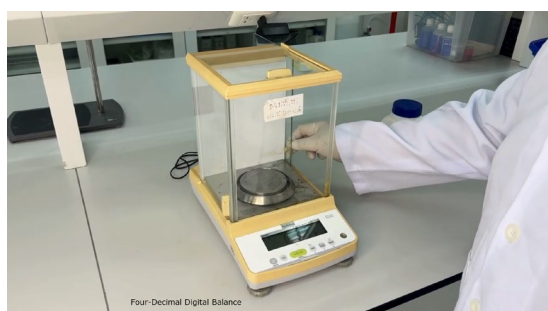


Figure 2: Four-decimal digital balance

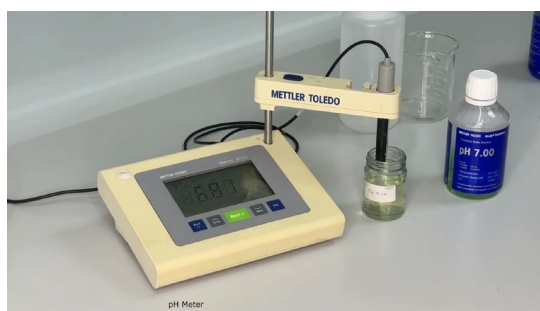


Figure 3: pH meter



Figure 4: Brix refractometer



Figure 5: Hot air oven

The quality analysis of the microlearning media on using basic chemical instruments in agriculture for undergraduate students encompassed two aspects: content quality and technical production quality. Each aspect was evaluated by three experts, and the results of the analysis are presented in Table 1.

Table 1: Mean scores, standard deviations, and quality levels of the microlearning media on using basic chemical instruments in agriculture for undergraduate students, classified by overall and individual aspects.

Evaluation items	$\bar{x}$	SD	Quality level
1. Content aspect	4.69	0.38	The highest
2. Technical production aspect	4.52	0.40	The highest
Total	4.60	0.39	The highest

As shown in Table 1, the evaluation of the developed microlearning media indicated that its overall appropriateness was rated at the highest ($\bar{x} = 4.60$, $SD = 0.39$) based on assessments by three experts. When examining each aspect individually, the content quality received the highest mean score ($\bar{x} = 4.69$, $SD = 0.38$), also rated at the highest, followed by the technical production quality ($\bar{x} = 4.52$, $SD = 0.40$), which was similarly assessed the highest.

4.2 Results of the efficiency analysis of the microlearning media on using basic chemical instruments in agriculture for undergraduate students.

The results of the efficiency evaluation of the microlearning media on using basic chemical instruments in agriculture for undergraduate students, calculated using the E1/E2 formula, are presented in Table 2.

Table 2: Results of the efficiency analysis of the microlearning media using basic chemical instruments in agriculture for undergraduate students.

Scores	Students (n=50)			Specified criterion
	Full score	Mean score	Average percentage	
End-of-lesson test	25	24.20	96.80	80 (E ₁)
Post-test	20	16.88	84.40	80 (E ₂)

* Specified criterion E₁/E₂ (80/80)

From Table 2, the results of the efficiency evaluation of microlearning media on using basic chemical instruments in agriculture for undergraduate students revealed that the developed media met the established efficiency standard. The mean efficiency during learning (E₁) was 96.80, and the post-learning efficiency (E₂) was 84.40, both exceeding the specified 80/80 standard criterion.

4.3 Results of the comparative analysis of students' learning achievement before and after instruction.

The results of the analysis comparing students' learning achievement before and after instruction, conducted using the Dependent Samples t-test, are presented in Table 3.

Table 3 Comparison of students' learning achievement before and after instruction with the microlearning media on using basic chemical instruments in agriculture

Test	n	$\bar{x}$	SD	t	df	p
Pre-test	50	6.90	1.38	25.24	49	<0.001
Post-test	50	16.88	2.92			

* Statistically significant at the .05 level



From Table 3, the analysis comparing students' learning achievement before and after instruction using the microlearning media on basic chemical instruments in agriculture, conducted with the Dependent Samples t-test, revealed that the mean post-test score ($\bar{x} = 16.88$, $SD = 2.92$) was higher than the mean pre-test score ($\bar{x} = 6.90$, $SD = 1.38$). This difference was statistically significant at the 0.05 level ($t = 25.24$, $df = 49$, $p < 0.001$), indicating that the developed microlearning media effectively enhanced students' learning achievement.

V. CONCLUSION AND DISCUSSION

The developed microlearning media on basic chemical instruments in agriculture proved to be of very high quality, efficient, and effective in enhancing first-year undergraduate students' learning achievement. It not only improved knowledge and practical skills but also promoted self-directed learning and motivation. These results suggest that microlearning media can be successfully applied in practice-oriented courses, providing a flexible, accessible, and engaging approach to laboratory instruction for digital-age learners. Furthermore, the flexibility of this microlearning media allows for its effective adaptation to other laboratory courses within agricultural or agricultural science curricula, particularly for instruction involving similar basic agricultural tools. Whether utilized for reviewing prior knowledge or acquiring new skills and engaging learning method that perfectly meets the needs of learners in the digital age.

The self-directed microlearning media on "Using Basic Chemical Instruments in Agriculture" for first-year undergraduate students were developed to enhance knowledge, understanding, and practical laboratory skills. A quasi-experimental one-group pretest–posttest design was employed with a sample of 50 students from the Department of Agricultural Education, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang. The evaluation of the media indicated very high overall quality ($\bar{x} = 4.60$, $SD = 0.39$) in both content and technical aspects. The content was systematically aligned with learning objectives and reviewed by experts, ensuring accuracy, appropriateness, and learner-centered design. Consequently, the media were found to be complete, suitable, and effective for instructional use. These findings align with Anderson and Krathwohl (2001, p. 131), who emphasized instructional design principles under the ADDIE Model, including learner analysis, alignment of learning activities with objectives, and continuous evaluation. They also support Boonmapan et al. (2021, pp. 65-78), who reported that microlearning is particularly suited for digital-age learners due to its concise, accessible, and easily understandable content, which enhances motivation and fosters self-directed learning. The media's efficiency was measured using the E1/E2 (80/80) standard criterion. The mean efficiency during learning (E1) was 96.80, and post-learning efficiency (E2) was 84.40, both exceeding the standard criterion. This demonstrates that the media facilitated continuous understanding and enabled learners to apply knowledge effectively, in line with the efficiency standards proposed by (Brahmawong, 2013, pp. 7-20). These results are consistent with findings by Mohammed et al. (2018, pp. 32-38), who noted that microlearning improves learning efficiency and content retention compared to traditional methods, and



Kongsomboon (2019, pp. 51-62), who reported that systematically designed microlearning media can surpass standard efficiency benchmarks and significantly enhance academic achievement. A comparison of pre- and post-test scores revealed a significant increase in students' learning achievement. The mean post-test score ($\bar{x} = 16.88$, $SD = 2.92$) was significantly higher than the mean pre-test score ($\bar{x} = 6.90$, $SD = 1.38$) at the 0.05 significance level ($t = 25.24$, $p < 0.001$). This indicates that the microlearning media effectively enhanced students' understanding and practical skills. The findings support, who suggested that microlearning allows learners to quickly grasp essential knowledge, reinforces learning, and improves content retention, and align with Boonmapan et al. (2021, pp. 65-78), who confirmed that microlearning media increase learners' motivation and satisfaction. Overall, the results demonstrate that self-directed microlearning media are an effective tool for practice-oriented courses, particularly those involving laboratory work or the use of scientific instruments. The combination of high-quality design, strong efficiency, and significant learning gains highlights the potential of microlearning to support flexible, engaging, and learner-centered education in the digital age. Consistent with cognitive load theory, the human brain possesses a finite capacity for processing new information; thus, an excessive influx of data can lead to cognitive overload and hinder learning (Sweller, 1988, pp. 257–285). Microlearning mitigates this challenge by decomposing complex subject matter into manageable segments, typically ranging from 3 to 5 minutes. By excising unnecessary elements and prioritizing concise content, microlearning delivers focused, self-contained learning units that directly address learning objectives.

SUGGESTION

The developed microlearning media can be applied in practice-oriented courses, particularly those involving scientific instruments or laboratory work, to support learners in using equipment accurately and safely. Integration with hands-on sessions is recommended to promote holistic learning and enhance overall learning efficiency. Future research should involve more diverse samples and educational contexts to examine the effectiveness of microlearning on additional outcomes, such as analytical thinking and learning motivation. Furthermore, the development of interactive media utilizing Virtual Reality (VR) or Augmented Reality (AR) is suggested to provide realistic and sustainable learning experiences for digital-age learners. Additionally, future research should extend to measuring knowledge retention (e.g., administering a follow-up test after four weeks) to verify that knowledge acquired through microlearning remains durable over time.



REFERENCES

- Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman.
- Asha, P. (2016). *Benefits of microlearning-based training*. eLearning Industry. Retrieved from <https://shorturl.asia/qsWOx>.
- Boonmapan, S., Insaard, S., & Ingaat, S. (2021). The development of micro-learning lessons on social networks based on the constructivist approach to enhance analytical thinking for Matthayom Suksa 6 students. *Journal of Educational Technology and Communication*, 16(21), 65-78. Retrieved from <https://so01.tci-thaijo.org/index.php/ectstou/article/view/249675>. (in Thai)
- Brahmawong, C. (2013). Developmental Testing of Media and Instructional Package. *Silpakorn Educational Research Journal*, 5(1), 7-20. (in Thai)
- Detphong, W. (2020). Effects of using infographic as instructional media for secondary students: A case study in Bangkok schools. *Journal of Communication Studies*, 24(3), 274-282. Retrieved from <https://so06.tci-thaijo.org/index.php/jca/article/view/245115>. (in Thai)
- Insa-ard, S. (2021). Microlearning and the learning of the new generation. *Journal of Education*, 32(1), 45-59. (in Thai)
- Kongsomboon, L. (2019). Development of microlearning for vocational students. *Journal of Academic Studies*, Bangkok Thonburi University, 8(2), 51-62. (in Thai)
- Leekitwattana, P. (2016). *Kan wichai thang kan sueksa* [Educational research]. (11th ed.). Meen Service Supply. (in Thai)
- Mohammed, G. A., Wakil, K., & Nawroly, S. (2018). The effectiveness of microlearning to improve students' learning ability. *International Journal of Educational Research Review*, 3(4), 32-38.
- Office of the National Economic and Social Development Council. (2018). The 20-year national strategy (2018–2037). Office of the National Economic and Social Development Council. Retrieved from https://www.ratchakitcha.soc.go.th/DATA/PDF/2561/A/082/T_0001.PDF.
- Suphalai, S. (2021). Curriculum development for 21st century learning. Bangkok: Faculty of Education, Chulalongkorn University. (in Thai)
- Thanomchayathawat, B., Wanichsupawong, P., Niamthet, W., & Pojjantanti, N. (2016). 21st century skills: Challenges in student development. Southern College Network *Journal of Nursing and Public Health*, 3(2), 208-222. (in Thai)
- Thienthong, M. (2005). *Design and development of courseware for computer-assisted instruction (2nd ed.)*. Bangkok: Department of Computer Education, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok. (in Thai)



- Jainuri, M., Kamid, K., Syaiful, S., & Huda, N. (2025). Microlearning effectiveness in higher education: A systematic review and meta-analysis of student retention and learning outcomes. *MATHEMA: Jurnal Pendidikan Matematika*, 2(7), 630-642.
- Sweller, J. (1988). Cognitive load during problem solving: effects on learning. *Cognitive Science*, 12(2), 257–285.

The content, as well as the use of lan gauge in the article, is the responsibility of the author.



Krit Taweeponsarn*, Chedthida Kusalsaiyanon, and Jutharat Pinthapataya

kritmct@gmail.com*, chedthida.k@bid.kmutnb.ac.th, and jutharat.p@bid.kmutnb.ac.th

Department of Industrial Business and Human Resource Development, Faculty of Business and Industrial Development, King Mongkut's University of Technology North Bangkok, Bangkok 10800 Thailand

*Corresponding author E-mail: kritmct@gmail.com

Received: January 30, 2026 **Revised:** February 26, 2026 **Accepted:** March 10, 2026

Citation reference :

Taweeponsarn, K., Kusalsaiyanon, C., & Pinthapataya, J. (2026). The acceptance of technology affecting digital transformation of the Thai furniture industry. **International Journal of Industrial Education and Technology**, 8(1), 13-24.

 ABSTRACT

This study investigates technology adoption and digital transformation among entrepreneurs in the Thai furniture industry. The objectives aimed: 1) to study the level of opinions regarding technology adoption among entrepreneurs in the Thai furniture industry, 2) to study the level of opinions on digital transformation within the same group of Thai furniture industry, 3) to compare the level of technology acceptance among Thai furniture industry classified by different business characteristics, 4) to compare the level of digital transformation among Thai furniture industry classified by different business characteristics, and 5) to study technology adoption influencing digital transformation among entrepreneurs in the Thai furniture industry. A total of 331 entrepreneurs participated in the study. Data was collected through structured questionnaires and analyzed using descriptive statistics, ANOVA, and multiple regression analysis. The findings revealed that both technology adoption and digital transformation were perceived at a high level. Significant differences in technology adoption were found across most business characteristics, except for the type of business operation. Similarly, digital transformation varied significantly across business characteristics, excluding main distribution channels. Furthermore, four key factors of technology adoption perceived usefulness, perceived ease of use, intention to use, and perceived acceptance in terms of investment and budget allocation were identified as significant predictors of digital transformation ($p < 0.05$). These insights highlight the critical role of technology adoption in driving digital transformation within the Thai furniture sector, offering valuable implications for strategic planning and policy development.

Keywords: Technology adoption, Digital transformation, Thai furniture manufacturing industry

I. INTRODUCTION

The Thai furniture industry is a significant contributor to the nation's economy, accounting for approximately 0.36% of GDP and generating substantial export revenues. Historically, the sector experienced steady growth, with exports increasing from USD 1,436 million in 2020 to USD 1,673 million in 2021. However, recent trends reveal a decline in production volume, averaging a 16.8% annual decrease between 2021 and 2024, despite a slight recovery in 2024 (Office of Industrial Economics, 2025, pp. 1-14). This shift reflects structural changes as manufacturers transition from mass production of low-cost furniture where competition from imports, particularly from China, is intense toward high-value products such as multi-functional and luxury furniture. While production volume has decreased, export value continues to grow, driven by demand from key markets like the United States. The industry faces challenges including rising raw material and labor costs, fragile domestic purchasing power, and stricter international environmental regulations, prompting firms to adopt sustainable practices and advanced technologies to remain competitive. (Thianprasith & Ritsuk, 2025, pp. 1-5)

Several studies have examined technology adoption and digital transformation in manufacturing sectors, emphasizing their role in enhancing efficiency, reducing costs, and improving competitiveness. Research grounded in the Technology Acceptance Model (TAM) highlights factors such as perceived usefulness, ease of use, and intention to adopt as critical determinants of technology acceptance. (Marikyan and Papagiannidis, 2025, pp. 1-17) Prior literature also suggests that digital transformation enables businesses to expand market reach, innovate product design, and integrate into global supply chains. However, small and medium-sized enterprises (SMEs) often face barriers such as high investment costs, lack of technical expertise, and limited awareness of long-term benefits, which hinder technology adoption. These challenges are particularly relevant in traditional industries like furniture manufacturing, where manual processes and conventional marketing strategies remain prevalent. (Lee et al., 2021, pp. 8289-8304)

Building on these insights, the present study investigates technology adoption and digital transformation among entrepreneurs in the Thai furniture industry. Using a structured questionnaire, data were collected from 331 entrepreneurs and analyzed through descriptive statistics, ANOVA, and multiple regression. The research examines entrepreneurs' perceptions of technology adoption and digital transformation, compares these levels across different business characteristics, and explores how technological adoption influences digital transformation. By identifying key factors driving digital integration, this study provides practical implications for strategic planning and policy development aimed at fostering competitiveness and sustainability in the Thai furniture sector.

This study aims to explore the perspectives of entrepreneurs in the Thai furniture industry regarding both technology adoption and digital transformation. It seeks to assess their overall opinions on these two critical aspects and examine how these perceptions vary across businesses with different characteristics. In addition, the research investigates whether differences exist in the levels of technology acceptance and digital transformation when classified by specific business attributes. Finally, the study focuses on understanding the extent to which technology adoption influences digital transformation within this industry, providing insights into the factors that drive successful digital integration.



II. LITERATURE REVIEW

The Thai furniture industry is a key contributor to the national economy, accounting for 0.36% of GDP. Between 2020 and 2021, export value rose from USD 1,436 million to USD 1,673 million. In 2024, production volume reached 8,106 thousand units (+3.6% YoY), but the long-term trend shows a decline of 16.8% annually, driven by a shift toward high-quality, multifunctional, and luxury furniture. Domestic sales in 2024 were 2,079 thousand units (+0.1%), with early 2025 showing a 7.5% YoY increase, largely due to rising imports from China. Exports remain the industry's core, representing 70% of production. In 2024, export volume was 6,113 thousand units (+3.1%), though the long-term trend reflects a 17.4% annual decline. Despite this, export value grew to USD 1,796 million (+11.5%), led by the U.S. market (+26.8%), signaling a transition to high-value products. (Office of Industrial Economics, 2025, pp. 1-14) Early 2025 saw a further 20% increase in export value, driven by accelerated shipments ahead of countervailing duties. Major export destinations in 2024 included the U.S. (54.2%), ASEAN (11.4%), Japan (9.8%), China (3.4%), and the EU (2.9%). Imports also surged, reaching USD 1,544 million (+11.2%) in 2024, with China dominating at 79.3%. In early 2025, imports grew by 16.2% YoY. (Thianprasith and Ritsuk, 2025, pp.1-5).

The Thai furniture industry faces multiple risk factors, including declining domestic purchasing power due to high household debt, rising production costs, and intense competition from low-cost Chinese imports. Additional challenges stem from currency appreciation and stricter environmental regulations such as CARB, EUDR, and CBAM, compelling entrepreneurs to adopt ESG frameworks and eco-friendly product strategies for long-term competitiveness. (Malisuwan, 2018, pp. 23-42) Technology adoption is critical for sustainable growth, yet SMEs remain hesitant due to perceived high costs, complexity, and limited short-term benefits. The Technology Acceptance Model (TAM), emphasizing Perceived Usefulness and Ease of Use, explains this reluctance, as many firms still rely on traditional production systems (Prathum and Usenyang, 2022, pp. 9-15). Digital transformation is essential, requiring a shift from mere technology implementation to comprehensive organizational reengineering (Deloitte, 2022, pp. 23-36). Key technologies include ERP systems, automation, supply chain management, and online platforms, aimed at improving efficiency, reducing costs, and fostering innovation. Successful transformation involves three dimensions: enhancing customer experience, optimizing operations, and creating new digital business models. (Rattanahame, 2018, pp. 50-52) Failure to adapt risks loss of competitiveness and inability to meet modern consumer demands such as modular furniture, FaaS, and sustainable design. Government support, training, and education are vital to accelerate Industry 4.0 adoption. (Sapsanguanboon and Faijaidee, 2020, pp. 16-22) Ultimately, technology acceptance drives digital transformation, which is no longer optional but a necessity for survival amid rapid digital disruption. This study focuses on technology acceptance and its impact on the digital transformation of Thailand's furniture industry. The research adopts the Technology Acceptance Model (TAM) as the theoretical foundation, following the framework developed by Marikyan and Papagiannidis (2025, pp. 1-17). The study examines factors influencing technology acceptance and innovations related to digital transformation within the industry. Based on this approach, the conceptual framework for the research is outlined as shown in Figure 1.



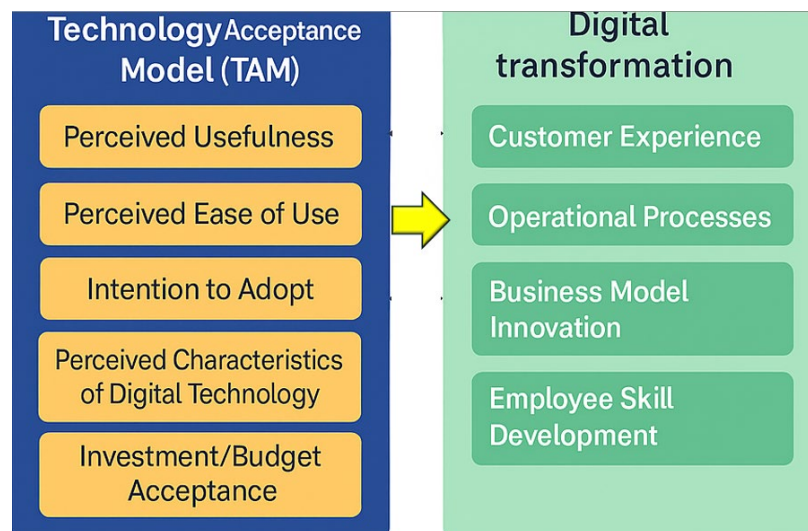


Figure 1: Technology acceptance

III. RESEARCH METHODOLOGY

This study is quantitative research. The population in this research consists of entrepreneurs in Thailand's furniture industry who hold decision-making authority in business policy within their organizations or act as authorized representatives, totaling 2,974 individuals. (Office of Industrial Economics, 2025, pp. 1-14) The sample group includes 353 furniture industry entrepreneurs in Thailand, with the sample size determined using Taro Yamane's formula (Yamane, 1973, pp. 368-391) and selected through simple random sampling. A total of 331 complete responses were received.

This research focuses on technology acceptance and its influence on the digital transformation of Thailand's furniture industry. The study adopts the Technology Acceptance Model (TAM) based on the theoretical framework by Marikyan and Papagiannidis (2025, pp. 1-17) to examine the factors influencing technology acceptance and its impact on digital transformation (Phuengyaem, 2023, pp. 49-51). Technology acceptance is driven by the intention to use technology, which is influenced by perceived usefulness, perceived ease of use, intention to adopt, perceived characteristics of digital technology, and perceived acceptance in terms of investment and budget. These factors affect digital transformation in four key areas: customer experience, operational processes, business model innovation, and employee skill development.

This study employs quantitative data analysis to explore the personal and business characteristics of entrepreneurs in Thailand's furniture industry. Descriptive statistics, including frequency and percentage, are used to present the basic information of the sample group. Additionally, the levels of opinion regarding technology acceptance and digital transformation within organizations are analyzed using mean and standard deviation. To compare differences in business characteristics with technology acceptance and digital transformation, the study applies One-Way Analysis of Variance (ANOVA). Furthermore, the impact of technology acceptance on digital transformation is examined using Multiple Regression Analysis, to identify causal relationships between the variables.

IV. RESULTS

This study, titled Technology Acceptance and Its Impact on the Digital Transformation of Thai Furniture Industry, was conducted using a quantitative research approach to examine the relationship between technology acceptance and digital transformation among 331 furniture industry entrepreneurs in Thailand.

The findings revealed that, in terms of personal factors, most respondents were male, aged between 26-45 years, held a bachelor's degree, and had 11-15 years of experience in the industry as shown in Figure 2.

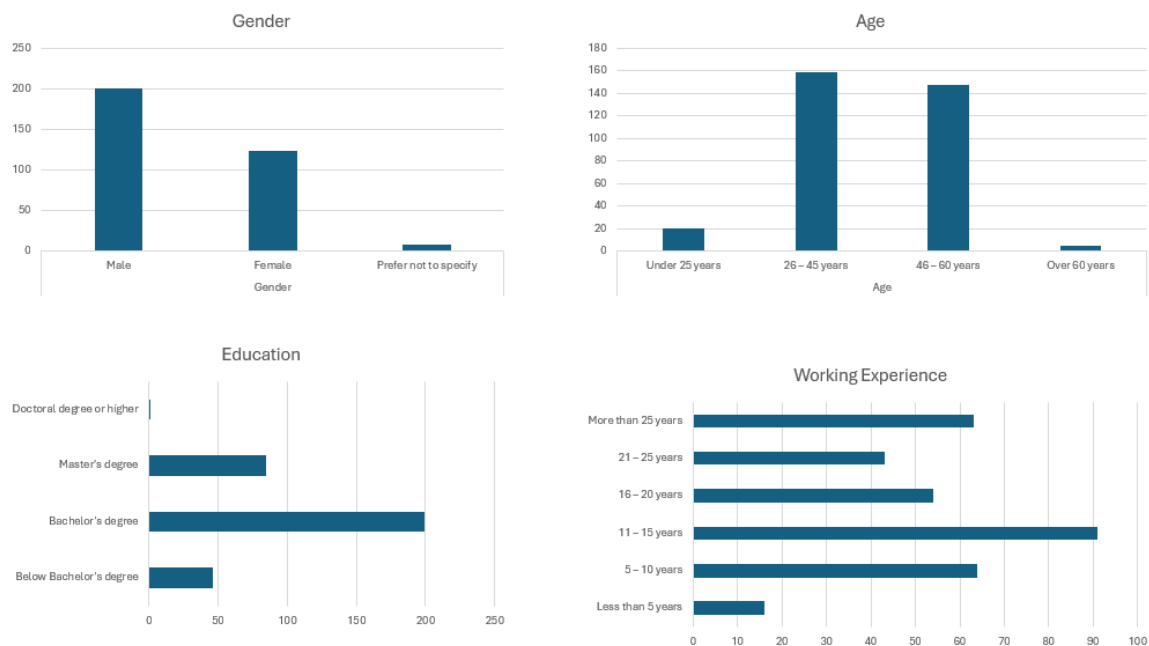
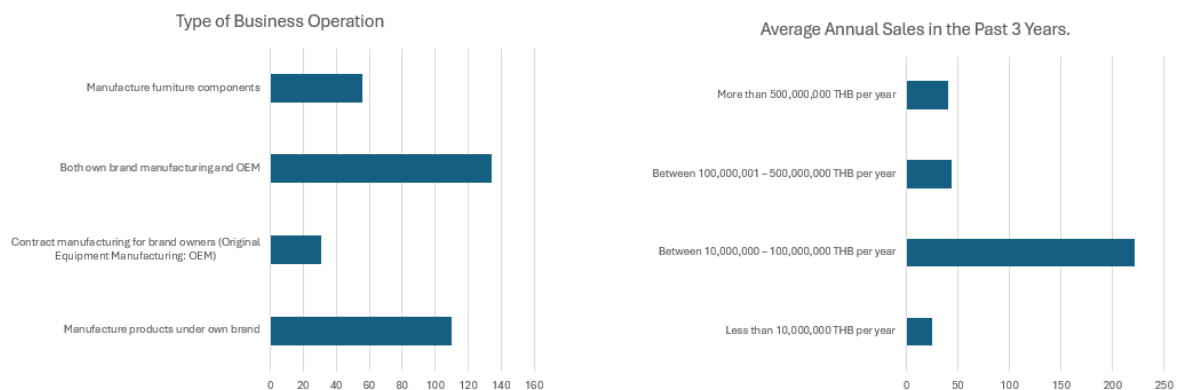


Figure 2: The results of the analysis of personal factors of entrepreneurs in the Thai furniture industry by gender, age, education and working experience

Regarding business characteristics, the majority of respondents operated both as Original Equipment Manufacturers (OEM) and under their own brands. Their average annual sales ranged between 10-100 million baht, with organizations employing between 50-100 staff members. The primary products were knock-down furniture, and distribution channels were diversified (hybrid channels) as shown in Figure 3.



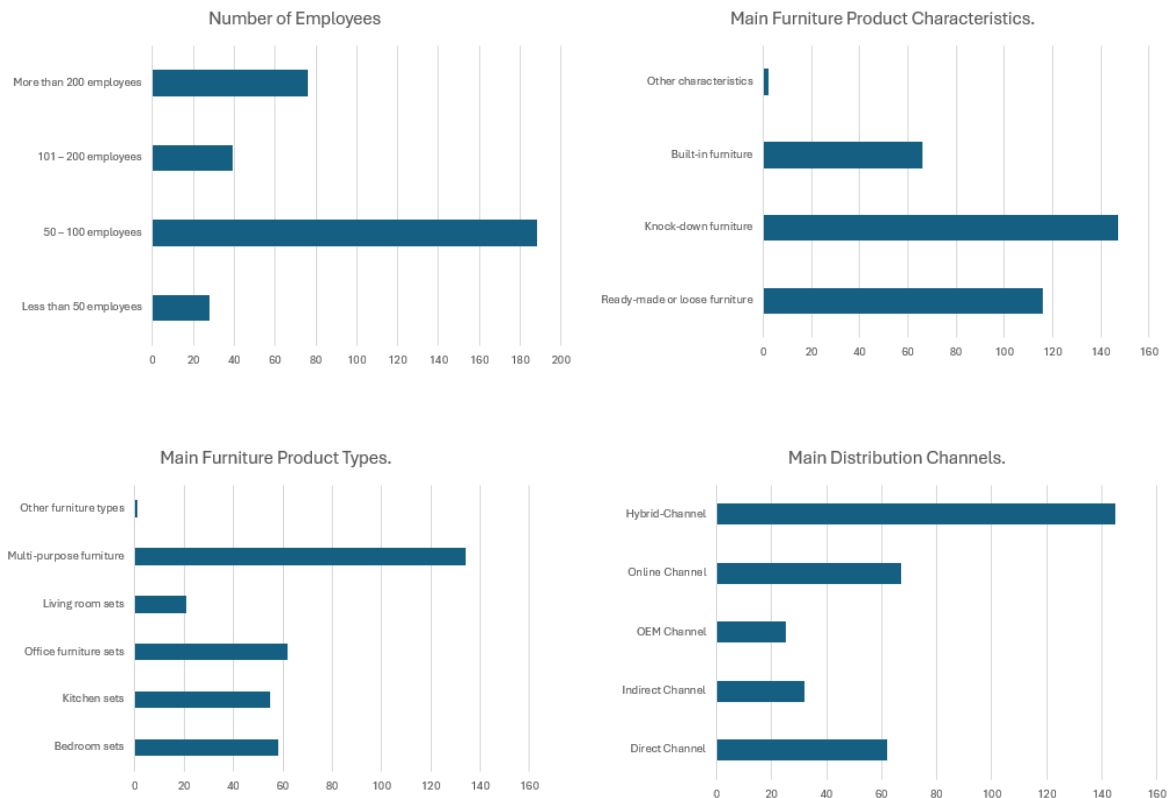


Figure 3: The analysis results of business characteristics of entrepreneurs in the Thai furniture industry

Analysis of the level of opinion regarding technology acceptance showed a high level, particularly in areas such as perceived investment and budget, perceived usefulness, and intention to use as shown in Table 1. Similarly, the level of digital transformation was also high, with emphasis on customer experience, operational processes, and business model innovation reflecting the readiness of entrepreneurs to effectively adapt the digital era as shown in Table 2.

Table 1: Analysis results of overall and individual levels of opinion on technology adoption

Technology adoption factors	$\bar{x}$	SD	Level of opinion
Perceived usefulness	4.18	0.41	High
Perceived ease of use	4.16	0.44	High
Intention to use	4.18	0.76	High
Perceived digital technology format	4.18	0.43	High
Perceived acceptance in investment and budget	4.20	0.58	High
Overall	4.18	0.40	High

Table 2: Analysis results of overall and individual levels of opinion on organizational digital transformation

Digital transformation	$\bar{x}$	SD	Level of opinion
Customer experience transformation	4.19	0.69	High
Operational process transformation	4.19	0.70	High
Business model transformation	4.18	0.75	High
Employee skill development	4.13	0.78	High
Overall	4.17	0.69	High

The comparative analysis of different business characteristics and levels of technology acceptance revealed that the type of business operation did not show statistically significant differences at the 0.05 level. However, variables such as average sales over the past three years, number of employees, product characteristics, product types, and primary distribution channels showed statistically significant differences at the 0.05 level. Specifically, entrepreneurs with average sales exceeding 500 million baht and those with less than 10 million baht demonstrated higher levels of technological acceptance than those with mid-range sales. Organizations with fewer than 50 employees and those with more than 200 employees also showed higher levels of technological acceptance compared to mid-sized organizations. Regarding product characteristics, companies producing built-in furniture exhibited higher technology acceptance than those producing knock-down or freestanding furniture. In terms of product types, entrepreneurs manufacturing bedroom and office sets showed higher acceptance than those producing kitchen and living room sets. Additionally, direct and online distribution channels had a significantly greater impact on technology acceptance compared to intermediary-based distribution channels, at the 0.05 significance level as shown in Table 3.

Table 3: Analysis results comparing the characteristics of different types of Thai furniture industry businesses with the technology adoption of Thai furniture entrepreneurs

Technology adoption aspect	Statistically significant difference	Notes
Type of business operation	×	—
Average sales in the past 3 years	✓	Organizations with annual sales exceeding 500,000,000 THB demonstrate higher levels of technological adoption compared to smaller enterprises
Number of employees in the organization	✓	Organizations with fewer than 50 employees tend to have higher levels of technological adoption.
Nature of furniture products	✓	Built-in furniture shows higher levels of technological adoption compared to other types
Main furniture product type	✓	Bedroom furniture as the main product type shows higher levels of technology adoption compared to other product types
Main distribution channels	✓	Entrepreneurs who sell directly exhibit higher levels of technology adoption compared to those using other distribution methods



The comparative analysis of different business characteristics within Thailand's furniture industry and the level of digital transformation among entrepreneurs revealed statistically significant differences based on the type of business operation. Entrepreneurs who operated under their own brand or as OEMs exhibited higher levels of digital transformation compared to those engaged in component manufacturing.

Regarding average sales, entrepreneurs with annual sales below 10 million baht and above 500 million baht demonstrated significantly higher levels of digital transformation than those with mid-range sales. The number of employees also influenced the level of digital transformation, with small and large organizations showing greater transformation than medium-sized ones.

In terms of product characteristics, organizations producing built-in furniture showed higher levels of digital transformation than those producing ready-to-assemble or freestanding furniture. For product types, manufacturers of bedroom sets exhibited significantly higher levels of digital transformation than those producing office sets, multi-purpose furniture, kitchen sets, or living room sets, at the 0.05 significance level. However, the primary distribution channel did not show a statistically significant effect on the level of digital transformation at the 0.05 level as shown in Table 4.

Table 4: Analysis results comparing the characteristics of different types of Thai furniture industry businesses with the digital transformation of Thai furniture entrepreneurs

Digital transformation aspect	Statistically significant difference	Notes
Type of business operation	✓	Manufacturers with their own brand show higher levels of digital transformation than other groups.
Average sales in the past 3 years	✓	Organizations with annual sales of over 10,000,000 THB exhibit higher levels of digital transformation.
Number of employees in the organization	✓	Organizations with at least 50 employees demonstrate greater technological adoption.
Nature of furniture products	✓	Smart furniture products show higher levels of digital transformation than other types.
Main furniture product type	✓	Multi-functional furniture products have higher levels of digital transformation than other types.
Main distribution channels	✗	—

The multiple regression analysis between technology acceptance and digital transformation among furniture industry entrepreneurs in Thailand revealed that the variables of perceived usefulness (X1), perceived ease of use (X2), intention to use (X3), and perceived investment and budget acceptance (X5) had a statistically significant influence on digital transformation at the 0.05 level. The overall correlation coefficient was 0.94, indicating a strong relationship, particularly with intention to use (X3), which had the highest influence as shown in Table 5 and Table 6.



Table 5: Results of regression analysis on technology acceptance affecting the digital transformation of Thai furniture industry

Technology adoption factor	Regression coefficient	Standard error	β	t-value	Significance (Sig.)
Constant	4.17	0.01		3.2	0.00*
Perceived usefulness (X1)	0.06	0.02	0.09	3.33	0.00*
Perceived ease of use (X2)	0.06	0.02	0.09	3.5	0.00*
Intention to use (X3)	0.63	0.02	0.91	33.4	0.00*
Perceived digital technology format (X4)	0.04	0.03	0.06	1.61	0.11
Perceived investment and budget acceptance (X5)	0.06	0.02	0.08	2.55	0.01*

$R = 0.94$, $R^2 = 0.89$, Adjusted $R^2 = 0.88$, $S.E._{est} = 0.24$

* $p < 0.05$

Table 6: Regression analysis of technology adoption factors affecting each aspect of digital transformation among Thai furniture industry entrepreneurs

Digital transformation aspect	X ₁ : Perceived usefulness	X ₂ : Perceived ease of use	X ₃ : Intention to use	X ₄ : Perceived digital technology format	X ₅ : Perceived investment and budget acceptance
Customer experience transformation (Y ₁)	—	✓	✓	✓	—
Operational process transformation (Y ₂)	—	✓	✓	-	—
Business model transformation (Y ₃)	✓	✓	✓	-	✓
Employee skill development (Y ₄)	✓	—	✓	-	✓

The predictive equation for digital transformation in raw score format is:

$$\hat{Y} = 4.17 + 0.06X_1 + 0.06X_2 + 0.65X_3 + 0.04X_5$$

The predictive equation in standardized score format is:

$$\hat{Z} = 0.08X_1 + 0.07X_2 + 0.93X_3 + 0.05X_5$$

These findings indicate that intention to use is the most influential factor driving digital transformation among furniture industry

V. CONCLUSION AND DISCUSSION

This study examined technology acceptance and its impact on digital transformation within the Thai furniture industry, based on responses from 331 business operators. The majority of respondents were male (60.42%), aged 26–45 years (51.13%), holding a bachelor's degree (60.12%), and having 11–15 years of industry experience (27.49%). Most businesses combined their own branded production with OEM services (40.48%), reported average annual sales between 10 and 100 million THB (66.77%), employed 50–100 staff (56.80%), and primarily produced knock-down furniture (44.41%). Multi-purpose furniture was the leading product category (40.48%), and hybrid distribution channels were most common



(43.81%). Overall technology acceptance was rated high, with the strongest emphasis on investment and budget considerations, followed by perceived benefits, intention to use, preferred technological formats, and ease of use. Digital transformation was also rated high, prioritizing changes in customer experience, operational processes, business models, and workforce skill development. Comparative analysis revealed significant differences in technology acceptance based on sales volume, workforce size, product type, and distribution channels. Firms with the highest and lowest sales volumes exhibited greater acceptance than mid-range groups, while small and large organizations outperformed medium-sized firms. Businesses producing built-in furniture or bedroom sets demonstrated higher acceptance than others. For digital transformation, significant differences were observed across business types, sales volumes, workforce size, and product characteristics. Companies manufacturing their own brands and OEM products achieved higher transformation levels than component producers. Firms with annual sales below 10 million THB or above 500 million THB showed greater transformation compared to mid-range groups. Regression analysis indicated that perceived benefits, ease of use, intention to use, and investment considerations significantly influenced digital transformation, with a correlation coefficient of 0.94, reflecting a strong positive relationship between technology acceptance and digital transformation. The predictive equation is $\hat{Y} = 4.17 + 0.06X_1 + 0.06X_2 + 0.65X_3 + 0.04X_5$, where intention to use (X_3) is the most influential factor. In conclusion, technology acceptance serves as a critical driver of digital transformation in the Thai furniture industry.

The high levels of technology acceptance observed among entrepreneurs reflect substantial readiness to adopt digital technologies in response to labor shortages and rising production costs conditions that increasingly necessitate efficiency enhancing solutions. These findings reinforce earlier research by Sarawong et al. (2009, pp. 336-345) and Phophueanno (2022, pp. 51-65), which emphasized the strategic role of technology in industrial advancement and consumer decision-making. The strong influence of intention to use and perceived usefulness is consistent with the core assumptions of the Technology Acceptance Model (TAM) and is aligned with the work of Lee et al. (2021, pp. 8289-8304) and Silviana and Pudjiarti (2024, pp. 71-84), who highlighted the importance of supportive policies and workforce preparedness, particularly within SMEs. Evidence of elevated digital transformation manifested in the adoption of online ordering systems, AR/VR visualization tools, and digital customer communication-corresponds with the conclusions of Rattanahame (2018, pp. 50-52) and Sapsanguanboon and Faijaidee (2020, pp. 16-22), who associated such technological initiatives with organizational restructuring and skill enhancement. Differences in technology acceptance across firms of varying sizes, product characteristics, and revenue levels suggest that organizational capacity and resource availability materially shape adoption decisions, supporting the perspectives of Promkhet and Prommawong (2018, pp. 119-133), Zhu and Kraemer (2005, pp. 61-84), Rame (2023, pp. 53-63) and Červený et al. (2022, pp. 21-27). Finally, the significant effects of perceived usefulness, ease of use, intention to use, and investment readiness on digital transformation reaffirm insights from Ortiz-López et al. (2024, pp. 9-18) and Elizabeth (2024, pp. 265-271), which highlight contextual factors, usability, and consumer trust as critical enablers of technological adoption. Overall, the findings emphasize that technology acceptance constitutes a fundamental determinant of digital transformation, underscoring the necessity for integrated strategies that enhance organizational readiness, strengthen workforce capabilities, and foster long term competitiveness within Thailand's furniture industry.



VI. SUGGESTION

This study examined technology acceptance and its role in driving digital transformation among entrepreneurs in Thailand's furniture industry. Results indicate strong readiness for digital adoption, particularly in intention to use, perceived usefulness, and ease of use. Business characteristics such as size, sales, workforce, and product type significantly influenced acceptance levels, while regression analysis confirmed intention to use as the strongest predictor of transformation ($r = 0.94$). Recommendations include financial support, tax incentives, and awareness programs for SMEs, alongside practical workshops and tailored training. Businesses should prioritize customer focused technologies like CRM, online platforms, and AR/VR, while restructuring processes and innovating business models. Support measures must be customized by business profile, with consulting for low-adoption firms and skill development for medium-sized enterprises. Finally, fostering positive perceptions and applying predictive models will enable targeted strategies for sustainable digital transformation.

REFERENCES

- Červený, L., Sloup, R., & Červená, T. (2022). The Potential of Smart Factories and Innovative Industry 4.0 Technologies - A Case Study of Different-Sized Companies in the Furniture Industry in Central Europe. *Forests*, 2022(2171), 21-27. Retrieved from <https://doi.org/10.3390/f13122171>.
- Deloitte. (2022). *Thailand Digital Transformation Survey Report 2021*. <https://www.deloitte.com/content/dam/assets-zone1/southeast-asia/en/docs/services/consulting/2025/sea-tt-th-digital-transformation-survey-report-2021-en.pdf>.
- Elizabeth. (2024). The Influence of Perceived Value of Benefits, Perceived Ease of Technology Use and Customer Trust on Intention to Use Digital Banking Applications. *Jurnal Informasi dan Teknologi*. 2023(5), 265-271. <https://doi.10.34128/jra.v7i1.272>.
- Lee, Y. Y., Ab Latib, H., Ratnasingam, J., Lim Choon Liat, M. M., Othman, K., Amir, M. A., & Jegatheswaran, N. (2021). Readiness for an adoption of Industry 4.0 among small and medium-sized enterprises in the Malaysian furniture industry. *BioResources*, 16(4), 8289–8308. <https://doi.org/10.15376/biores.16.4.8289-8308>.
- Malisuwan, S. (2018). Thailand's Digital Transformation For Thailand 4.0. *NBTC Academic Journal*, 2(12), 23-42. (in Thai)
- Marikyan, D., & Papagiannidis, S. (2025). Technology Acceptance Model: A Review. TheoryHub Book. <https://open.ncl.ac.uk/theory-library/technology-acceptancemodel.pdf>.
- Office of Industrial Economics. (2025). Industrial Economic Situation Report Q1/2025 and Forecast for Q2/2025. <https://www.oie.go.th/assets/portals/1/fileups/2/files/Industry%20condition%20s/Q1-2568V3.pdf>. (in Thai)
- Ortiz López, A., Sánchez-Prieto, C., & Olmos-Migueláñez, S. (2024). Perceived Usefulness of Mobile Devices in Assessment: A Comparative Study of Three Technology Acceptance Models using PLS SEM. *Journal of New Approaches in Educational Research*, 3(1), 1-23. doi:10.1007/s44322-023-00001-6.
- Phophueanno, C. (2022). Technology Acceptance Factors Influencing Online Purchase Decisions of Furniture and Home Decor Products among Consumers in Bangkok. *Ratchaphruek Journal of Humanities and Social Sciences*, 8(2), 51-65. <https://so03.tci-thaijo.org/index.php/rpu/article/view/26296.8> (in Thai)



- Phuengyaem, K. (2023). Artificial Intelligence Acceptance in the Design Industry. [Master's thesis]. Mahidol University. (in Thai)
- Prathum, S., & Usenyang, S. (2022). Information Technology Acceptance in the New Normal Era. *Lawasri Journal*, 6(1), 1-18. Retrieved from <https://so04.tcithaijo.org/index.php/lawasrijo/article/view/257078>. (in Thai)
- Promkhet, C., & Prommawong, P. (2018). Technological Change Management Potential and Proactive Service Toward Excellence Affecting Operational Efficiency in the Furniture Business: A Case Study of Thailand and Lao PDR. *RMUTT Global Business and Economics Review*, 13(2), 117–136. Retrieved from <https://so03.tcithaijo.org/index.php/RMUTT-Gber/article/view/241490>. (in Thai)
- Rame, R. (2023). Transforming The Furniture Industry in The Digital Age. *Jurnal Riset Teknologi Pencegahan Pencemaran Industri* 14(3), 53-69 Retrieved from <http://www.jrtppi.id/index.php/jrtppi/article/view/178>.
- Rattanahame, N. (2018). Trust in Furniture Businesses Affecting Purchase Intentions via E-Commerce Systems. [Master's Thesis]. Silpakorn University. (in Thai)
- Sapsanguanboon, W., & Faijaidee, W. (2020). Digital Transformation of Government Agencies to Enhance Thailand's Competitiveness. *Modern Management Frontier Journal*, 18(1), 15–22. Retrieved from <https://so04.tci-thaijo.org/index.php/stou-smspr/article/view/240133>. (in Thai)
- Sarawong, R., Khamananrong, S., & Khamananrong, K. (2009). Factors influencing the development of small and medium furniture industry for export. *Khon Kaen University Research Journal*, 14(4), 336–345. (in Thai)
- Silviana, A., & Pudjiarti, E. (2024). The Critical Role of Technology Adoption and Competency Through Improving Teamwork and Knowledge Transformation in the Furniture Business in Jepara. *Fokus Ekonomi Jurnal Ilmiah Ekonomi*, 19(1), 71-84. <https://doi.org/10.34152/fe.19.1.71-84>.
- Thianprasith, L., & Ritsuk, P. (2025). Trump Launches New Trade War: Thai Exports at Risk – Electronics, Rubber, Appliances, Furniture. <https://www.kasikornresearch.com/th/analysis/k-social-media/Pages/Trump-EBR4122-FB-04-02-25.aspx>. (in Thai)
- Yamane, T. (1973). Statistics: An introductory analysis (3rd ed.). *Harper & Row*. 368-391.
- Zhu, K., & Kraemer, K. L. (2005). Post-Adoption Variations in Usage and Value of EBusiness by Organizations. *Information Systems Research* 16(1), 61-84 <http://doi.org/10.1287/isre.1050.0045>.

The content, as well as the use of language in the article, is the responsibility of the author.



A COMPARISON OF LEARNING ACHIEVEMENT IN MATHEMATICS FOR PRIMARY SCHOOL AMONG FIRST-YEAR UNDERGRADUATE STUDENTS MAJORING IN MATHEMATICS ADMITTED THROUGH DIFFERENT ADMISSION PATHWAYS

Thirdsak Kajornboon*, Kanchana Boonphak, and Mai Charoentham

Thirdsak.ka@kmitl.ac.th*, kanchana.bo@kmitl.ac.th, and mai.ch@kmitl.ac.th

Department of Industrial Education, School of Industrial Education and Technology,
King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520 Thailand

*Corresponding author E-mail: Thirdsak.ka@kmitl.ac.th

Received: February 24, 2026 **Revised:** March 4, 2026 **Accepted:** March 17, 2026

Citation reference :

Kajornboon, T., Boonphak, K., & Charoentham, M. (2026). A comparison of learning achievement in Mathematics for primary school among first-year undergraduate students majoring in Mathematics admitted through different admission pathways. **International Journal of Industrial Education and Technology**, 8(1), 25-33.

ABSTRACT

As learning outcomes may differ across university admission pathways, this study examined this association in the course Mathematics for Primary School. The participants were 30 first-year undergraduate students enrolled in the Learning Management Science Program (mathematics major). Students were admitted through five pathways: Portfolio (PF), Mathematics–Science Teacher Preparation Program (MS), Allocated School Quota (QT), Central Admission System (CA), and Independent Direct Admission (DA). Learning outcomes were assessed across cognitive, psychomotor, and affective domains using formative assessments (70%) conducted weekly and a summative final examination (30%). One-way analysis of variance revealed statistically significant differences in overall learning achievement among students admitted through different pathways at the 95% confidence level ($F = 3.932, p \leq .05$). Post hoc analyses indicated significant differences between the PF and CA. However, no significant differences in mean learning achievement were found between the PF and MS, QT, or DA. Similarly, no significant differences were observed between the CA and MS, QT, or DA. The findings suggest that admission pathways are associated with variations in students' learning achievement in teacher education contexts. The selection process for first-year students should not rely solely on high academic scores. Instead, admission processes should also consider applicants' genuine motivation and their awareness of the profession they intend to pursue.

Keyword: Admission pathways, Learning achievement, Mathematics teacher education, Pre-service mathematics teachers, TCAS

I. INTRODUCTION

Higher education is a developmental process that supports learners' transition from upper secondary education to becoming individuals prepared for specialized professions. These graduates constitute a critical workforce that underpins the economic system and directly contributes to national development (Office of the Higher Education Commission, 2016, 28 pp. 1-3).

Thailand's higher education admission system has undergone several revisions, evolving from institution-specific entrance examinations to a centralized system and, more recently, to the Thai University Central Admission System (TCAS). These reforms were implemented to improve fairness, standardization, and alignment between admission criteria and disciplinary requirements. TCAS currently offers multiple admission pathways-such as portfolio-based, quota-based, and examination-based tracks-each reflecting different student characteristics and competencies (Association of University Presidents of Thailand, 2023, pp. 2-4). Accordingly, higher education plays a central role in integrating knowledge, skills, attributes, and values in alignment with the disciplinary and professional orientations of each field of study (Knight & Yorke, 2003, pp. 1-5). This role renders student development at the higher education level fundamentally different from that at the upper secondary level, which primarily emphasizes foundational knowledge. Although secondary education incorporates certain skills and attributes across subject groups, such development remains largely general and preparatory rather than specialized. Upon entering higher education, the nature of learning undergoes a substantial transformation. For example, medical students are required to develop clinical competence (Harden, 2016, pp. 1010-1012), engineering students must cultivate systems thinking abilities (Froyd & Ohland, 2005, pp. 148-152), and teacher education students need to develop instructional design skills and a deep understanding of learners (Darling-Hammond, 2006, pp. 23-30). Developing students' capacities in accordance with program-specific learning outcomes therefore relies heavily on the characteristics and preparedness of incoming students, as these factors directly influence the effectiveness of development at the higher education level (Astin, 1993, pp. 7-11). Consequently, student selection processes play a crucial role in determining the quality of educational outcomes.

Existing studies suggest that admission modalities are associated with distinct patterns of learning achievement. Selection methods based on centralized examinations tend to predict academic performance effectively during the early years of higher education, although their predictive power diminishes in later years (Mahidol R2R e-Journal, 2019, pp. 50- 54). In contrast, admission criteria incorporating GPAX have been linked to more sustained academic performance, particularly in health sciences, engineering, and teacher education programs (Mahidol R2R e-Journal, 2019, pp. 50-54). Similarly, GAT/PAT and subject-specific examination scores show positive associations with academic achievement, albeit with declining influence as students advance through their studies (Thonburi University Journal, 2022, pp. 35-38). These findings suggest that different admission pathways select students with diverse learning profiles, which subsequently influence their academic development in higher education. This result aligns with Input-Environment-Outcome (I-E-O) model (Astin, 1993, pp. 7-11), which highlights the importance of student inputs in determining educational outcomes.



It can be observed that different admission pathways influence students' learning effectiveness in different ways, depending on the instructional approaches employed by each faculty or academic field chosen by the students. Therefore, this study hypothesizes that students admitted through different admission pathways will demonstrate different learning outcomes across the domains of knowledge, skills, and attitudes. Accordingly, the study aimed to examine whether significant differences in learning achievement exist among first-year mathematics teacher education students admitted through five distinct TCAS pathways.

II. LITERATURE REVIEW

Student development in higher education is shaped by multiple interrelated factors, among which the characteristics and attributes of admitted students play a critical role. Admission modalities influence not only the academic preparedness of students but also their motivation, learning behaviors, and capacity for sustained development within specific disciplinary contexts. This perspective aligns with Astin's (1993, pp. 7-11) I-E-O model, which conceptualizes educational outcomes as the result of interactions between student inputs, learning environments, and institutional processes. Within this framework, student input-particularly prior academic performance and motivational characteristics-constitutes the initial condition that shapes subsequent learning trajectories and academic achievement. There was numerous research studies have shown the relation between input, environment, and output based on I-E-O model. Empirical evidence supports the central role of student input in predicting academic success. (Heaney & Fisher, 2011, pp. 65-70) applied the I-E-O model to examine student persistence within learning communities and found that both input and environmental factors significantly influenced the likelihood of academic success.

Research on specific admission pathways further illustrates the differentiated effects of student input. Studies on portfolio-based admissions indicate that in disciplines such as communication arts, architecture, and teacher education, students who present authentic prior work tend to demonstrate more continuous academic development, particularly in project-based learning contexts. These students often exhibit stronger intrinsic motivation and clearer commitment to skill development (Phayao University Health Sciences Research, 2021, pp. 58-62). Comparable patterns have been observed in quota-based admission systems, such as the Collaborative Project to Increase Production of Rural Doctors (CPIRD), where high motivation and structured institutional support contribute to positive academic and professional development (Collaborative Project to Increase Production of Rural Doctors, 2020, pp. 12-16). Furthermore, a comparative study of students admitted through all four TCAS rounds revealed statistically significant differences in academic achievement, with TCAS 3 students achieving the highest outcomes and TCAS 1 students the lowest (Phayao University Health Sciences Research, 2021, pp. 60-65). These findings indicate that different admission modalities may select students with distinct learning profiles and developmental potential. Beyond academic credentials, motivational factors have been consistently linked to learning effectiveness. Richardson & Watt (2006, pp. 35-40) reported that students entering teacher education programs with strong intrinsic motivations-such as interest in teaching and a desire to contribute to society-demonstrated clearer professional self-development trajectories. This conclusion was reinforced by Watt et al. (2012, pp. 795-800) in a cross-national study involving pre-service teachers from Australia, Germany, the United States, Taiwan, and Hong Kong, which found that intrinsic motivation and perceived professional value were significantly associated with higher engagement and long-term commitment to the profession. Studies in vocational and industrial education indicate that learner-related factors play a critical role in learning achievement. Chen & Chen (2022, pp. 6-9) found that learning motivation



significantly and positively influenced learning performance among higher vocational students. Similarly, Phungsuk et al. (2023, pp. 50-55) reported that learners' engagement behaviors and responsibility for self-directed learning were essential conditions for success in technology-enhanced learning environments. These findings highlight the significant role of student inputs in influencing effective outcomes across different educational programs. However, the literature also highlights limitations in the predictive power of admission criteria alone. Hudson (2013, pp. 775-778) found that competency development during practicum experiences depended primarily on the quality of mentoring and learning environments rather than on selection mechanisms. In contrast, Al-Asmar et al. (2021, pp. 4-6) demonstrated a significant positive relationship between high school GPA and graduating academic achievement among dental students, suggesting that GPA can function as a valid indicator of long-term academic success. Moreover, GPA has been shown to reflect not only academic performance but also learning motivation (Richardson et al., 2012, pp. 360-368; Robbins et al., 2004, pp. 270-275). Therefore, different programs require admission or selection methods that support effective student learning, and these methods may vary depending on the specific characteristics of each program or profession. This study aims to examine the extent to which different student admission modalities- representing diverse learner characteristics and attributes- affect learning success among pre-service mathematics teachers in the core course Mathematics for Primary School.

III. RESEARCH METHODOLOGY

Participants

The population consisted of 30 first-year undergraduate students enrolled in the mathematics major of the Learning Management Science Program, Department of Industrial Education, Faculty of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang (KMUTL), during the first semester of the 2025 academic year. The participants were admitted through different admission pathways, including Portfolio admission ($n = 11$), Mathematics–Science Teacher Preparation Program ($n = 8$), Allocated School Quota ($n = 4$), Central Admission System ($n = 5$), and Independent Direct Admission ($n = 2$), yielding a total of 30 participants.

Variables and Definitions

Students admitted through the Portfolio pathway were coded as PF. Students admitted through the Mathematics–Science Teacher Preparation Program were coded as MS. Students admitted through the Allocated School Quota pathway were coded as QT. Students admitted through the Central Admission System were coded as CA. Students admitted through Independent Direct Admission were coded as DA. PF students were qualified based on their portfolio, academic records (GPAX), group activity, and a structured interview; MS students were qualified based on their portfolio, GPAX, and a traditional unstructured interview; QT students were qualified based on their portfolio, GPAX, the teacher professional aptitude test, and a traditional unstructured interview; CA students were qualified based on standardized national test scores submitted through the Thai University Central Admission System (TGAT, TPAT3, and TPAT5); and DA students were qualified based on their portfolio, GPAX, and a traditional unstructured interview.



Data Collection

Data were collected in the form of formative assessment scores, which accounted for 70% of the total course grade and were conducted on a weekly basis. The assessments included quizzes, questioning, self-assessment, and peer assessment implemented through a variety of learning activities. Criterion Score and Rubric-based scoring were used for evaluation, and feedback was provided on all student work to support their improvement in subsequent learning activities. These assessments focused on three domains with equal weight. The cognitive domain emphasized the analysis of mathematical content aligned with Grades 3 and 6 of primary education. The assessment content covered six mathematical strands: Numbers and Operations, Algebra, Geometry, Measurement, Statistics, and Probability. The assessments emphasized relationships and differences across grade levels through higher-order thinking skills, including identifying key ideas, interpreting weekly content, defining concepts based on provided information (comprehension), comparing and contrasting concepts, and applying understanding across grade levels to design learning activities that progress from simple to complex. In addition, the psychomotor domain, which is essential for the teaching profession, was assessed through communicative and collaborative competencies. The affective domain was evaluated based on students' attitudes, perspectives, and beliefs toward mathematics learning. The remaining 30% of the total grade was derived from a summative assessment (final examination). The examination is a subjective test that focused on analyzing students' learning difficulties transferred from Grades 3 and 6, connecting mathematical learning strands to national educational visions, and applying understanding of Grade 3 and Grade 6 content to design appropriate learning activities.

Data Analysis

Data were analyzed using descriptive statistics, including the mean and standard deviation, and one-way Analysis of Variance (ANOVA) to compare mean learning achievement among students admitted through different admission pathways at a 95% confidence level ($\alpha = .05$). When statistically significant differences were found, Scheffé post hoc tests were conducted. All analyses were performed using JASP statistical software.

IV. RESULT

Based on formative assessments from the population of 30 first-year undergraduate students enrolled in the mathematics major of the Learning Management Science Program in three domains conducted throughout the course, which accounted for 70% of the total course grade and were administered weekly, data were collected from various assessment activities. These assessments included quizzes, questioning, self-assessment, and peer assessment implemented through a variety of learning activities. Criterion scores and rubric-based evaluations were used to assess student performance, and feedback was provided on all student work to support students' improvement in subsequent learning activities. The descriptive statistics indicated differences in mean learning achievement across admission pathways. Students admitted through the PF pathway achieved the highest mean score ($M = 31.14$, $SD = 7.22$), followed by those admitted through DA ($M = 30.03$, $SD = 1.23$), MS ($M = 26.45$, $SD = 4.36$), QT ($M = 25.24$, $SD = 3.29$), and CA ($M = 18.98$, $SD = 1.77$). When learning outcomes across all three domains were analyzed collectively using one-way analysis of variance. **Table 1**, presents the results of the one-way analysis of variance (ANOVA) comparing students' learning achievement based on different admission methods. The findings indicate that there was a statistically significant difference in learning achievement among at least one of the groups that the mean learning achievement of students admitted through different admission pathways differed significantly at the 95% confidence



level ($F = 3.932$, $p = .014$). These findings suggest that different admission pathways are associated with differences in students' learning achievement. To further examine which groups differed from one another, a Scheffé post hoc test was performed.

Table 1 Results of One-way Analysis of Variance (ANOVA) comparing learning achievement across admission pathways

Variance	Sum of squares	df	Mean square	F	p
between-group variance	477.3	4	119.31	3.932	.014
within-group variance	728.3	24	30.34		

Table 2, which presents the multiple comparisons of mean learning achievement using the Scheffé post hoc test, revealed that the comparison of mean differences among groups with different admission pathways showed a statistically significant difference between students admitted through the PF and those admitted through CA. However, no significant differences in mean learning achievement were found between the PF and MS, QT, or DA. Similarly, no significant differences were observed between the CA and MS, QT, or DA.

Table 2 Results of pairwise comparisons of mean learning achievement across admission pathways using the Scheffé post hoc test

	PF	MS	QT	CA	DA
μ	31.14	26.45	25.24	18.98	30.03
PF	31.14	-	4.69	5.90	12.17*
MS	26.45	-	1.21	7.48	-3.58
QT	25.24	-	-	6.27	-4.79
CA	18.98	-	-	-	-11.06
DA	30.03	-	-	-	-

Significant at the .05 level

V. CONCLUSION AND DISCUSSION

The results of this study indicate that admission pathways influence students' learning achievement in the course Mathematics for Primary School among students majoring in mathematics in the Learning Management Science Program. Statistically significant differences in learning achievement were found between students admitted through PF and those admitted through the CA, whereas differences among other admission pathways were not statistically significant. No significant differences were observed between PF and MA, QT, and DA. This may be because the selection processes in these pathways are similar, typically including a portfolio, academic records (GPAX), and an interview. Likewise, no significant differences were found between CA and the MA, QT, and DA groups. One possible explanation is that these pathways employ similar interview procedures, which are generally conducted as traditional unstructured interviews, whereas PF uses a structured interview. Another possible factor is the timing of the admission decision. The PF pathway requires applicants to apply earlier than other pathways. This earlier application period may reflect applicants' stronger passion or motivation to pursue a teacher education program. Such characteristics may partly explain the significant difference in learning outcomes observed between PF and CA. Therefore, the interview process should be emphasized and designed in a specific way. Additionally, interviewers should work as a team and receive proper training or preparation to conduct interviews in a professional manner. This strongly demonstrates the importance of inputs in the I-E-O model, which conceptualizes educational outcomes as the result of interactions among student inputs, learning environments, and institutional processes



(Astin, 1993, pp. 7–11). On the other hand, GPAX, which was not directly related to the interview process and for which all candidates met the required qualifications, was not found to be a significant factor in this study. This finding differs from previous studies suggesting that GPAX significantly predicts academic performance (Mahidol R2R e-Journal, 2019, pp. 52-55). An area in which students demonstrated relatively low performance was the cognitive domain, particularly in higher-order thinking skills, including interpretation, understanding mathematical meanings and concepts, summarization, application of understanding to instructional design, and knowledge synthesis through discussion. The development of these skills requires a strong foundation in long-term memory, enabling learners to connect prior knowledge with new concepts and to synthesize ideas through collaborative discourse. However, many students lacked behaviors associated with self-learning and intellectual curiosity (Phungsuk et al., 2023, pp. 53-56). Within this context, students who are able to adapt, possess positive attitudes toward learning, and demonstrate intrinsic motivation to develop themselves as future teachers are more likely to achieve meaningful learning outcomes (Phayao University Health Sciences Research, 2021, pp. 60–63; Richardson and Watt, 2006, pp. 38-41). This may partly explain why the PF-requiring self-awareness, clear goals, and prior engagement in activities related to the teaching profession—was associated with different learning outcomes compared to CA, which primarily relies on knowledge-based examinations (Watt et al., 2012, pp. 798-802).

Therefore, effective learning in teacher education relies on students' ability to understand their interests and envision their future professional roles. Providing opportunities for self-exploration and authentic experiences within admission criteria may help identify candidates who possess strong motivation and clear professional goals, thereby supporting effective learning and professional development in teacher education programs. Furthermore, admission requirements should assess candidates in ways that allow high school students to explore their interests and engage meaningfully with their learning experiences. These opportunities should extend beyond guidance counseling courses to include real-life experiences of significant duration that encourage self-exploration. If the Thai school curriculum cannot sufficiently facilitate such experiences, university admission strategies should provide a realistic picture of the teaching profession so that applicants can make informed decisions. Consequently, the selection of first-year students should not rely solely on high academic scores. Instead, admission processes should also consider applicants' genuine motivation and their awareness of the profession they choose to pursue.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the students for participating in the study and contributing authentic learning experiences in the classroom. The authors also acknowledge School of Industrial Education and Technology (SIET) for providing resources and facilities that contributed to the completion of this study. Finally, appreciation is extended to all support staff for their encouragement and assistance throughout the course of this research.



REFERENCE

- Al-Asmar, A. A., Al-Shehri, A. M., Al-Qahtani, N. A., Al-Hazmi, A. M., & Al-Madi, E. M. (2021). The predictive value of high school grade point average on graduating academic achievement among dental students. *BMC Oral Health*, 21(1), 292. <https://doi.org/10.1186/s12903-021-01633-0>.
- Association of University Presidents of Thailand. (2023). *Thai University Central Admission System (TCAS): Admission handbook*.
- Astin, A. W. (1993). *What matters in college? Four critical years revisited*. Jossey-Bass.
- Chen, Y., & Chen, C. (2022). Digital game-based learning (Quizlet) and learning motivation affecting learning performance of higher vocational students. *International Journal of Industrial Education and Technology*, 4(2), 1-12.
- Collaborative Project to Increase Production of Rural Doctors. (2020). *CPIRD annual report 2020*. Ministry of Public Health.
- Darling-Hammond, L. (2006). *Powerful teacher education: Lessons from exemplary programs*. Jossey-Bass.
- Froyd, J. E., & Ohland, M. W. (2005). Integrated engineering curricula. *Journal of Engineering Education*, 94(1), 147-164. <https://doi.org/10.1002/j.2168-9830.2005.tb00835.x>.
- Harden, R. M. (2016). Ten key features of the future medical school—Not an impossible dream. *Medical Teacher*, 38(10), 1010–1015. <https://doi.org/10.3109/0142159X.2016.1173666>.
- Heaney, A., & Fisher, R. (2011). Supporting conditionally-admitted students: A case study of assessing persistence in a learning community. *Journal of the Scholarship of Teaching and Learning*, 11(1), 62-78.
- Hudson, P. (2013). Mentoring as professional development: “Growth for both” mentor and mentee. *Professional Development in Education*, 39(5), 771-783. <https://doi.org/10.1080/19415257.2012.749415>.
- Knight, P. T., & Yorke, M. (2003). *Assessment, learning and employability*. Open University Press.
- Mahidol R2R e-Journal. (2019). Predictive validity of GPAX on academic achievement in health science and teacher education programs. *Mahidol R2R e-Journal*, 6(2), 45-58.
- Office of the Higher Education Commission. (2016). *Thailand higher education standards and framework*. Ministry of Education.
- Phayao University Journal of Health Sciences. (2021). Comparison of academic achievement among students admitted through TCAS 1-4. *Phayao University Journal of Health Sciences*, 8(2), 55-70.
- Phungsuk, R., Viriyavejakul, C., & Ratanaolarn, T. (2023). Technology-enhanced flipped classroom: Conditions, challenges, and learner behaviors in industrial education. *International Journal of Industrial Education and Technology*, 5(1), 45-60.
- Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students’ academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, 138(2), 353-387.



- Richardson, P. W., & Watt, H. M. G. (2006). *Who chooses teaching and why? Profiling characteristics and motivations across three Australian universities*. *Teaching and Teacher Education*, 22(2), 149-167.
- Robbins, S. B., Lauver, K., Le, H., Davis, D., Langley, R., & Carlstrom, A. (2004). Do psychosocial and study skill factors predict college outcomes? *Psychological Bulletin*, 130(2), 261-288.
- Thonburi University Journal. (2022). Relationships between GAT/PAT scores and academic achievement in higher education. *Thonburi University Journal*, 16(1), 33-48.
- Watt, H. M. G., Richardson, P. W., Klusmann, U., Kunter, M., Beyer, B., Trautwein, U., & Baumert, J. (2012). Motivations for choosing teaching as a career: An international comparison using the FIT-Choice scale. *Teaching and Teacher Education*, 28(6), 791–805. <https://doi.org/10.1016/j.tate.2012.03.003>.

The content, as well as the use of lan gauge in the article, is the responsibility of the author.



THE SPECIFIC CHARACTERISTICS OF TIME AND TEMPERATURE INSIDE A VACUUM GLASS TUBE FOR COOKING RAW INGREDIENTS BY ADJUSTING THE ANGLE OF SOLAR RADIATION AND TYPE OF REFLECTOR

**Nattakorn Borwornpornmetee¹, Chawakorn Chanasit¹, Thanagorn Khuanpanya¹
Boonchoat Paosawatanyong², and Nathaporn Promros^{1*}**

65056032@kmitl.ac.th, chawakornku66@gmail.com, tkggghelpmest@gmail.com,
boonchoat.p@chula.ac.th, and nathaporn_promros@kyudai.jp

¹Department of Physics, School of Science, King Mongkut's Institute of Technology
Ladkrabang, Bangkok 10520 Thailand

²Kamnoetvidya Science Academy, Rayong 21210 Thailand

*Corresponding author E-mail: nathaporn_promros@kyudai.jp

Received: February 11, 2026 **Revised:** March 13, 2026 **Accepted:** March 28, 2026

Citation reference :

Borwornpornmetee, N., Chanasit, C., Khuanpanya, T., Paosawatanyong, B., & Promros, N. (2025). The specific characteristics of time and temperature inside a vacuum glass tube for cooking raw ingredients by adjusting the angle of solar radiation and type of reflector. *International Journal of Industrial Education and Technology*, 8(1), 34-54.

ABSTRACT

This research reports the design and construction of a solar oven for the cooking of raw ingredients with reduced gas consumption. There are three main components to the solar oven: an adjustable angle base, a parabolic rail, and an ingredient tray. The designed components are used together with a vacuum tube to cook raw ingredients. The performance testing process of the constructed solar oven was separated into two conditions. First, the improvement of the temperature inside the solar oven was measured with a tilt angle of 0° using foil, aluminum, and stainless steel as the base materials of the parabolic rail. Second, the temperature inside the solar oven was measured using a stainless-steel parabolic rail at 0°, 15°, and 30°. After one hour of testing, the solar oven produced an inside temperature in the vacuum tube of 116.6 °C, 118.1 °C, 100.5 °C, and 84.4 °C for the parabolic rail with foil, aluminum, stainless steel, and solar without a parabolic rail. The ingredients weighing 50 grams were reduced to around 20 grams after testing. With the angle adjustment of the parabolic rail condition, the temperature inside the vacuum tube reached maximum values at a tilt angle of 15°, with the inside temperature ranging from 90 to 120 °C. The weight of the ingredients after testing was reduced to around 33 grams without the reflector and to between 25 and 28 grams with the reflector

attached. The results suggested that solar oven equipped with aluminum reflector below the vacuum glass tube and when tilting at 15° produce the most heat to cook the raw ingredients.

Keywords: Solar oven, Parabolic rail, Solar energy, Cooking, Reflection angle

I. INTRODUCTION

Sunlight is a clean and abundant natural energy source. Over the decades, humans have developed various technologies to utilize solar energy a source for both heat and electricity conversion. These technologies have gathered increasing interest and usage because of their low investment cost and non-pollutive properties. As for the use of solar heat energy in particular, humans have developed technologies for various applications such as water heaters, dryers, solar cooking stoves, etc (Department of Alternative Energy Development and Efficiency, 2010, pp. 23-25; Sonsaree et al., 2014, pp. 105-121; Dasin et al., 2011, pp. 43-51; Al-Soud et al., 2010, pp. 463-470).

Base on literature, a solar oven is a low-cost instrument that heats the contents of a container, and it can be used for cooking and drying, based on the materials used to construct the oven. A solar oven concentrates solar radiation and converts it into heat energy. When used for cooking, ramping time is needed to raise the temperature until it reaches the appropriate cooking point. Concentrated sunlight needs to be distributed across the solar oven for it to operate (Al-Soud et al., 2010, pp. 463-470; SLiCK Solar Stove UK, 2017, Online; Rathore & Chopra, 2012, pp. 2277-9477). In the case of a solar oven with a parabolic reflector, solar rays are concentrated on a singular focal point. The material commonly used to construct the reflector is either polished aluminum or stainless steel (Rathore & Chopra, 2012, pp. 2277-9477). The advantage of this variant of solar oven is that it has faster temperature ramping compared to box-type ovens (Coccia et al., 2012, p. 023110; Öztürk, 2004, pp. 67-71; Ayompe et al., 2011, pp. 3370-3378).

A further review of the literature also reveals that the design and construction of a vacuum glass tube solar oven with a parabolic reflector is still very rare in Thailand. Therefore, this study proposes the design and construction of this variant of solar oven to heat raw ingredients using solar thermal energy. In addition, the characteristics of time and temperature inside the vacuum glass tube when cooking and the effect of solar radiation intensity on the temperature inside the vacuum tube are determined by adjusting the solar radiation angle and the type of reflector (Al-Soud et al., 2010, pp. 463-470; Coccia et al., 2012, p. 023110; Öztürk, 2004, pp. 67-71; Ayompe et al., 2011, pp. 3370-3378). This solar oven with a parabolic reflector has the potential to be viable for practical use, with the temperature inside the vacuum glass tube being sufficient to cook raw ingredients within the appropriate time (Clean Heat Energy Saving Solutions (Pty) Ltd, 2018, Online). However, there are sparsely amount of report regarding comparative study of multiple materials of parabolic rail in combination of tilting angle for solar cooker applied in Thailand.



The reflected light from the parabolic reflector with appropriate types of materials and tilt angles converging on the vacuum glass tube coated with a substance that can absorb heat well should allow the temperature inside the glass tube to increase to a level sufficient to cook raw ingredients. In addition, this study proposes the application of solar thermal energy for cooking to replace the use of gas and reduce pollution by using clean energy.

II. LITERATURE REVIEW

A parabola is a conic section originating from an intersection between the cone surface and a plane parallel to the original line of the cone surface. The parabola can be defined by the points in a two-dimensional plane that are equidistant from a fixed focal point, while the fixed line is the directrix line (Alkhaldi, 2014, p. 64). For an analysis to find the size of the parabolic rail, the equation of an upward-opening parabola has the vertex at the origin (0,0) is as display in Equation (1) (Abdulhamed, 2020, pp. 47-65). The design for the vertical distance or depth of the parabolic rail equals the focus length, are as shown in the Equation (2) to (4). For the design of a parabolic rail, the suitable ratio of the focus per aperture should be equal to 0.25. Meanwhile, the reflection of light is a phenomenon in which light travels from the medium of one density to another, causing the incident light to bounce off the new medium and be reflected back to the original one. For example, the reflection of light from air to the surface of a mirror causes the light to reflect off the surface of the flat mirror and return to the air (He et al., 1991, pp. 175-186). When light hits the surface of any medium, the intensity and direction of reflection depend on the nature of the surface of that medium. If a parallel beam of light hits a smooth surface, the light reflects as a parallel beam in the same manner as the incident beam. This may result in a possibly perfect reflection or an incomplete reflection with a distorted physical image while still conserving energy, depending on the type of opaque medium in which the light is reflected (He et al., 1991, pp. 175-186). The two laws of reflection are presented in Figure 1 (Fitzpatrick, 2007, Online): (1) The incident ray that hits the medium, the reflected ray that bounces off the medium, and the normal line that divides the two exist in the same plane. (2) The incident angle is equal to the reflecting angle.

$$x = \frac{x^2}{4f} \quad (1)$$

$$y = f ; x = w^2 \quad (2)$$

$$y = \frac{\left(\frac{w}{2}\right)^2}{4f} \quad (3)$$



$$\frac{f}{w} = 0.25 \quad (4)$$

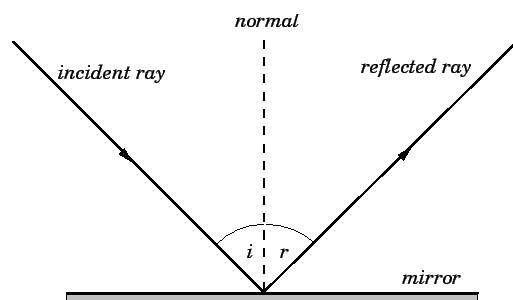


Figure 1: Light reflection
Source: Fitzpatrick (2007, Online)

Parabolic solar ovens have been studied by international researchers such as Öztürk et al. (2004, pp. 67-71), who designed and built a low-cost parabolic solar oven and evaluated the energy efficiency and energy usage of the constructed device. The energy efficiency and energy usage were found to range from 2.8 to 15.7 and 0.4 to 1.25, respectively. Al-Soud et al. (2010, pp. 463-470) designed and built a parabolic solar oven with a two-axis solar tracking system. A three-day test showed that the temperature of the water inside the glass tube used for heating can reach 90 °C on a hot summer's day when the ambient temperature is at its maximum of 36 °C. Hence, the water temperature increases when the ambient temperature is higher or the light intensity is higher. Ayompe et al. (2011, pp. 3370-3378) reported that a vacuum tube solar collector for a solar oven showed remarkable efficiency at low temperatures compared to a flat plate solar collector. In the same study, the thermal efficiency of the vacuum tube and flat plate solar furnaces when heating water under the same environmental conditions was 60.7 and 46.1, respectively. Under a fixed angle, the capability of parabolic rail materials to heat the thermally insulated glass tube should rely on their UV reflectivity. Based on study of Hussain et al. (2017, pp. 44-52), aluminum has noticeably higher capability to reflect large number of solar radiations to absorber resulting in higher thermal efficiency. Their paper report two identical conical solar collectors systems for water heating having different reflector materials under similar operating conditions where maximum thermal efficiency of aluminum reflector at 45° was 73% in comparison to 65% of stainless steeler reflector. As for comparison of aluminum and aluminum foil, the morphology of reflector plays a crucial role on specular reflection of the solar radiation as the more polished surface will has higher specular reflectivity not just in UV but in board wavelength due to lower dispersion as reported by Pozzobon et al. (2020, p. e00399). In their report, both bright side and matte side of foil result in similar total reflection but the polished bright side yielded 52.5% for specular reflection and 41.5% for diffused reflection while rough matte side yield 19.8% and 76.2%, respectively. Since specular reflection was key to control direction of solar radiation toward solar collector, the more polished aluminum surface would be more suitable as reflector. Therefore, the parabolic rail created from polished aluminum



should possess superior heating capability comparing to aluminum foil and stainless steel made ones due to its high UV reflectivity in board range. Regardless, the study to compare the performance of this cost-effective reflector material relative to each other for cooking need to be studied. To take advantage of Thailand where the country is sunny all years, the solar oven could reduce reliance on natural gas for cooking to help people who live on countryside and cut down budget for One Tambon One Product (OTOP) as well (Sanboonrat, 2001, pp. 1-2; Thipwong et al., 2022, pp. 167-180). With these knowledges in mind, the use of highly UV-reflective material as a rail combined with an appropriate tilting angle for the location (Thailand in our case study) should improve the ramp up time and temperature inside a thermally insulated glass tube for cooking purpose. As a result, chicken meat should lose its weight when properly cooked by solar oven.

III. RESEARCH METHODOLOGY

Design of the Solar Oven

Solar oven was designed through Solid Works 2017 software. Each component was design around the purchased solar collector and assembled into solar oven. Model detailing each component of the solar oven was shown in Figure 2 indicated by corresponding number as following:

1. Solar collector
2. Food tray
3. Parabolic rail
4. Ring for securing the closed end of a solar collector.
5. Ring for securing the open end of a solar collector.
6. Tilttable base



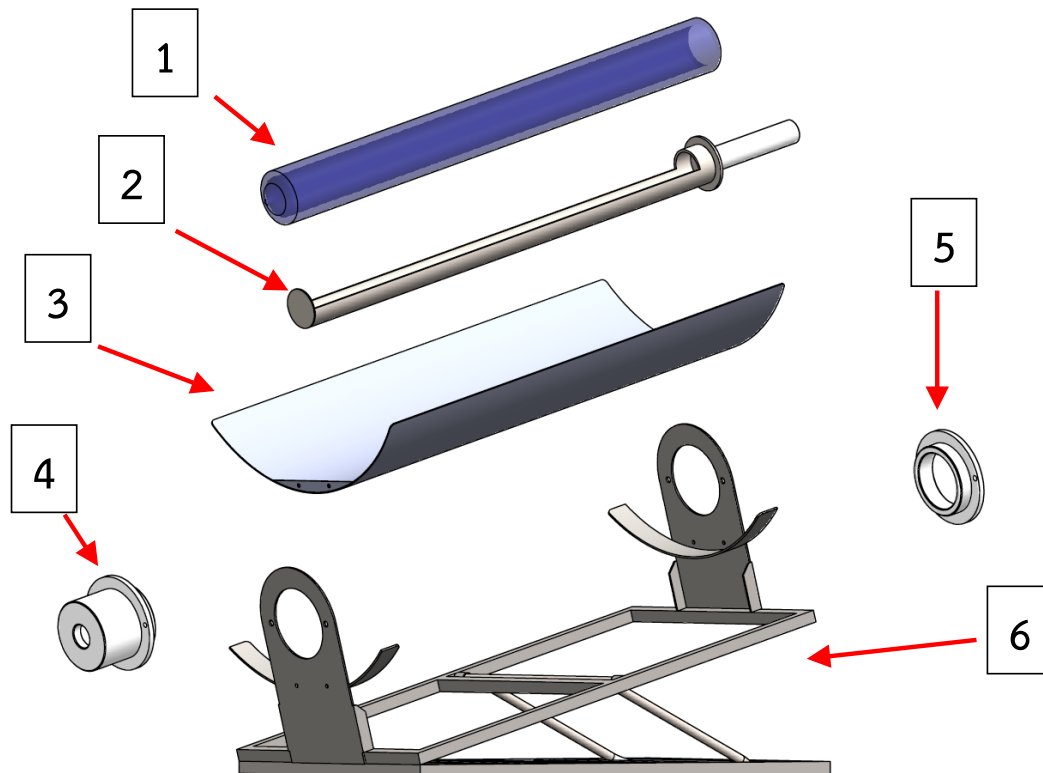


Figure 2: Model detailing each component of the solar oven

Food tray

The food tray is a component designed and constructed to hold experimental ingredients inside a vacuum glass tube of solar collector. The design details are as follows: a hollow cylindrical structure of 550 mm long, with an outer radius of 21 mm and a thickness of 2.7 mm. Both ends are sealed with circular plates of 42 mm in diameter and 1.5 mm in thickness. A 10-mm diameter hole was drilled on one of the sealed ends to insert a temperature probe of thermocouple. A handle with a 24-mm diameter and 120-mm length was attached to one end of the food tray. The main materials used in its construction are stainless steel and Teflon for the food tray and the handle, respectively.

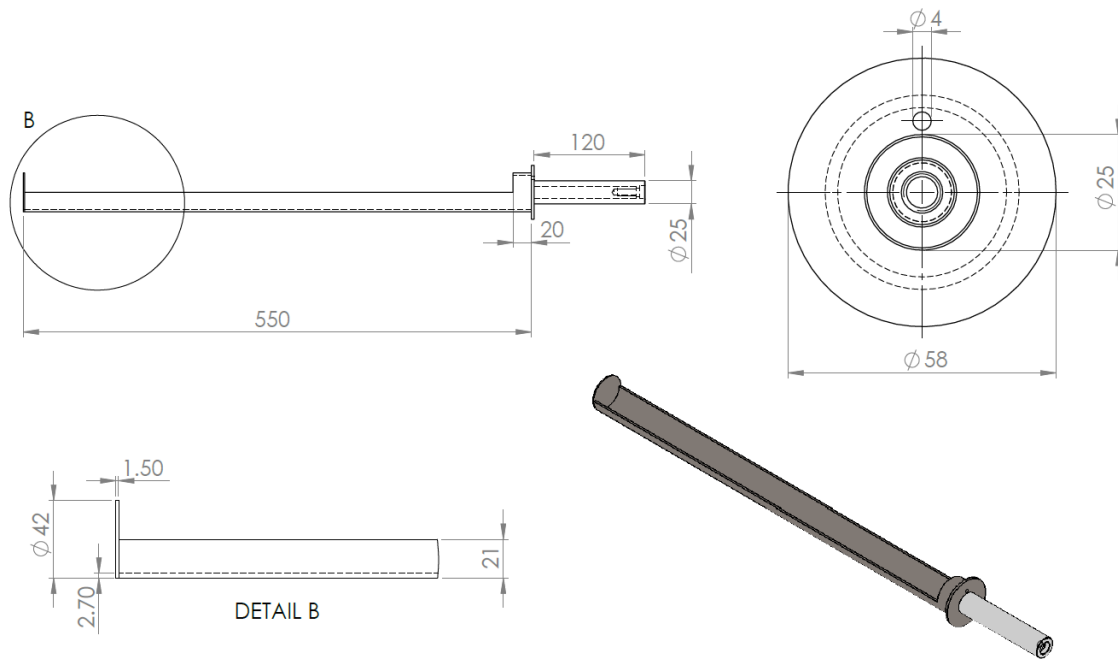


Figure 3: Schematics of food tray

Parabolic rail

The parabolic rail is a component designed to reflect solar radiation onto a vacuum glass tube, converting solar rays into thermal energy, thus increasing the temperature inside the tube. The design specifications included a width of 300 mm and a length of 540 mm, constructed primarily from stainless steel to create a curved shape with a focal length of 75 mm. The focal point was calculated using the equation $W = f / 0.25$, where f is the focal length, and W is the width of the curved base. Figures 4 and 5 show the ratio of the width and focal point of the parabolic rail and a detailed schematic of the parabolic rail, respectively. After design and construction, the parabolic rail is mounted on a tiltable base.

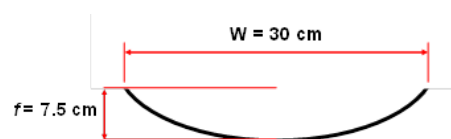


Figure 4: Ratio of the width and focal point of the parabolic rail

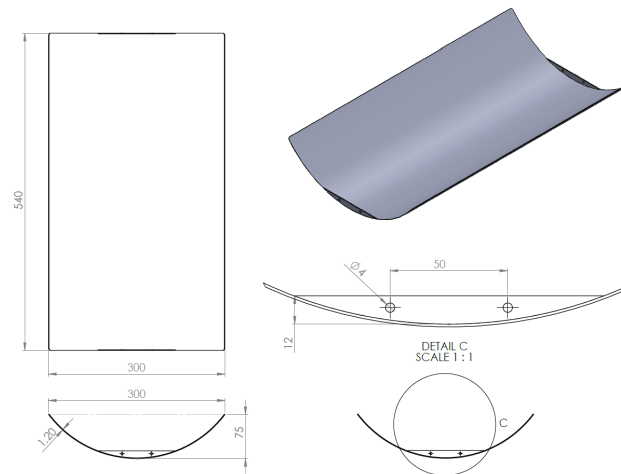


Figure 5: Detailed schematic of the parabolic rail

Ring for securing the closed end and open end of a solar collector

The clamping rings for vacuum glass tubes were designed in two directions to secure the vacuum solar collector to the main frame at both the closed and open ends of the tube, which were made of Teflon material. The design details for the closed-end securing ring of the vacuum glass tube are as follows: a hollow cylinder with an outer diameter of 100 mm and an inner diameter of 60 mm, connected to a cylinder with an outer diameter of 75 mm and an inner diameter of 60 mm, as shown in Figure 6. The design details for the open-end securing ring are as follows: a hollow cylinder with an outer diameter of 75 mm and an inner diameter of 60 mm, and a thickness of 6 mm, connected to a long cylindrical tube with an outer diameter of 100 mm and an inner diameter of 60 mm at a distance of 14 mm from one end of the long cylindrical tube, as shown in Figure 7.

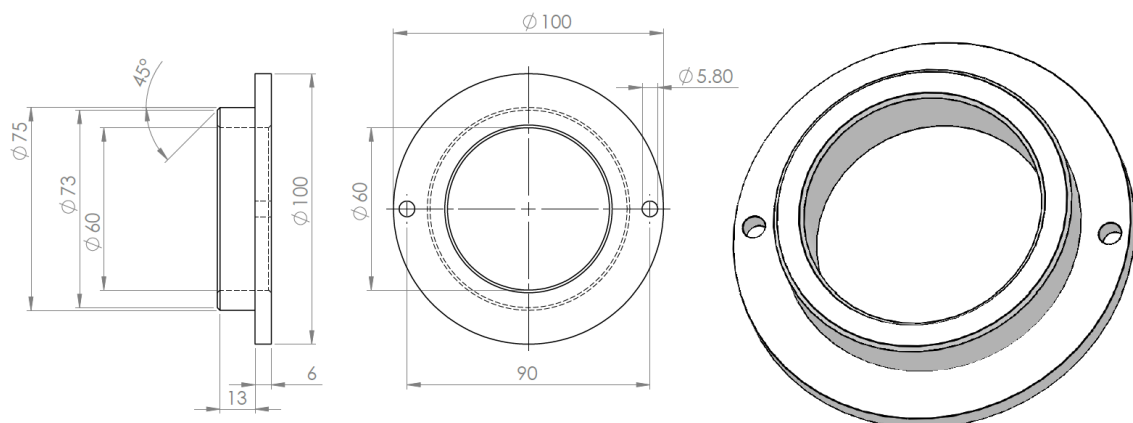


Figure 6: Schematics of ring for securing the closed end of a solar collector

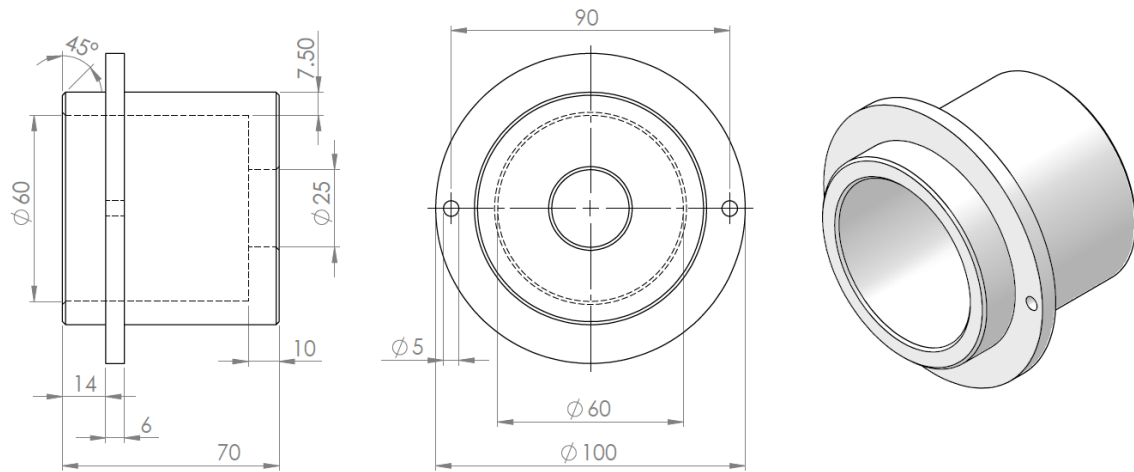


Figure 7: Schematics of ring for securing the open end of a solar collector

Tiltable base

The tiltable base is a component designed to support all the assembled parts of the solar furnace. The researchers designed this base to allow adjustment of the parabolic rail's tilting angle relative to the horizontal axis, ranging from 0, 15, to 30 degrees. The base consists of three main parts: the vacuum solar collector holder, the angular stand, and the base itself. All parts are constructed from stainless steel. The vacuum solar collector holder was designed as a frame for connection to the parabolic rail, with an overall height of 220 mm and an overall width of 120 mm. Both ends of the holder were designed for connection of the vacuum solar collector and its end-securing rings. A 76-mm diameter hole is drilled, centered at 150 mm from the horizontal base for inserting the ring and vacuum solar collector. The central section of the frame, with curved ends on both sides, was designed for connecting the parabolic rails. The width of the curve is 250 mm, and the frame panel is 2 mm thick, as shown in Figure 8.

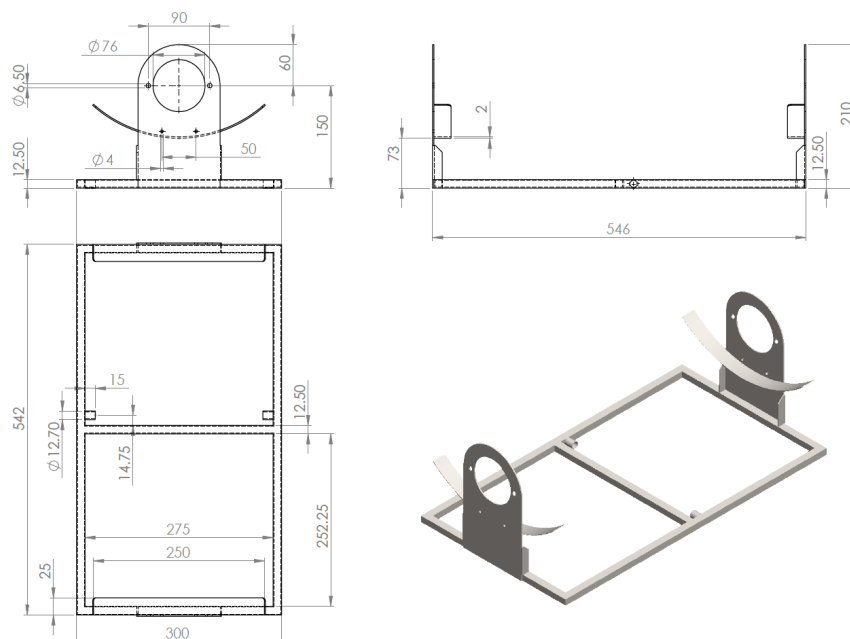


Figure 8: Schematics of holder for solar collector



The angular stand is a component that holds the tiltable base when adjusts the angular position of the system's plane. The angular stand was designed as a rectangular frame with rounded section made from a 9.50 mm diameter stainless steel cylinder welded to a 274 mm long cylindrical shaft. The combined longitudinal and transversal dimensions of the section are 274 mm and 216 mm, respectively, as shown in Figure 9.

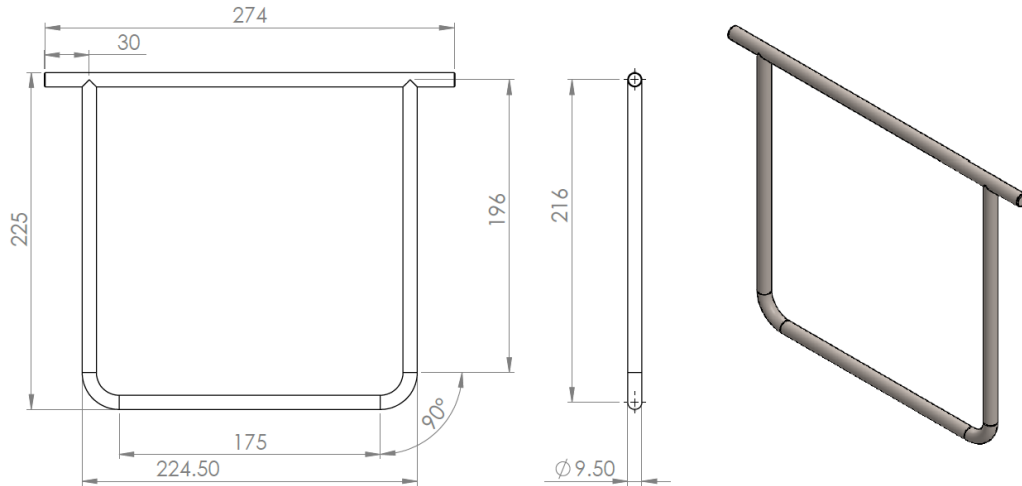


Figure 9: Schematics of angular stand

The angle-fixing base is a component that adjusts the tilting angle of the parabolic rail by adjusting the position of the angular stand according to the position of the secondary perpendicular alignment of the base. The angle-fixing base was designed as a rectangular frame with a width of 300 mm and a length of 542 mm, constructed from 12.50 mm-wide stainless steel box sections. The secondary perpendicular alignment positions were specified at distances of 390 mm and 482 mm from the bottom end of the angle-fixing base, which allows for the determination of the parabolic rail's tilting angle in respect to the horizontal axis at values of 30 and 15°, respectively. The design diagram of the angle-fixing base is shown in Figure 10.

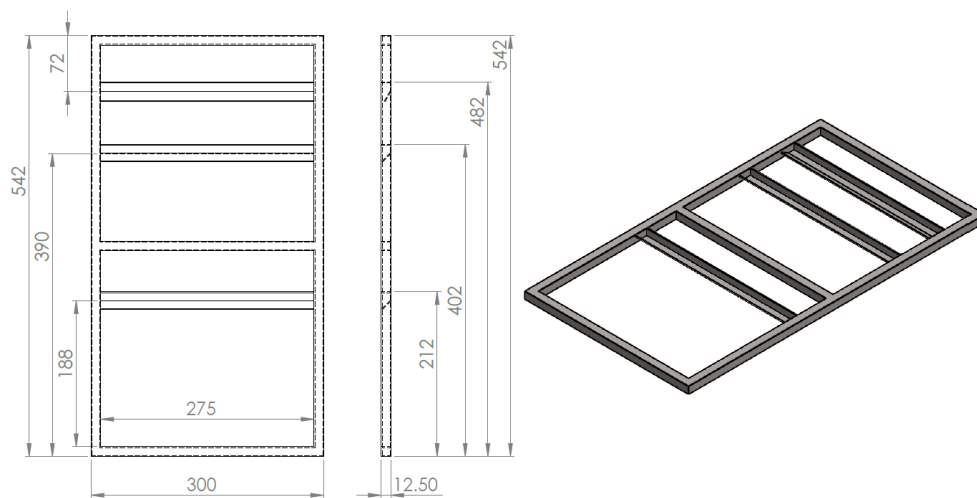


Figure 10: Schematics of angle-fixing base



Each adjustable tilting angle achievable by the tiltable base were portrayed in Figure 11.

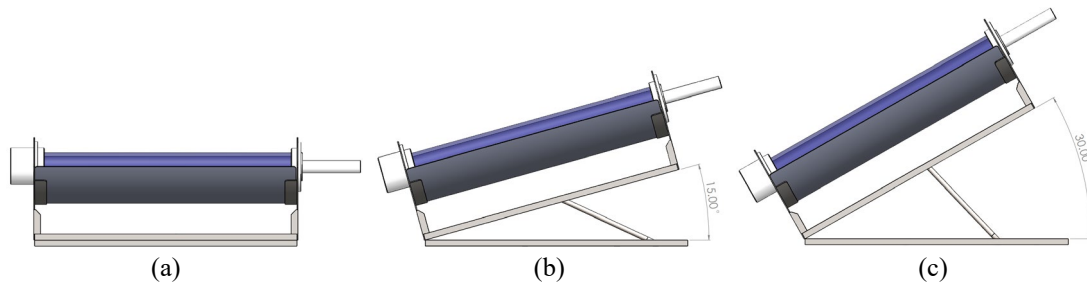


Figure 11: Tilting angle of solar oven (a) 0° , (b) 15° , and (c) 30°

The heating efficiency of the solar oven was tested under two experimental conditions. First, the experiment involved a parabolic rail made from different reflector materials fixed at a 0° angle horizontally. Next, the experiment involved a stainless-steel parabolic rail at various tilting angles of 0° , 15° , and 30° . The purpose of the experiment was to assess the heating efficiency inside the vacuum glass tube based on different reflector materials and reflector angles.

Testing of the Solar Oven Under Different Reflector Conditions

The research group set up a solar oven connected to a thermocouple inside the vacuum glass tube without a parabolic rail and with a parabolic rail of stainless steel, aluminum foil, and aluminum plate. The raw chicken weighing around 50 grams was prepared and inserted into the four trays inside the solar oven. Four solar ovens were then set in a clear location, and the light intensity and temperature inside the oven were recorded every minute for a 60-minute period in total. Figure 12 shows the solar oven under four conditions, namely (a) without parabolic rail, (b) stainless steel, (c) aluminum foil, and (d) aluminum plate.



(a)



(b)

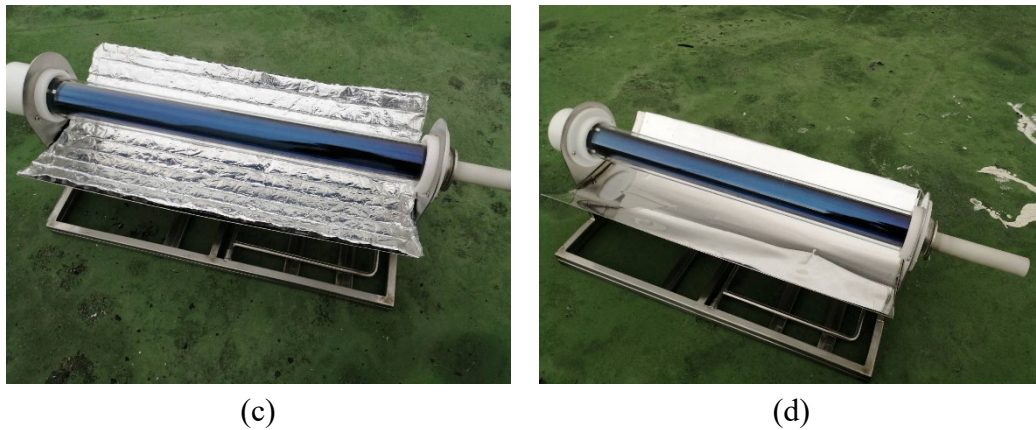


Figure 12: Solar oven together with parabolic rail material consisting of (a) without parabolic rail, (b) stainless steel, (c) aluminum foil, and (d) aluminum plate

Testing the Solar Oven Under Different Reflector Angle Conditions

The research team set up a solar oven with a thermocouple inside the vacuum glass tube. The stainless-steel plate was selected for this experiment. The angle between the reflector and base was set at (a) 0° , (b) 15° , and (c) 30° as shown in Figure 13.

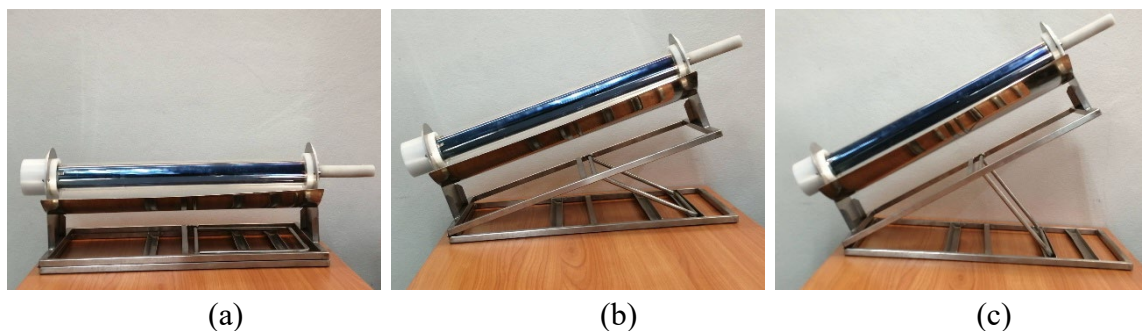


Figure 13: Solar oven at different angles: (a) 0° , (b) 15° , and (c) 30°

IV. RESULTS

Table 1: Experimental data for heating efficiency at an angle of 0° under various reflector materials

Experimental details	Results
Date of experiment	June 20, 2019
Experiment duration	12.30–13.30 p.m.
Heating duration	60 minutes
Location	In front of Amazon (SC08 building, KMITL)
Type of reflector material	1. Without a reflector 2. Stainless steel 3. Aluminum foil 4. Aluminum plate
Angle between the reflector and base	0°
Light intensity	115–1150 W/m ²
Weather conditions	Cloudy



Figure 14 shows the relationship between temperature and time based on experimental data for temperature generation inside a vacuum glass tube. The temperature-time relationship reveals that the highest temperature was achieved in the range of 100 to 106 °C. Comparing the temperature throughout 30 minutes of heating, the bare oven without a parabolic rail showed the lowest trend in temperature increase inside the vacuum glass tube at approximately 65.3 °C at 30 minutes. Meanwhile, the solar ovens with parabolic rails for radiation concentration showed internal temperatures of 86.5, 97.0, and 100.5 °C, depending on the reflector material, namely foil, stainless steel, and aluminum, respectively. Afterward, the temperature in the vacuum tube were around 84.4 °C for solar oven without a parabolic rail then 116.6 °C, 100.5 °C, and 118.1 °C for solar oven with the parabolic rail made of stainless steel, aluminum, and aluminum foil at one hour. The temperatures achieved were within a suitable range for cooking raw ingredients.

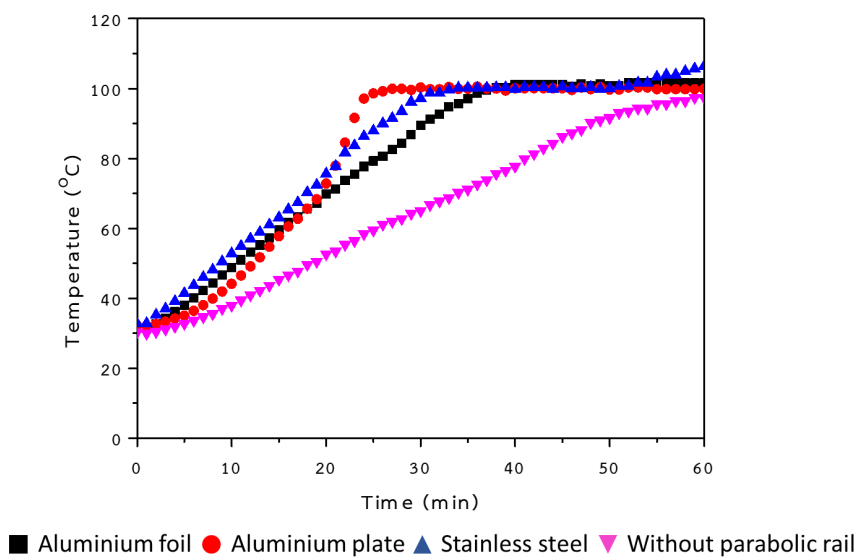


Figure 14: The graph represents the relationship between time and temperature inside ovens constructed using a parabolic rail made of aluminum foil, aluminum plate, and stainless steel, compared to a bare oven on June 20, 2019

Figure 15 shows the relationship between solar radiation intensity and time of the experimental data for the temperature accumulated inside a vacuum glass tube. The graph shows a trend of intensity values ranging from 800 to 1000 W/m² throughout the experiment, except for the period from the 21st to the 24th minute, when the intensity decreases due to a transient change occurring in the environment.

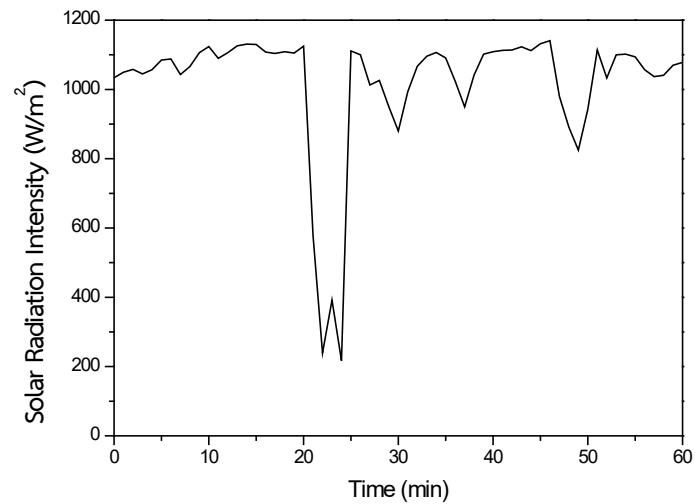


Figure 15: The graph represents the relationship between time and solar radiation intensity measured on June 20, 2019

Table 2: Weight of ingredients before and after heating at an angle of 0° under various reflector materials

Reflector material	Weight of ingredients before the experiment	Weight of ingredients after the experiment
Without a reflector	50.5513 g	33.1366 g
Stainless steel	50.7233 g	25.6328 g
Aluminum foil	50.5247 g	27.6663 g
Aluminum plate	50.7420 g	25.3301 g



(a)



(b)



(c)



(d)

Figure 16: Weight of chicken meat before heating by a solar oven constructed without a parabolic rail and with a parabolic rail made from (b) stainless steel, (c) aluminum foil, and (d) aluminum plate



(a)



(b)



(c)



(d)

Figure 17: Weight of chicken meat after by a solar oven constructed without a parabolic rail and with a parabolic rail made from (b) stainless steel, (c) aluminum foil, and (d) aluminum plate

Table 3: Experimental parameters for determining the performance of a solar oven using a stainless-steel rail at different tilting angles

Parameters	Results
Date	July 4, 2019
Time	11.00 a.m.–12.00 p.m.
Heating duration	60 minutes
Location	Roof of SC04 building, KMITL
Reflector material	Stainless steel
Tilting angle compared to the base	0°, 15°, and 30°
Radiation intensity 0°	400–930 W/m ²
Radiation intensity 15°	260–410 W/m ²
Radiation intensity 30°	250–370 W/m ²
Weather conditions	Slightly cloudy

Figure 18 represents the relationship between time and temperature inside the solar oven at different tilting angles of 0°, 15°, and 30°. According to the experiment to measure the temperature inside a vacuum glass tube, the highest temperature was 120.9 °C measured at 15°. By tilting the reflector to 0° and 30°, the maximum measured temperatures were 100.8 and 100.1 °C, respectively.

Figure 19 represents the relationship between time and solar radiation intensity at different tilting angles. The intensity ranged from 290 to 408 W/m² in the experiment where the tilting angles were 15° and 30°. At a tilting angle of 0°, the system exhibited an initial intensity of 605 W/m², rising to a maximum intensity of 922 W/m² after 29 minutes.

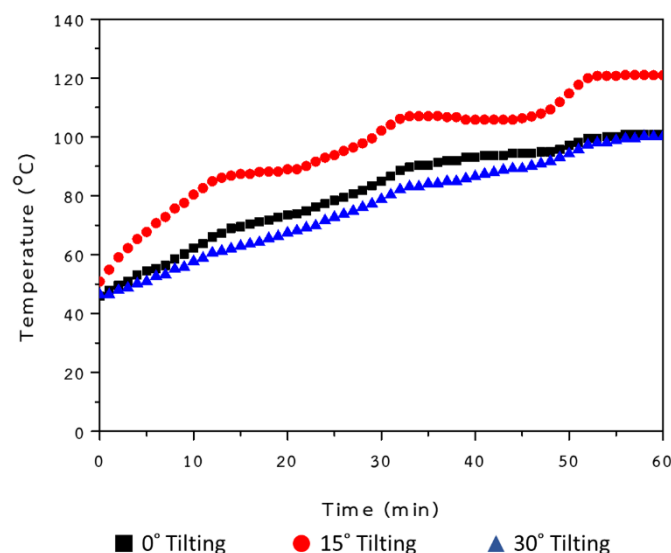


Figure 18: The graph represents the relationship between time and temperature inside the solar oven measured on July 4, 2019, at different tilting angles



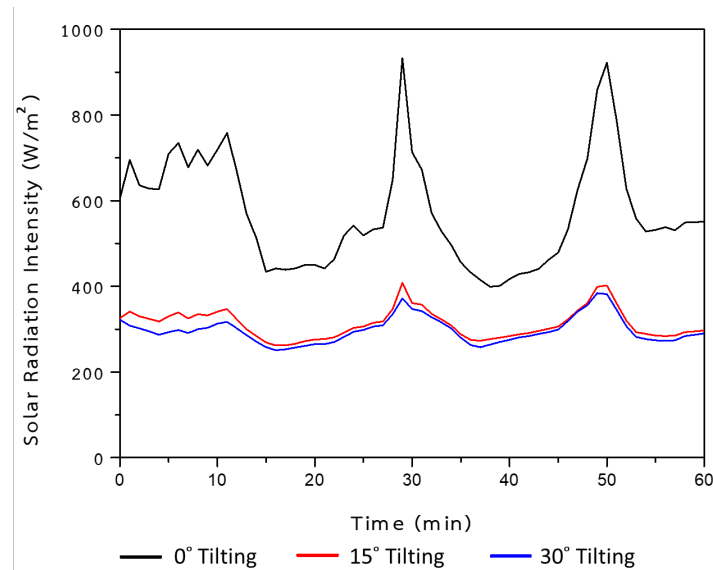


Figure 19: The graph represents the relationship between time and solar radiation intensity measured on July 4, 2019, at different tilting angles

Table 4: Weight of the chicken meat before and after heating in the solar oven at different angles

Tilting angle	Weight before the experiment	Weight after the experiment
0°	50.6244 g	20.5780 g
15°	50.4363 g	20.9683 g
30°	50.8899 g	20.7203 g

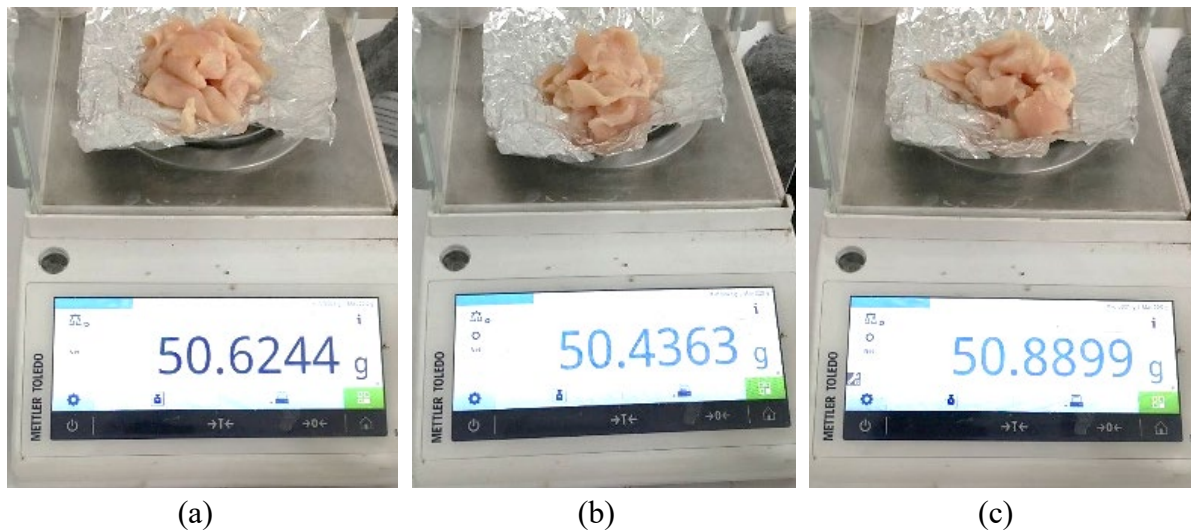


Figure 20: Weight of the chicken meat before heating by the solar oven at different angles: (a) 0°, (b) 15°, and (c) 30°

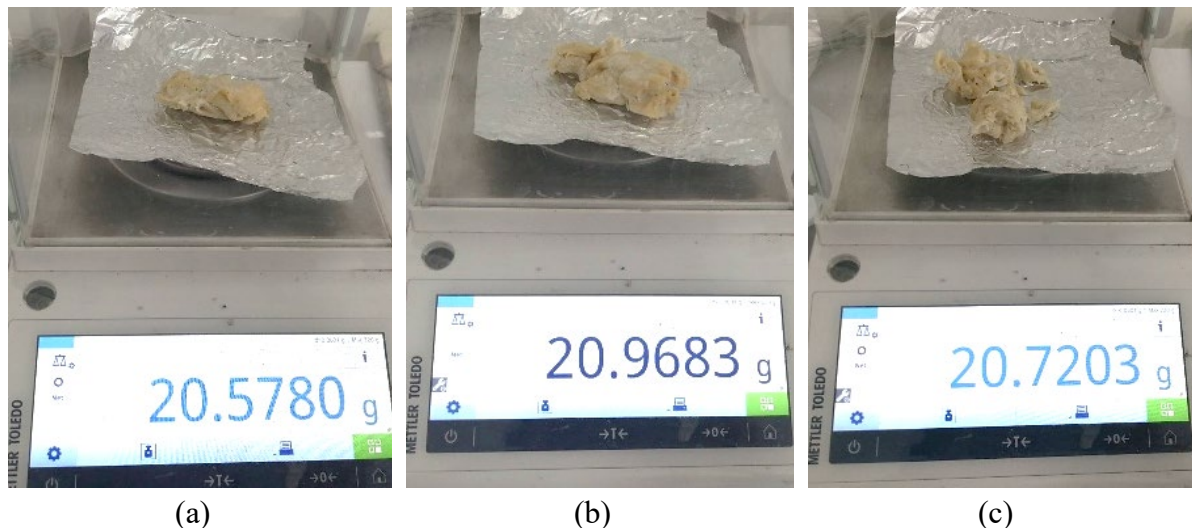


Figure 21: Weight of the chicken meat after heating by the solar oven at different angles: (a) 0°, (b) 15°, and (c) 30°

V. CONCLUSION AND DISCUSSION

The aim of this research was to study and design a solar oven with the purpose of applying solar energy to cook raw ingredients. A parabolic rail was designed for a solar oven with the capability to adjust the angle of light reflection into the vacuum glass tube and the reflector material to study the temperature inside the vacuum glass tube under two different conditions. For the first case, a myriad of materials was used, such as aluminum plate, aluminum foil, and stainless steel as the reflector material. In the second case, the light reflection angle was adjusted to 0°, 15°, and 30°. The researchers designed and constructed all the main components, including the food tray, parabolic rail, rings for securing the closed ends of the vacuum glass tube, rings for securing the open ends of the vacuum glass tube, and the adjustable tilt base. These were assembled with purchased equipment, comprising a vacuum glass tube, a thermocouple, a K-type temperature probe, and a solar irradiance meter. The heat values tested in the case involving the parabolic rail material showed that polished aluminum plate could ramp up to a maximum temperature of 100 °C faster than the other materials. The weight of the raw material was found to have decreased by approximately 20 to 30 grams after the experiment. Thermal testing in the case where the tilt angle of a stainless-steel parabolic rail was changed revealed that the maximum temperature ranged from 60 to 120 °C, with the highest temperature observed at a tilt angle of 15° relative to the horizontal of the base. The weight reduction in the raw material after the experiment was approximately 30 grams.

The thermal gain efficiency over time of the design is around 2.5 °C/minutes allowing it to reach 100 °C in less than 30 minutes for the solar oven with parabolic rail and able to sustain temperature of 100 °C or beyond throughout cooking time of chicken which is 20-30 minutes. This result in cooking time under time frame of 60 minutes which is the typical range for cooking of commercial solar oven (Prompuge and Sirisamphanwong, 2018, pp. 1-15; Silva et al., 2025, p. 428). The result of variation of materials under fixed angle showed that aluminum plate yielded highest heating rate implying highest amount of solar radiation reflected to the



solar collector following by stainless steel then aluminum foil. For the result of the experiment on tilting angle, the 15° yield the best result in our case, as this angle was the closest to the estimated optimal tilt angle for Bangkok of approximately 13.5° (Jacobson & Jadhav, 2018, pp. 55-66). The weight loss from cooking using our solar oven is roughly half compared to the result from a commercial cooker that would yield the weight loss of 64.93 g/100g as per calculation from a formula derived in a study of Barbantia and Pasquini (2005, pp. 895-901). Regardless, the doneness of chickens was examined by split through the cooked chicken which revealed fully opaque white with no on pink area. This indicate there is no raw part inside and safe to eat as the chickens was cooked at temperature exceed that of typical cooking temperature (Nisbet, 2025, Online). As for recommendation of the research, the dimension and type of solar collector could be redesign and study for further improvement of the solar oven.

ACKNOWLEDGEMENT

This research was successfully performed owing to the support and collaborative effort from the Integrated Science for Electronic, Material and Industry (ISEMI) Research Unit from School of Science, KMITL, Thailand. The allowance for carrying out this research was provided by the Academic Research Fund, Faculty of Science, King Mongkut's Institute of Technology Ladkrabang, with grant numbers 2562-01-05-25.

REFERENCES

- Abdulhamed, A. J., Rasheed, M. H., Kareem, H. K., Mariah, N., Ab-Kadir, M. Z. A., & Hairuddin, A. A. (2020). Design and performance testing of a parabolic trough collector including deformation test of the receiver tube. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, 67(2), 47-65.
- Al-Soud, M.S., Abdallah, E., Akayleh, A., Abdallah, S., & Hrayshtat, E.S. (2010). A parabolic solar cooker with automatic two axes sun tracking system. *Applied Energy*, 87(2), 463-470.
- Alkhaldi, A. (2014). The Parabola in Universal Hyperbolic Geometry (Doctoral dissertation, UNSW Sydney).
- Ayompe, L. M., Duffy, A., Mc Keever, M., Conlon, M., & McCormack, S. J. (2011). Comparative field performance study of flat plate and heat pipe evacuated tube collectors (ETCs) for domestic water heating systems in a temperate climate. *Energy*, 36(5), 3370-3378.
- Barbanti, D., & Pasquini, M. (2005). Influence of cooking conditions on cooking loss and tenderness of raw and marinated chicken breast meat. *LWT-Food Science and Technology*, 38, 895-901.
- Clean Heat Energy Saving Solutions (Pty) Ltd. (2018). *Evacuated Tube SA*. <http://www.cleanheatsolar.com/evacuated-tube-sa.html>.



- Coccia, G., Latini, G., & Sotte, M. (2012). Mathematical modeling of a prototype of parabolic trough solar collector. *Journal of Renewable and sustainable energy*, 4(2), 023110.
- Dasin, D.Y., Asere, A.A., & Habou, D. (2011). Parabolic solar cooker dish: design and simulation. *Nigerian Journal of Solar Energy*, 22, 43-51.
- Department of Alternative Energy Development and Efficiency. (2010). *Handbook on Development and Investment in Renewable Energy Production Volume 2*. Ministry of Energy. (in Thai)
- Fitzpatrick, R. (2007). *Law of Reflection*. <https://farside.ph.utexas.edu/teaching/316/lectures/node127.html>.
- He, X. D., Torrance, K. E., Sillion, F. X., & Greenberg, D. P. (1991). A comprehensive physical model for light reflection. *ACM SIGGRAPH computer graphics*, 25(4), 175-186.
- Hussain, M. I., Lee, G. H., & Kim, J. T. (2017). Experimental validation of mathematical models of identical aluminum and stainless steel engineered conical solar collectors. *Renewable Energy*, 112, 44-52.
- Jacobson, M. Z., & Jadhav, V. (2018). World estimates of PV optimal tilt angles and ratios of sunlight incident upon tilted and tracked PV panels relative to horizontal panels. *Solar energy*, 169, 55-66.
- Nisbet, J. (2025). *CHICKEN TEMPERATURE CHART*. <https://www.fooddocs.com/food-safety-templates/chicken-temperature-chart>.
- Pozzobon, V., Levasseur, W., Do, K. V., Palpant, B., & Perre, P. (2020). Household aluminum foil matte and bright side reflectivity measurements: Application to a photobioreactor light concentrator design. *Biotechnology Reports*, 25, e00399.
- Prompuge, W., & Sirisamphanwong, C. (2018). Technical performance for heat storage of solar cooker using vegetable oil as working fluid. *Journal of Renewable Energy and Smart Grid Technology*, 13(1), 1-15.
- Öztürk, H. H. (2004). Experimental determination of energy and exergy efficiency of the solar parabolic-cooker. *Solar energy*, 77(1), 67-71.
- Rathore, R. C. P. M. M., & Chopra, M. (2012). An overview of solar cookers. In *1st International Conference on Recent Trends in Engineering & Technology, Special Issue of International Journal of electronics, Communication & Soft Computing Science & Engineering*, ISSN, 2277-9477.
- Sanboonrat, W. (2001). Solar Cookers Design Development (Bachelor dissertation, Naresuan University Phitsanulok). (in Thai)
- Silva, J., Serrano, L., Martins, P., Ferreira, H., Váz, P., & Guerra, E. (2025). A Case Study of a Solar Oven's Efficiency: An Experimental Approach. *Sustainability*, 17(2), 428.
- SLiCK Solar Stove UK. (2017). *The Great British Solar Bake Off 2017- SliCK*. <http://www.slicksolarstove.com/blog/>.



- Sonsaree, S., Chramsa-ard, W., Sukchai, S., Laodee, P., & Sirisamphanwong, C., (2014). Development of a Compound Parabolic Concentrating Solar Collector. *Burapha Science Journal*, 19(2), 105-121. (in Thai)
- Thipwong, S., Srisawad, S., & Keownok, S. (2022). Development of Low Cost Radiation Protection Solar Drying Technology for Duang Thong Community Enterprise Group in Phetchabun Province. *Academic Journal Uttaradit Rajabhat University*, 17(2), 167-180.

The content, as well as the use of language in the article, is the responsibility of the author.



Montha Polrak, Napalai Meela, and Charinee Chansri*

montha.po@kmitl.ac.th, napalai.me@kmitl.ac.th, and charinee.ch@kmitl.ac.th*

Department of Languages, School of Liberal Arts, King Mongkut's Institute of Technology
Ladkrabang, Bangkok 10520 Thailand

*Corresponding author E-mail: charinee.ch@kmitl.ac.th

Received: March 9, 2026 **Revised:** April 22, 2026 **Accepted:** May 8, 2026

Citation reference:

Polrak, M., Meela, N., & Chansri, C. (2025). Factors causing demotivation in English language learning among agriculture undergraduate students. **International Journal of Industrial Education and Technology**, 8(1), 55-68.

 ABSTRACT

In Thailand, agriculture undergraduate students have encountered difficulties in improving their English language, and demotivation has been explored as one of the reasons behind such difficulties. Hence, the study aimed to investigate factors that demotivated undergraduate students in the Thai context. The participants comprised 95 agriculture undergraduate students in a public university, and the stratified technique was used to obtain the participant sample. The research instrument was a demotivation questionnaire which included 35-item rating-scale questions exploring students' perceptions on demotivation factors in five aspects: 1) Learning contents and materials, 2) Teachers' competence and teaching styles, 3) Lack of intrinsic motivation, 4) Inadequate school facilities, and 5) Test scores. The findings show that the most demotivating factor in each of the five aspects were, namely, 1) expectation to use grammatically correct English, 2) inappropriate pace of lessons, 3) lack of use on language learning equipment and materials, 4) learners' attitudes on English as a compulsory course, and 5) learners' low test scores. Among all of the 35 items from the five categories, the participants (54.73%) strongly agreed that Item 4 'I was expected to use (or speak and write) grammatically correct English.' was a factor that demotivated them the most. The findings can help agricultural English language lectures and English language curriculum developers/policy makers create and revise their course, curriculum, or policy so that it enhances students' motivation which is one of the keys to students' success.

Keywords: Demotivation, Demotivation factors, Agriculture undergraduate students, English language learning, English language teaching

I. INTRODUCTION

In spite of the significant role of English in the globalized era, agriculture students in various educational levels, including a tertiary level, have encountered using English language. Bhanu and Selvaraj (2025, p. 2) have stated that agriculture students, particularly, those who are non-native speakers have faced difficulties in improving their English language proficiency. Such challenges range from basic aspects, such as grammar and vocabulary, to more complicate ones, such as culture and abilities to express ideas in a variety of contexts. Similarly, Sanico et al. (2025, pp. 1134 -1135) pointed out that agriculture students have experience critical challenges in English language skills. Specifically, when it comes to witting and grammar, many agriculture students strive to generate ideas and form sentences since they struggle to recognize and apply certain grammatical aspects such as subject-verb agreement. This is in line with what Injan (2024, pp. 540-542) found that agriculture university students had problems in listening, reading, writing, and, especially, speaking which was the most critical aspect.

To cope with such challenges among agriculture students, researchers have explored cognitive as well as affective domains which have a vital role in enhancing learners' English language proficiency. Among a wide range of affective domains which include psychological constructs, motivation has received a clear attention for decades in the field of English language. Generally, motivation refers to the stimulus which directs and operates human's behavior at a conscious as well as an unconscious level (American Psychological Association, 2018, Online). Specifically, motivation for learning or learning motivation can be defined as a construct comprising both subjective expectations and anticipated consequences such as pride, sorrow, or shame (Schrader, & Helmke, 2015, p. 48). Thus, learning motivation which stimulates and sustains learners' behaviors is the factor that direct learners towards particular academic goals (Junfeng, 2025, p. 831) which comes from various sources. Bandhu et al. (2024, p. 2) have elaborated that motivation on the one hand can come from internal sources such as the pressure to be successful and the fear to face failure. On the other hand, it is derived from external sources such as instability in personal finance and responsibilities for families. Both types of sources, internal and external sources, hence have led to the two types of motivation which are namely intrinsic and extrinsic motivation to learn, respectively.

To better understand motivation in academic settings is to understand demotivation. While motivation directs learners to attain their goals and acquire new body of knowledge, demotivation obstructs learning progress and learning process (Mohd et al., 2024, p. 569). To illustrate, demotivating factors discourage learners and diminish their motivation as well as engagement in learning. According to Ahmad (2021, p. 51); Zolkapli et al. (2023, p. 1450), certain demotivation factors include 1) lack of relevance, 2) excessive pressure, 3) unsupportive environment, 4) lack of autonomy, 5) fear of failure, and 6) resource limitations and burnout. As Zolkapli et al. (2023, p. 1438) stated, identifying demotivation factors is comprehending the roots of learners' demotivation, which can cause lecturers and other stakeholders to prevent learners from their academic failure.

With respect to the significance of motivation as well as the interplay between motivation and demotivation, the present research study aimed to examine the demotivation factors in English language learning among agriculture undergraduate students. The data obtained can shed light on what lecturers should take into accounts when designing an English language course which effectively generate learners' motivation.



II. LITERATURE REVIEW

Motivation is one of the psychological constructs, which has attracted attention from academicians in the field of educational psychology. Literature review shows that motivation is basically defined as “a process in which goal-directed activity is instigated and sustained” (Schunk et al., 2014, p. 5). It can be seen as a stimulus that leads as well as manipulates behavior and performance of human-beings, and this occurs at a conscious level and an unconscious level (American Psychological Association, 2018, Online). All in all, motivation is a construct that initiates human’s actions and performances. In the academic context, motivation refers to as a construct which consists of subjective anticipations as well as expected outcomes, e.g., pride, sorrow, and shame (Schrader, & Helmke, 2015, p. 48). It stimulates and sustains learners’ behaviors, so it is the factor that directs learners towards particular academic goals (Junfeng, 2025, p. 831). The concepts of motivation have been explored in several ways. On the one hand, it can be categorized as intrinsic motivation and extrinsic motivation. Intrinsic motivation can be referred to as value (Eccles & Wigfield, 2020, p. 4), and that is why it is associated with how individuals perform activities for their own and personal interest (Gottfried et al., 2001, p. 3). Unlike intrinsic motivation, extrinsic motivation is driven when individuals expect positive outcomes or avoid negative outcomes (Pekrun, 2024, p. 16). Consequently, it exploits the environment or circumstances unlike intrinsic motivation that focuses on willingness to do the task itself. On the other hand, motivation involves two main concepts: integrative motivation and instrumental motivation. Gardner and Lambert (1972, p. 146) have divided motivation into two types, namely, integrative motivation and instrumental motivation. Integrative motivation is related to learners’ needs to acquire a particular language to attain the level that is quite close to a native speaker as well as to be integrated to the culture and social aspects of the target language, while instrumental motivation includes a desire to learn the target language for practical reasons such as high-salary jobs or further studies. In addition to types of motivation, motivation has been highlighted in its relation to learners’ engagement and accomplishments, which can be seen in numerous prior research studies. For example, Arcipe and Balones (2023, p. 14) found that learning motivation is positively and significantly correlated to students’ engagement in the context of the Philippines. Besides, in the Chinese setting, motivation to learn, along with, self-efficacy and learning strategies, could positively predict English achievements among undergraduate non-English majors (Liu & Sun, 2025, p. 9). In a similar way, Kimly et al. (2024, p. 54) reported on the effects of motivation, both intrinsic and extrinsic, on English language learning of Cambodian undergraduate students. In summary, some exemplars of the aforementioned previous studies help confirm the impact of learning motivation on learners’ success.

Unlike motivation that is a stimulus that directs and operates human’s behavior, demotivation can be defined as a drive that weakens individuals’ motivation for certain actions. Dörnyei and Ushioda (2021, p. 139) have stated that demotivation refers to ‘specific external forces that reduce or diminish the motivational basis of a behavioral intention or an ongoing action’. Correspondingly, it can be referred to as a psychological phenomenon which is portrayed by a reduce or loss of individuals’ force, eagerness, and readiness to participate in a task or achieve a goal (Psychological Scales, n.d., Online). From the definitions mentioned above, demotivation is far beyond related psychological concepts such as lack of interest or apathy, and, in the field of psychological education, it has been investigated in various aspects, particularly in terms of its causes. Demotivation factors or demotivators are external drives which impede learning process and thus reduce learners’ motivation. Mainly, demotivation factors can be divided into two groups: internal factors and external factors. According to De Asis et al. (2021, p. 1689), internal factors include learners’ internal forces, namely, attitude towards learning English, socialization, and



English language competency, while external factors that are related to external drives involve teachers' behavior, teachers' competence, classroom learning resource preparedness/availability, course content, class size, and classroom assessment and requirements. Similarly, Gao & Liu (2022, p. 3) have explained the classification of demotivation factors as the two major types: internal factors and external factors. That is to say, internal factors comprise learner-related factors, whereas the external factors are associated with teacher-related, environment-related, curriculum related factors, and important others-related factors. To sum up, factors of motivation can be categorized into two groups: 1) internal factors that consist of learner-related factors such as learners' attitude toward learning English and their language proficiency; and 2) external factors which contain (a) teacher-related factors including teachers' behavior as well as teachers' competence, (b) environment-related factors such as classroom learning resource preparedness/availability, (c) curriculum related factors such as course content and classroom assessment and requirements, and (d) other important others-related factors. In addition, in the ELT context, demotivation factors have been widely explored in terms of perceptions of learners toward the causes of their decreased motivation. Although perceptions of demotivation factors were first examined in 1990s in the United States (Gorham & Christophel, 1992, p. 239), research that has left a distinctive mark for the aspect in the English as a Foreign Language (EFL) setting was Sakai and Kikuchi (2009, p. 64)'s. The study was implemented on the basis of five demotivating factors: 1) learning contents and materials, 2) teachers' teaching styles, 3) inadequate school facilities, 4) lack of intrinsic motivation, and 5) test scores. The findings demonstrate that learning contents and materials factors, as well as test scores factors were the factors that highly demotivated high school students. Yet, either teacher competence factors or teaching style factors were not perceived as a strong demotivation factor. The 35-item questionnaire created by Sakai and Kikuchi (2009, p. 64) was later adopted by later researchers such as De Asis et al. (2021, p. 1689), Zhou et al. (2023, pp. 5-6; Huwari et al. (2023, p. 1026). To illustrate, De Asis et al. (2021, p. 1689) indicated that Filipino college students were highly motivated by the internal factors, including, attitude towards learning English Interpretation and socialization. As external factors, the participants were much demotivated by teachers' behavior, teachers' competence, and classroom learning resource preparedness/availability. Besides, findings gained from Zhou et al. (2023, pp. 5-6) pointed out that the five factors that demotivated Chinese college students were (1) low expectancy for success, (2) loss of task value, (3) negative teacher behavior, (4) inappropriate learning environment, and (5) lack of self-discipline in learning online. Apart from that, Huwari et al. (2023, p. 1027) revealed that classroom environment is the most demotivating factor, whereas, lack of self-confidence as well as interest were the least demotivating factors which demotivated Jordanian undergraduate students. In order to expand the body of knowledge of motivation factors from Eastern Asia to Southeastern Asia, the present study was undertaken with the objective to examine perceptions on demotivation factors among undergraduate students in Thailand.

III. RESEARCH METHODOLOGY

Participants

The population of the study was 2,174 first-year to third-year agriculture undergraduate students from a public university, Bangkok, Thailand (Office of Registrar of KMITL, 2024, Data of undergraduate students section). Ninety-five of the students were selected to participate in the current study by means of the stratified technique. The number of the participants was based on Yamane's sample size (Yamane, 1967, p. 886) with $\pm 10\%$ variance. Based on Yamane's sample, the proper sample size should be at least 95.



Research instrument

The research tool was adopted from a questionnaire developed by Sakai and Kikuchi (2009, p. 64), which was based on the conceptual framework of Dörnyei's nine categories of demotivation (Dörnyei & Usioda, 2021, p. 145). The research instrument aimed to measure demotivation factors that impede learning process and reduce learners' motivation which has been considered one of significant cognitive domains that influence language learners' success, as shown in Figure 1. The demotivation factors could be categorized into four groups, namely, 1) Learning contents and materials, 2) Teachers' competence and teaching styles, 3) Inadequate school facilities, 4) Lack of intrinsic motivation, and 5) Test scores.

To be specific, the five categories of demotivation factors stated in the questionnaire are associated with Dörnyei's nine categories of demotivation. That is, 1) Learning contents and materials refers to Dörnyei's (9) Course books used in class; 2) Teachers' competence and teaching styles refers to Dörnyei's (1) Teachers' personalities, commitments, competence, teaching methods; 3) Inadequate school facilities are in line with Dörnyei's (2) Inadequate school facilities; and 4) Lack of intrinsic motivation included Dörnyei's (3) Reduced self-confidence due to experience of failure, (4) Negative attitude toward foreign language studies, (5) Compulsory nature of foreign language study, (6) Interference of another foreign language that pupils are studying, (7) Negative attitude toward the community of the foreign language spoken, and (8) Attitudes of group members. Apart from the four categories of demotivation factors, Sakai and Kikuchi have added 'Test scores' as the last category of factors causing demotivation.

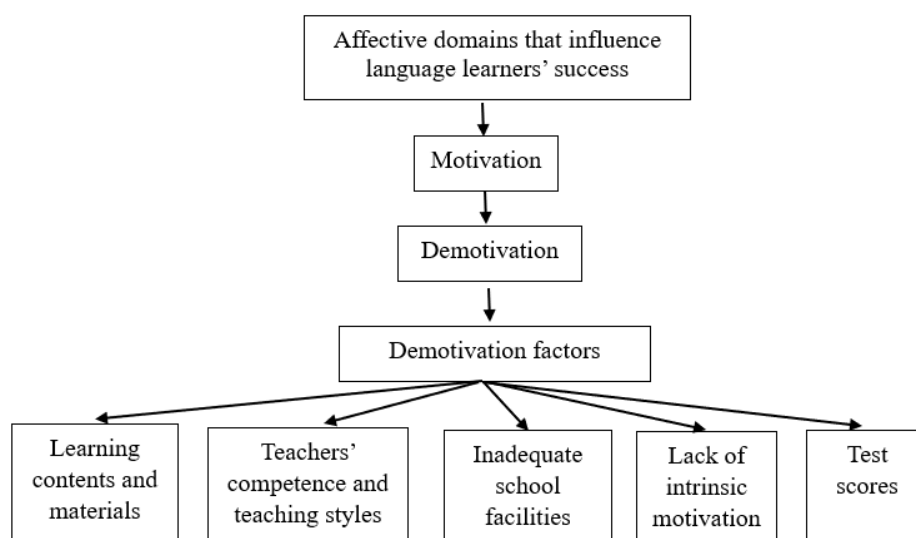


Figure 1: Conceptual framework of this study

The questionnaire consisted of two major parts. The first part involved the items asking about the respondents' background information, namely, gender, level of studies. Also, the second part included thirty-five rating-scale items requiring the respondents to identify their demotivation experience. The rating criteria were as follows:

5	refers to	Strongly agree
4	refers to	Agree
3	refers to	Moderate
2	refers to	Disagree
1	refers to	Strongly disagree



Data collection and data analysis

The data were collected in the second semester of Academic Year 2024. The hardcopy questionnaire which was in the Thai language was distributed to the participants. In terms of statistics, frequency and percentage, arithmetic mean, and standard deviation were employed to analyzed the data on the participants' demographic information about their gender and year of the studies, as well as those regarding the participants' perceptions of each range of the rating scale on that particular item.

IV. RESULTS

The results of the current study were presented into two main sections: 1) Participants' background information that includes Gender and Year of studies, and 2) Participants' perceptions toward demotivation factors in five categories, namely, (1) Learning contents and materials, (2) Teachers' competence and teaching styles, (3) Inadequate school facilities, (4) Lack of intrinsic motivation, and (5) Test scores.

Table 1: Participants' background information

Background information		Number of participants	Percentage
Gender	Male	31	32.60
	Female	64	67.40
Year of studies	Freshman	19	20
	Sophomore	34	35.80
	Junior	42	44.20
	Senior	0	0

The findings in the Table 1 indicated that of all the participants who completed questionnaire, 32.60% (31 participants) were male and 67.40% (64 participants) were female. The majority of participants were studying in the second year (sophomore) and third year (junior), with 35.80% (34 participants) and 44.20% (42 participants) respectively. However, none of the participants were from the fourth year (senior).

Table 2: Participants' perceptions toward demotivation factors

Factors		Perceptions toward demotivation factors presented in frequency (f) and percentage (%)									
Factor 1: Learning contents and materials		5		4		3		2		1	
		f	%	f	%	f	%	f	%	f	%
1	Most of the lessons focused on translation.	30	31.57	42	44.21	22	23.15	1	1.05	0	0.00
2	Most of the lessons focused on the grammars.	23	24.21	49	51.57	21	22.10	2	2.10	0	0.00
3	Most of the lessons were entrance examination oriented	39	41.05	36	37.89	16	16.84	4	4.21	0	0.00



Table 2: (Continued) Participants' perceptions toward demotivation factors

Factors		Perceptions toward demotivation factors presented in frequency (f) and percentage (%)									
Factor 1: Learning contents and materials		5		4		3		2		1	
		f	%	f	%	f	%	f	%	f	%
4	I was expected to use (or speak and write) grammatically correct English.	52	54.73	32	33.68	10	10.52	1	1.05	0	0.00
5	Topics of the English passages used in lessons were not interesting	45	47.36	33	34.73	16	16.84	1	1.05	0	0.00
6	English passages in the textbooks were too long.	28	29.47	23	24.21	34	35.78	7	7.36	3	3.15
7	English sentences dealt within the lessons were difficult to interpret.	18	18.14	24	25.26	28	29.47	21	22.10	4	4.21
8	A great number of textbooks and supplementary readers were assigned.	25	26.31	19	20.00	18	18.94	27	28.42	6	6.31
9	Topics of the English passages used in lessons were old.	33	34.73	27	28.42	25	26.31	6	6.31	4	4.21
10	English questions did not have clear answers.	12	12.63	17	17.89	28	29.47	28	29.47	10	10.52
11	The pace of lessons was not appropriate.	20	21.05	34	35.78	28	29.47	9	9.47	4	4.21
12	Teachers' pronunciation of English was poor.	16	16.84	37	38.94	30	31.57	8	8.42	4	4.21
13	Teachers ridiculed students' mistakes.	12	12.63	26	27.36	38	40.00	14	14.73	5	5.26
14	Teachers made one- way explanations too often.	17	17.89	25	26.31	31	32.63	17	17.89	5	5.26
15	Teachers' explanations were not easy to understand.	7	7.36	31	32.63	24	25.26	19	20.00	14	14.73



Table 2: (Continued) Participants' perceptions toward demotivation factors

Factors		Perceptions toward demotivation factors presented in frequency (f) and percentage (%)									
Factor 3: Inadequate school facilities		5		4		3		2		1	
16	Teachers shouted or got angry.	19	20.00	32	33.68	34	35.78	9	9.47	1	1.05
17	Computer equipment was not used.	6	6.31	33	34.73	39	41.05	14	14.73	3	3.15
18	Visual materials (such as videos and DVDs) were not used.	7	7.36	28	29.47	32	33.68	21	22.10	7	7.36
19	The Internet was not used.	8	8.42	27	28.42	36	37.89	15	15.78	9	9.47
20	LL equipment was not used.	16	16.84	19	20.00	32	33.68	22	23.15	6	6.31
21	Audio materials (such as CDs and tapes) were not used.	16	16.84	37	38.94	30	31.57	8	8.42	4	4.21
22	The number of students in classes was large.	12	12.63	26	27.36	38	40.00	14	14.73	5	5.26
23	I seldom had chances to communicate in English.	17	17.89	25	26.31	31	32.63	17	17.89	5	5.26
24	I was forced to memorize the sentences in the textbooks too often.	7	7.36	31	32.63	24	25.26	19	20.00	14	14.73
25	I had difficulty memorizing words and phrases.	19	20.00	32	33.68	34	35.78	9	9.47	1	1.05
26	I got lost in how to self-study for English lessons	6	6.31	33	34.73	39	41.05	14	14.73	3	3.15
27	I did not like my classmates.	7	7.36	28	29.47	32	33.68	21	22.10	7	5.26
28	My friends did not like English.	8	8.42	27	28.42	36	37.89	15	15.78	9	9.47
29	I was often compared with my friends.	16	16.84	19	20.00	32	33.68	22	23.15	6	6.31
30	English was a compulsory subject.	30	31.57	42	44.21	22	23.15	1	1.05	0	0.00



Table 2: (Continued) Participants' perceptions toward demotivation factors

Factors		Perceptions toward demotivation factors presented in frequency (f) and percentage (%)									
		5		4		3		2		1	
Factor 5: Test scores		f	%	f	%	f	%	f	%	f	%
31	I lost my understanding of the purpose of studying English.	24	25.26	38	40.00	30	31.57	3	3.15	0	0.00
32	I lost my interest in English.	10	10.52	37	38.94	33	34.73	13	13.68	2	2.10
33	I lost my goal to be a speaker of English.	18	18.94	24	25.26	28	29.47	21	22.10	4	4.21
34	I got low scores on tests (such as mid-term and final examinations).	20	21.05	34	35.78	28	29.47	9	9.97	4	4.21
35	I could not do as well on tests as my friends.	12	12.63	26	27.36	38	40.00	14	14.73	5	5.26

According to Table 2, 52 participants (54.73%) perceived Item 4 'I was expected to use (or speak and write), grammatically correct English.' as a factor that demotivated them the most all the factors included in Factor 1, Learning contents and materials. It was followed by, Item 5 'Topics of the English passages used in lessons were not interesting.', Item 3 'Most of the lessons were entrance examination-oriented.', Item 9 'Topics of the English passages used in lessons were old.', Item 1 'Most of the lessons focused on translation.', Item 6 'English passages in the textbooks were too long.', Item 8 'A great number of textbooks and supplementary readers were assigned.', Item 2 'Most of the lessons focused on the grammars.', Item 7 'English sentences dealt within the lessons were difficult to interpret.', and Item 10 'English questions did not have clear answers.', respectively.

As for Factor 2, Teachers' competence and teaching styles, the majority of the participants, 20 participants (21.05%) strongly agreed that Item 11 'The pace of lessons was not appropriate.' was the cause of demotivation. Besides, the remaining participants viewed Item 16 'Teachers shouted or got angry.', Item 14 'Teachers made one-way explanations too often.', Item 12 'Teachers' pronunciation of English was poor.', and Item 15 'Teachers' explanations were not easy to understand.', as demotivators, respectively.

When it came to Factor 3, Inadequate school facilities, Item 20 'LL equipment was not used.' (16.84%) and Item 21 'Audio materials (such as CDs and tapes) were not used.' (16.84%) were considered the most demotivating factors among 16 participants. The rest of the participants perceived Item 22 'The number of students in classes was large.', Item 19 'The Internet was not used.', Item 18 'Visual materials (such as videos and DVDs) were not used.', and Item 17 'Computer equipment was not used.' as causes of demotivation, respectively.



In terms of Factor 4, Lack of intrinsic motivation, most of the participants, 30 participants as 31.57%, thought that Item 30 'English was a compulsory subject.' as a factor of demotivation. This was followed by Item 31 'I lost my understanding of the purpose of studying English.', Item 25 'I had difficulty memorizing words and phrases.', Item 33 'I lost my goal to be a speaker of English.', Item 23 'I seldom had chances to communicate in English.', Item 29 'I was often compared with my friends.', Item 32 'I lost my interest in English.', Item 28 'My friends did not like English.', Item 27 'I did not like my classmates.' Item 24 'I was forced to memorize the sentences in the textbooks too often.', and Item 26 'I got lost in how to self-study for English lessons.', respectively.

With regard to Factor 5, Test scores, Item 34 'I got low scores on tests (such as mid-term and final examinations).' was viewed as a factor which most demotivated the participants (20 participants as 21.05%), whereas the rest considered Item 35 'I could not do as well on tests as my friends.' as a demotivator for the participants.

Overall, when considering all of the five factors, Item 5 'Topics of the English passages used in lessons were not interesting.' was the factor that most demotivated the participants. This was followed by Item 4, 'I was expected to use (or speak and write) grammatically correct English.' and Item 5, 'Topics of the English passages used in lessons were not interesting.', which ranked second and third among all demotivators, respectively.

V. CONCLUSION AND DISCUSSION

The objective of the present study was to examine demotivation factors among agriculture undergraduate students in the Thai context in the five aspects, namely, 1) Learning contents and materials, 2) Teachers' competence and teaching styles, 3) Lack of intrinsic motivation, 4) Inadequate school facilities, and 5) Test scores. The findings demonstrate that the factor that demotivated the students the most in each of the five aspects were: 1) expectation to use grammatically correct English, 2) inappropriate pace of lessons, 3) lack of use on language learning equipment and materials, 4) learners' attitudes on English as a compulsory course, and 5) learners' low test scores. The results can be discussed in the five aforementioned aspects.

With regard to Factor 1, Learning contents and materials, the findings reveal that most of the participants viewed Item 4 'I was expected to use (or speak and write), grammatically correct English.' as a cause that demotivated the most. The result was in accordance with what was discovered by Sakai and Kikuchi (2009, pp. 62-63). That is, in the present study, the factor 'I was expected to use (or speak and write), grammatically correct English.' was categorized as a factor concerning learning contents and materials, and such as factor was also found in the research conducted by Sakai and Kikuchi (2009, pp. 62-63) as the one which most highly demotivated the participants. The influence of grammar on students' grammar can be seen in another study undertaken by Mettadewi et al. (2023, p. 299). Based the results the research study, half of the Indonesian student participants felt demotivated when learning English Grammar. This can help explain why the expectation to use English language with correct grammar most highly demotivated the participants in the current study. When it came to Factor 2, Teachers' competence and teaching styles, Item 11 'The pace of lessons was not appropriate.' was perceived as the strongest demotivator for the participants. This corresponded with what De Asis et al. (2021, pp. 1689-1690) and Rone et al. (2023, p. 641) revealed. That is to say, teacher-oriented factors were external factors which were highly involved students' demotivation in their learning. Thus, the pace of lessons and the limited timeframe for learning hours caused by teaching styles could result in students' negative reinforcement. Regarding Factor 3, Inadequate school facilities, both Item 20 'LL equipment was not used.' and Item 21 'Audio materials (such as CDs and tapes) were not used.' were considered as the most



demotivating factors. As mentioned earlier, language learning equipment and audio materials were classified as a factor included in learning contents and materials. Thus, such a finding was in line with what Sakai and Kikuchi (2009) reported on. Besides, a study implemented in Pakistan by Puspitarini and Hanif (2019, p. 57) accordingly supports the crucial role of language learning equipment and materials. To illustrate, the results demonstrated by Puspitarini & Hanif shows that lack of interesting materials could lead students to be less engaged and motivated. This was because integrating effective materials, particularly the authentic ones, a language class could provide students more related, appealing, and motivating language learning (Lee, 2025, Using authentic materials section). As for Factor 4, Lack of intrinsic motivation, the majority of the participants agreed that Item 30 'English was a compulsory subject.' was the cause that most contributed to their demotivation. Such perceptions of participants on English as a compulsory course might reflect the lack of task value which was one of the important factors that demotivated students in a large extent (Zhou et al., 2023, pp. 5-6). That is to say, English as a compulsory course could not make them realize the value of those relevant English language tasks, and this reduced their learning motivation eventually. With reference to the findings concerning Factor 5, Test scores, most of the participants considered Item 34 'I got low scores on tests (such as mid-term and final examinations).' as a factor which most demotivated the participants. The finding helps confirm the impact of test scores on students' motivation, which coincided with research results portrayed by Adara et al. (2019, p. 221) and Bribesh (2024, pp. 71-72). According to the two research studies students' motivation was mostly demotivated by several factors, including their test scores that influenced students' overall learning behavior in both males and females. In general, Item 5 'Topics of the English passages used in lessons were not interesting.', from Factor 1, Learning contents and materials, was perceived as the most demotivating factor among all of 35 demotivators from the five main aspects. This highly supports the important part of a demotivated factor regarding learning contents and materials as shown in the research results revealed by Sakai and Kikuchi (2009, pp. 62-63). It also highlights the significance of such a factor as an external factor that can cause extrinsic motivation, which can be explained with the Self-determination Theory. According to the theory, extrinsic motivation is one main type of motivation that has effects on human's behavior (Ryan & Deci, 2017, p. 14). Consequently, when the learning contents are not interesting, and they are supposed to accomplish an academic task, they are facing external pressure which can demotivate them in the long run (Johansen et al., 2023, p. 2).

SUGGESTIONS

Due to the fact that this study focuses on investigating demotivation factors agriculture undergraduate students, further research could examine perceptions on demotivators from students with a variety of background, such as engineering students and science students, so that extensive knowledge of demotivating factors can be found. Furthermore, in order to extend understanding on demotivation, researchers can aim to explore the relationship between causes of demotivation and other psychological constructs such as learning motivation, self-efficacy, and self-regulation. Besides, given the fact that the key demotivation factors have been identified in this study, some recommendations can be made. First, English language lecturers can design a course that can foster students' motivation by placing an emphasis on both external and internal factors to increase both extrinsic and intrinsic motivation. With respect to the findings concerning the external factors, the special focuses should be placed on the learning contents, the pace of teaching and the language learning equipment and materials. As for intrinsic motivation, with regard to the negative attitudes of the students toward the status of



English as a compulsory course, lecturers should concentrate on the vital role of how learning English is meaningful for their further studies and future jobs. This is to encourage students' willingness to be engaged in class activities, which can increase their intrinsic motivation in the end. Second, regarding curriculum planners and policy makers, when designing or reforming a language curriculum both at a micro level and a macro level, key demotivators which were found in the present study along with those portrayed in related research should be highly taken into considerations. Taking the impact of demotivation factors on learners' success into account while creating and revising a language curriculum can lead to a more appealing, up to date, and effective language curriculum for the practitioners.

REFERENCES

- Adara, R. A., Nuryadi, N., & Nasution, R. A. (2019). Investigating the difference in demotivation Factors: A case study of two groups of Indonesian EFL learners. *Journal of English Language Studies*, 4(2), 212-225. <https://doi.org/10.30870/jels.v4i2.6228>.
- Ahmad, C. (2021). What makes our students demotivated in learning?. *Indonesian Journal of Educational Research and Technology*, 1(2), 51-56. <https://doi.org/10.17509/ijert.v1i2.3340>.
- Arcipe, V. L., & Balones, J. G. (2023). Exploring the impact of motivation on language Learning and student engagement. *Asian Journal of Education and Social Studies*, 46(3), 1-21. doi: 10.9734/ajess/2023/v46i31002.
- American Psychological Association. (2018). Motivation. *APA Dictionary of Psychology*. Retrieved November, 27, 2025, from <https://dictionary.apa.org/motivation>.
- Bandhu, D., Mohan, M. M., Nittala, N. A. P., Jadhav, P., Bhadauria, A., & Saxena, K. K. (2024). Theories of motivation: A comprehensive analysis of human behavior drivers. *Acta Psychologica*, 244, 1-16. <https://doi.org/10.1016/j.actpsy.2024.104177>.
- Bhanu., S. P., & Selvaraj, V. (2025). Improving English proficiency among agriculture students: An intervention using CLT and CLIL methods. *Journal of Science, Research and Teaching*, 4(1), 1-15.
- Bribesh, S. (2024). Demotivation factors in L2 learning: A case study of graduate students. *Journal of English Language Teaching and Applied Linguistics*, 6(1), 69-74. doi:10.32996/jeltal.
- De Asis, L. A., Romero, B. N., De Asis-Estigoy, K. M. A., & Piczon, V. A. (2021). Demonstrating factors causing demotivation in learning English as a second language in the University of Eastern Philippines: Basis for institutional teaching strategies. *International Journal of Trend in Scientific Research and Development (IJTSRD)*, 5(6).
- Dörnyei, Z., & Usioda, E. (2021). *Teaching and Researching Motivation*. (3rd Edition). Routledge. Retrieved January, 26, 2022, from <https://doi.org/10.4324/9781351006743>.
- Eccles, J. S., & Wigfield, A. (2020). From expectancy-value theory to situated expectancy value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary Educational Psychology*, 61, 101859. <https://doi.org/10.1016/j.cedpsych.2020.101859>.
- Gao, L., & Liu, H. (2022). Revisiting students' foreign language learning demotivation: From concepts to themes. *Frontiers in Psychology*, 13, 1-8. <https://doi.org/10.3389/fpsyg.2022.1030634>.



- Gardner, R. C., & Lambert, W. E. (1972). *Attitudes and motivation in second language learning*. Rowley, MA: Newbury House.
- Gorham, J., & Christophel, D. M. (1992). Students' perceptions of teacher behaviors as motivating and demotivating factors in college classes. *Commun. Q.*, 40, 239–252. doi: 10.1080/01463379209369839.
- Gottfried, A. E., Fleming, J. S., & Gottfried, A. W. (2001). Continuity of academic intrinsic motivation from childhood through late adolescence: A longitudinal study. *Journal of Educational Psychology*, 93(1), 3–13. <https://doi.org/10.1037/0022-0663.93.1.3>.
- Huwari, I. F., Alhammaideh, A. H. J., Alqaryouti, M. H., Rashid, R. A., Alruzzi, K. A., & Sadeq, A. E. (2023). Demotivation factors for learning English (students' perspectives). *Journal of Language Teaching and Research*, 14(4), 1023–1030. doi: <https://doi.org/10.17507/jltr.1404.2>.
- Injan, A. (2024, November, 26). *Needs Analysis of English Skills Development for Agripreneur of Thai Students in Higher Education*. [Conference presentation]. The Asian Conference on Education 2024, Tokyo, Japan. https://papers.iafor.org/wp-content/uploads/papers/ace2024/ACE2024_85353.pdf?t=8.
- Johansen, M. O., Eliassen, S., & Jeno, L. M. (2023). Why is this relevant for me?": Increasing content relevance enhances student motivation and vitality. *Front. Psychol.*, 14, 1–12. <https://doi.org/10.3389/fpsyg.2023.1184804>.
- Kimly, C., Hoeun, S., Roeun, S., Ron, S., & Khann, S. (2024). Factors Affecting Learners' Motivation in English Language Education. *Journal of Language and Linguistics in Society*, 4(45), 45–58. DOI: 10.55529/jlls.45.45.58.
- Junfeng, Z. (2025). Learning Motivation. *The ECPH Encyclopedia of Psychology*. Retrieved August, 15, 2025, from https://link.springer.com/rwe/10.1007/978-981-97-7874-4_1111.
- Lee, S. (2025, June 17). *Motivating English language learners*. Number Analytics. <https://www.numberanalytics.com/blog/motivation-techniques-for-english-language-learners>.
- Liu, S., & Sun, H. (2025). The relationship between learning motivation and English achievement among undergraduate non-English majors in China: The mediating role of self-efficacy and learning strategies. *Sage Open*, October-December, 1–15. <https://doi.org/10.1177/215824402513881>.
- Mettadewi, B., Sitohang, M., & Sutrisno, B. (2023). Exploring factors that cause the students demotivation in learning English grammar and English writing STIBA IEC students during Covid-19 pandemic. *JELL (Journal of English Language and literature)*, 8(2), 291–304. doi: 10.37110/jell.v8i1.193.
- Mohd, W, N. H. W., Rahman, M. A., Rick, A.M., & Mokhtar, R. (2024). Motivating and demotivating factors in learning: How do they relate to each other?. *International Journal of Academic Research in Business and Social Sciences*, 14, 568–584. doi:10.6007/IJARBSS/v14-i1/18497.
- Office of Registrar of KMITL. (2024, May 10). *Data of undergraduate students*. KMITL Registration and Educational Service Office. https://regis.reg.kmitl.ac.th/#/statistic_split_curr.
- Pekrun, R. (2024). Control-Value Theory: From Achievement Emotion to a General Theory of Human Emotions. *Educational Psychology Review*, 36(3), 83. <https://doi.org/10.1007/s10648-024-09909-7>.
- Psychological Scales. (n.d.). Demotivation. *Encyclopedia of Psychology*. Retrieved September, 12, 2025, from <https://encyclopedia.arabpsychology.com/demotivation/>.



- Puspitarini, Y. D., & Hanif, M. (2019). Using learning media to increase learning motivation in elementary school. *Anatolian Journal of Education*, 4(2), 53-60. <https://doi.org/10.29333/aje.2019.426a>.
- Rone, N. A., Guao, N. A. A., Jariol Jr., M. S., Acedillo, N. B., Balinton, K. R., & Francisco, J. O. (2023). Students' lack of interest, motivation in learning, and classroom participation: How to motivate them?. *Psych Educ*, 7, 636-645. doi: 10.5281/zenodo.7749977.
- Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory - Basic psychological needs in motivation, development and wellness*. The Guilford.
- Sakai, H., & Kikuchi, K. (2009). An analysis of demotivators in the EFL classroom. *System*, 37(1), 57-69.
- Sanico, J. J., Convicto, L. A., Victoriano, H. A., & Escandallo, J. C. (2025). A needs analysis on the English language needs among agriculture students: Basis for curriculum development. *EPRA International Journal of Multidisciplinary Research (IJMR)*, 11(6), 1127-1138. doi: 10.36713/epra22576.
- Schrader, F. W., & Helmke, A. (2015). School achievement: motivational determinants and processes. *International Encyclopedia of the Social & Behavioral Science*, 21, 48-54.
- Schunk, D. H., Meece, J. L., & Pintrich, P. R. (2014). *Motivation in education: Theory, research, and applications* (4th ed.). Pearson.
- Yamane, T. (1967). *Statistics: An Introductory Analysis* (2nd ed.). New York: Harper and Row.
- Zhou, W., Zhan, Y., & Jawing, E. (2023). Analyzing EFL learners' demotivating factors in blended learning context. *Frontiers in Psychology*, 14, 1-9, <https://doi.org/10.3389/fpsyg.2023.1290034>.
- Zolkapli, R. B. M., Kenali, S. F. M., Hadi, N. F. A., Basiron, M. K., Iqbal, M., Latif, M. N. L. A., & Rahmat, N. H. (2023). Exploring Motivation and Demotivation Factors for Learning Communication Skills. *International Journal of Academic Research in Business & Social Sciences*, 13(7), 1501-1520. <http://dx.doi.org/10.6007/IJARBSS/v13-i7/17871>.

The content, as well as the use of lan gauge in the article, is the responsibility of the author.



Pornpat Phusittananan^{1*}, Sataporn Deeying¹, and Aungkana Koolnapadol²
65027260003@mail.rru.ac.th*, sataporn.deeying@gmail.com, and aungkana.kool@gmail.com

¹Faculty of Science and Technology, Rajabhat Rajanagarindra University,
Chachoengsao 24000 Thailand

²Faculty of Education, Rajabhat Rajanagarindra University, Chachoengsao 24000 Thailand

*Corresponding author E-mail: 65027260003@mail.rru.ac.th

Received: March 16, 2026 **Revised:** May 10, 2026 **Accepted:** June 24, 2026

Citation reference:

Phusittananan, P., Deeying, S., & Koolnapadol, A. (2026). Development of The Double P-CE Model Integrated with Context-Based Learning to Enhance Critical Thinking For 11th Grade Students. **International Journal of Industrial Education and Technology**, 8(1), 69-81.

 ABSTRACT

This study aimed to: 1) develop a learning facilitation model to enhance critical thinking integrated with context-based learning, 2) compare the learning achievement and critical thinking of the experimental group and control group after using the learning facilitation model, 3) study the students' satisfaction of the experimental group toward the learning facilitation model. The participants consisted of students in Matthayom 5/3 as the experimental group and students in Matthayom 5/4 as the control group from Watsothonwararamworawiharn School. The research methodology followed a Research and Development. The findings indicated that: 1) The learning facilitation model consisted of four components: the principles of the model, the objectives of the model, the learning facilitation process, which consisted of four steps (Double P-CE model): Step 1: Preparation (P), Step 2: Process (P), Step 3: Conclusion (C), Step 4: Evaluation (E) and the model's measurement and evaluation methods. and the overall appropriateness of the model was rated at the highest level ($\bar{x} = 4.92$, $SD = 0.15$). 2) The findings from the comparison of posttest learning achievement and critical thinking between the experimental and control groups indicated that the post-test learning achievement of the experimental group, which received the Double P-CE model, was significantly higher than that of the control group, which received traditional teaching, at the .05 level. 3) The experimental group students' satisfaction with the Double P-CE model designed to develop critical thinking, was at a high level.

Keywords: Double P-CE model, Critical thinking, Context-based learning, Learning achievement

I. INTRODUCTION

The 21st century is the time of digital revolution and transformation to 4.0 industry. Hence, National Education Plan aims to develop all learners to possess desired characteristics and learning skills of the 21st century (3Rs8Cs). This is particularly on critical thinking that learners should have. At present, most students lack of a critical thinking process and the National Educational Testing indicate that students at Watsothonwararamworawihan School have average science scores below provincial and national benchmarks. This performance gap suggests limitations in students' analytical reasoning and critical thinking processes. To address the evolving demands of 21st century education and the Industry 4.0 era, instructional practices must transition from passive content transmission to active, inquiry-driven, and contextually meaningful learning environments.

As a result, Office of the Basic Education Commission has determined a learning facilitation policy on active learning and collaborative work to enhance critical thinking. The said learning gains the concept of constructivist or self-body of knowledge building which emphasize on self-knowledge creating through actual practice and critical thinking. This conforms to some researchers applying the constructivist theory to learning design. Zandvakili et al. (2019, pp. 1-13) conducted a study on teaching patterns of critical thinking: The 3CA model-concept maps, critical thinking, collaboration, and assessment. It was found that the 3CA model could make learners' critical thinking processes more explicit and concrete, and that these skills could be systematically developed through structured practice. In particular, the use of WH-questions (what, when, where, how, who, and why) was found to stimulate deeper levels of critical thinking. In collaborative learning contexts, students tended to use higher-order analytical and explanatory questions such as "why" and "how" more frequently, whereas students in individual learning settings were more likely to focus on basic level questions such as "what". This conforms to a study of Indah et al. (2023, pp. 218-221) on integrated learning model (GIRQA) to enhance cognition and critical thinking of science students. The integration of GI or group investigation with RQA which consists of reading, questioning and answering called GIRQA. This learning model is designed for Science learning facilitation of students through 10 steps. It comprises: (1) topic indication, (2) investigation planning, (3) reading, (4) questioning, (5) answering, (6) work presenting, (7) investigation, (8) preparing the presentation of the investigation results, (9) presenting the results, and (10) assessment. These activities help the students understand scientific concepts and gain scientific experience with positive attitudes towards learning and critical thinking. The findings indicate that the learning facilitation model developed based on constructivist theory contributed to the enhancement of learners' self-body of knowledge building, which subsequently fostered the development of critical thinking ability.

Context-based learning helps promote students connect acquired knowledge with daily life or current situations (Gilbert 2006, p. 960). It focuses on learning which relies on the integration of scientific context with appropriate situations. This will allow learners to gain knowledge and skills for application at the same time. Actually, learners can learn under actual social or conditions and situations. Dori et al. (2018, p. 1198) conducted a study on context-based learning and metacognitive prompts for enhancing scientific text comprehension. Results of the study revealed that high-intensity CBL combined with metacognitive prompts improved students' chemistry understanding of the adapted scientific articles and the ability to regulate their learning. This conforms to a study of Dehkordi (2021, p. 426) on a comparison of learning by using basic context and normal teaching to investigate intellectual domain (cognitive)/psychomotor domain skills and critical thinking of undergraduate nursing students. It was found that the students using CBL for learning had a higher score of cognitive domains than before. This was in terms of an increase in knowledge, understanding, application, analysis, synthesis, and evaluation. Additionally, they achieved higher scores in both the psychomotor and affective domains. The psychomotor domain reflected improved performance skills, while the affective domain



encompassed respect, awareness, self-assessment, communicative skills, responsibility, critical thinking, and increased learning motivation. The aforementioned studies reflect that context-based learning, in which students learn through authentic experiences, can effectively enhance both knowledge acquisition and critical thinking skills. Thus, the constructivist is used to integrate with context-based learning in physical science course content to develop students' critical thinking skills.

Based on the theoretical foundations and empirical evidence discussed above, this study aimed to develop a constructivist-based learning facilitation model integrated with context-based learning to enhance critical thinking among Matthayomsuksa 5 students. In addition, the study sought to examine the effectiveness of the proposed model by comparing students' learning achievement and critical thinking between the experimental and control groups. Furthermore, the study investigated students' satisfaction with the learning facilitation model in order to determine its overall instructional effectiveness and suitability for implementation in Physical Science subject.

II. LITERATURE REVIEW

Constructivist theory is fundamentally grounded in the cognitive developmental theories of Piaget and Vygotsky (Chand, 2024, p. 276). It can be broadly categorized into two major perspectives: 1) cognitive constructivism and 2) social constructivism. Cognitive constructivism, primarily associated with Piaget, posits that intellectual development progresses through sequential stages as individuals interact with their natural environment. Knowledge is constructed through active engagement, logical-mathematical experiences, social transmission, maturation, and the process of equilibration. Learners build mental structures by assimilating new experiences into existing schemas and accommodating those schemas when confronted with cognitive conflict. In contrast, social constructivism, influenced by Vygotsky, emphasizes the fundamental role of social interaction and cultural context in cognitive development. From birth, individuals are shaped by their social environment, particularly the family as the primary institution influencing early intellectual growth. Language serves as a crucial psychological tool that mediates higher-order thinking and cognitive development. Through social interaction and guided participation, learners internalize knowledge and cognitive strategies. Synthesizing both perspectives, several shared principles emerge: (1) Learners actively construct their own understanding. (2) New learning depends on prior knowledge and existing cognitive structures. (3) Social interaction plays a significant role in knowledge construction. (4) Learning activities should be meaningful and connected to real-life contexts. Therefore, applying constructivist theory in educational practice requires shifting instructional goals from knowledge transmission to facilitating active knowledge construction. Learning should emphasize authentic problem solving, transferable skills, and alignment with students' interests to ensure meaningful understanding. Supporting this perspective, Siregar et al. (2025, pp. 16-17) conducted a study entitled development of constructivism-based learning models to improve student learning outcomes with the aim of developing and evaluating a constructivism-based learning model that emphasizes learners' active construction of knowledge through meaningful experiences and interactions with their environment. The model engaged students in authentic learning activities designed to promote active participation in the learning process. The findings revealed that students achieved higher learning outcomes in terms of knowledge acquisition and demonstrated critical thinking, creativity, and effective problem-solving skills. Similarly, Bunyodom et al. (2023, pp. 489-493) investigated the effect of learning management based on constructivist theory using hand-on activities of grade 6 students' geometrical concepts on triangle. The synthesized instructional model consisted of four stages: (1) Reviewing prior knowledge, (2) Conceptual change, (3) Understanding check, and (4) Knowledge application. The findings revealed that students' geometric conceptual understanding after being taught through constructivist theory using hands-on activities were higher than 60% of the criterion



at the .05 level of significance. Furthermore, the findings are supported by the study conducted by Rullis and Fauzan (2021, pp. 3-4) examined the development of constructivism-based mathematics interactive learning media tools on the material of constructing a flat side space for class VIII junior high school students. This developmental research employed a Problem-Based Learning model (PBL) and was conducted in three phases: preliminary research, prototype development, and evaluation. The results indicated that integrating PBL with constructivist-oriented interactive media was highly appropriate. The developed materials featured clear language and well-designed text, facilitating students' comprehension and enhancing their understanding of mathematical content effectively.

Furthermore, context-based learning (CBL) is an instructional approach that encourages learners to connect newly constructed knowledge with real-life situations or social contexts in relation to scientific content. This approach emphasizes the integration of subject matter with relevant and meaningful situations, thereby fostering learners' independent thinking processes. Various scholars have proposed procedural frameworks for implementing context-based learning; in this study, the researcher adopted the four-stage model proposed by Gilbert (2006, pp. 961-975), which consists of: (1) Situation setting, (2) Investigation or hands-on inquiry, (3) Presentation of findings derived from the inquiry, and (4) Discussion and application of knowledge. Empirical studies have supported the effectiveness of this instructional approach. For example, Rubini and Ardianto (2021, pp. 304-307) conducted a study entitled empowering contextual approach in science learning to enhance critical thinking skills. The findings indicated that the implementation of context-based learning has the potential to enhance students' critical thinking skills, with the improvement observed among students in all three classes being at a moderate level. Some developed critical thinking skills were providing simple explanations, building basic skills, managing strategies and tactics, providing further explanation, and formulating solutions. Similarly, Yulaisa and Desnita (2024, pp. 391-395) examined the effect of using context-based learning videos on fluid materials on students critical thinking ability. The results revealed that students in the experimental group demonstrated significantly higher levels of critical thinking skills than those in the control group. Based on the review of constructivist theory and context-based learning, it can be concluded that the effectiveness of constructivist-oriented instruction depends largely on how individual educators adapt and implement these theoretical principles in their specific teaching contexts. The synthesis indicates that both constructivist theory and context-based learning contribute to learners' ability to construct knowledge independently through hands-on activities, analytical thinking, and social interaction. In addition, linking learning content with contemporary situations or contexts enables learners to approach problem-solving in a systematic and comprehensive manner, thereby fostering the development of critical thinking skills. Previous studies also highlight the development of instructional models designed by educators to address specific learning objectives using a single theoretical framework. Therefore, the researcher proposes integrating both approaches into a structured, clear, and continuous learning process. Each stage of the Double P-CE model is designed to explicitly stimulate critical thinking processes in order to enhance learners' learning development effectively. Accordingly, the Double P-CE model was developed by integrating Gilbert's context-based learning framework (Gilbert, 2006, pp. 961-975).

III. RESEARCH METHODOLOGY

Conceptual Framework

According to the research, concepts and theory as mentioned, the researcher designed the learning facilitation process into four steps: 1) Preparation (P), 2) Process (P), 3) Conclusion (C), and 4) Evaluation (E) as shown in conceptual Framework of this study. (Figure 1)



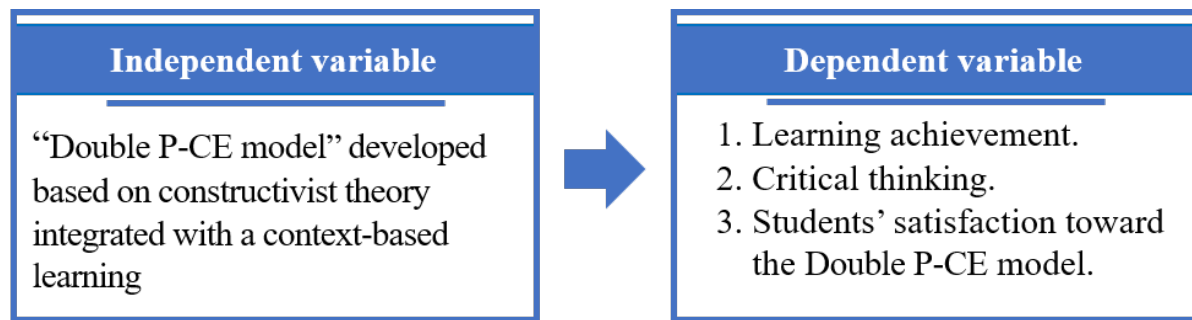


Figure 1: Conceptual framework

Population and samples

1. The population consisted of 200 Mattayomsuksa 5 students at Watsothonwararamworawihan school, Chachoengsao province (5 classrooms), academic year 2025 and 5 chemistry teachers.
2. The sample group consisted of 80 Mattayomsuksa 5 students (2 classrooms), academic year 2025. They were divided into 2 groups: the experimental group and the control group. They were obtained by purposive sampling based on their interest and ability in learning.

Research instrument

The research instruments included:

1. An interview schedule for science teachers.
2. A learning facilitation model and lesson plans based on the Double P-CE model (12 hours).
3. A 30 item multiple choice learning achievement test covering the unit “Food and Packaging” constructed according to Bloom’s revised taxonomy (remember, understand, apply, analyze, evaluate, and create).
4. A critical thinking test consisting of six subjective items assessed using analytic rubric scoring, covering five components derived through synthesis: problem identification, data collection, analysis, conclusion, and evaluation.
5. A satisfaction questionnaire using a five-point Likert scale covering six dimensions: content, model components, objectives, learning activities, assessment, and learner outcomes.

Validity and Reliability of Instruments

All instruments were examined for content validity by five experts using the Index of Item Objective Congruence (IOC), following standard procedures in educational research. The IOC values ranged from 0.60 to 1.00, indicating acceptable content validity.

The learning achievement test demonstrated acceptable item difficulty (0.45-0.75) and discrimination indices (0.20-0.35). The reliability of the learning achievement test was examined using KR-20 coefficient, yielding a value of 0.89, which indicates high internal consistency reliability. The critical thinking test and satisfaction questionnaire also demonstrated acceptable validity and reliability indices.

Research procedure

Phase 1: Research (R1)

Basic data were collected through document analysis and semi-structured interviews with five science teachers. The curriculum analysis was based on the Basic Education Core Curriculum B.E. 2008 (Revised 2017). Interview data were analyzed and synthesized to determine guidelines for model development using a context-based approach.

Phase 2: Development and Design (D1)

The Double P-CE learning model was designed based on constructivist theory, context-based learning, and critical thinking principles. The development process followed systematic R&D procedures including prototype design, expert validation, and refinement. The model comprised four key components: (1) principles, (2) objectives, (3) learning facilitation process, and (4) measurement and evaluation.

The learning facilitation process followed four stages: Preparation (P), Process (P), Conclusion (C), and Evaluation (E). The lesson plans were developed for 12 hours under Unit 3: Food and Packaging. The overall suitability of the model was rated at the highest level ($\bar{x} = 4.93\text{--}5.00$), which followed the learning facilitation process as shown in Figure 2.

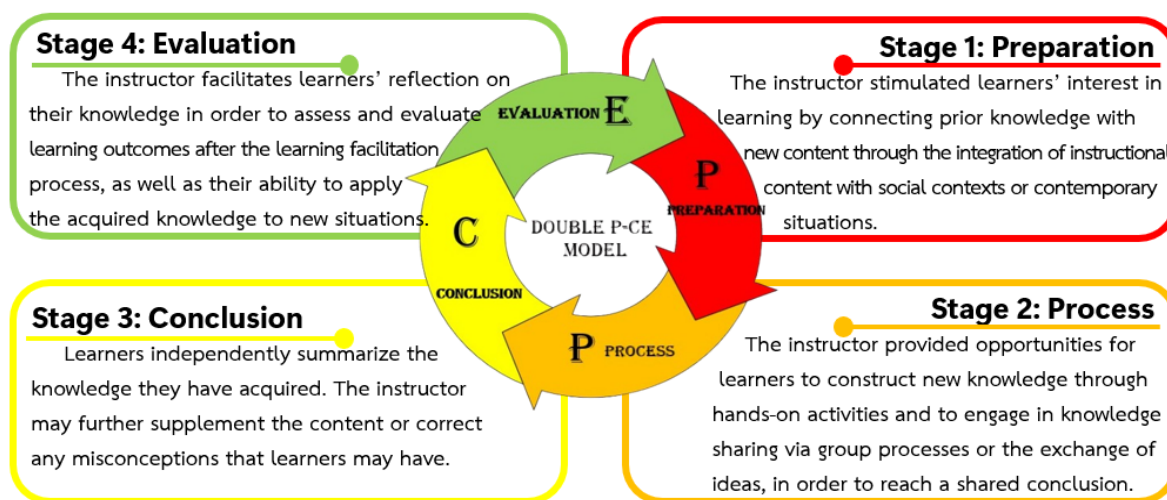


Figure 2: The Double P-CE model

Phase 3: Implementation

The effectiveness of the model was tested using a pretest-posttest control group design (Klockars, 1992, pp. 96-98).

Table 1: Research design

Group	Before	Experiment	After
E	T ₁	X	T ₂
C	T ₁	~X	T ₂

Symbols used in the research format

- E = The experimental group
- C = The control group
- T₁ = Pretest
- T₂ = Posttest
- X = Double P-CE Model
- ~X = Traditional teaching

Both groups completed the learning achievement and critical thinking tests before and after the intervention. The experimental group received the Double P-CE learning model, while the control group received the traditional teaching.

Phase 4: Evaluation (D2)

Quantitative data were analyzed using descriptive and inferential statistics in accordance with educational research principles. Mean ($\bar{x}$) and standard deviation (SD) were used to summarize data. independent samples t-tests were used to compare posttest scores between groups. Students' satisfaction was analyzed using mean and standard deviation. A mean score higher than 3.50 indicated a high level of satisfaction shown in Figure 3.

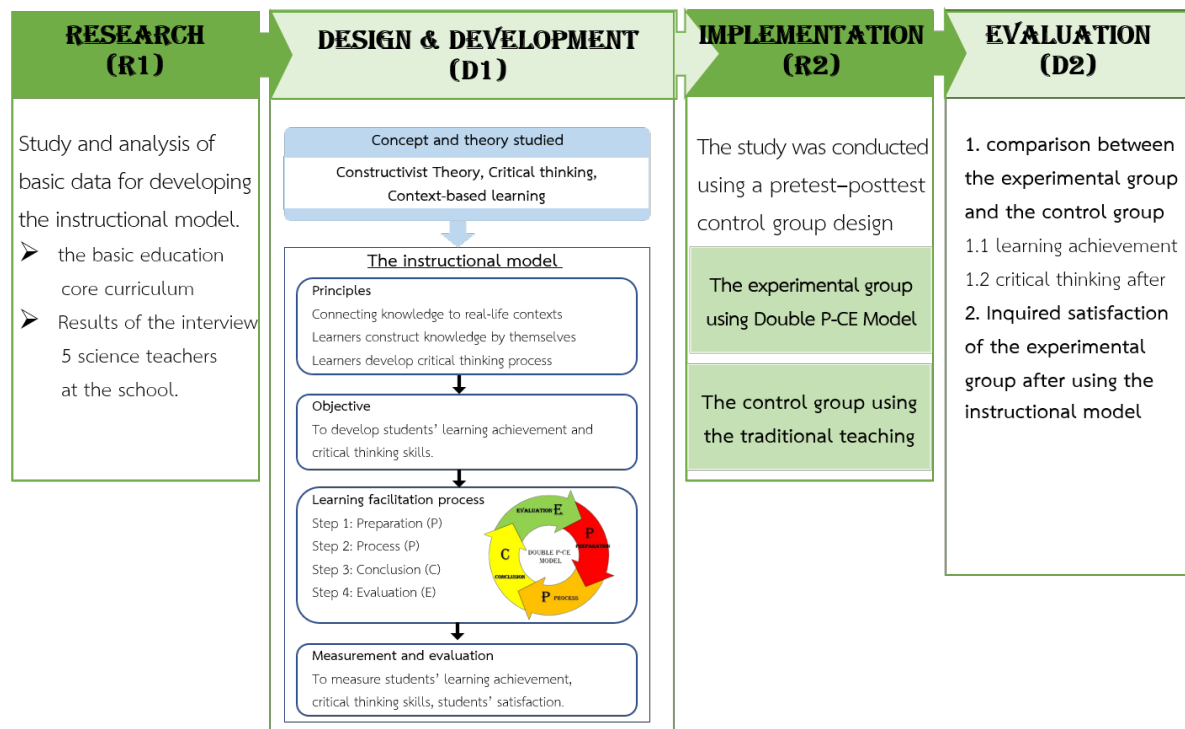


Figure 3: Research procedure

Data Analysis

The researcher analysed various data by using the statistical package as follows: 1) Basic statistics: mean ($\bar{x}$) and standard deviation (SD), 2) Hypothesis testing statistics comparing pretest and posttest learning achievement and critical thinking between the experimental group and the control group by using t-test independent.

IV. RESULTS

Results of the analysis of the development of the Double P-CE model to enhance critical thinking through context-based learning in this study are as follows;

1. Results of the appropriateness assessment of the learning facilitation model was as shown in Table 2.

Table 2: Results of the appropriateness assessment of the learning facilitation model

Items	$\bar{x}$	SD	Description
1. Principles	4.40	0.89	High
2. Objectives	5.00	0.00	Highest
3. Learning facilitation process	5.00	0.00	Highest
4. Measurement and evaluation	4.80	0.20	Highest
Total	4.92	0.15	Highest

Legend: 4.51-5.00 Highest, 3.51-4.50 High, 2.51-3.50 Moderate, 1.51-2.50 Low, 1.00-1.50 Lowest.

As shown in Table 2, the overall suitability of the learning facilitation model was rated at the highest level ($\bar{x} = 4.92$, $SD = 0.15$). The objectives and learning facilitation process received the highest mean scores ($\bar{x} = 5.00$), indicating strong alignment with the intended outcomes. The measurement and evaluation component was also rated at the highest level ($\bar{x} = 4.80$), while the principles component was rated at a high level ($\bar{x} = 4.40$). Overall, the findings indicate that the constructivist context-based learning facilitation model is theoretically sound and practically appropriate for enhancing students' critical thinking in Physical Science.

2. Results of the comparison of the learning achievement and critical thinking of experimental group using the learning facilitation model and the control groups using the traditional teaching in terms of pretest and posttest was as shown in Table 3-6.

Table 3: Comparison of learning achievement between the experimental group before using the learning facilitation model and the control group before using the traditional teaching

Group	Experiment	n	$\bar{x}$	SD	t	df	p
Experimental group	before	40	10.15	2.82	-1.39	78	.17
Control group	before	40	10.90	1.93			

$p > .05$

As shown in Table 3, the learning achievement of the experimental and control groups were not significantly different, indicating that students in both groups had comparable learning abilities. This similarity is attributed to the heterogeneous grouping of students in both classes. The equivalence of the experimental groups is considered an essential condition for ensuring a sound and valid experimental research design.

Table 4: Comparison of critical thinking ability between the experimental group before using the learning facilitation model and the control group before using the traditional teaching

Group	Experiment	n	$\bar{x}$	SD	t	df	p
Experimental group	before	40	59.35	2.78	-1.08	78	.28
Control group	before	40	58.70	2.60			

$p > .05$

As shown in Table 4, the critical thinking ability of the experimental and control groups were not significantly different, indicating that students in both groups had comparable levels of critical thinking. This similarity is attributed to the heterogeneous grouping of students in both classes. The equivalence of the experimental groups is considered an essential condition for ensuring a sound and valid experimental research design.

Table 5: Comparison of learning achievement between the experimental group after using the learning facilitation model and the control group after using the traditional teaching

Group	Experiment	n	$\bar{x}$	SD	t	df	p
Experimental group	After	40	22.83	1.82	5.56*	65.93	.000
Control group	After	40	19.83	2.89			

* $p < .05$

As shown in Table 5, the learning achievement of the experimental group after the intervention ($\bar{x} = 22.83$, $SD = 1.82$) was significantly higher than that of the control group ($\bar{x} = 19.83$, $SD = 2.89$) at the .05 level ($t = 5.56$, $p < .05$). This finding indicates that the learning facilitation model facilitated students' systematic construction of knowledge in connection with real-life contexts, thereby promoting a deeper understanding of the content compared to traditional teaching.

Table 6: Comparison of critical thinking ability between the experimental group after using the learning facilitation model and the control group after using the traditional teaching

Group	Experiment	n	$\bar{x}$	SD	t	df	p
Experimental group	After	40	96.83	4.71	11.17*	78	.000
Control group	After	40	86.23	3.71			

* $p < .05$

As shown in Table 6, the critical thinking ability of the experimental group after the intervention ($\bar{x} = 96.83$, $SD = 4.71$) was significantly higher than that of the control group ($\bar{x} = 86.23$, $SD = 3.71$) at the .05 level ($t = 11.17$, $p < .05$). This finding indicates that the learning facilitation model encouraged students to analyze, discuss, exchange ideas, and systematically connect knowledge with various situations. Consequently, students were able to apply reasoning in making judgments, decisions, and solving problems, thereby enhancing their critical thinking ability more effectively than traditional teaching.

3. Results of the survey on student satisfaction with the learning facilitation model

Table 7: Results of student satisfaction toward the learning facilitation model

Items	$\bar{x}$	SD	Description
Content and learning content			
1. The content is consistent with daily life and social context of the student.	4.49	0.50	High
2. The course content is clear and easy to understand.	4.51	0.50	Highest
3. The content is up-to-date.	4.46	0.53	High
4. The content is consistent with daily life and suitable for critical thinking practice.	4.46	0.53	High
Total	4.48	0.52	High
Components of the learning facilitation model			
5. The principles help the student develop critical thinking and systematic problem solving.	4.55	0.50	Highest
6. The principles involve daily life and context of the student.	4.48	0.66	High
7. The principles are easy to understand.	4.53	0.50	Highest
Total	4.52	0.55	Highest
Objectives of the learning facilitation model			
8. It focuses of enhancing the ability in critical thinking of the student.	4.48	0.59	High
9. It is clear and can be evaluated.	4.48	0.55	High
10. It is clear and can be applied in daily life.	4.45	0.61	High
Total	4.47	0.58	High
Learning activities			
11. It is appropriate and consistent with content in the society	4.44	0.57	High
12. It truly gives an opportunity to practice critical thinking.	4.36	0.56	High
13. It promotes the process of high-level thinking and problem solving.	4.50	0.50	High
14. It promotes the creation of body of knowledge which can be applied.	4.45	0.50	High
15. It gives the student an opportunity to reflect critical thinking through actual practice with suggestions of the teacher.	4.45	0.55	High
16. It is in line with scheduled time.	4.41	0.54	High
Total	4.44	0.57	High

Table 7: (Continued) Results of student satisfaction toward the learning facilitation model

Items	$\bar{x}$	SD	Description
Measurement and evaluation			
17. Having evaluation criteria for appropriate learning facilitation.	4.51	0.53	Highest
18. Measurement and evaluation are clear.	4.48	0.53	High
19. Results of the evaluation can promote the student to improve their learning.	4.39	0.56	High
Total	4.46	0.54	High
Outcomes for the learner			
20. Direct outcomes for the student are clear in accordance with The learning objectives.	4.40	0.54	High
21. Indirect outcomes for the student are clear and can further develop.	4.35	0.60	High
Total	4.38	0.57	High
As a whole	4.46	0.55	High

Legend: 4.51-5.00 Highest, 3.51-4.50 High, 2.51-3.50 Moderate, 1.51-2.50 Low, 1.00-1.50 Lowest.

As shown in Table 7, students' overall satisfaction with the learning facilitation model was at a high level ($\bar{x} = 4.46$, $SD = 0.55$). The highest ratings were found that components of the learning facilitation model ($\bar{x} = 4.52$) which contributes to the development of critical thinking. All other components, including learning activities, objectives, content, measurement/evaluation and learner outcomes, were also rated at a high level. These findings indicate that students perceived the learning facilitation model as appropriate, relevant, and supportive of their critical thinking development.

V. CONCLUSION AND DISCUSSION

In conclusion, the core findings of this research demonstrate that the learning facilitation model developed to enhance critical thinking is called Double P-CE Model, which consists of four steps as follows: Step 1 Preparation (P), Step 2 Process (P), Step 3 Conclusion (C), and Step 4 Evaluation (E). The developed learning facilitation model was evaluated as being appropriate at the highest level ($\bar{x} = 4.92$, $SD = 0.15$). The model was then implemented with the experimental group and compared with a control group using the traditional teaching. The experimental and control groups showed no statistically significant differences in learning achievement and critical thinking in terms of pretest, as students in both groups possessed comparable baseline abilities, the inclusion of pretest data enhanced the reliability and internal validity of the experimental study. Consequently, any differences observed in the posttest outcomes could be more confidently attributed to the instructional innovation rather than to pre-existing differences among the participants (Schochet, 2010, pp. 379-406). The results revealed that the experimental group achieved significantly higher posttest learning achievement than the control group at the .05 level of significance (the posttest mean of the experimental group was 22.83 and the control group was 19.83). In addition, the posttest critical thinking of the experimental group were significantly higher than those of the control group at the .05 level of significance (the posttest mean of the experimental group was 96.83 and the control group was 86.23). Furthermore, an investigation of students' satisfaction with the Double P-CE model indicated that the experimental group reported a high level of satisfaction in all aspects.

The results can be discussed as follows: There are 4 components of the learning facilitation model for developing critical thinking: (1) principles, (2) objectives, (3) learning facilitation process, and (4) measurement and evaluation. Hence, it can be that all of these components are consistent and systematically related. According to this study, the researchers begin with the investigation of related concepts, theories, researches and social context conditions. Also, guidelines for problem solving and content selection are involved to determine the principles, objectives and others which must be consistent and systematically related. The developed learning facilitation



model is based on constructivist theory and critical thinking concept integrated with context-based learning. They are synthesized to obtain the instructional model “Double P-CE Model” with 4 steps as follows: Step 1: Preparation (P). This step creates interest of the student in learning. There is the connection of existing knowledge with new knowledge. Meanwhile, the teacher integrates this step with the content. In addition, this stage corresponds to the situation definition stage and the critical thinking process of problem definition. Step 2: Process (P). This step gives the student an opportunity to truly practice in order to create new knowledge. Then, there is knowledge exchange using group process or opinion presentation to gain the same conclusion. In this regard, it is supported or assisted by the teacher in terms of knowledge enhancement and convenience facilitation. Actually, this step corresponds to the step of actual practice of the student, critical thinking process in data collection and analysis. Step 3: Conclusion (C). The student makes conclusion about what they have learned. The teacher may add knowledge or correct the student’s misunderstandings. This step corresponds to the step of learning key concepts and critical thinking based on conclusion. Step 4: Evaluation (E). This step reflects knowledge of the student to measure and evaluate themselves after learning and are able to apply acquired knowledge to new situations. This step corresponds to the step of the application of knowledge and critical thinking processes in evaluation. According to the learning facilitation process, it can be seen the Double P-CE model demonstrates a significant strength through the systematic synthesis of various concepts, theories, and learning processes. In particular, the integration of constructivist theory, critical thinking concepts, and context-based learning enables the model to effectively promote learners’ self-construction of knowledge, hands-on practice, and in-depth analytical thinking. Learners are not merely passive recipients of knowledge; rather, they play active roles in investigating information, exchanging ideas, analyzing data, drawing conclusions, and conducting self-evaluation. As a result, meaningful learning is fostered, allowing learners to connect acquired knowledge with real-life situations. Furthermore, the four learning facilitation steps are systematically interconnected and sequentially organized. The process begins with stimulating learners’ interest and linking prior knowledge to new experiences, followed by knowledge construction through authentic practice, knowledge summarization, and reflective evaluation. This sequential learning process supports the progressive development of critical thinking among learners. In addition, the model encourages collaborative learning, knowledge sharing, and active classroom participation, which are consistent with student-centered learning approaches and 21st century learning paradigms. Besides, there is an assessment of suitability and quality of the learning facilitation model by the experts. These findings are consistent with the study conducted by Vong & Kaewurai (2017, pp. 90-94), who investigated instructional model development to enhance critical thinking and critical thinking teaching ability of trainee students at regional teaching training center in Takeo province, Cambodia. The findings revealed that trainee students' post critical thinking was much higher than pre-critical thinking implementation, while their abilities in teaching critical thinking were at the exemplary level. Similarly, the study conducted by Khamthanu (2023, pp. 247-264) on development of teaching methods to promote critical thinking skills and scientific concepts of students mathayom 1, found that students’ critical thinking skills and scientific concepts after instruction were significantly higher than before instruction at the .05 level of statistical significance. Both studies, together with the Double P-CE model, emphasize learners’ self-construction of knowledge as a significant factor contributing to the enhancement of critical thinking skills. This supports the suitability and effectiveness of the Double P-CE model in improving both learning achievement and critical thinking skills within contemporary learning contexts. It can be said that the learning facilitation model that focuses on self-knowledge creation, actual practice, thinking training and exchange of knowledge. Meanwhile, the traditional teaching may help increase learning achievement but may be less in critical thinking development. This depends on the difference and ability in thinking of an individual. Regarding student satisfaction, the overall level



was high, indicating that learners perceived the instructional model as relevant and engaging. The integration of real-world contexts enhanced intrinsic motivation and promoted meaningful learning, which aligns with contemporary student-centered learning perspectives. Furthermore, a supportive classroom environment, together with opportunities for collaborative learning and knowledge exchange, further strengthened students' confidence and engagement. These findings are consistent with previous research demonstrating that active learning approaches connected to meaningful contexts contribute to positive learning experiences and higher levels of student satisfaction. Similar results were reported in the studies of Khamthanu (2023, pp. 247-264), who found that students' satisfaction with the learning facilitation model was at a high level.

SUGGESTION

Future studies should investigate the long-term impact of the model through longitudinal designs to examine sustained development in critical thinking. Replication across different subjects, educational levels, or sociocultural contexts is also recommended to enhance external validity. Additionally, future research may explore the integration of this model with other 21st century competencies, such as creativity and problem-solving, to broaden its instructional applicability.

REFERENCES

- Bunyodom, N., Ugsonkid, S., & Kasemsukpipat, W. (2023). The effect of learning management based on constructivist theory using hands-on activities of grade 6 students' geometrical concepts on triangle. *Interdisciplinary Academic and Research Journal*, 3(5), 481-496. <https://doi.org/10.14456/iarj.2023.263>.
- Chand, S. P. (2024). Constructivism in education: Exploring the contributions of Piaget, Vygotsky, and Bruner. *International Journal of Science and Research*, 12(7), 274-278. <https://doi.org/10.21275/SR23630021800>.
- Dehkordi, H. A. (2021). Comparison of context-based learning and traditional method in cognitive and psychomotor domains and critical thinking of undergraduate nursing students. *Przegl Epidemiol*, 75(3), 424-429. <https://doi.org/10.32394/pe.75.39>.
- Dori, Y. J., Avargil, S., Kohen, Z., & Saar, L. (2018). *Context-based learning and metacognitive prompts for enhancing scientific text comprehension*. *International Journal of Science Education*, 40(10), 1198-1220. <https://doi.org/10.1080/09500693.2018.1470351>.
- Gilbert, J. K. (2006). On the Nature of "context" in Chemical Education. *International Journal of Science Education*, 28(9), 957-976. <https://doi.org/10.1080/09500690600702470>.
- Indah, P. P., Herawati, S., & Betty, L. (2023). The Integration of Group Investigation and Reading, Questioning, Answering (GIRQA): An Instructional Model to Enhance Metacognition and Critical Thinking of Students in Science Classroom. *Journal of Education and Instruction*, 13(4), 214-223. <https://doi.org/10.47750/pegegog.13.04.26>.
- Khamthanu, K. (2024). Development of teaching methods to promote critical thinking skills and scientific concepts. *Interdisciplinary Academic and Research Journal*, 4(1), 247-266. <https://doi.org/10.60027/iarj.2024.273178>.
- Klockars, A. J. (1992). Evaluating Pretest-Posttest Control Group Experiments. *Perceptual and Motor Skills*, 75(1), 96-98. <https://doi.org/10.2466/pms.1992.75.1.96>.



- Rubini, B., & Ardianto, D. (2021). Empowering contextual approach in science learning to enhance critical thinking skills: Some cases of learning science at secondary school. In A. Permanasari, I. Hamidah, R. Hurriyati, A. G. Abdullah, L. P. Artini, N. N. Padmadewi, S. Aisyah, V. Andriany, H. S. H. Munawaroh, G. Yuliani, I. Kustiawan, P. I. Rahmawati, Trianasari, A. A. Danuwijaya, C. U. Abdullah, & N. K. Wedhanti (Eds.), *Proceedings of the 5th Asian Education Symposium 2020 (AES 2020): Vol. 566. Advances in Social Science, Education and Humanities Research* (pp. 304-307). Atlantis Press. <https://doi.org/10.2991/assehr.k.210715.064>.
- Rullis, R. M., & Fauzan, A. (2021). Development of constructivism-based mathematics interactive learning media tools on the material of constructing a flat side space for class VIII junior high school students. *Journal of Physics: Conference Series*, 1742, 1-5. <https://doi.org/10.1088/1742-6596/1742/1/012031>.
- Schochet, P. Z. (2010). The late pretest problem in randomized control trials of education interventions. *Journal of Educational and Behavioral Statistics*, 35(4), 379-406. <https://doi.org/10.3102/1076998609353112>.
- Siregar, H. D., Salim, A., Jannah, M. R., Nurkhayati, A., & Hidayati, N. (2025). Development of constructivism-based learning models to improve student learning outcomes. *Journal of Gateway for Understanding Research in Education*, 1(2), 11-19. <https://doi.org/10.69855/guru.v1i2.335>.
- Vong, S. A., & Kaewurai, W. (2017). Instructional model development to enhance critical thinking and critical thinking teaching ability of trainee students at regional teaching training center in Takeo province, Cambodia. *Kasetsart Journal of Social Sciences*, 38(1), 88-95. <https://doi.org/10.1016/j.kjss.2016.05.002>.
- Yulaisa, G., & Desnita, D. (2024). The Effect of Using Context-Based Learning Videos on Fluid Materials on Students Critical Thinking Ability. *Journal Pijar Mipa*, 19(3), 391-395. <https://doi.org/10.29303/jpm.v19i3.6510>.
- Zandvakili, E., Washington, E., Gordon, E. W., Wells, C., & Mangaliso, M. (2019). Teaching patterns of critical thinking: The 3CA model—Concept maps, critical thinking, collaboration, and assessment. *SAGE Open*, 9(4), 1-14. <https://doi.org/10.1177/2158244019885142>.

The content, as well as the use of language in the article, is the responsibility of the author.



Duangporn Janon* and Pornpimol Chaiwuttisak

64605045@kmitl.ac.th*, and pornpimol.ch@kmitl.ac.th

Department of Statistic, Faculty of Science, King Mongkut's Institute of Technology
Ladkrabang (KMITL), Bangkok Thailand 10520

*Corresponding author E-mail: 64605045@kmitl.ac.th

Received: April 22, 2026 **Revised:** June 9, 2026 **Accepted:** June 24, 2026

Citation reference :

Janon, D., Chaiwuttisak, P.(2026). Deep Learning Models for Early Detection of Depression from Social Media Text. **International Journal of Industrial Education and Technology**, 8(1), 82-92.

ABSTRACT

Depression is a major global health concern. Recent studies suggest that language used on social media may reveal early signs of psychological distress before individuals seek formal clinical support. The objective of this study was to develop and evaluate transformer-based natural language processing models for detecting depressive risk signals in long-form Reddit posts using the ERISK2025 dataset. A traditional TF-IDF representation combined with Logistic regression served as the baseline and was compared with BERT-base and the emotion-aware Emotion-RoBERTa model under identical experimental conditions. Model performance was assessed using accuracy, risk-class recall, macro-F1, AUC, and confusion-matrix-based error distribution. Emotion-RoBERTa achieved the highest overall accuracy (0.76) and the strongest sensitivity to high-risk users with a risk-class recall of 0.91 and the lowest false-negative rate among the tested models. BERT-base showed moderate performance. The TF-IDF baseline was weakest at identifying high-risk cases. These findings indicate that emotion-aware language representations can improve early detection of depression risk in social media text and may identify vulnerable users more reliably than traditional text-representation methods. The results also indicate that model evaluation in this setting should rely on clinically meaningful metrics rather than accuracy alone. Future work should consider larger datasets together with temporal patterns in user posts and ethical constraints related to real-world mental health screening.

Keywords: Depression detection, Reddit, eRisk2025, TF-IDF; BERT-base, Emotion-RoBERTa

I. INTRODUCTION

Over the past decade, social media has become deeply integrated into everyday life. Large proportions of the global population now depend on online platforms for communication, information exchange, and self-expression (Chaffey, 2025, Online; Pew Research Center, 2025, Online). In Thailand, national statistics report high levels of internet and mobile phone use, particularly after the COVID-19 pandemic shifted many activities into digital environments (National Statistical Office of Thailand, 2025, p. 33). During periods of social distancing, social media was widely used to share experiences, concerns, and uncertainty, making these platforms a primary space for emotional expression and social support (Tsao et al., 2021, p. 184; Handayani et al., 2023, p. 8). Platform features such as status updates, comments, and reactions allow users to express feelings quickly and respond to others in real time, creating conditions where emotional content spreads easily (Steinert & Dennis, 2022, pp. 11-13; Chen et al., 2022, p. 61). Prior studies show that online language can reflect psychological conditions, including depression, social exclusion, and bullying among adolescents (Ophir et al., 2019, pp. 3-4), and emotional changes can be observed in online discussions during recovery from substance use (Yang et al., 2023, p. 2). These findings suggest that social media data may reveal signs of distress before individuals seek formal help.

Depression is a major global health problem, affecting a large number of people and contributing substantially to disability and suicide worldwide (WHO, 2025a, Online). Recent estimates indicate that depressive and anxiety disorders account for a significant share of disability-adjusted life years and have increased steadily over the past decades (Fan et al., 2025, pp. 8-10). Many cases remain undiagnosed or untreated, leading to functional impairment and economic burden (Yoch & Sirull, 2021, Online; Proudman et al., 2021, p. 620). Social and economic pressures, including chronic stress, loss, and inequality, are associated with the onset and progression of depressive symptoms (Reddy, 2010, pp. 1; Moreno-Agostino et al., 2021, p. 241). In Thailand, mental health reports show rising levels of stress and depression risk, especially among young people, while access to mental health services remains limited (WHO, 2025b, Online; Bangkok Post, 2022, Online; Munthuli et al., 2023, p. 3; National Health Security Office, 2023, Online). Stigma toward mental illness also discourages help-seeking behaviour (Pruksarungruang & Rhein, 2022, p. 2). In such conditions, individuals often express emotional distress online before contacting health professionals, making social media a useful source of early indicators.

Recent research has explored the use of natural language processing and machine learning to identify depressive signals in social media text. Patterns of sadness, hopelessness, and loneliness in online posts have been used to predict depression with promising results. Social media data are suitable for early detection because they are abundant, time-stamped, and reflect real-world communication. Advances in deep learning have improved the ability to extract emotional features from large text corpora, but several challenges remain. Social media language is informal and often includes slang, spelling variation, sarcasm, and code-switching, which can obscure emotional meaning (Alaramma et al., 2023, p. 77). Emojis and special characters also add complexity to interpretation (Alqahtani et al., 2023, p. 325). Many earlier studies relied on short texts, small datasets, or simple binary labels, which limit the detection of subtle psychological states (Salas-Zárate et al., 2022, p. 2; Ahmed et al., 2022, p. 5; Bao et al., 2025, p. 1). Long-form platforms such as Reddit provide richer narratives that allow observation of emotional change over time, and the eRisk dataset offers longitudinal posts labelled using validated self-report instruments for research on early risk detection (Boettcher, 2021, pp. 2-3; Bao et al., 2025, p. 1). These characteristics make long-form data suitable for



testing transformer-based models designed to capture contextual and emotional information in text (Triantafyllopoulos et al., 2023, p. 3; Bokolo & Liu, 2023, p. 9; Zhang et al., 2022, pp. 46-47).

Based on these considerations, this study investigates the effectiveness of transformer-based classification models for detecting depressive risk signals in long-form Reddit posts using the ERISK2025 dataset. The research compares three model conditions under identical experimental settings. The first condition is a traditional baseline that combines TF-IDF features with Logistic regression. The second is the general-purpose BERT-base transformer. The third is the emotion-aware Emotion-RoBERTa model. The comparison gives particular attention to performance measures that are relevant for early screening. These include recall for high-risk users and reduction of false-negative predictions. In addition, the study applies a multi-metric evaluation framework, including accuracy, macro-F1, recall, and AUC, in order to provide a more clinically meaningful interpretation of model performance in early depression risk detection.

II. LITERATURE REVIEW

Recent studies have examined the use of natural language processing and machine learning for detecting depression from textual data, particularly from social media where users often express emotions and personal experiences. Automated text analysis has been proposed as an alternative to traditional screening methods based on interviews and questionnaires, allowing large volumes of text to be analysed for linguistic patterns associated with depressive symptoms (Teferra et al., 2024, pp. 1-2). Transformer-based language models such as BERT and related architectures have been widely used because they capture contextual relationships more effectively than feature-based approaches, and domain-adapted models trained on mental-health corpora have shown improved ability to detect emotional cues in informal language (Mao & Han, 2025, p. 6). Comparative studies also report that traditional machine learning algorithms, including logistic regression and support vector machines, can perform competitively depending on dataset size, class balance, and feature representation, which makes multi-metric evaluation necessary for reliable comparison (Ding et al., 2025, p. 1; Mao & Han, 2025, pp. 8-9). Other research shows that combining contextual embeddings with additional linguistic or behavioural information, as well as applying balancing techniques, can improve classification performance when analysing social-media text (Kerasiotis et al., 2024, p. 1; Qasim et al., 2025, p. 4; Zhang et al., 2024, pp. 6-8).

Taken together these studies establish that transformer models can detect depressive language in social media text and that domain adaptation tends to improve sensitivity to emotional cues. Two methodological questions remain less settled. The first concerns long-form posts because extended writings place greater demands on context handling than the short texts examined in much prior work. The second concerns emotionally nuanced modelling because the added value of emotion-aware pretraining over general contextual representation is not yet clear under directly comparable conditions. Simpler classifiers also remain competitive under some data conditions which further complicates model selection. The present study addresses these unresolved points by comparing a traditional baseline with general-purpose and emotion-aware transformers on long-form Reddit text under identical conditions and by evaluating the models with multiple metrics.

The present research is based on previous findings comparing traditional classifiers and transformer-based models for depression detection, particularly studies showing that contextual and emotion-aware representations may improve the identification of risk-related language in social-media text, while simpler models may still provide stable performance under certain data conditions (Kuzmin et al., 2025, p. 34535). Research using long-form data from platforms



such as Reddit indicates that extended text provides richer emotional context, which supports the use of transformer architectures for risk detection (Qasim et al., 2025, pp. 3-4; Zhang et al., 2024, p. 3). Prior work also shows that evaluation based only on accuracy may not reflect true model behaviour, especially when class imbalance and false-negative errors are present, and therefore multiple metrics should be used for reliable comparison (Bokolo & Liu, 2023, p. 11). Based on these findings, the present study proposes three hypotheses: that an emotion-aware transformer model will achieve higher recall for the depressive risk class than a general-purpose transformer model (H1), that the emotion-aware model will produce fewer false-negative predictions in long-form text classification (H2), and that differences in model performance will be more clearly identified when multiple evaluation metrics such as accuracy, macro-F1, recall, and AUC are used instead of accuracy alone (H3).

III. RESEARCH METHODOLOGY

This study employed a quantitative experimental design with a comparative approach to evaluate the performance of deep learning-based natural language processing models for detecting depressive signals in social media text. A cross-sectional framework was used to analyse patterns of emotional expression within a defined time period and to ensure a fair comparison between models under identical conditions (Teferra et al., 2024, p. 12). The data source was the ERISK2025 benchmark dataset, which contains 11,042 English-language text instances derived from longitudinal Reddit user writings for early mental health risk research. Each instance was labeled as risk or non-risk. To maintain reproducibility and class balance, the dataset was divided using a stratified procedure into 8,833 instances for training and 2,209 instances for testing, preserving the original distribution (risk = 55.4%, non-risk = 44.6%). This corresponds to an approximately 80:20 train/test partition in which the test set was held out from model development and used only for final evaluation. Included texts were required to be written in English, contain interpretable emotional content, and exceed a minimum length, while posts consisting only of links, symbols, advertisements, duplicated content, or very short messages without clear emotional meaning were excluded to reduce noise during model training (Salas-Zárate et al., 2022, p. 4; Ahmed et al., 2022, p. 6).

Data processing and analysis were performed using Python. Text preprocessing and model implementation were conducted with the HuggingFace Transformers library together with PyTorch. A TF-IDF + Logistic Regression classifier was implemented as a traditional machine-learning baseline using the same stratified train/test partition to provide a direct comparison with the transformer-based models. Two transformer-based language models were evaluated: BERT-base (uncased) as a general-purpose pretrained model and Emotion-RoBERTa as a model pretrained on mental health-related text. Both models were adapted for binary classification using the same classification head to allow direct comparison (Bokolo & Liu, 2023, p. 7; Qasim et al., 2025). The ERISK2025 dataset was constructed from longitudinal Reddit posts provided by users who participated voluntarily in standardized mental health assessments. Risk labels were assigned from validated self-report questionnaires, including the Beck Depression Inventory (BDI), rather than clinical diagnosis, so the labels indicate elevated depressive risk rather than confirmed disorder (Bao et al., 2025, p. 2). Therefore, the labels used in this study represent depressive risk identified through screening instruments rather than confirmed clinical diagnoses. Text data were cleaned, deduplicated, and standardised before tokenisation. Inputs were prepared using padding, truncation, and attention masks, with a fixed maximum sequence length of 256 tokens. Texts longer than this limit were truncated, and shorter texts were padded to ensure consistent batch processing.



Model development and evaluation used the same stratified partition of 8,833 training instances and 2,209 testing instances described above. The train/test split was generated with the class label used for stratification and `random_state = 42` specified for the split procedure. Separating data into distinct training and evaluation sets follows established practice in text-classification research (Kowsari et al., 2019, p. 4; Wang, 2023, pp. 93-96). Both models were fine-tuned with the AdamW optimiser, learning rate 2×10^{-5} , batch size 16, and 3 training epochs. A linear learning-rate scheduler with warmup (ratio = 0.1) was applied, and all settings were kept identical for both models to maintain a controlled comparison. Model performance was evaluated on the test set using accuracy, recall, F1-score, AUC, and confusion-matrix-based error distribution, with macro or weighted F1 reported when class imbalance occurred, and confusion matrices were used to analyse classification errors (Bokolo & Liu, 2023, p. 12; Teferra et al., 2024, p. 9).

IV. RESULTS

The ERISK2025 dataset used in this study contained 11,042 text instances. To ensure fair evaluation, the data were divided using a stratified split into 8,833 documents for training and 2,209 documents for testing while preserving the original label distribution. The proportion of texts labelled as risk was 55.4%, whereas 44.6% were labelled as non-risk. Model performance on the held-out test set was reported using accuracy, risk-class recall, macro-F1, AUC, and confusion-matrix-based error distribution to provide both threshold-dependent and threshold-independent assessment. Each evaluation metric was linked to one of the study hypotheses. Recall for the risk class served as the primary indicator for H1 because it measures the proportion of high-risk users that a model identifies. False-negative counts from the confusion matrices served as the indicator for H2 because they record missed high-risk cases directly. The combined use of accuracy, risk-class recall, macro-F1, AUC, and error distribution addressed H3 because performance differences among models are identified more clearly with multiple metrics than with accuracy alone. Table 1 presents the dataset summary and class distribution.

Table 1: Dataset summary and class distribution

Item	Count
Total documents	11,042
Train set	8,833
Test set	2,209
Non-risk	4,925 (44.6%)
Risk	6,117 (55.4%)

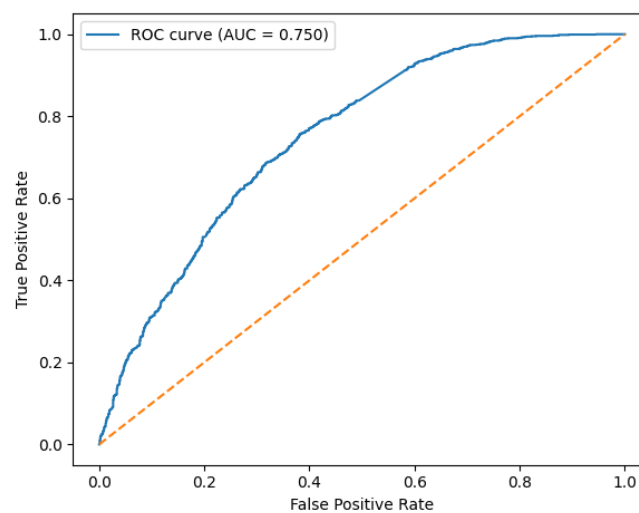
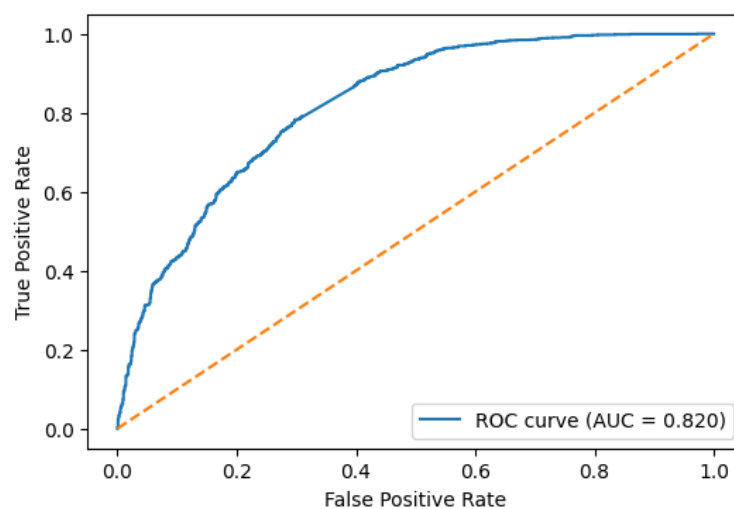
The performance of the evaluated models on the test set is shown in Table 2, including the TF-IDF + Logistic regression baseline, BERT-base, and Emotion-RoBERTa. Evaluation focused on accuracy, macro-F1, recall for the risk class, and AUC. Emotion-RoBERTa achieved the highest recall for the risk class (0.91), followed by BERT-base (0.88) and the baseline model (0.81). Overall accuracy values were 0.69 for TF-IDF + Logistic regression, 0.75 for BERT-base, and 0.76 for Emotion-RoBERTa. The hypothesis mapping is therefore interpreted from the main held-out test-set results in Table 2 and the error-distribution results in Table 3, rather than from a separate additional comparison table.



Table 2: Performance comparison across models

Model	Accuracy	Precision	Recall	Macro-F1	AUC
TF-IDF + Logistic regression	0.69	–	0.81 (Risk)	0.67	0.75
BERT-base	0.75	–	0.88 (Risk)	0.73	0.82
Emotion-RoBERTa	0.76	–	0.91 (Risk)	0.74	0.82

Receiver Operating Characteristic (ROC) curves for the three models are shown in Figures 1–3. The baseline model produced an AUC of 0.75, indicating moderate discrimination ability. The BERT-base model achieved an AUC of 0.82, showing improved separability between risk and non-risk instances. Emotion-RoBERTa also produced an AUC of 0.82 with a curve closer to the upper-left corner, indicating stronger sensitivity across thresholds.

**Figure 1:** ROC curve of the TF-IDF + Logistic regression model on the test set**Figure 2:** ROC curve of the BERT-base model on the test set

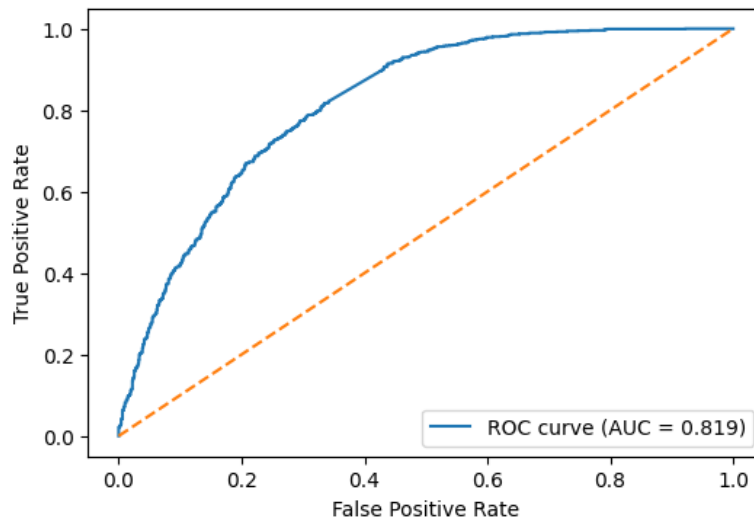


Figure 3: ROC curve of the emotion-RoBERTa model on the test set

Error distribution across models is summarised in Table 3, including true positives, false positives, false negatives, and true negatives. The baseline model produced 228 false negatives and 458 false positives. BERT-base reduced false negatives to 143 and false positives to 407. Emotion-RoBERTa produced the lowest number of false negatives (109) with 431 false positives. These results show differences in classification outcomes across models and provide additional information on prediction behaviour in the test set.

Table 3: Summary of FN / FP of three models

Model	TP	FP	FN	TN
Baseline (TF-IDF + LR)	996	458	228	527
BERT-base	1081	407	143	578
Emotion-RoBERTa	1115	431	109	554

V. CONCLUSION AND DISCUSSION

The study evaluated the effectiveness of different natural language processing approaches for detecting depressive risk in social media text using the ERISK2025 dataset. The comparison included a TF-IDF + Logistic regression baseline, the BERT-base model, and the Emotion-RoBERTa model, with performance assessed using accuracy, recall, macro-F1, AUC, and error distribution. The results showed that Emotion-RoBERTa achieved the highest recall for the risk class and the lowest number of false-negative predictions, indicating stronger sensitivity to high-risk language than the other models. The results also show that model selection should not rely on accuracy alone. The TF-IDF + Logistic regression model remains a useful traditional baseline because it provides an interpretable comparison point. However, BERT-base improved over the baseline in accuracy, risk-class recall, macro-F1, and AUC, while Emotion-RoBERTa provided the strongest risk-class recall and the lowest false-negative count. For depression-risk screening, model selection should therefore consider risk-class recall, false negatives, macro-F1, AUC, and error distribution rather than overall accuracy alone. The analysis also confirmed that evaluating models with multiple metrics provided a clearer understanding of performance than relying on accuracy alone, particularly when class imbalance and safety-related errors were considered. Error distribution analysis further showed that the emotion-aware model minimized missed high-risk cases, whereas the baseline model produced the highest number



of false negatives. These findings indicate that model evaluation in depression risk detection should consider both aggregate metrics and error patterns to obtain reliable results.

The findings indicate that the emotion-aware transformer model provided stronger performance in detecting depressive risk signals than the general-purpose transformer architecture, as Emotion-RoBERTa showed higher recall for the risk class and a more balanced macro-F1 score, reflecting improved sensitivity to psychologically vulnerable users. This result is consistent with previous studies reporting that transformer architectures can capture richer semantic and affective information from text, while domain-adapted or emotionally trained models may better detect subtle psychological expressions in social media language (Mao & Han, 2025, pp. 1-3; Kuzmin et al., 2025, p. 34542). The comparison between Logistic Regression and BERT also suggests that higher model complexity does not always result in more stable classification performance. Although BERT-base achieved better overall evaluation scores, the TF-IDF + Logistic Regression baseline remained competitive and provided consistent results under the same experimental conditions. This finding supports previous studies indicating that simpler classifiers may remain effective when feature representations are informative and class distributions are relatively stable. Therefore, model selection in mental health NLP should consider not only predictive performance but also interpretability, computational efficiency, and deployment requirements. In addition, the results confirm that multi-metric evaluation provides a more reliable interpretation of model behaviour than accuracy alone, because recall, macro-F1, and AUC revealed differences in class detection and error distribution that were not visible from accuracy values, which is consistent with methodological recommendations that high-stakes NLP applications should rely on multiple performance indicators to capture differences in sensitivity, stability, and error patterns (Mao & Han, 2025, p. 5).

SUGGESTION

Future research should extend the present findings by using larger and more diverse datasets, including longitudinal user histories, to improve robustness and support earlier identification of depressive risk patterns. Additional work should examine alternative model architectures and hybrid approaches, such as temporal or hierarchical transformers and ensemble methods that combine semantic and emotional features, in order to improve detection stability and sensitivity beyond the performance observed in this study. Validation across different platforms, languages, and cultural contexts is also recommended to assess generalisability and reduce dependence on a single dataset, with evaluation under conditions that resemble practical screening use. Further studies should also consider issues related to model interpretability, error balance, and ethical use, including the need to protect user privacy and to apply automated detection as a supportive tool rather than a clinical diagnosis.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the faculty members and academic experts from the Department of Statistics and Business Analytics, Faculty of Science, King Mongkut's Institute of Technology Ladkrabang, for their valuable guidance, support, and encouragement throughout the course of this research.



REFERENCES

- Chaffey, D. (2025). Global social media statistics research summary. *Smart Insights*. <https://www.smartinsights.com/social-media-marketing/social-media-strategy/new-global-social-media-research/>.
- Pew Research Center. (2025). Social media fact sheet. <https://www.pewresearch.org/internet/fact-sheet/social-media/>.
- National Statistical Office of Thailand. (2025). *Survey on the use of information and communication technology in households, 2025 (Quarter 2)*. Ministry of Digital Economy and Society. https://www.nso.go.th/nsoweb/storage/survey_detail/2025/20250903131427_86572.pdf.
- Tsao, S. F., Chen, H., Tisseverasinghe, T., Yang, Y., Li, L., & Butt, Z. A. (2021). What social media told us in the time of COVID-19: A scoping review. *The Lancet Digital Health*, 3(3), 175–194.
- Handayani, P. W., Zagatti, G. A., Kefi, H., & Bressan, S. (2023). Impact of social media usage on users' COVID-19 protective behavior: Survey study in Indonesia. *JMIR Formative Research*, 7(1).
- Steinert, S., & Dennis, M. J. (2022). Emotions and digital well-being: On social media's emotional affordances. *Philosophy & Technology*, 35(2), 36.
- Chen, J. C. J., Yan, Y. Y. Y., & Leach, J. L. J. (2022). Are emotion-expressing messages more shared on social media? A meta-analytic review. *Review of Communication Research*, 10.
- Ophir, Y., Asterhan, C. S., & Schwarz, B. B. (2019). The digital footprints of adolescent depression, social rejection and victimization of bullying on Facebook. *Computers in Human Behavior*, 91, 62–71.
- Nesi, J., Rothenberg, W. A., Bettis, A. H., Massing-Schaffer, M., Fox, K. A., Telzer, E. H., & Prinstein, M. J. (2022). Emotional responses to social media experiences among adolescents: Longitudinal associations with depressive symptoms. *Journal of Clinical Child & Adolescent Psychology*, 51(6), 907–922.
- Yang, G., King, S. G., Lin, H. M., & Goldstein, R. Z. (2023). Emotional expression on social media support forums for substance cessation: Observational study of text-based Reddit posts. *Journal of Medical Internet Research*, 25.
- WHO. (2025a). Depressive disorder (depression). <https://www.who.int/news-room/fact-sheets/detail/depression>.
- Fan, Y., Fan, A., Yang, Z., & Fan, D. (2025). Global burden of mental disorders in 204 countries and territories, 1990–2021: Results from the global burden of disease study 2021. *BMC Psychiatry*, 25(1), 486.
- Yoch, M., & Sirull, R. (2021). New global burden of disease analyses show depression and anxiety among the top causes of health loss worldwide. Institute for Health Metrics and Evaluation. <https://www.healthdata.org/news-events/insights-blog/acting-data/new-global-burden-disease-analyses-show-depression-and>.
- Proudman, D., Greenberg, P., & Nellesen, D. (2021). The growing burden of major depressive disorders (MDD): Implications for researchers and policy makers. *Pharmacoeconomics*, 39(6), 619–625.
- Reddy, M. S. (2010). Depression: The disorder and the burden. *Indian Journal of Psychological Medicine*, 32(1), 1–2.



- Moreno-Agostino, D., Wu, Y. T., Daskalopoulou, C., Hasan, M. T., Huisman, M., & Prina, M. (2021). Global trends in the prevalence and incidence of depression: A systematic review and meta-analysis. *Journal of Affective Disorders*, 281, 235-243.
- WHO. (2025b). Mental health and social connection in Thailand.
<https://www.who.int/thailand/news/feature-stories/detail/mental-health-and-social-connection-in-thailand>.
- Bangkok Post. (2022). Teens face pandemic woes.
<https://www.bangkokpost.com/thailand/general/2314054/teens-face-pandemic-woes>.
- Munthuli, A., Pooprasert, P., Klangpornkun, N., Phienphanich, P., Onsuwan, C., Jaisin, K., & Tantibundhit, C. (2023). Classification and analysis of text transcription from Thai depression assessment tasks among patients with depression. *PLoS ONE*, 18(3).
- National Health Security Office. (2023). Mental health hotline integrated into the UCS.
<https://eng.nhso.go.th/view/1/DescriptionNews/Mental-health-hotline-integrated-into-the-UCS/511/EN-US>.
- Pruksarungruang, J., & Rhein, D. (2022). Depression literacy: An analysis of the stigmatization of depression in Thailand. *SAGE Open*, 12(4).
- Alaramma, S. K., Habu, A. A., Ya'u, B. I., & Madaki, A. G. (2023). Sentiment analysis of sarcasm detection in social media. *Gadua Journal of Pure and Allied Sciences*, 2(1), 76-82.
- Alqahtani, A., Alhenaki, L., & Alsheddi, A. (2023). Text-based sarcasm detection on social networks: A systematic review. *International Journal of Advanced Computer Science and Applications*, 14(3).
- Salas-Zárate, R., Alor-Hernández, G., Salas-Zárate, M. P., Paredes-Valverde, M. A., Bustos-López, M., & Sánchez-Cervantes, J. L. (2022). Detecting depression signs on social media: A systematic literature review. *Healthcare*, 10(2).
- Ahmed, A., Aziz, S., Toro, C. T., Alzubaidi, M., Irshaidat, S., Serhan, H. A., & Househ, M. (2022). Machine learning models to detect anxiety and depression through social media: A scoping review. *Computer Methods and Programs in Biomedicine Update*, 2.
- Bao, E., Pérez, A., & Parapar, J. (2025). ReDSM5: A Reddit dataset for DSM-5 depression detection. In *Proceedings of the ACM International Conference on Information and Knowledge Management* (pp. 6323-6327).
- Boettcher, N. (2021). Studies of depression and anxiety using Reddit as a data source: Scoping review. *JMIR Mental Health*, 8(11).
- Triantafyllopoulos, I., Paraskevopoulos, G., & Potamianos, A. (2023). Depression detection in social media posts using affective and social norm features. *arXiv preprint arXiv:2303.14279*.
- Bokolo, B. G., & Liu, Q. (2023). Deep learning-based depression detection from social media: Comparative evaluation of ML and transformer techniques. *Electronics*, 12(21).
- Teferra, B. G., Rueda, A., Pang, H., Valenzano, R., Samavi, R., Krishnan, S., & Bhat, V. (2024). Screening for depression using natural language processing: Literature review. *Interactive Journal of Medical Research*, 13(1).
- Mao, H., & Han, Q. (2025). Applications of transformer-based language models for depression detection: A scoping review. *Journal of Integrated Social Sciences and Humanities*.
- Ding, Z., Wang, Z., Zhang, Y., Cao, Y., Liu, Y., Shen, X., & Dai, J. (2025). Trade-offs between machine learning and deep learning for mental illness detection on social media. *Scientific Reports*, 15(1), 14497.



- Kerasiotis, M., Ilias, L., & Askounis, D. (2024). Depression detection in social media posts using transformer-based models and auxiliary features. *Social Network Analysis and Mining*, 14(1), 196.
- Qasim, A., Mehak, G., Hussain, N., Gelbukh, A., & Sidorov, G. (2025). Detection of depression severity in social media text using transformer-based models. *Information*, 16(2), 114.
- Zhang, Z., Zhu, J., Guo, Z., Zhang, Y., Li, Z., & Hu, B. (2024). Natural language processing for depression prediction on Sina Weibo. *JMIR Mental Health*, 11.
- Kuzmin, G., Strepetov, P., Stankevich, M., Chudova, N., Shelmanov, A., & Smirnov, I. (2025). Exploring large language models for detecting mental disorders. In *Proceedings of the Conference on Empirical Methods in Natural Language Processing* (pp. 34523-34547).
- Kowsari, K., Jafari Meimandi, K., Heidarysafa, M., Mendu, S., Barnes, L., & Brown, D. (2019). Text classification algorithms: A survey. *Information*, 10(4), 150.
- Wang, M. (2023). Research on text classification method based on NLP. *Advances in Computer, Signals and Systems*, 7(2).

The content, as well as the use of language in the article, is the responsibility of the author.



Yangyang Sui^{1*}, and Thanawan Phongsatha²
343974180@qq.com^{1*}, thanawanphn@au.edu²

^{1*}Department of Health and Tourism, Sichuan Tourism School, Chengdu, Sichuan 610041
People Republic of China

²Teaching and Technology Program, Graduate School of Business and Advanced Technology
Management, Assumption University of Thailand, Bangkok, 10240 Thailand

*Corresponding author E-mail: 343974180@qq.com

Received: April 29, 2026 **Revised:** May 30, 2026 **Accepted:** June 25, 2026

Sui, Y. & Phongsatha, T. (2026). Effects of AI-augmented Tai Chi instruction on performance and learning outcomes in secondary vocational physical education. **International Journal of Industrial Education and Technology**, 8(1), 93-101.

ABSTRACT

This study examined the effects of AI-augmented Tai Chi instruction on students' performance and learning outcomes in secondary vocational physical education. A post-test-only quasi-experimental design was employed with 91 first-year vocational students in China, who were randomly assigned to an experimental group ($n = 46$) and a control group ($n = 45$). During an eight-week intervention, the experimental group received AI-supported Tai Chi instruction featuring motion capture and real-time corrective feedback, whereas the control group received traditional demonstration-imitation teaching. Tai Chi performance was evaluated using an IWUF-based rubric rated by three trained judges, and learning satisfaction, self-directed learning attitude, behavioral intention, and self-efficacy were measured using validated Likert-scale instruments. The results showed that the AI-assisted group achieved significantly higher overall Tai Chi performance ($p = .040$), particularly in action quality ($p = .020$). The experimental group also reported significantly greater learning satisfaction, self-directed learning attitude, and self-efficacy ($p < .05$) than the control group. However, no statistically significant difference was observed in behavioral intention. These findings suggest that AI-augmented instruction is effective in enhancing movement quality and selected psychological outcomes in vocational physical education and may serve as a valuable instructional support tool for skill-based teaching. Nevertheless, longer-term interventions may be necessary to influence students' sustained participation intentions.

Keywords: AI-assisted physical education, Tai Chi instruction, Secondary vocational education, Self-efficacy, Learning satisfaction

I. INTRODUCTION

The profound transformative influence of artificial intelligence (AI) across diverse industries has been widely recognized, and the field of education is similarly undergoing such changes (Harry, 2023, p. 260), including physical education (PE). In recent years, AI-based motion analysis, real-time feedback systems, and intelligent coaching tools have been increasingly integrated into skill-based instruction to enhance learning efficiency and personalization (Kotte et al., 2024, p. 230). In sports scenarios, such technologies provide real-time support for athletes' training and competitions through data collection infrastructure. (Suo et al., 2024, pp. 8-9), making them particularly suitable for movement-based courses that rely on accurate action execution and posture control. However, conventional Tai Chi instruction centers on teacher demonstration and student imitation, which renders the teaching process tedious. Given the intrinsic difficulty of Tai Chi movements, students present low learning interest and efficiency, thus leading to poor teaching effectiveness. (Ren, 2021, p. 2774).

Lee and Lee (2021, p. 9) found that AI-assisted physical education courses had significant positive effects on both students' perceived physical competence [$F(1, 176) = 25.899$, $p < 0.001$] and physical self-expression confidence [$F(1, 176) = 15.059$, $p < 0.001$]. Related studies have also shown that artificial intelligence technology can improve student engagement and learning effectiveness (Zhang et al., 2025, p. 85). In parallel, motor learning theory highlights the importance of augmented feedback during early skill acquisition (Fitts & Posner, 1967, pp. 30-33), while self-efficacy theory emphasizes the role of performance-related information in shaping learners' confidence (Bandura, 1986, pp. 391-417). Together, these perspectives indicate that AI-augmented feedback may influence both performance and learner-related outcomes in technology-enhanced environments.

Despite these contributions, several limitations remain. First, empirical evidence on AI-assisted learning remains limited for culturally and technically complex skills such as Tai Chi, which demand precise movement, rhythm, and full-body coordination. Such characteristics make Tai Chi particularly suitable for AI-assisted instruction, which can provide timely and individualized movement feedback. Second, existing studies have largely overlooked secondary vocational education (SVE) students, who often lack learning motivation and classroom engagement (Fang et al., 2022, p. 1). To address these gaps, this study uses an AI-based Digital Sports Assessment Machine (AI-DSAM) to provide real-time motion feedback in Tai Chi instruction and examine AI-assisted motor learning in context.

AI-supported instructional technologies have shown increasing potential for enhancing skill acquisition in vocational education settings. Therefore, this study aims to investigate the effects of AI-augmented Tai Chi instruction in a secondary vocational PE context. Specifically, it compares AI-supported teaching with traditional demonstration-imitation instruction, examining both objective performance outcomes and learner-related variables, including learning satisfaction, self-learning attitude, behavioral intention, and self-efficacy. By situating AI-assisted instruction within a culturally meaningful motor skill and an underexplored educational population, this study seeks to provide empirical evidence for the pedagogical integration of intelligent technologies in physical education.



II. LITERATURE REVIEW

Artificial intelligence (AI) has increasingly been integrated into physical education (PE) to enhance motor learning through real-time feedback, motion analysis, and personalized guidance. Prior studies have demonstrated that technology-enhanced feedback environments can improve students' skill accuracy, engagement, and learning efficiency (Atatekin & Kara, 2024, p. 843; Zhao, 2024, p. 833). Specifically, AI systems can analyze movement data and provide instant, personalized feedback via motion capture technology (Kotte et al., 2024, p. 223). Empirical research has also documented the positive effects of video feedback, intelligent coaching systems, and AI-supported platforms on motor performance and learner motivation across various sport settings (BenitezSantiago & Miltenberger, 2016, pp. 12-27; Migliaccio et al., 2024, pp. 8-9). However, existing studies have largely focused on general fitness training, exergaming, or high-intensity sport skills, with relatively limited attention to culturally grounded and technique-sensitive activities such as Tai Chi. Moreover, research involving secondary vocational education (SVE) students remains scarce. Given the slow, coordination-intensive nature of Tai Chi and the strong feedback demands of novice learners, the pedagogical value of AI-assisted instruction in this context warrants further empirical investigation. Collectively, this evidence suggests that technology-supported physical education can improve students' motivation, engagement, and performance, particularly in skill-based learning contexts where digital tools provide instructional support and feedback (Maněnová et al., 2022).

Grounded in motor learning theory and social cognitive theory, augmented feedback can improve movement accuracy as well as enhance learning satisfaction, self-directed learning attitude, and self-efficacy (Bandura, 1986, pp. 391- 417; Fitts & Posner, 1967, pp. 30-33). To fill the identified research gaps, this study adopted a quasi-experimental design to compare the effects of AI-assisted Tai Chi instruction with traditional teaching methods among secondary vocational education (SVE) students. The following hypotheses were tested: H1: AI-assisted instruction would significantly improve students' Tai Chi performance; H2: AI-assisted instruction would significantly enhance learning satisfaction; H3: AI-assisted instruction would significantly strengthen self-directed learning attitude; H4: AI-assisted instruction would significantly increase behavioral intention toward Tai Chi participation; and H5: AI-assisted instruction would significantly improve students' self-efficacy.

III. RESEARCH METHODOLOGY

A. Research Design

This study adopted a quasi-experimental post-test-only control group design to examine the effects of AI-augmented Tai Chi instruction on secondary vocational students' skill performance and learning-related attitudes. A post-test-only approach was considered appropriate because preliminary screening confirmed that all participants had no prior formal Tai Chi learning experience, ensuring no established Tai Chi performance foundation at baseline. For psychological variables, random assignment helped reduce potential pre-existing differences, while avoiding a pre-test minimized pre-test sensitization in the natural classroom setting.

To enhance internal validity and reproducibility, a two-stage randomization procedure was implemented using R statistical software with a fixed random seed. First, two intact classes were randomly selected from the eligible Grade-1 population. Second, students within the selected classes who met the inclusion criteria were randomly assigned to the experimental and control groups. Because the study was conducted in a natural school setting using intact classes as the initial sampling units, the design is classified as quasi-experimental despite the use of reproducible random assignment procedures. The intervention lasted eight weeks. The independent variable was instructional mode (AI-assisted vs. traditional instruction), and the dependent variables



included Tai Chi performance, learning satisfaction, self-directed learning attitude, behavioral intention, and self-efficacy.

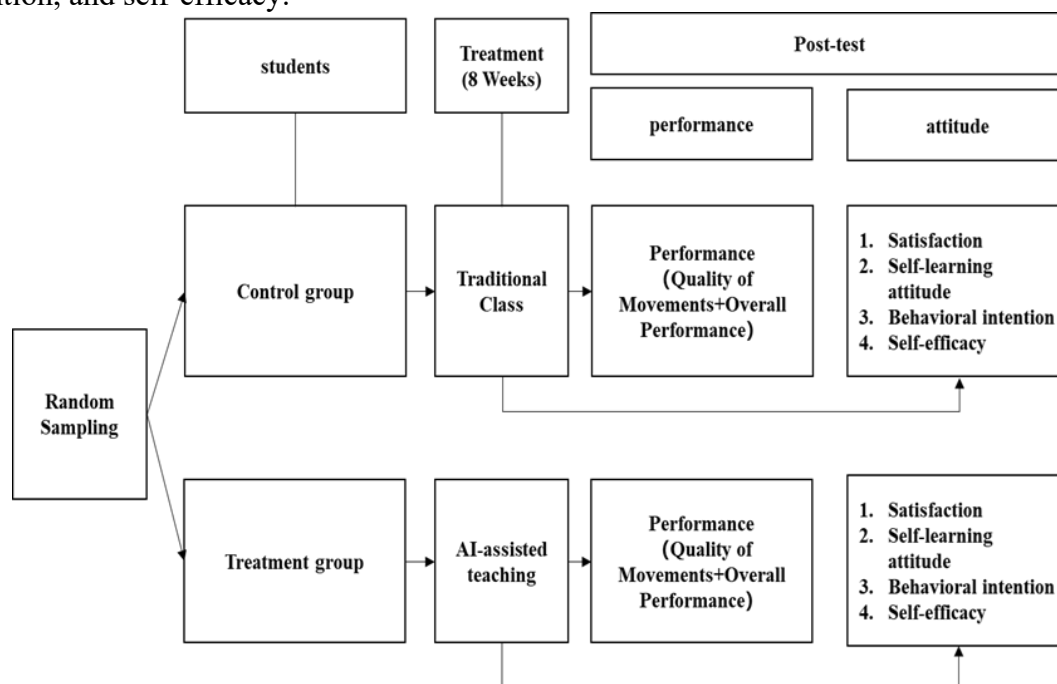


Figure 1: Research design and experimental procedure

B. Population and Participants

The study population consisted of first-year students enrolled in a secondary vocational education (SVE) school in Sichuan, China. Inclusion criteria required that students (a) were full-time vocational students aged 16–18 years, (b) regularly attended physical education classes, (c) had no prior Tai Chi or martial arts training, (d) were physically fit to participate in sports activities, and (e) provided informed consent (with guardian consent obtained for minors).

A total of 91 eligible students participated in the study. Using reproducible random assignment in R, students were allocated to the experimental group ($n = 46$) and the control group ($n = 45$). Power analysis indicated that the sample size achieved statistical power exceeding .80, suggesting adequacy for detecting medium-sized effects.

C. Instructional Intervention

Both groups completed an eight-week Tai Chi instructional program (one 90-minute session per week) based on the standardized 24-form Tai Chi routine required by the school curriculum. To ensure treatment fidelity, instructional content, duration, teacher, and learning objectives were kept consistent across groups.

The control group received traditional teacher-centered instruction consisting of live demonstration, verbal explanation, and repeated student imitation with teacher-provided corrective feedback.

The experimental group received AI-assisted instruction supported by an AI Digital Sports All-in-one Machine (AI-DSAM). The system provided 3D motion demonstrations, skeletal motion capture, real-time error prompts, and automated visual feedback. The AI-DSAM system captured students' real-time skeletal movement trajectories, compared them with standard Tai Chi movement models, scored detected deviations, and generated visual and audio prompts. Students practiced in rotating small groups using six AI devices while the teacher remained present to provide pedagogical guidance. In this study, the AI system functioned as a feedback enhancement tool rather than a replacement for the instructor. To minimize contamination,

the two groups were taught at different times and locations, and only the experimental group used the AI-DSAM devices during the intervention.

D. Research Instruments and Quality Inspection of Instruments

Tai Chi performance was assessed using a rubric adapted from the International Wushu Federation (IWUF) competition rules, covering two dimensions: action quality and performance level (5 points each; total score = 10). Students' performances were video-recorded and independently evaluated by three certified martial arts teachers.

Inter-rater reliability was examined using the intraclass correlation coefficient (ICC) based on a two-way random-effects model with average measures. The average-measures ICC showed good agreement among raters (ICC = .84, 95% CI [.78, .89]), supporting the reliability of the performance assessment. The mean of the three raters' scores was used for subsequent analyses.

Learning satisfaction was measured using a 12-item scale adapted from the Student Evaluation of Educational Quality (SEEQ) (Vernadakis et al., 2012, pp. 141-142). Self-directed learning attitude and behavioral intention were measured using 3-item scales adapted from Zheng et al. (2021, p. 8). Self-efficacy was assessed using the General Self-Efficacy Scale (Chen et al., 2001, p. 79). All items were rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). Prior to the main study, three experts in physical education and martial arts reviewed the instruments to ensure content validity. A pilot test (n = 30) demonstrated satisfactory internal consistency, with Cronbach's α values exceeding the recommended threshold of .70.

Table 1: Reliability statistics of questionnaire instruments (pilot test, n = 30)

Variable	Number of Items	Previous Research α	Pilot Test α
Satisfaction	12	0.90	0.908
Self-learning Attitude	3	0.898	0.867
Behavioral Intention	3	0.902	0.925
Self-efficacy	8	0.90	0.938

Note. Cronbach's α values above .70 indicate acceptable internal consistency.

E. Data Collection

Ethical approval was obtained prior to data collection (Approval No. 120/2025). Participation was voluntary, and parental consent was secured for underage students.

Data collection followed three stages. First, students were randomly assigned and completed the eight-week instructional intervention. Second, Tai Chi performance assessments were conducted in a standardized gymnasium setting using video recording. Third, questionnaires measuring satisfaction, self-directed learning attitude, behavioral intention, and self-efficacy were administered during regular class time. All 91 returned questionnaires were complete and valid for analysis.

F. Data Analysis

Data were analysed using Jamovi. Descriptive statistics (means and standard deviations) were computed for all variables. Normality and homogeneity of variance were examined using Shapiro-Wilk tests and Levene's tests before group comparisons. Independent samples t-tests were conducted to examine group differences between the AI-assisted and traditional instruction conditions. When Levene's test indicated violation of the homogeneity of variance assumption, Welch's t-test results were consulted.



The significance level was set at $\alpha = .05$. Effect sizes (Cohen's d) were reported to evaluate the magnitude of observed differences.

IV. RESULTS

A. Descriptive Statistics

Descriptive statistics for the primary study variables are presented in Table 2. Overall, students in the AI-assisted group demonstrated slightly higher mean scores than those in the traditional instruction group across most outcome variables. The differences were most evident in action quality, learning satisfaction, self-directed learning attitude, and self-efficacy, whereas the gap in behavioral intention was relatively modest.

Table 2: Descriptive Statistics of Major Variables by Group

Variable	Group	Mean	SD
Action Quality	Control	3.38	0.23
	Experimental	3.48	0.18
Practice Level	Control	3.39	0.28
	Experimental	3.44	0.22
Total Performance	Control	6.77	0.42
	Experimental	6.92	0.29
Learning Satisfaction	Control	3.49	0.38
	Experimental	3.73	0.32
Self-directed Learning Attitude	Control	3.69	0.59
	Experimental	3.96	0.51
Behavioral Intention	Control	3.38	0.69
	Experimental	3.58	0.35
Self-efficacy	Control	3.39	0.55
	Experimental	3.59	0.28

Note. Control group ($n = 45$); experimental group ($n = 46$).

B. Effects on Tai Chi Performance

Independent samples t -tests were conducted to examine whether AI-assisted instruction significantly improved Tai Chi performance (Table 3).

Results indicated that the experimental group scored significantly higher than the control group in total performance. A significant between-group difference was also found in action quality, with a medium effect size.

However, the difference in practice level was not statistically significant, suggesting that the AI intervention mainly improved movement precision rather than overall practice fluency. This may be because action quality reflects discrete movement accuracy, whereas practice level involves broader rhythm, fluency, and overall performance stability that may require a longer training period.



Table 3: Independent Samples t-Test Results for Tai Chi Performance

Variable	t	df	p	Cohen's d	Interpretation
Action Quality	-2.37	89	.020*	0.50	Significant
Practice Level	-1.08	89	.285	0.23	Not significant
Total Performance	-2.09	89	.040*	0.44	Significant

C. Effects on Learning Attitudes

To evaluate the broader psychological impact of AI-assisted instruction, independent samples t-tests were conducted on learning satisfaction, self-directed learning attitude, behavioral intention, and self-efficacy (see Table 4). The results revealed that students in the AI-assisted group scored significantly higher in learning satisfaction, self-directed learning attitude, and self-efficacy, with all effect sizes in the small-to-medium range. In contrast, no statistically significant difference was found in behavioral intention between the two groups, though the experimental group had a descriptively higher mean score.

Table 4: Independent Samples t-Test Results for Learning Attitude Variables

Variable	t	df	p	Cohen's d	Interpretation
Learning Satisfaction	-2.09	89	.020*	0.44	Significant
Self-directed Learning	-2.31	89	.023*	0.49	Significant
Behavioral Intention	-1.74	89	.084	0.37	Not significant
Self-efficacy	-2.19	89	.031*	0.46	Significant

D. Summary of Findings

Taken together, the results demonstrate that AI-assisted Tai Chi instruction produced statistically significant improvements in students' technical performance and several key learning-related attitudes. Specifically, the AI-supported group showed superior outcomes in total performance, action quality, learning satisfaction, self-directed learning attitude, and self-efficacy.

However, the intervention did not yield a statistically significant effect on behavioral intention. This pattern suggests that AI-enhanced motion feedback may be particularly effective in improving proximal learning outcomes, whereas influencing students' longer-term participation intentions may require more sustained or comprehensive interventions.

V. CONCLUSION AND DISCUSSION

The present study investigated the effects of AI-augmented Tai Chi instruction on secondary vocational students' motor performance and learning-related attitudes. The findings indicate that students who received AI-supported instruction demonstrated significantly higher overall Tai Chi performance, particularly in action quality, compared with those receiving traditional teaching. In addition, the experimental group reported significantly greater learning satisfaction, self-directed learning attitude, and self-efficacy. However, no statistically significant difference was observed in behavioral intention. Overall, the results suggest that integrating AI-based motion feedback into Tai Chi instruction can effectively enhance proximal learning outcomes in vocational physical education, especially in terms of movement precision and learner psychological engagement.

The observed performance and attitudinal advantages may be attributed to the real-time feedback, visualized movement analysis, and individualized error correction provided by the AI system, which together strengthened the feedback loop essential for motor learning. From the perspective of motor learning theory, such augmented feedback may help learners identify movement errors and refine motor execution during skill acquisition (Fitts & Posner, 1967, pp. 30-33). The improvement in self-efficacy also aligns with self-efficacy theory, as timely



performance feedback may strengthen learners' confidence in completing Tai Chi movements (Bandura, 1986, pp. 391-417). This result is consistent with studies on AI-supported physical education and motion-based feedback systems, which suggest that digital feedback can support motor skill development and learning experiences (Atatekin & Kara, 2024, p. 843; Kotte et al., 2024, p. 223; Lee & Lee, 2021, p. 9; Chen et al., 2020, p. 75275). At the same time, the non-significant change in behavioral intention suggests that short-term instructional interventions-even when technologically enhanced-may have limited influence on students' longer-term exercise intentions, which are often shaped by broader motivational and contextual factors. This finding may also be related to the novelty effect of AI-assisted learning, in which students' attention may have been directed more toward the immediate experience of using new technology than toward forming stable long-term participation intentions. This pattern aligns with earlier studies noting that while digital supports can improve immediate learning experiences, sustained behavioral change typically requires longer exposure and ecological reinforcement. Therefore, AI-assisted physical education should be viewed as a powerful instructional support rather than a standalone solution for promoting long-term physical activity engagement.

VI. SUGGESTION

Based on the findings of this study, several practical and research-oriented suggestions can be proposed. From an instructional perspective, educators in vocational physical education may consider integrating AI-supported motion feedback systems as a supplementary tool to enhance movement accuracy and learner engagement, particularly during the early stages of skill acquisition. However, successful implementation requires appropriate alignment among class size, equipment availability, and teaching organization to ensure that technological support translates into meaningful learning benefits. AI systems should be positioned as feedback-enhancement tools that complement, rather than replace, teacher guidance. Because this study was conducted in one secondary vocational school in Sichuan, China, the findings should be interpreted within this specific context. For future research, longer intervention periods and longitudinal designs are recommended to better examine whether AI-assisted instruction can influence students' sustained participation intentions in Tai Chi and other physical activities. Expanding the sample to multiple schools and learner populations would also help strengthen the generalizability of the findings. In addition, future studies may incorporate mixed-method designs, such as classroom observations or learner interviews, to further explore how students interact with AI feedback during motor learning. Such efforts would contribute to a more comprehensive understanding of the pedagogical role of artificial intelligence in skill-based physical education.

REFERENCES

- Atatekin, B., & Kara, M. (2024). The impact of augmented video feedback on middle school students' skill development in physical education. *Education and Information Technologies*, 29(1), 843-860.
- Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory (pp. 391-417). Prentice-Hall.
- BenitezSantiago, A., & Miltenberger, R. G. (2016). Using video feedback to improve martial arts performance. *Behavioral Interventions*, 31(1), 12-27.
- Chen, G., Gully, S. M., & Eden, D. (2001). Validation of a new general self-efficacy scale. *Organizational research methods*, 4(1), 62-83.
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *IEEE Access*, 8, 75264-75278.



- Fang, Z., Chang, B., & Dang, J. (2022). Growth mindset matters: Influences of socioeconomic status on Chinese secondary vocational students' learning engagement. *Journal of Pacific Rim Psychology*, 16, 18344909221141984.
- Fitts, P. M., & Posner, M. I. (1967). *Human Performance* (pp. 30–33). Brooks/Cole Publishing Company.
- Harry, A., & Sayudin, S. (2023). Role of AI in Education. *Interdisciplinary Journal and Hummanity (INJURITY)*, 2(3), 260-268.
- Kotte, H., Daiber, F., Kravcik, M., & Duong-Trung, N. (2024). *FitSight: Tracking and Feedback Engine for Personalized Fitness Training* Proceedings of the 32nd ACM Conference on User Modeling, Adaptation and Personalization.
- Lee, H. S., & Lee, J. (2021). Applying artificial intelligence in physical education and future perspectives. *Sustainability*, 13(1), 351
- Migliaccio, G. M., Padulo, J., & Russo, L. (2024). The Impact of Wearable Technologies on Marginal Gains in Sports Performance: An Integrative Overview on Advances in Sports, Exercise, and Health. *Applied Sciences*, 14(15).
- Ren, L. (2021, October). Research on Improvement of the Effectiveness of Tai Chi Practice Via Intelligent Robot-assisted Teaching. In 2021 3rd International Conference on Artificial Intelligence and Advanced Manufacture.
- Maněnová, M., Knajfl, P., & Wolf, J. (2022). Motivation and Performance of Students in School Physical Education in Which Mobile Applications Are Used. *Sustainability*, 14(15), 9016.
- Suo, X., Tang, W., & Li, Z. (2024). Motion Capture Technology in Sports Scenarios: A Survey. *Sensors*, 24(9), 2947.
- Vernadakis, N., Giannousi, M., Tsitskari, E., Antoniou, P., & Kιoumourtzoglou, S. (2012). A comparison of student satisfaction between traditional and blended technology course offerings in physical education. *Turkish Online Journal of Distance Education*, 13(1), 137-147.
- Zhang, Z., Rittisom, S., & Hongseanyatham, P. (2025). Utilizing Wearable Technology to Enhance Physical Education Teaching in Chinese High Schools. *International Journal of Sociologies and Anthropologies Science Reviews*, 5(3), 77-86.
- Zhao, Z. (2024, 26-28 Aug. 2024). Research on Immersive Experience System of Virtual Reality Technology in College Physical Education Teaching. 2024 International Conference on Computers, Information Processing and Advanced Education (CIPAE).
- Zheng, W., Ma, Y.-Y., & Lin, H.-L. (2021). Research on blended learning in physical education during the COVID-19 pandemic: A case study of Chinese students. *Sage Open*, 11(4), 21582440211058196.

The content, as well as the use of language in the article, is the responsibility of the author.



IJIET

INTERNATIONAL JOURNAL OF INDUSTRIAL
EDUCATION AND TECHNOLOGY



 www.siet.kmitl.ac.th | www.tci-thaijo.org/index.php/IJIET

 journal-enided@kmitl.ac.th  02 329 8000 ext. 3723

1 Chalongkrung Rd. Ladkrabang, Bangkok Thailand 10520