

The 16 th TCU International E-LEARNING Conference and 4th International Conference Thai
Association for Educational Communications and Technology

AI Learning

TRANSFORMATIVE AI-LEARNING ECOSYSTEMS FOR SUSTAINABLE FUTURES:
INNOVATIONS, INCLUSIVITY, AND IMPACT

**IEC2025 x
ICTAECT2025 x
AIAT2025**

Organizers:

Thai Association for Educational Communications and
Technology [THAI AECT]

Co-Organizers:

IEC International e-Learning Conference
Ministry of Higher Education, Science, Research and Innovation
THAILAND CYBER UNIVERSITY
Thailand Massive Open Online Course (ThaiMOOC)
IEEE Education Society (Thailand Chapter)
IEEE Thailand Section
Artificial Intelligence Association of Thailand (AIAT)

Conference Proceeding IEC2025 x ICTAECT2025 x AIAT2025

Transformative AI-Learning Ecosystems for Sustainable Futures: Innovations, Inclusivity, and Impact

The 16th TCU International E-LEARNING Conference
and The 4th International Conference Thai Association
for Educational Communications and Technology

August 5-6, 2025 Time : 9:00 a.m. - 5:00 p.m

Room A1 Mayfair A11 flo. Berkely hotel, Bangkok, Thailand

Organizers: Thai Association for Educational Communications
and Technology [THAI AECT]

Website : <https://thaiaect.org/ictaect-4-2025/>

Facebook : Thai Association for Educational Communications
and Technology [THAI AECT]

Email : thaiaect@gmail.com

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Welcome session and Trend Report
Director of the Thailand Cyber University Project
IEC2025 x ICTAECT2025 x AIAT2025
August 5th, 2025



Good morning, everyone.

On behalf of the Association of Educational Communications and Technology (AECT) of Thailand, I am pleased to welcome all of you to this special gathering.

This year, our association is honored to host the annual AECT event in collaboration with King Mongkut's University of Technology North Bangkok and King Mongkut's University of Technology Thonburi. The event will take place from November 27th to 29th.

During this conference, we will also reorganize our executive committee and present updates about our upcoming activities, collaborations, and achievements.

Our official website will be launched soon, but for now, we have released the event poster and conference information. All accepted conference papers will be indexed in IEEEExplore.

Last year, our annual event was successfully organized at Burapha University, and we are grateful for the continued support of our members and partners.

Every year, the AECT of Thailand recognizes individuals who have made significant contributions to the field of educational technology. We also extend our cooperation with universities and organizations nationwide—currently, 12 universities, 20 Rajabhat universities, and over 10 private companies—with more than 2,000 student members actively participating in our activities.

Our ongoing projects include academic training, workshops, international conferences, and publication of international journals indexed in TCI2, with the goal of being indexed in ERIC next year.

We have also collaborated with major partners such as Apple (SPVI), Siam Commercial Bank, and various educational institutions to provide teacher training, short film competitions, and innovation workshops.

Additionally, our association contributes to national projects such as the Thai Encyclopedia for Educational Technology and signs MOUs with partner universities, including Srinakharinwirot University, to enhance academic cooperation.

We are honored to welcome distinguished guests, including Dr. Eugene, the former AECT President from Canada, who has continuously supported our activities in Thailand, and Dr. Tony, who joins us today as a keynote speaker for the ETHC 2024 conference.

Our partnerships extend internationally—to Malaysia, India, and the United States—where we have signed MOUs to strengthen academic collaboration. These connections continue to expand our network and promote global knowledge exchange in educational technology.

This year, our association—now officially recognized as Thai AECT—continues to grow, and we look forward to seeing you all again at our international conference in November.

Thank you very much for your attention and continuous support.

Assoc. Prof. Thapanee Thammetar

Director of the Thailand Cyber University Project

Letter from the President
of the Thai Association for Educational Communications and Technology (ThaiAECT)
Conference Proceedings of IEC2025 x ICTAECT2025 x AIAT2025



On behalf of the Thai Association for Educational Communications and Technology (ThaiAECT), I am truly delighted and deeply honored to welcome all association members and distinguished participants, both Thai and international researchers, who have gathered here today.

The Thai Association for Educational Communications and Technology is a professional organization founded through a nationwide network of scholars in the field of educational technology and communications. Its purpose is to serve as a central hub for collaboration, sharing, and dissemination of academic works in educational technology—both nationally and internationally.

This academic conference represents an important international collaboration among the Thai Cyber University Project, the Association for Educational Communications and Technology (AECT), USA, the Artificial Intelligence Association of Thailand (AIAT), and the Thai Association for Educational Communications and Technology (ThaiAECT). This event holds significant meaning for researchers in online learning, educational technology, and communication studies—fields that have been continuously developed and refined for decades.

This year marks the first time that ThaiAECT has had the honor to serve as a co-host of this prestigious international event. I would like to express my heartfelt appreciation to the Thai Cyber University Project, AECT (USA), AIAT, ThaiAECT, and all participating researchers for their contributions in sharing knowledge, perspectives, and research findings, as well as for engaging in meaningful activities that enrich our collective experience.

Together, we are strengthening the discipline of educational technology in Thailand and expanding its connections globally.

I sincerely hope that this event will serve as a launching point for emerging researchers, a platform that empowers and unites scholars, and a vibrant space for continuous learning and academic collaboration—leading to a strong and sustainable academic network in the years to come.

Thank you very much.

Assoc. Prof. Dr. Surapon Boonlue

President, Thai Association for Educational Communications and Technology (ThaiAECT)

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4. Associate Professor Dr.Surapon Boonlue, King Mongkut's University of Technology Thonburi, Thailand (President Thai AECT)
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6. Professor Dr.Panita Wannapiroon, (IEEE member: 100582897) King Mongkut's University of Technology North Bangkok, Thailand
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13. Assistant Professor Dr. Mongkon Narmruk, King Mongkut's University of Technology Thonburi, Thailand
14. Assistant Professor Dr. Nakhon Lalognum, Burapha University, Thailand
15. Assistant Professor Dr. Sitthichai Laisema, Silapakorn University, Thailand
16. Dr. Paitoon Karnthunyalak, King Mongkut's University of Technology Thonburi, Thailand

Details of the IEC 2025 X ICTAECT 2025 conference

The 16th TCU International e-Learning Conference 2025 take: MOOOCs for Lifelong Learning Summit and EXPO (IEC2025) And 4th International Conference Thai Association for Educational Communications and Technology will be jointly organized by the Thai Association for Educational Communications and Technology (Thai AECT) and co-hosted by Thailand Cyber University (TCU). Additionally, IEEE Education Society, IEEE Education Society (Thailand Chapter), and IEEE Thailand Section will provide technical co-sponsorship.

This prestigious conference will take place from 5 - 6 August 2025, and will serve as a platform for researchers, scholars, practitioners, and students from public organizations, private sectors, and the industrial sector to exchange knowledge, discuss emerging challenges, and explore advancements in educational technology and related fields. Both full manuscripts and abstracts are invited for submission and presentation. We are delighted to announce that research articles that have been accepted and selected will be published in the International Journal of Educational Communications and Technology (IJECT), indexed in the Thai-Journal Citation Index Centre (TCI 2).

CONFERENCE TOPICS

1. Technological Issues in Education

- Technology-Enhanced Learning
- AR / VR / MR / XR / Metaverse in Immersive Learning
- Online Learning, e-Learning, Distance Learning
- Mobile learning: Phones, Tablets, Apps for education
- Blended Learning, Hybrid and HyFlex Learning
- Online/Virtual Laboratories
- Classroom and Laboratory: Integration Managed Learning Environments (MLEs)
- Learning Management Systems (LMS)
- MOOC and SPOC
- Smart Classroom and Teaching Environment
- Industry and Business Innovation
- Cloud Computing
- ICT skills and competencies among teachers
- ICT enhanced language teaching and learning
- Social Media in Education

- Technology in Education

2. AI for ALL and SDGs

- AI for Inclusive and Equitable Education
- AI-Enhanced Teaching and Learning Innovations
- AI in Educational Communications and Digital Media
- AI for Learning Analytics and Smart Assessment
- AI for Workforce Development and Lifelong Learning
- AI and Sustainability in Education
- AI and Ethical, Policy, and Governance Issues in Education
- AI in Hybrid and HyFlex Learning Models
- AI literacy and AI Competency
- 21st Century Skills
- Educational administration
- Curriculum and Instruction

3. Computer Supported Collaborative Work

- Collaborative Virtual Environments (CVEs)
- Virtual Learning Environments (VLEs)
- Social Media in Education
- Experiences in Web Technologies in Education
- Training the e-trainer
- Professional Learning Community (PLC), Community of Practice (CoP), Knowledge Management (KM)

List of presenters of the IEC 2025 X ICTAECT 2025 AIAT2025 academic conference
August 5th, 2025.

Afternoon Session, at The Lounge on 10th floor (ThaiAECT)

Session Type/Title: Paper Presentations	
Moderator: Assoc. Prof. Dr. Ophat Kaosaiyaporn	
13:30-14:00	Meeting with Dr. Tonia A. Dousay, President of AECT USA
14:00-14:15	Presenter 2: By Suwannee Thammaratthara, Surapon Boonlue. Thailand. (No.ICTAECT402) Topic: Developing a phenomenon-based learning model with a digital learning companion. To promote commercial law competencies as entrepreneurs of vocational education students, certificate level.
14:15-14:30	Presenter 3: Ratasa Laohasurayodhin, Sirimonpak Suwannakhun and Sirawit Chaihang,Thailand, (No.ICTAECT403) Topic: The Effect of e-Sports of Analytical Thinking of undergraduate students of The Faculty of Education, Mahasarakham University.
14:30-14:45	Presenter 4: Min Zhang and Kanyarat Sriwisathiyakun, China. (No.ICTAECT404) Topic: Adapting Teacher Roles in the Age of Online Learning: A Study of Primary School Educators' Experiences in Beijing.
14:45-15:00	Presenter 5: Yaowaret Jantakat, Chomphak Jantakat and Pongpun Juntakut, Thailand. (ICTAE,CT405) Topic: Development of Team Working in Higher Education with Project-based Learning for Designing Research Framework of Geospatial Artificial Intelligence (GeoAI) to Manage Natural Resources and Environment.
15:00-15:15	Presenter 6: By Syazreen Nadia Sulaiman, Che Mohd Farhan Che Mat Dusuki, Ahmad Danial Azzahari, Mahfuzah Yusoff and Muhammad Farris Khyasudeen, Malaysia. (No.ICTAECT406) Topic: ARChem: Augmented Reality Tool for Enhanced Visualization and Understanding of Atomic Structures in Pre-University Chemistry Education.
15:15-15:30	Presenter 7: By Manee Nakanakupt and Anuchit Butkhunthong, Thailand. (No.ICTAECT417) Topic: Innovative Hybrid Peer-Teaching Learning Model using Interactive Video and Simulation to Promote Professional Self-Efficacy and Clinical Competence Among Nursing Students.

15:30-15:45	Presenter 8: By Wannasiri Thurapaeng and Anirut Satiman, Thailand. (No.ICTAECT411) Topic: Developing a Blended Instructional Model through Active Learning with Digital and AI Tools to Promote Digital and AI Competencies for Educational Innovation among Pre-service Teachers at Muban Chombueng Rajabhat University.
15:45-16:00	Presenter 9: By Apiradee Dechphongsumrit, Daruwan Srikaew, Sorakrich Maneewan, Vitsanu Nittayathamkul and Chacharin Lertyosbordin, Thailand. (No.ICTAECT408) Topic: Digital Game Developer Skills in the Generative AI Era: Research Trends.
16:00-16:15	Presenter 10: By Chanchai Yothasoot, Surapon Boonlue, Saranya Chuathong and Sutiwat Supaluk, Thailand. (No.ICTAECT409) Topic: The SVEI Model: A Concept for Enhancing Career Decision-Making Competency in Vocational Education Through an Integrated Immersive Technology Framework.
16:15-16:30	Presenter 11: By Panutchaya Kunpakdee and Santirat Nansaarn, Thailand. (No.ICTAECT412) Topic: Success in Transition: A Systematic Review of Multilevel Factors Influencing Industrial Vocational Students in Thailand's Shift to the New Industrial Era.
16:30-17:00	Meeting with AECT president
*** Break will be served in the room at 15:00***	

August 6th, 2025.

Afternoon Session, at The Lounge on 10th floor (ThaiAECT room)

Session Type/Title: Paper Presentations Moderator: Associate Professor Dr. Sirirat Petchsangri	
13:30-14:00	Professor Dr.Prachyanun Nilsook , King Mongkut's University of Technology North Bangkok, Thailand (ThaiAECT Past Presidents) Professor Dr.Panita Wannapiroon , King Mongkut's University of Technology North Bangkok, Thailand (ThaiAECT Executive Committee) Associate Professor Dr.Surapon Boonlue , King Mongkut's University of Technology Thonburi, Thailand (ThaiAECT President)
14:00-14:15	Presenter 2: By Supatra Suriwong and Anirut Stiman , Thailand. (No.ICTAECT410) Topic: The Development of a Blended Learning Model According to the Whole Language Approach Combined with Artificial Intelligence to Enhance the English Communication Skills of Grade 4 Students in Schools Under the Bangkok Metropolitan Administration.
14:15-14:30	Presenter 3: By Naruemon Saengduangkhae and Angkana Jaemsai , Thailand. (No.ICTAECT413) Topic: Design and Development of Augmented Reality Learning Media on Economics in Daily Life.
14:30-14:45	Presenter 4: By Ruoqi Jiang and Poonsri Vate-U-Lan , China. (No.ICTAECT414) Topic: Generative Artificial Intelligence in the Global Classroom: Unpacking Perceptions and Relational Dynamics in Thai International Schools.
14:45-15:00	Presenter 5: By Dr. U. Ganesh Naidu, Boorla Asritha, Tirumalaraju Srujay, Dasari Rini Ruha and B. Sourav , India. (No.ICTAECT415) Topic: Warrant-Z:Digitalization of Warranty for Enhanced Efficiency and Customer Experience.
15:00-15:15	Presenter 6: By Jiajia Deng and Poonsri Vate-U-Lan , China. (No.ICTAECT416) Topic: Guidelines to Enhance eLearning Effectiveness for Teachers at Guangxi Modern Polytechnic College of Engineering.
15:15-15:30	Presenter 7: By Kridsanapong Lertbumroongchai, Ruksarat Khanankhoaw, Vitsanu Nittayathamakul, Prachyanan Nilsook and Thakorn Yuvijit , Thailand. (No.ICTAECT407)

	Topic: The Digital PR Media via 360° VR System to Enhance Local Citizens' Public Perception: A Case Study of Thotsamintra Phirom Park
15:30-15:45	Presenter 8: By Binghui Yang, Kanyarat Sriwisathiyakun and Sirirat Petsangsri, China, (No.ICTAECT418) Topic: Disciplinary Differences in Generative AI Adoption: A Comparative Study of Arts and Science Students in Chinese Universities.
15:45-16:00	Presenter 9: By Yilong Liang, Sirirat Petsangsri, Kanyarat Sriwisathiyakun and Weihui Lai, China, (No.ICTAECT419) Topic: THE EFFECTS OF MICRO-LEARNING WITH SIMULATED SCENARIO ON THE LEARNING ACHIEVEMENT AND MOTIVATION OF TELEMARKETING EMPLOYEES.
16:00-16:15	Presenter 10 : By Naphatsawan Supat, Thailand. (No.ICTAECT420) Topic: The Journey of AI-Powered Virtual Speech in Enhancing Presentation Skills for University Students and Staff.
16:15-16:30	Presenter 11: By Supanut Hamawat, Poomrapee Somtrup,Natthaphath Sinsuebchuea, WonSeok Yang, Surapon Boonlue, Thailand.(No.ICTAECT401) Topic: Comparative Study of UI and Kansei Design in ThaiMOOC and JapanMOOC.
*** Break will be served in the room at 15:00***	

Welcome session and Trend Report

AECT President – Elect Designate

August 5th, 2025



Good morning, everyone.

Thank you all for joining me today. It is truly an honor to be here. I personally enjoy speaking with small groups, as it allows for more meaningful conversations and personal connections.

I would like to take this opportunity to extend a warm invitation for you to join us in Las Vegas this November for the upcoming AECT Convention. We are delighted to have several wonderful Thai AECT members who have participated in our past events. For example, some of you may know Mr. Suanet Wentto, one of our former interns, with whom I had the pleasure of co-authoring a paper in 2021 on designing hybrid conferences in the post-COVID era.

AECT is more than just an organization—it is a place to connect, collaborate, and learn. Many of our members often say that “AECT is where you can meet your textbooks.” It is the place where the authors you’ve read become real people you can talk to, share ideas with, and learn from. AECT is, in many ways, an extended family.

Earlier today, I had the pleasure of taking a photo with students and faculty from Chulalongkorn University. I was once an AECT intern myself, and one of my dearest friends, Ava Chen, is a graduate of Chulalongkorn. I even messaged her, saying, “You’ll never believe it—I’m in Bangkok!”

Through AECT, I have had the opportunity to travel and connect globally. I have presented in South Africa, Indonesia, and at the EdTech World Conference 2016 hosted by the University of Jakarta in Bali. That experience completely changed my perspective on education—shifting my

mindset from a deficit model to an appreciation model when working with diverse student populations.

When I visited Botswana, I saw firsthand why mobile learning thrived in sub-Saharan Africa. In some universities, computer labs contained 15-year-old machines enclosed in cases to keep out desert dust. It reminded me that true innovation begins with practical solutions—and that is what AECT inspires us to discover.

AECT has given me countless opportunities to meet inspiring colleagues from around the world. And I would love for you to join us and experience the same.

Next summer, we are thrilled to announce our first truly international publishing summit, which will take place in Dublin, Ireland, around the second week of July. This event will bring together researchers and educators to collaborate on writing projects, refine manuscripts, and receive guidance from expert facilitators. We are proud to have Springer Nature as a confirmed sponsor, with their editorial team hosting sessions on open access publishing and global research dissemination.

As AECT approaches its 100th anniversary, we continue to look toward the future—asking how we can best support our members in a rapidly changing educational landscape.

Earlier today, someone asked me a thought-provoking question: “How do we avoid being replaced by AI?”

My answer is simple—by staying human. The expertise, creativity, and empathy in this very room are what will guide us into the future. Together, we must help society adapt to technology critically and thoughtfully while preserving what makes us human—our relationships, our curiosity, and our compassion.

It is inspiring to see all of you dedicating your time to be here today. I sincerely hope to meet you again at future AECT events, whether in person or online, and to continue strengthening our professional and personal connections.

Thank you once again for your attention and commitment to advancing educational technology.

Dr. Tonia A. Dousay

AECT President – Elect Designate

ICTAECT2025_01

Comparative Study of UI and Kansei Design in ThaiMOOC and JapanMOOC

Supanut Hemwa
King Mongkut's University
of Technology Thonburi
Bangkok, Thailand

Poomrapee Somtrup
King Mongkut's University
of Technology Thonburi
Bangkok, Thailand

*Surapon Boonlue

King Mongkut's University
of Technology Thonburi
Bangkok, Thailand
Suraponboonlue@gmail.com

Supanut Hemwat¹, Poomrapee Somtrup², Natthaphath Sinsuebchuea³,
Assoc. Prof. Dr. Surapon Boonlue⁴, Prof. WonSeok Yang⁵
King Mongkut's University
of Technology Thonburi
Bangkok, Thailand

WonSeok Yang

Shibaura Institute of Technology, Japan

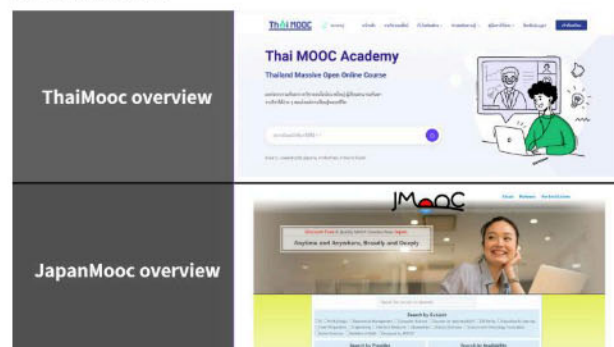
Abstract— This research examines user perceptions of User Interface (UI) and emotional experience in Massive Open Online Courses (MOOCs) from Thailand and Japan, focusing on cultural interpretation through Kansei design principles. The study aims to understand how emotional perception and visual communication differ between Thai and Japanese learners. Using a questionnaire integrating UI assessment and Kansei word-pair evaluation, 20 participants (10 Thai and 10 Japanese) were surveyed. Findings indicate that Japanese users emphasize friendliness, clarity, and modernity, while Thai users associate more strongly with formality, trustworthiness, and cultural familiarity. The study underscores the importance of culturally sensitive design for enhancing learning motivation and inclusivity in MOOC platforms.

Keywords— User Interface, Kansei Design, MOOC, Cross-cultural UX, Thailand, Japan

I. INTRODUCTION

Massive Open Online Courses (MOOCs) have transformed global education by removing geographical barriers and enabling self-paced learning. However, UI design often lacks attention to cultural and emotional factors, which can significantly affect user satisfaction. ThaiMOOC and JapanMOOC represent two regional approaches to online learning, reflecting distinct aesthetic and cultural values.

This study applies **Kansei Design**, a Japanese methodology focusing on emotional response and human perception, to compare how Thai and Japanese users emotionally interpret MOOC interfaces. The research contributes to the understanding of cross-cultural UX and aims to provide insights for designing emotionally engaging and culturally adaptive online learning environments.



II. OBJECTIVES

1. To examine Japanese users' perceptions of MOOC UI using Kansei principles.
2. To examine Thai users' perceptions of MOOC UI using Kansei principles.
3. To explore differences in UI communication and emotional perception between Thai and Japanese users.
4. To identify perceptual differences in color and visual design between ThaiMOOC and JapanMOOC.

III. RESEARCH HYPOTHESES

A. Participants

The study involved 20 participants (10 Thai and 10 Japanese). Eighteen were university students, and two were working adults. Participants were selected through accidental sampling between June and July 2025. All had prior experience using either ThaiMOOC or JapanMOOC.

B. Research Tools

The instrument consisted of two main parts:

1. **UI Evaluation Form** — assessing color scheme suitability, font readability, icon usage, navigation flow, and cultural clarity.
2. **Kansei Evaluation Scale** — assessing emotional perception using five semantic pairs: Cold–Warm, Confusing–Friendly, Untrustworthy–Trustworthy, Outdated–Modern, and Uninspiring–Motivating.

C. Procedures

Participants evaluated both MOOC interfaces and rated their perceptions on a –2 to +2 Likert scale. Open-ended comments were also collected to support emotional findings.

D. Data Analysis

Quantitative data were analyzed descriptively to identify patterns of perception across nationality groups, while qualitative responses were analyzed thematically to capture cultural tendencies and emotional differences.

IV. RESULTS

The study revealed clear cultural differences in UI and emotional perception between Thai and Japanese users.

A. Perception of Color and Visual Design

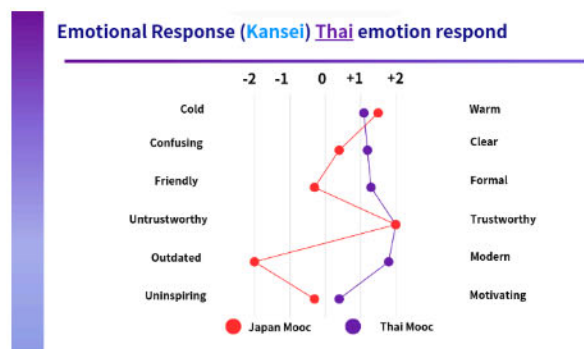
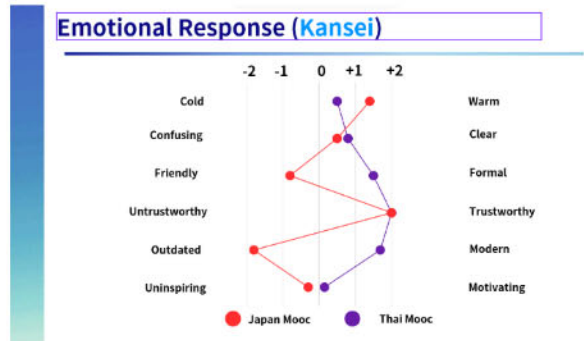
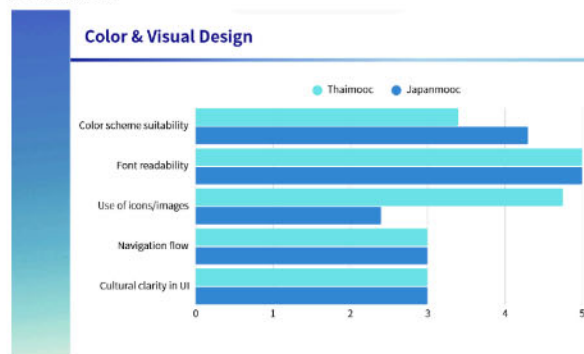
Japanese users rated JapanMOOC higher in terms of **color harmony, layout clarity, and navigation flow**, describing it as “modern and easy to follow.”

Thai users rated ThaiMOOC as “more formal and culturally familiar,” yet “less dynamic and less visually engaging.”

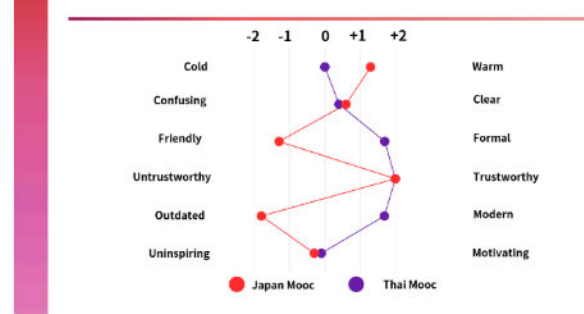
B. Emotional Responses (Kansei Evaluation)

- **Japanese users** perceived JapanMOOC as friendly, clear, and motivating.
- **Thai users** perceived ThaiMOOC as trustworthy and formal but also described it as monotonous and less inspiring.

These patterns indicate that cultural background influences how users emotionally connect with online interfaces.



Emotional Response (Kansei) Japan emotion respond



C. User Feedback Summary

Participants reported that both platforms were informative but could improve accessibility for elderly or low-tech users. Some noted that ThaiMOOC’s interface was “too formal,” while JapanMOOC felt “welcoming but slightly outdated.”

V. DISCUSSION

The findings demonstrate that cultural background shapes both visual interpretation and emotional engagement with MOOC interfaces. Japanese users valued simplicity and warmth, consistent with Kansei principles emphasizing human-centered clarity and friendliness. Thai users, influenced by hierarchical cultural norms, valued structured, respectful, and trustworthy layouts.

These insights reveal that emotional resonance in UI is as critical as functionality. The research confirms that **Kansei evaluation** effectively captures the subtle emotional impact of interface design beyond usability metrics.

From a design perspective, ThaiMOOC could improve engagement by incorporating color psychology and dynamic visual cues, while JapanMOOC could enhance local relevance through contextual imagery and cultural adaptation. Integrating these approaches would make both platforms more inclusive and emotionally appealing to global learners.

VI. SUGGESTIONS AND FUTURE WORK

1. **Community interaction:** Incorporate chat or discussion features to foster learner connection.
2. **Simplified navigation:** Redesign menus and reduce cognitive load for older and beginner users.
3. **Emotionally engaging visuals:** Use color schemes that convey warmth, energy, and motivation.
4. **Milestone recognition:** Add badges or visual feedback for learner achievement to boost motivation.
5. **Mobile-first design:** Optimize for small screens with responsive layouts and larger text.

Future studies should expand to other cultural groups and explore how emotional design influences long-term learner retention and satisfaction.

VII. CONCLUSION

This comparative study reveals that emotional and cultural factors significantly influence user experience in MOOCs. Japanese users prioritize friendliness, clarity, and modern aesthetics, while Thai users favor structure, formality, and cultural familiarity. The findings suggest that integrating Kansei design principles into educational interfaces can create a balance between emotional engagement and functional usability. Designers should therefore consider cultural sensitivity, emotion-driven layout, and inclusive UI to enhance learning motivation and accessibility for diverse global learners.

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Developing a phenomenon-based learning model with digital learning companion. To promote commercial law competencies as entrepreneurs of vocational education students, certificate level.

Suwannee Thammarathara
King Mongkut's University
of Technology Thonburi

Bangkok, Thailand Suwannee Thammarathara

Suwannee.Tha@mail.kmutt.ac.th



Surapon Boonlue

*Surapon Boonlue
King Mongkut's University
of Technology Thonburi

Bangkok, Thailand
surapon.boonlue@kmutt.ac.th

Abstract—This research aims to: 1) study the factors of commercial law competency for entrepreneurship among vocational students; 2) develop a learning model based on phenomenon-based learning integrated with digital learning companion to enhance the commercial law competency for entrepreneurship among vocational students at the certificate level; 3) investigate the commercial law competency for entrepreneurship of vocational students after learning through the developed model; and 4) evaluate the satisfaction of vocational students towards the learning model developed using the ADDIE model. The data collection was conducted in three phases. In Phase 1, the research instrument was a questionnaire on the factors of commercial law competency for entrepreneurship, with data gathered from teachers under the Office of Vocational Education Commission and entrepreneurs (vocational alumni with their own businesses). A simple random sample of 222 participants revealed three key factors of commercial law competency essential for entrepreneurship: knowledge of commercial law, skills in applying commercial law, and attributes of applying commercial law in entrepreneurship. In Phase 2, the research instruments included: 1) the developed learning model based on phenomenon-based learning integrated with digital learning companion; and 2) content and media production quality assessment forms by experts. The findings showed that the phenomenon-based learning model, known as the "aCHIC model," integrated with digital learning companion "Konsamong" Brain Lump via the LINE Official Account application, achieved high content quality ($\bar{x} = 4.98$, S.D. = 0.03) and excellent media production quality ($\bar{x} = 4.94$, S.D. = 0.08). In Phase 3, the research instruments included: 1) competency tests; 2) behavior observation forms; and 3) satisfaction assessment forms. Data were collected from a group of 40 second-year vocational certificate students in Business Computer studies during the first semester of the academic year 2024, selected through cluster sampling. The findings showed that the phenomenon-based learning model, known as the "aCHIC model," integrated with digital learning companion "Konsamong" via the LINE Official Account application, achieved high content quality ($\bar{x} = 4.98$, S.D. = 0.03) and excellent media production quality ($\bar{x} = 4.94$, S.D. = 0.08). Post-learning competencies were statistically significantly higher than pre-learning competencies (t -test = 13.88, $p < 0.05$). The skill in applying commercial law was at a good level (81.50%), while the attributes of applying commercial law in entrepreneurship were also at a good level (84.76%). The satisfaction evaluation of the students indicated a very high level of satisfaction ($\bar{x} = 4.54$, S.D. = 0.53).

Therefore, the developed learning model based on phenomenon-based learning integrated with digital learning companion to enhance commercial law competency for entrepreneurship among vocational students is practical and applicable in real-world settings.

Keywords—commercial law competency, digital learning companion, entrepreneurship, phenomenon-based learning, vocational students

I. INTRODUCTION

National Strategy Issues 2018-2037 on Human Resource Development and Potential Strengthening. It is necessary to create and develop Thai entrepreneurs to become "new-age entrepreneurs" who can keep up with and utilize technology and innovation to drive their businesses [1]. The Office of the Vocational Education Commission of Thailand has therefore developed a vocational education curriculum so that graduates have professional competencies that match their professional competencies, allowing them to immediately take up a career as practitioners or work independently. This is an important focus of vocational education management according to the Vocational Education Act of 2008, in line with the National Economic and Social Development Plan, the National Education Plan, and the National Education Act of 1999. In 2024, the quality of graduates must be consistent with the identity of the vocational curriculum, the nation, and the global context, consisting of at least 4 learning outcomes: 1. Morality, ethics, desired characteristics, characteristics according to good social norms, and personal characteristics 2. Knowledge 3. Skills and 4. Ability to apply and be responsible [2]

It is an issue that should be studied to find out which competency factors can increase the opportunity of becoming an entrepreneur for vocational students. Therefore, a review of the literature on the competency factors of McClelland [3] and Boyatzis [4] mentioned 5 competency factors: 1. Knowledge 2. Skills 3. Personality 4. Self-image and 5. Motivation. In the view of Parry [5], the last 3 factors are combined and called "Attributes". A review of the literature on phenomenon-based learning is an integration of subjects and topics

across subject boundaries. It uses a systematic teaching method in a holistic manner in a real context. It is a situation where students must use information and skills to learn. The teacher's role is to facilitate and stimulate students' learning [6, 7, 8] by selecting interesting phenomena, analyzing the learning units in order to apply them to the chosen phenomena. The teacher makes teaching fun, looks for new activities, plans the sequence of activities, encourages learners to express their opinions and participate, and summarizes the activities so that learners gain new information and skills [9, 10]. It is child-centered. Focuses on creating real-world experiences and organizing learning processes rather than imparting knowledge [11]. It is a step-by-step learning model to ensure students have acquired the correct and complete set of skills and content, allowing them to apply them to their own learning processes [12]. A review of the literature on digital learning companions (DLCs) [13, 14, 15] acts as a companion to students during learning activities, allowing them to practice iteratively [16, 17]. Similar to chatbots such as ChatGPT, it is a self-learning strategy generator and uses IT tools to facilitate learning [18]. It is an online tutoring that supports personalized, one-to-one learning, using communication technologies to provide learners with access to supplementary educational materials [19]. The role of the teacher is as a facilitator for students. Adapting flexible teaching strategies to students' needs [20]. In addition, research related to phenomenon-based learning management by Chuthamas Meesuk et al. [21], Patcharaporn Pinta and Thitiya Bongkotphet [22], Wattana Suriwan and Angkana Tungkasamit [23], Bercasio and Adornado [24], Kangas and Rasi [25], Santhalia et al. [26], Yuliati et al. [27], and Yuliati [28] found that there is no specific study on commercial law competency in promoting entrepreneurship of vocational students.

Entrepreneurship requires knowledge of the basics of law. Therefore, vocational students should have entrepreneurial competencies that support their careers in each discipline. Students should start by developing a natural entrepreneurial mindset and mastering cross-disciplinary skills. According to the study of Platts-Mills and Wapples [29], teaching law students to be entrepreneurial should create awareness of legal issues that affect entrepreneurship. Teaching law that emphasizes the recognition of new opportunities to develop students' skills, confidence to act, and readiness to succeed at the instinctive level of entrepreneurship. In addition, the study of Kuratko [30] cited Ronstadt's statement that effective entrepreneurship teaching must have an innovation drive that encourages students to use creative vision, courage, take critical risks, and be strong leaders, which are essential for entrepreneurs in the 21st century. By creating a classroom atmosphere that is conducive to innovation, drive entrepreneurship in students, using appropriate technology in teaching and learning, using Artificial Intelligence (AI) designed to enhance human intellectual

and social abilities, should be strictly monitored and supervised, and human-centered [31]. Therefore, the learning design should have teachers manage the classroom along with the appropriate use of technology.

Problems in the management of Thai vocational education: Such basic subject curricula emphasize memorization, lack of diverse and appropriate teaching media, insufficient number of teachers, and lack of expertise in the subjects being taught [32]. Therefore, the researcher sees the challenge in selecting which learning formats and digital media will help promote self-learning skills according to the level, specific needs, and learning pace of each student, promote creative collaboration, flexibility, and growth mindset for students, leading to the development of a phenomenon-based learning format with digital learning companion to promote commercial law competencies in preparing students for entrepreneurship.

II. MATERIALS AND METHODS

A. Objectives of the Study

- 1) To study the factors of commercial law competency in entrepreneurship of vocational students at the vocational certificate level.
- 2) To develop a phenomenon-based learning model with digital learning companion to promote commercial law competency in entrepreneurship of vocational students at the vocational certificate level.
- 3) To study commercial law competency in entrepreneurship of vocational students after learning with the said learning model.
- 4) To study the satisfaction of vocational students at the vocational certificate level towards the said learning model while studying in the commercial law course, vocational certificate level, year 2, Business Computer major, Bangkok College of Business Administration and Tourism, Office of the Vocational Education Commission.

B. Expected Benefits

- 1) There is a model of commercial law competency factors for entrepreneurship for vocational students at the vocational certificate level that can be used as a model.
- 2) There are self-learning resources to promote commercial law competency for entrepreneurship for vocational students at the vocational certificate level.
- 3) There are more students who are new entrepreneurs with commercial law competency in their careers.
- 4) There are teaching methods that are appropriate for vocational students at the vocational certificate level that can be applied in practice and are consistent with the educational context of Thailand.
- 5) Increase opportunities to access teaching media on commercial law for entrepreneurship for educational institutions under the Office of the Vocational Education Commission that lack teaching media and teachers of law subjects.

C. Scope of the Study

This research is divided into 3 phases and has the following research scope:

Phase 1: Study of commercial law competency factors for entrepreneurship of vocational students at the vocational certificate level.

Phase 2: Development of a phenomenon-based learning model with digital learning companion to promote commercial law competence in entrepreneurship of vocational students.

Phase 3: Use of a phenomenon-based learning model with digital learning companion to promote commercial law competency for entrepreneurship of vocational students.

The scope of the subject content is divided into 3 levels as follows:

1) Basic level is the subject content of commercial law, course code 20001-1005, competency in preparing supporting documents related to commercial law, according to the vocational certificate curriculum 2019, Office of the Vocational Education Commission, Ministry of Education.

2) Intermediate level is the content of laws related to being a modern entrepreneur.

3) Advanced level is the content about legal responsibilities that modern entrepreneurs must know. In terms of media production techniques, it is divided into 2 types as follows:

1) Learning model using phenomena as a base with digital learning partner to promote commercial law competence in becoming entrepreneurs of vocational students, consisting of 1.1) classroom management and 1.2) digital learning partner system.

2) Digital learning partner system is a model for creating interactions between artificial intelligence and students who use the system on the LINE Official Account (LINE OA) application, consisting of 2.1) the main LINE OA system (course content and chatbot) and 2.2) supplementary system, linking to external websites.

D. Method

Phase 1: Study of commercial law competency factors for entrepreneurship of vocational students at the vocational certificate level.

The development of the questionnaire on the study of commercial law competency factors for being an entrepreneur of vocational students at the vocational certificate level has the following steps:

1) Analyze the commercial law subject competency of the learner group, Thai vocational students at the vocational certificate level, and analyze commercial law competency for being an entrepreneur of vocational students at the vocational certificate level that is consistent with the vocational education qualification standards at the vocational certificate level, adapted to be consistent with the 3 competency factors of Parry [5], consisting of 1.1)

commercial law knowledge, 1.2) commercial law application skills, 1.3) commercial law application attributes for being an entrepreneur, which in terms of attributes is divided into 3 subfactors: 1.3.1) motivation to be an entrepreneur, 1.3.2) self-concept or concept about being an entrepreneur, and 1.3.3) the role of social responsibility in being an entrepreneur [3, 4].

2) Create a questionnaire to study the factors of commercial law competency necessary for being an entrepreneur of vocational students. Take it to experts to assess the index of consistency of the questionnaire (IOC) between 0.67 - 1.00 [33] and pass the certification of the assessment of ethics of human research.

3) Collect data with the sample group, using simple random sampling [34], 2 groups: 3.1) a sample group of teachers in educational institutions under the Office of the Vocational Education Commission, 178 people, and 3.2) a sample group of entrepreneurs (vocational alumni who have their own businesses), 44 people, totaling 222 people [35].

4) Analyze the factors to confirm the factors of commercial law competence necessary for being an entrepreneur of vocational students at the vocational certificate level. It was then used in developing and designing the research instruments in the second phase by analyzing statistically with IBM SPSS Amos (version 24) to examine 2 parts: Convergent validity and Discriminant validity, where the CR value was greater than 0.7, the AVE value was greater than 0.5, the MSV value was less than the AVE value, and the ASV value was less than the AVE value [35,36].

Phase 2: Development of a phenomenon-based learning model with digital learning companion to promote commercial law competence in entrepreneurship of vocational students.

The development of a phenomenon-based learning model with digital learning companion to promote commercial law competence in entrepreneurship of vocational students at the vocational certificate level and the creation of a digital learning partner system using the 5-step ADDIE Model process of media analysis and design [37, 38, 39] as follows:

Step 1: Analysis (A) Analyze commercial law course competence, learner groups, vocational students, learning models appropriate for the student context, commercial law competence in entrepreneurship of vocational students in accordance with the vocational qualification framework, and phenomenon-based learning with digital learning companion to promote commercial law competence in entrepreneurship of vocational students. Based on the concept of Orapan Butraktanyu [6], Schaffar and Wolff [7], Silander et al. [8], Daehler and Folsom [9], Shermer [10], Symeonidis and Schwarz [11], and Mathewson [12], and analyzing the digital learning peer system, based on the concept of Otanga et al. [13], Chou et al. [14], Khosrawi-Rad et al. [15], Chan and Baskin [16], Uresti [17], Schlimgach et al. [18], Tran et al. [19], Seibert et al. [20].

Step 2: Design (D) consists of 1) classroom management with teachers as facilitators throughout the classroom learning and 2) digital learning peers with AI as facilitators throughout the out-of-class learning by planning the teaching management that focuses on phenomena based on real situations or case studies, creating teaching media, exercises, tests, animations and games. Emphasizing self-learning, assignment, tracking work, included in the learning management plan that promotes prior knowledge to have commercial law competence in being an entrepreneur and designing a digital learning partner system through an application that can support teaching media in the form of videos, links, and automatic text messages, consisting of 1) subject content and 2) chatbots, which must be an application that vocational students can easily access via mobile phones and have a format appropriate for the age of the students.

Step 3: Developing (D) (Draft) a learning model using phenomena as a base with digital learning companion to promote commercial law competence in being an entrepreneur for vocational students and (Draft) a digital learning partner system in the subject content on the LINE OA application, creating standard topics that must be learned from basic, intermediate, and advanced levels, consisting of video content, online exercises, and game-based tests, so experts can assess the quality. Three people in the content and three people in the media production technique.

Step 4: Implementation (I) Try out with twenty second-year vocational certificate students in the foreign language program who had previously studied commercial law in the second semester of the 2023 academic year for two weeks.

Step 5: Evaluation (E) Analyze results and improve learning models and systems to develop learning management plans and apply them to teaching and learning with the sample group in the first semester of the 2024 academic year.

Phase 3: Use of a phenomenon-based learning model with digital learning companion to promote commercial law competency for entrepreneurship of vocational students.

3.1) Creating a commercial law competency test in entrepreneurship of vocational students at the vocational certificate level, covering 3 factors of commercial law competency in entrepreneurship: 1) commercial law knowledge, 2) commercial law application skills, and 3) commercial law application attributes in entrepreneurship, totaling 60 questions, sent to 3 subject matter experts to consider and evaluate the index of consistency (IOC) of the questions and the purpose of the questions. The IOC of the quality assessment form was between 0.67 and 1.00 [33]. It can be used for 55 questions. The experts provided suggestions to improve the questions to be more appropriate. The revised test was tested with the tryout group to select 40 questions as pre-test and post-test. The difficulty analysis result (p) was at an average of 0.56, which is an appropriately difficult (good) test [40]. The discrimination power (r) was at an average of 0.34, which

is a good (acceptable) test [41]. The reliability value was calculated using Cooter Richardson's KR-20 formula [42]. The average value was at 0.98, which has a very high reliability. Then, the test was printed. The selection of items was done by using the results of the first phase of confirmatory factor analysis to create a 20-item pre-test and a 20-item post-test, divided into 5 items on commercial law knowledge, 8 items on commercial law application skills, and 7 items on commercial law application attributes for entrepreneurship. The test was conducted with 40 second-year vocational certificate students in the Business Computer program at the Bangkok College of Business Administration and Tourism, Office of the Vocational Education Commission. The dependent sample t-test was used, with the statistical significance set at .05. The analysis was performed using a computer program, comparing the sig values with the significance level [43].

3.2) Creating a behavioral observation form for students, studying related documents, and determining the assessment issues, consisting of 1) an assessment form for the application of commercial law skills based on content at 3 levels: basic, intermediate, and advanced; 2) an assessment of the attributes of the application of commercial law in entrepreneurship, divided into 3 sub-factors: entrepreneurial motivation, entrepreneurial self-concept, and social responsibility role in entrepreneurship. Then, the advisors considered, revised, and submitted it to 3 content experts to consider and evaluate the index of consistency (IOC) of the questions and the purpose asked. The index of consistency (IOC) of the assessment form was between 0.67 and 1.00 [33]. All items can be used. The experts provided suggestions, adjusted the questions to be more appropriate, and printed them to observe the behavior of the sample group. The Rubric Score criteria were divided into 3 levels: Excellent, Competent, and Needs work [44], as follows:

3.2.1) Commercial law application skills measure skills based on 3 levels of content: 1) Basic level, competence in preparing documents related to commercial law according to the curriculum, 2) Intermediate level, being a modern entrepreneur, and 3) Advanced level, legal responsibilities that modern entrepreneurs must know. The assessment criteria are 3 levels, students should have skills at the level of "Good skills" from 80 percent and above.

3.2.2) In terms of attributes of applying commercial law to entrepreneurship, the attributes are analyzed according to 3 sub-factors: 1) motivation to be an entrepreneur, 2) concept or idea about oneself in being an entrepreneur, and 3) the role of social responsibility in being an entrepreneur. The assessment criteria are 3 levels, in which students should have attributes at a level of having good attributes from 80 percent and above.

3.3) The development of a satisfaction assessment form for vocational certificate students on the learning model using phenomena as a base with digital learning companion to promote commercial law competence in being entrepreneurs for vocational certificate students.

Study related documents, determine assessment issues, and ask for opinions divided into 5 levels [45]. The advisors consider and improve it, and then submit it to three content experts and three media production experts. Consider and evaluate the index of consistency (IOC) of the questions and the purpose asked. The index of consistency (IOC) of the assessment form is between 0.67 and 1.00 [33]. All items can be used. The experts provide suggestions, adjust the questions to be more appropriate, and print it so that the sample group can evaluate their satisfaction. The method of finding the average using frequency distribution and finding the standard deviation is used. The obtained values are calculated using the 5-level rating scale assessment criteria [45], and the average is calculated. The results are compared with the score weight [46] as follows:

- 4.51 - 5.00 means very good
- 3.51 - 4.50 means good
- 2.51 - 3.50 means moderate
- 1.51 - 2.50 means fair
- 1.00 - 1.50 means should be improved
- Acceptable value from 3.50 and up

Data Acquisition Procedure

The researcher determined the learning activities for the subject of Commercial Law, Semester 1, Academic Year 2024, for 6 weeks, using an experimental research design, one group pretest-posttest design [47].

III. RESULTS AND DISCUSSION

1. Results of the study of the factors of commercial law competence in entrepreneurship of vocational students at the vocational certificate level (Phase I)

The results of the first-order confirmatory component analysis of the factors of commercial law competence necessary for entrepreneurship of vocational students using the IBM SPSS Amos software program (version 24) obtained the following model fit index values: $\chi^2 = 85.462$, $df = 75$, relative $\chi^2 = 1.139$, $p = .192$, $RMSEA = .025$, $RMR = .016$, $GFI = .951$, $TLI = .993$, which were statistically significant at the .05 level ($p < .05$). When considering the convergent validity as a test of the appropriateness of the factors, it was found that the factors with observable variables under the real factors had AVE values between .635-.806. The reliability of each component had Composite Reliability (CR) values between .839-.925. The results of the correlation analysis between latent variables obtained the Maximum Shared Variance: MSV, which is the square of the highest correlation between two latent variables, equal to .336. Average Shared Variance: ASV, which is the average of the square of the correlation between latent variables, equal to .285. The AVE values were between .635-.806. When considering the discriminant validity, which is the test that the latent variables (construct) are different and not related to each other, it was found that $MSV < AVE$, $ASV < AVE$. The results of the second-order confirmatory component analysis of the commercial law competency factors

necessary for being an entrepreneur of Thai vocational students using the IBM SPSS Amos software program (version 24) obtained the following model fit index values: $\chi^2 = 87.015$, $df = 79$, relative $\chi^2 = 1.101$, $p = .251$, $RMSEA = .021$, $RMR = .019$, $GFI = .951$, $TLI = .995$, statistically significant at the .05 level ($p < .05$). When considering the Convergent validity as a test of the appropriateness of the factors, it was found that the factors with observable variables under the real factors had an AVE value between .635-.806. The reliability of each component had a Composite Reliability (CR) value between .839-.925. In conclusion, the factors of commercial law competence necessary for entrepreneurship of vocational students consisted of 5 factors: commercial law knowledge, commercial law application skills, entrepreneurial motivation, self-concept or idea of being an entrepreneur, and the role of social responsibility in being an entrepreneur. The last 3 factors are the attributes of commercial law application in being an entrepreneur. The results of the first and second order confirmatory factor analysis were in accordance with the specified criteria, that is, when χ^2 is divided by df , the value is less than 2, which is considered valid, as stated by Wheaton et al. [48]. The relative χ^2 is less than 2, the RMSEA and RMR indices are less than .05, and the GFI and TLI indices are more than .95, as stated by Poonpong Suksawang [36] and Schumacker and Lomax [49]. The CR value is higher than .7, indicating that the competencies are consistent and measured reliably. The MSV value is less than AVE, and the ASV value is less than AVE, indicating that the latent variables (construct) are different and not related to each other, which meets the specified criteria, as stated by Poonpong Suksawang [36] and Hair et al. [35]. Therefore, it confirms that the measurement model has sufficient quality for use in research (model fit). The opinions of the sample group confirmed that the commercial law competency model necessary for entrepreneurship of vocational students consists of 1) commercial law knowledge, 2) commercial law application skills, and 3) commercial law application attributes in entrepreneurship. It is consistent with the hypothesis and concept of competency factors of Parry [5], which in terms of attributes is divided into 1) motivation to be an entrepreneur, 2) self-concept or idea about being an entrepreneur, and 3) the role of social responsibility in being an entrepreneur, according to the concept of McClelland [3] and Boyatzis [4], and covers the criteria of vocational qualification standards at the certificate level [2].

2. Results of the development of a phenomenon-based learning model with digital learning companion to promote commercial law competence in entrepreneurship of vocational students (Phase 2)

aCHIC model is a phenomenon-based learning model with digital learning companion to promote commercial law competence in entrepreneurship of vocational students

at the vocational certificate level. There are 2 formats: 1) Classroom management with teachers as facilitators throughout the classroom learning and 2) Digital learning companion with AI as facilitators throughout the learning outside the classroom. The learning management steps are as follows:

1) A: Awareness. Creating awareness of entrepreneurship learning. Before starting to manage the learning, teachers should create awareness of the importance of having commercial law competence in vocational students to prepare them for becoming entrepreneurs. To stimulate students' interest in learning about entrepreneurship, according to the main mission of teaching management of the Office of the Vocational Education Commission

2) C: Coach. Facilitating throughout the learning. In the classroom, teachers manage the classroom by creating a learning management plan, explaining the phenomenon-based learning model, assigning students to select interesting phenomena to create their own business plans. In parallel, outside the classroom, teachers develop a digital learning partner system. By explaining the method of self-study and assigning tasks via LINE OA, Brain Lump.

3) H: Holistic. Holistic learning with a variety of learning activities from various real situations in the classroom, along with students' self-learning via LINE OA, Brain Lump. Learn content at 3 levels through videos, exercises and games, Q&A via chatbots, providing coupons, studying via additional links, and asking questions about commercial law in entrepreneurship via ChatGPT.

4) I: Identity entrepreneur. Creating your own business plan After learning by using phenomena as a base with digital learning companion to promote commercial law competence in entrepreneurship for vocational students at the vocational certificate level throughout the 6-week period, teachers monitored the students' work. Students were able to successfully create their own business plan pieces individually or in groups based on the phenomena selected by the students, along with monitoring the usage and taking tests via LINE OA, Brain Lump.

5) C: Competence. Commercial law competence in entrepreneurship for vocational students. When the learning is fully organized, it will result in promoting commercial law competence in entrepreneurship for vocational students in 3 parts: 1) Commercial law knowledge, assessed by tests, 2) Commercial law application skills, evaluated from the work of creating their own business plan and 3) In terms of the attributes of applying commercial law in being an entrepreneur, evaluated from the work behavior and attitude of the students.

The digital learning partner system, "Konsamong" Brain Lump, is a system developed through the LINE OA application, consisting of 2 main work processes as follows:

1) The main LINE OA system, teachers develop a Q&A system via chatbots, organizing teaching media content at 3 levels in the system's functions that connect to other websites such as Edpuzzle, Vonder Go, etc., setting activities to provide coupons, notifications, and other information to be put in the system's database.

2) Supplementary system, teachers create content to be a database for asking questions about commercial law in being an entrepreneur using OpenAI's ChatGPT and provide external supplementary website links that are useful for promoting commercial law competencies in being an entrepreneur of vocational students.

The course content is divided into 3 levels of learning:

1) Basic level, 2) Intermediate level, and 3) Advanced level. Each level consists of various teaching media using games as a base, as follows:

1) The developed video covers commercial law competencies for entrepreneurs for vocational students in 3 parts: 1) Commercial law knowledge, 2) Commercial law application skills, 3) Commercial law application attributes in entrepreneurship, linked to the Edpuzzle website for students to study the content in the form of video games, knowledge, and exercises together.

2) Tests in the form of games developed and linked to the Vonder Go website for students to review in the form of a competition game.

The results of the quality assessment of the content on the development of a learning model using phenomena as a base with digital learning companion to promote commercial law competence in entrepreneurship of vocational students at the vocational certificate level found that the average value of all aspects was 4.98, with a standard deviation of 0.03. When compared with the specified criteria, the overall quality was at a very good level. When considering the quality in each aspect, the item with the highest average value was the learning model using phenomena as a base with digital learning companion and the content aspect, which had a very good quality ($\bar{x}$ = 5.00, S.D. = 0.00). The second highest average value was classroom management aspect, which had a very good quality ($\bar{x}$ = 4.94, S.D. = 0.08). The results of the quality assessment of the production technique of the media on the development of a learning model using phenomena as a base with digital learning companion to promote commercial law competence in entrepreneurship of vocational students at the vocational certificate level found that the average value of all aspects was 4.94, with a standard deviation of 0.08. When compared with the specified criteria, the overall quality was at a very good level. When considering the quality in each aspect. The

first-ranked average item was the chatbot system, which had a very good quality ($\bar{x} = 4.95$, S.D. = 0.07). The second-ranked average item was the digital learning partner system, which had a very good quality ($\bar{x} = 4.94$, S.D. = 0.09). The results of the development of a phenomenon-based learning model with a digital learning partner to promote commercial law competence in entrepreneurship of vocational students used the 5-step ADDIE model design principles of Kurt [37], Rizal et al. [38], Salas-Rueda et al. [39] to develop a phenomenon-based learning model with a digital learning partner, called the “aCHIC model”, which is consistent with the concept of a phenomenon-based learning model. It integrates various subjects and topics together, teaches systematically in a holistic manner, and the role of the teacher is to facilitate and stimulate student learning, which is consistent with the results of the studies of Orrawan Butraktanyu [6], Schaffar and Wolff [7], and Silander et al. [8]. The teacher plans the sequence of activities, lets students choose phenomena of interest, and encourages them to express their opinions and participate. To provide students with new information and skills, consistent with the study results of Tawan Chaiyawan and Kulthida Nukultham, referring to Daehler and Folsom [9] and the study results of Shermer [10], focusing on students as the center, consistent with the study results of Symeonidis and Schwarz [11], and learning in a regressive and forward-facing style, to ensure that students will receive skills and content correctly and completely, and be able to apply them in their own style, consistent with the study results of Mathewson [12]. The development of a digital learning partner system via the LINE OA application called “Konsamong” Brain Lump is consistent with the study results of a learning partner system, acting as a companion for students during learning activities, and being able to practice repeatedly by Otanga et al. [13], Chou et al. [14], Khosrawi et al. [15], Chan and Baskin [16], Uresti [17], using chatbots as a self-learning strategy, and using IT tools to facilitate, consistent with the study results of Schlimbach et al. [18], is online learning that supports personalized, one-to-one learning, consistent with the study results of Tran et al. [19], the role of the teacher is to help students, adjusting teaching strategies flexibly according to students’ needs. Consistent with the results of Seibert et al.’s study [20], regardless of time and place, it is a way to motivate students to self-regulate for lifelong learning. Consistent with the results of Gebbing et al.’s study [50] and Schlimbach et al.’s study [51]. The results of the evaluation of the quality of the content and the production techniques of the media are consistent with the hypothesis, consistent with the results of Chuthamas Meesuk et al.’s study [21], Bercasio and Adornado [24], and Kangas and Rasi [25].

3. Results of the study on commercial law competence in entrepreneurship of vocational students after learning with a phenomenon-based learning model in collaboration with digital learning companion to promote commercial

law competence in entrepreneurship of vocational students at the vocational certificate level (Phase 3)

The average scores before and after learning, separated by commercial law competence in entrepreneurs of the sample group assessed from the test, found that all competences had higher average scores after learning than before learning, and the average scores after learning were more than half of the number of questions for each competence.

Comparison of commercial law competence of the sample entrepreneurs found that the competence before learning with the phenomenon-based learning model with digital learning companion had an average value of 6.30 with a standard deviation of 1.84 ($\bar{x} = 6.30$, SD = 1.84). As for the results after learning with the phenomenon-based learning model with digital learning companion, the average value was 13.03 with a standard deviation of 3.15 ($\bar{x} = 13.03$, SD = 3.15). When comparing, it was found that the level of commercial law competence of the sample entrepreneurs after learning with the phenomenon-based learning model with digital learning companion was higher than before learning, with statistical significance at the .05 level (t-test = 13.88). The average commercial law application skills competence of the sample group assessed from their own business plan creation work showed that the sample group had a score of 81.50, which is at a good level of skills (between 70-84.99). When considering the content at each level, it was found that the level with the highest average score was High, accounting for 89.38 percent (skill score 35.75 points out of 40 points). The next highest average score was basic, accounting for 80.00 percent (skill score 24 points out of 30 points), and medium, accounting for 72.50 percent (skill score 21.75 points out of 30 points), respectively. The average score of competency in the application of commercial law to be an entrepreneur of the sample group, assessed from the students’ work behavior and attitude, found that the sample group had a score of 84.76, which is at a good level (between 70-84.99). When considering each sub-component, it was found that the sub-component with the highest average score was motivation to be an entrepreneur, accounting for 87.50 percent (43.75 out of 50 points). The next highest average score was social responsibility in being an entrepreneur, accounting for 83.50 percent (20.88 out of 25 points), and self-concept or concept of being an entrepreneur. Accounting for 80.50 percent (20.13 out of 25 points), respectively.

Since the process of promoting commercial law competence in entrepreneurs for vocational students consists of organizing the content into 3 levels for students to gradually learn from the basics of legal contracts to the content of laws about being a modern entrepreneur, including the awareness of legal responsibilities that modern entrepreneurs must know, the knowledge video developed in the form of animation has content simulating the business creation situation of teenagers who have

turned into new entrepreneurs in the digital age that is close to the real phenomenon. Exercises and tests in the form of games that create interaction throughout the learning process, asking questions to stimulate learning, with teachers facilitating throughout the learning process both in the classroom and outside the classroom via LINE OA, Brain Lump, therefore, the results of the post-learning competence were higher than before learning, with statistical significance at the .05 level, consistent with the hypothesis, according to the concept of Gerald [52], and consistent with the results of the study of Funfuengfu [53], Yuliati et al. [27]. The results of the assessment of skills and attributes were consistent with the hypothesis and were training students to create their own business plans from the phenomena they chose, applying knowledge of commercial law and attributes necessary for being an entrepreneur, focusing on students as the center of learning, consistent with the teaching assessment criteria of the rubric of Ragupathi and Lee [54], which is an example of a change in clear assessment that focuses on students. Promote student success Teachers provide constructive and targeted feedback, encourage students to actively participate in creating work, change students' perspectives on their own abilities and potential, and help teachers better understand their own teaching methods.

As a result, after learning the commercial law content in entrepreneurship, students can create their own business plan work from selecting phenomena that they or their groups are interested in, creating different business models, a total of 13 businesses. All businesses are registered for e-commerce (DBD registered) to ensure that they have a real online presence, are legally registered for commerce, have knowledge of basic business contracts, business planning with consumers in mind, and how to file taxes by business type, which are important legal foundations that new entrepreneurs should know. In line with the Strategic Plan 2021–2030 of the Southeast Asian Ministers of Education Organization (SEAMEO), Sustainable Development Goal 4.4 and SEAMEO Target 7.1, which stipulates that support and increase the number of youth and adults with relevant skills, including technical and vocational skills, for employment and decent work. And entrepreneurship by 2030 [55]. This idea is also supported by the report document Entrepreneurial Learning for Vocational Education Institutions: Guidelines of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The Youth Co:Lab project [56] was established to empower youth in the Asia-Pacific region to achieve the Sustainable Development Goals (SDGs) through leadership, social innovation and entrepreneurship, and is in line with the Organization for Economic Co-operation and Development (OECD) policy on promoting entrepreneurship education in schools [56] and is consistent with the studies of Santhalia et al. [26], Wattana Suriwan and Angkana Tungkasamit [23],

Patcharaporn Pinta and Thitiya Bongkotpetch [22], Yuliati [28].

4. Results of the study on the satisfaction of vocational students at the vocational certificate level towards the learning model using phenomena as a base with digital learning companion to promote commercial law competence in being an entrepreneur of vocational students at the vocational certificate level (Phase 3)

Overall, the satisfaction was at the highest level, with an average of 4.54 and a standard deviation of 0.53. When considering each aspect, it was found that the item with the highest average value was the aspect of promoting commercial law competence in being an entrepreneur of vocational students, with the highest level of satisfaction ($\bar{x}$ = 4.59, S.D. = 0.52). The next highest average value was the aspect of learning model using phenomena as a base with digital learning companion, with the highest level of satisfaction ($\bar{x}$ = 4.53, S.D. = 0.52) and the aspect of teaching management of teachers, with a high level of satisfaction ($\bar{x}$ = 4.49, S.D. = 0.56), respectively. Therefore, the learning model using phenomena as a base with digital learning companion to promote commercial law competence in being an entrepreneur of vocational students at the vocational certificate level that was developed can be applied in practice.

Due to the development of the aCHIC model learning format in a step-by-step manner, the use of LINE OA brain cube technology and teaching media, easy access to the sample group and appropriate for the age group, having teachers and AI to provide advice and facilitate throughout the learning, experts evaluating the quality of both content and media production techniques, including the use with the experimental group before collecting real data, the satisfaction assessment results are consistent with the hypothesis and consistent with the study of Wattana Suriwan and Angkana Tungkasamit [23].

IV. CONCLUSION

The development of a phenomenon-based learning model with digital learning companion to promote commercial law competence in entrepreneurship of vocational students at the vocational certificate level with the aCHIC model has 2 forms: 1) classroom management with teachers as facilitators throughout the classroom learning and 2) digital learning companion with AI as facilitators throughout the learning outside the classroom using the digital learning partner system, "Konsamong" Brain Lump, developed through the LINE OA application. The subject content is divided into 3 levels of learning: 1) basic level, 2) intermediate level, and 3) advanced level. Each level consists of various teaching media using games as a base, resulting in the development of commercial law competence necessary for entrepreneurship of vocational students, including commercial law knowledge,

commercial law application skills, and commercial law application attributes in entrepreneurship (including motivation for entrepreneurship, concepts or ideas about oneself as an entrepreneur, and the role of social responsibility in entrepreneurship). This allows students to create their own business plan creation work from selecting phenomena that they or their groups are interested in, creating different business models, totaling 13 businesses. All businesses are registered for e-commerce (DBD registered) to certify that they really exist online, are registered for business according to the law, and have basic business contract knowledge. Business planning with consumers in mind and how to file taxes according to business type are important legal foundations that new entrepreneurs should know.

Limitations

1) The learning content has three levels, each level promotes three competencies. Therefore, the learning activity period using phenomena as a base with digital learning companion should be extended to more than 6 weeks so that students can learn gradually according to their own learning pace and so that teachers can enhance various activities in the classroom to promote commercial law competencies in becoming entrepreneurs for vocational students even more.

2) The digital learning partner system has a limitation in the LINE OA automatic menu bar. It can only be learned via mobile phones. However, this problem can be solved by allowing users to call it via a chatbot system instead.

3) Teachers can use the results of this component analysis to plan teaching in a format that is appropriate for the context of their own classrooms. They should focus on organizing learning at a level where students can actually apply the law in their professions. One of the goals of vocational education is to create independent careers. Therefore, this study helps to promote vocational students to be ready, build confidence in becoming entrepreneurs, and create awareness of being entrepreneurs who must create businesses on a legal basis.

Suggestions for Further Research

From the study results, it was found that the classroom is still the place of highest learning and learning with friends in the classroom is the most appropriate form. In addition, students like learning through game-based learning. Therefore, the researcher is interested in studying more about the guidelines for organizing classroom activities that emphasize interaction between students and teachers. From the study of additional research, it was found that there is still no application of phenomenon-based learning models with board games or gamification in organizing activities in vocational commercial law subjects. However, in order for vocational students to be prepared for the changes to Thailand 4.0 to become businesses that use digital technology (Smart Enterprises) and new technology entrepreneurs (Startups) with high

potential, teachers should assign students to create business plans. In order to provide teaching media and digital learning resources that can further enhance students' digital technology potential.

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The Effect of e-Sports of Analytical Thinking of undergraduate students of The Faculty of Education, Mahasarakham University

Ratasa Laohasurayodhin
dept. Educational Technology and
Communications,
Faculty of Education Mahasarakham
University, Mahasarakham, Thailand
ratasa.l@msu.ac.th

Sirimonpak Suwannakhun
dept. Learning Innovation and Technology
King Mongkut's University of Technology
Thonburi, Bangkok, Thailand
sirimonpak.sut@kmutt.ac.th

Sirawit Chaihang
dept. Electrical Technology Education,
King Mongkut's University of Technology
Thonburi, Bangkok, Thailand
sirawit.chai@kmutt.ac.th

Abstract— Objective To study the external environmental factors in playing electronic sports (e-Sports) that affected critical thinking of undergraduate students in the Faculty of Education. This research was divided into two parts including quantitative research and qualitative research. The research participants were 138 third-year undergraduate students majoring in Sports Science and Educational Technology and Communications, the Faculty of Education, Mahasarakham University selected by convenience sampling. The researchers distributed and assessed questionnaires online using the research instrument that was a questionnaire and assessment of higher-order thinking skills. The questionnaire and assessment was divided into the following sections as follows. Part 1 dealt with the respondents' general information and Part 2 included a critical thinking skills assessment. The statistics used for data analysis were mean, percentage, and standard deviation. The environmental factors in playing electronic sports (e-Sports) that affected higher-order thinking of undergraduate students in the Faculty of Education include (1) experience in e-Sports (2) preferred e-Sports game types (3) average playing hours per week (4) time spent playing e-Sports (5) in-game communication and (6) out-of-game e-Sports-related communication. 2) The analysis of higher-order thinking skills among undergraduate students in the Faculty of Education who studied and played e-Sports revealed that 82.6% of the participants demonstrated analytical thinking skills. Implications: The results of this research provide a guideline for developing innovative teaching and learning methods by applying gamification principles which involves designing

Keywords— e-Sports, analytical thinking, gamification

I. INTRODUCTION

The rapid changes in technology require changes along with the development of essential 21st-century skills. These changes influence teaching and learning methods of lecturers. The essential 21st-century skills include learning and innovation skills, information, media and technology skills and life and career skills. These skills rely on higher order thinking skills as a basis for developing skills to achieve greater effectiveness.

In addition to classroom learning, we must acknowledge that technology plays a major role in enabling interactions outside the classroom. However, such interactions are often not the intellectual interactions that lecturers anticipate. One of the interactions outside the classroom is e-Sports which is widely popular and very active. By upgrading from computer games on network systems to a recognized sport, following the approval and recognition of e-Sports as a sport by the Sports Authority of Thailand (SAT) under the Sports Authority of Thailand Act B.E. 2558, e-Sports has been accepted as a type of sport, similar to other brain-intensive sports such as Go, Chess, Bridge, Snooker and others. This has made electronic sports, or e-Sports attract attention due to its widespread global recognition. Furthermore, it was included as a sport category in the 2022 Asian Games. e-Sports requires complex planning, precise timing, and the right amount of actions which require analytical thinking. Therefore, e-Sports can effectively help students in developing their analytical thinking skills. Tisana Khemmani (2002) [2] describes thinking skills or basic thinking skills as a simple thinking process, serving as a basic skill for advanced or higher-level thinking skills, which involve complex processes. These skills are expressed through actions or behaviors that require thought and are divided into two types: basic thinking skills and higher-order thinking skills.

As mentioned above, the researcher was interested in studying the analytical thinking skills of undergraduate students in the Faculty of Education who studied and played electronic sports (e-Sports) and investigating the factors in e-Sports that affected the analytical thinking of the students. Bloom's Taxonomy (Bloom, 1956) [5] including analysis, synthesis and evaluation was applied. The aim was to identify the level of analytical thinking skills among students who played e-Sports and to determine the factors that affected these skills. The findings can serve as a guideline for developing teaching and learning methods that promote analytical thinking skills and can be applied to enhance the effectiveness of teaching other skills.

II. RESEARCH OBJECTIVES

- 1) To study the environmental factors in playing e-Sports that affected the analytical thinking of undergraduate students in the Faculty of Education.
- 2) To study the analytical thinking skills of undergraduate students in the Faculty of Education who played e-Sports.

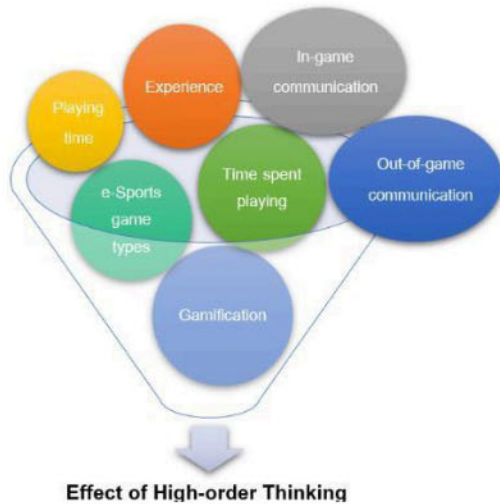


Fig. 1. Conceptual Framework The effects of e-Sports on critical thinking

III. METHODOLOGY

Population included 157 third-year undergraduate students majoring in Educational Technology and Communications and Sports Science.

The sample included 138 third-year undergraduate students majoring in Educational Technology and Communications and Sports Science selected by convenience sampling. The researcher distributed an online questionnaire to them.

Research instrument

A research instrument employed in data collection was an online questionnaire which was divided into two parts. Part 1 dealt with respondent background information aiming to gather the information about experience in e-Sports, gender, preferred e-Sports game types, average playing hours per week, time spent playing e-Sports in-game communication, player interactions and playing channels. Part 2 included assessment of critical thinking skills.

Research instrument

The researcher carried out the following procedures.

- 1) The researcher digitized the questionnaire to suit social media.
- 2) The researcher distributed the questionnaire through social media channel to the population with cooperation from lecturers in the Department of Sports Science and the Department of Educational Technology and Communications.
- 3) Upon completion, the researcher retrieved all completed questionnaires through social media and used

the data for further research procedures.

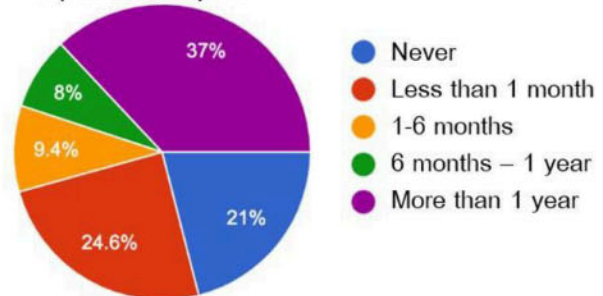
IV. RESULTS

This research is quantitative research aiming to investigate the environmental factors in electronic sports (e-Sports) that affected the analytical thinking of undergraduate students. The research also employed qualitative research method to explore the analytical thinking skills of undergraduate students in the Faculty of Education who played e-Sports. Both quantitative and qualitative data consisting of the numerical data and non-numerical data such as descriptive texts, narratives and explanations of observed events was analyzed to evaluate and draw conclusions. The scope of the research is as follows.

Results from the Quantitative Analysis

The environmental factors in e-Sports that affected the analytical thinking of undergraduate students in the Faculty of Education based on the respondents background information asking about experience in e-Sports, preferred e-Sports game types, average playing hours per week, time spent playing e-Sports, player interactions and playing channels were as follows.

Experience in e-Sports

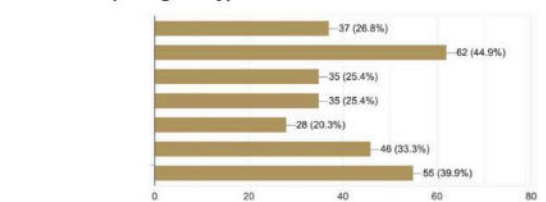


Students had experience in e-Sports

More than 1 year	51 respondents represent 37%
6 months – 1 year	11 respondents represent 8%
1 – 6 months	13 respondents represent 9.4%
Less than 1 month	34 respondents represent 24.6%
Never	29 respondents represent 21%

Fig. 2. Experience in e-Sports

Preferred e-Sports game types



FPS (First-person Shooter)	37 respondents represent 26.8%
MOBA (Multiplayer online battle arena)	62 respondents represent 44.9%
RTS (Real Time Strategy)	35 respondents represent 25.4%
FIGHTING Game	35 respondents represent 25.4%
SPORT Game	28 respondents represent 20.3%
BATTLE ROYALE	46 respondents represent 33.3%
MMORPG or RPG	55 respondents represent 39.9%

Fig. 3. Preferred e-Sports game types

Average playing hours per week

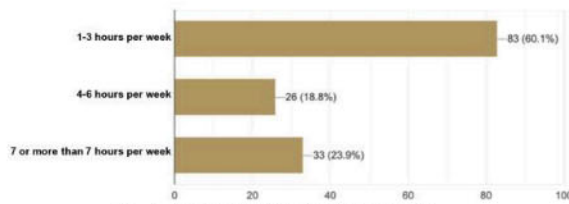


Fig. 4. Average playing hours per week

As shown in Figure 4 the average playing time was highest during the evening. The majority of students (83 students) spent 1-3 hours per week playing e-Sports, representing 60.1%, followed by 26 students who spent 7 hours or more per week and 26 students spent 4-6 hours per week, representing 18.8%.

Time spent playing e-Sports

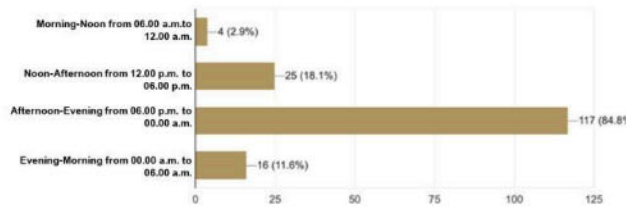


Fig. 5. Time spent playing e-Sports

The time the students spent playing e-Sports the most was from 06.00 p.m. to 12.00 a.m. with 117 students, representing 84.8%, followed by from 12.00 p.m. to 06.00 a.m. with 25 students, representing 18.1%. The time from 12.00 a.m. to 06.00 a.m. with 16 students, representing 11.6%, and from 06.00 a.m. to 12.00 p.m. with 4 students, representing 2.9%.

How often do the students have in-game communication to exchange ideas per playing time?

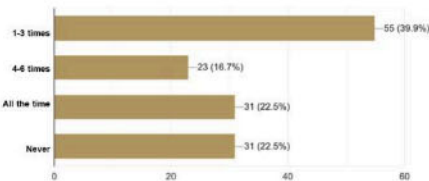


Fig. 6. How often do the students have in-game communication to exchange ideas per playing time

The most frequent in-game communication was 1-3 times with 55 students, representing 39.9%. The second most frequent in-game communication was 'all the time' and 'never' with 32 students, representing 22.5%. The third most frequent in-game communication was 4-6 times with 23 students, representing 16.7%.

How often do the students have out-of-game communication per week?

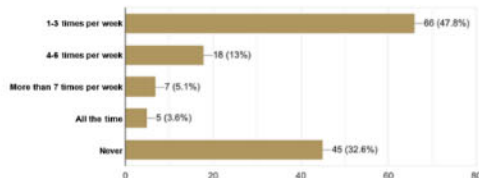


Fig. 7. How often do the students have out-of-game communication per week?

The most frequent out-of-game communication was 1-3 times per week with 66 students, representing 47.8%. The second most out-of-game communication was 'never' with 45 students, representing 32.6%, followed by 4-6 times per week with 18 students, representing 13%, 7 times per week with 7 students, representing 5.1% and 'all the time' with 5 students, representing 3.6%.

Results from the Qualitative Evaluation

The assessment results of higher-order thinking skills according to the components of analytical thinking of the Office of the Basic Education Commission (2005) of undergraduate students in the Faculty of Education who played electronic sports (e-Sports) were as follows.

Analytical Thinking

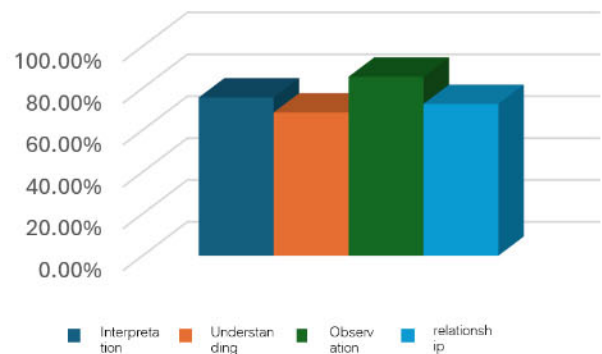


Fig. 8. Time spent playing e-Sports

According to analytical thinking skills in terms of interpretation, the students tried to understand and reason what the lecturers wanted them to analyze to interpret the meaning. The interpretation was based on experiential knowledge, representing 75.6%. In terms of the students' understanding, the students were able to distinguish sub-components and prioritize what the lecturers asked them to analyze, representing 68.4%. In terms of observation, 68.4% of students were able to detect abnormalities and think and reflect, representing 80.5%. In terms of relationships, the students searched for casual relationship, identifying causes, related factors and effects, representing 72.5%.

V. DISCUSSION AND CONCLUSION

1) The environmental factors in playing electronic sports (e-Sports) that affected the analytical thinking skills of undergraduate students in the Faculty of Education are as follows.

a) Regarding experience in e-Sports, the primary e-Sports experience was that 51 students had more than 1 year of experience in playing e-sports, representing 37%. This indicated that e-sports had external factors motivating students to continue playing for over 1 year. This may be due to gamification dynamics, which are the players' behaviors or reactions driven by game mechanics. These behaviors or reactions attempt to respond to basic human needs in playing games. The characteristics of basic human needs in gaming align with Jaitip Na-songkhla (2018) [1],

which described gamification as the application of game principles to non- game contexts to motivate learning. The use of learner behavioral responses with game mechanics is a response to basic human needs.

b) Considering preferred e-Sports game types, the first preferred e-Sports game type was MOBA (Multiplayer Online Battle Arena) selected by 62 students, representing 44.9%. This demonstrates that a majority of the students preferred to play in groups or teams. The nature of this game type is to collaborate, support and cooperate with each other which involves role assignments and coordination to overcome opponents or obstacles within the game. Most students preferred to play this game type because they wanted to exchange information and fulfill each other. This is in line with the principles of intrinsic factor gamification, which involves using internal motivation processes and behavioral design to engage players. This includes motivation related to relatedness, autonomy, competence and achievement. This also aligns with Vygotsky's social constructivism theory stating that collaborative activity facilitates knowledge exchange among learners. This is consistent with the research findings of Surapon Seesurong (2008) [4] who investigated the computer gaming behaviors of students in Mueang Chiang Mai District in Chiang Mai Province. The study showed that most of the students preferred playing online games with friends in groups rather than playing alone.

c) As for average playing hours per week, 83 students played e-Sports 1-3 hours per week, representing 60.1%. This could be because most students played games on smartphones which have small screens of about 6 inches or less. This caused eye fatigue, stress, neck pain, eye pain and Cellphone Elbow that causes pain, numbness or tingling in forearms and hand, trigger finger and headache.

d) Regarding time spent playing e-Sports, it was found that the heaviest e-Sports playing time was from 06.00 p.m. to 00.00 a.m. with 117 students, representing 84.8%. This time was the time when the students finished their classes and other activities such as exercising and having dinner and considered a personal free time when they could play e-Sports continuously until midnight. The reasons for stopping before midnight could be that most students had classes in the morning. This is consistent with the study by Tarin Sawaekchan (2009), [3] investigating the behavior and effect of online game media exposure among secondary school students in Mueang District, Surat Thani. The findings indicated that a majority of students played online games was from 04.00 p.m. to 08.00 p.m.

e) Regarding in-game communication, the most frequent amount of in-game communication was 1-3 times with 55 students, representing 39.9%. This was due to the nature of the game requiring players to coordinate and

exchange information during game time. If there is constant communication or no communication at all, players might not be able to achieve the goal.

f) Considering out-of-game communication, the most frequent amount of out-of-game communication was 1-3 times per week with 66 students, representing 47.8%. This might be due to the ongoing relationships between players, leading them to communicate and exchange information after the game. Notably, there was a higher percentage of out-of- game communication than in-game communication. This may be because communication and exchange of information after the game involved past performance, error analysis and synthesis of a game plan for the future, resulting in a higher percentage of out-of-game communication compared to in- game communication.

2) The results of the analytical thinking skills of undergraduate students in the Faculty of Education who studied and played electronic sports (e-Sports) indicated that the students had analytical thinking skills in interpretation, representing 75.6%. This means that the students who played e-Sports had average analytical thinking skills at a very good level. This was because e-Sports enable students to understand and give reasons for what the lecturers wanted them to analyze in order to interpret the meaning based on experiential knowledge. The students' understanding represented 68.4%.

This might be because the students were able to distinguish sub-components and prioritize what the lecturers asked them to analyze. The observation represented 80.5% as the students were able to detect abnormalities and reflect. The relationship represented 72.5% as the students searched for casual relationships, identifying causes, related factors and effects and saw the relationships between related parts. Analytical abilities vary depending on individual thinking. The students could apply knowledge and experience to solve problems in different situations which requires knowledge and understanding to achieve effective application. The students could integrate smaller parts into one story systematically to create something new that is more complete and better than before through easy-to-understand communication to others. This involves creating new plans or methods of operation or generating ideas that establish relationships between abstract concepts in new forms or frameworks. Furthermore, the students had the ability to judge, evaluate, or conclude the value of things in the form of morality with appropriate criteria that may align with the content or with socially accepted norms.

VI. RECOMMENDATIONS

1) It is recommended to study e-Sports playing behavior to determine which online game types the sample group prefers as adventure and strategy games typically have less violent content. The objective of playing online games

is primarily for entertainment, enjoyment, pleasure and stress relief. Regarding the emotional impact of online games, the students were relaxed and relieved from stress when playing. The sample most frequently played online games from 4.00 p.m. to 8.00 p.m. which was the heaviest time the students played e-Sports and it was after school. This time was the time when the students should do homework, work on assignments or do activities with family or friends. If excessive time is spent playing e-Sports during this time without proper time management, it can negatively impact students' academic performance and relationships with family and friends. Therefore, the primary issue with e-Sports gaming involves time management and students should allocate their gaming time appropriately.

2) Multifaceted effects of e-Sports should be investigated to consider both potential benefits and drawbacks. On the positive side, whether online gaming can stimulate creativity in education and intellect should be studied, nurture new social connections among family and friends and provide emotional stress relief. On the negative side, e-Sports may cause students to experience eye problems. Thus, it is important to allocate playing time appropriately and avoid prolonged screen time. Players should blink, close their eyes or take a 5–10-minute break before returning to the screen to protect their vision from prolonged screen time. Furthermore, e-Sports can increase students' expenses. Therefore, financial planning is necessary to avoid affecting daily expenses.

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Adapting Teacher Roles in the Age of Online Learning: A Study of Primary School Educators' Experiences in Beijing

Min Zhang
School of Industrial Education
and Technology,
King Mongkut's Institute of Technology
Ladkrabang Bangkok, Thailand
Min.Zhang@kmitl.ac.th
ORCID : 0009-0000-1741-7134

Kanyarat Sriwisathiyakun
School of Industrial Education and
Technology,
King Mongkut's Institute of Technology
Ladkrabang
Bangkok, Thailand
Kanyarat.sr@kmitl.ac.th
ORCID: 0000-0002-4533-6400

John Morris
Faculty of Engineering Mahasarakham
Universtiy Mahasarakham, Thailand
John.m@msu.ac.th
ORCID: 0000-0003-0539-1189

Abstract—The study aimed to provide a clear image of how primary school teachers adapted to online teaching. Online learning caused dramatic changes in teacher roles: we aimed to learn from the Era of Artificial Intelligence to prepare teachers to better cope with similar changes in the future. We investigated teacher and student roles during online teaching, as in many countries, Chinese teachers were forced to adapt to online teaching during the lockdown. We surveyed 182 teachers to collect opinions on their roles and interactions in primary schools in Beijing, China. The questionnaire sought opinions on changes in teacher roles when the lockdown prevented traditional in-class teaching.

We focused on the challenges faced by the need for teachers to change their role, differing from the many papers that discussed the effects on and behaviors of students during online teaching. Self-perceived satisfaction with online teaching has not to date been a focus. Improve interactions with students through technology and social media. Primary educational institutions are preparing for future disruptions to traditional teaching models. The results showed that many teachers considered it there was a lack of teacher-student interaction in online classes and difficulty in keeping all students motivated. It meant that online teaching also required innovative teaching methods, assume the results of this study will be able to supplement earlier findings and provide an increased understanding of the elements that contribute to developing countries take interest in online education.

Future researchers should focus on teacher gender and student performance to check gender effects on primary student achievement in online teaching. The results of this study will supplement earlier findings and provide an increased understanding of the elements that contribute to developing countries that take an interest in online education.

Keywords—Online teaching activities, Teacher roles, Teacher challenges, Gender effects, Primary school.

I. INTRODUCTION

By 2019, conventional classrooms were shut down, and more teachers turned to online teaching [1]. Therefore, it was time to rethink, reform, and redesign the system: we desperately needed a jump away from the status quo: both non-formal and formal education were affected. However, it was assumed that no teaching method could replace formal education, with direct interaction of teachers and students. Thus, the external environment has changed, leading to a pedagogical shift from traditional to modern teaching methods from classroom to online meetings, from personal to virtual, from seminars to webinars [2].

The benefit of online learning was that it leveraged modern digital media technology and the web to provide teachers and students with an excellent method of material delivery that is not limited by time and place; it can be accessed from anywhere at any time. Parents found the online environment was a convenient way for primary school students to follow teachers' lesson plans, even if they are busy with work and did not have time to manage children's home schooling. Someone noted that there were some benefits to using online learning: it increased the variety and creativity of learning activities, allowing for recording online interactions. Also, it improved students' learning outcomes.

Hence, we discuss the teacher's role in supporting primary education and parental engagement during online teaching. We analyzed teachers' online activities, roles in online teaching, and challenges in the sudden migration to online teaching, and lessons that were learned, which could be stepping stones to education reform. Our research questions were:

- 1) What are teachers' roles in online teaching?
- 2) Do gender affect their roles?

II. LITERATURE REVIEW

A. Online teaching activities

Athuraliya [3] listed ten online teaching activities to diversify student experiences, including brainstorming, Q&A sessions, storyboarding, virtual field trips, concept mapping, collaborative worksheets, building activities, online debates and presentations, timelines, and biography graphic organizers. Harasim [4] recommended that teachers working online plan upcoming activities and engage in a dialogue to guide students. Teachers provided a group structure that enabled students to solve problems or assume tasks, formulate strategies to standardize and coordinate their (collaborative) learning; teachers needed to be present, but must play background roles. Typical activities were to set the stage by establishing a warm environment and providing clear direction and support structure; monitor and encourage participation by following student activities to make expectations clear and build a response ability; use a proper (collaborative) teaching model. Teachers should form groups, allocate role responsibilities, establish norms and standards, plan and organize the interaction framework, and also offer social and emotional support. According to [5] found that, since the learning management system was the main learning platform in online education, learning activities were very important to easily attract students to participate and enhance motivation. The motivation must come from not just the students themselves, but teachers must be involved in motivating students to learn; it will enthruse students to know the learning direction. When students have the desire to learn, they will be motivated, therefore, they must motivate themselves so that the learning goals can be best achieved. The purpose of online teaching activities at this time was to prepare students to compete in the digital age, so the process was made easier for scheduling assignment deadlines or study materials, sending assignments on time and having longer study [6].

B. Teacher roles in online teaching

In a traditional classroom, the teacher's role was directive, rooted in authority, but in online teaching, the role is as a facilitator or guide: roles should be interactive and rooted in negotiation. During online teaching, teachers were changing traditional roles and moving to new ones. They became active participants, mentors, consultants, and guides when they worked closely with students online and helped students improve their learning techniques[7]. From the traditional classroom, where the teacher was the leader, they became helpers and facilitators for students: 'new' teachers needed to encourage students in "cognitive reconstruction" [8], through allowing students to discuss online to improve cognitive awareness, their beliefs and expectations about learning major subjects, e.g. English and mathematics. Through such discussions, teachers promoted the development of learner autonomy [9]. Overall, these studies supported online teaching methods; they showed that students appreciated their active teacher

participation. From communication with their teachers, students were motivated and improved their learning efficiency. Teachers provided support by setting a correct tone for discussion and contributing to the development of community consciousness. Regarding the teacher's role, students also had a role: at the beginning, students needed or appreciated active teaching guidance, but it should gradually transform into a different middle role towards the end of the discussion [10].

In three years, the global crisis changed traditional pedagogical methods and forced teachers to learn how to teach online. The focus shifted to teachers, urged them to operate online courses and quickly learn to build relationships and interactions to facilitate online learning. The teacher's role rapidly evolved [11].

C. The teacher challenges

Woltran et al. [12] found that when Austrian primary teachers were asked the major professional challenges they faced in remote teaching, in addition to workload, they reported a lack of technical equipment and digital skills. Some teachers reported that due to the rapid transition of remote teaching and a lack of preparation, they did not understand how to teach virtually. Several staff claimed that the transition to remote teaching was especially challenging for older colleagues, who had less experience with new technologies. Furthermore, Kundu [13] suggested that technical difficulties, such as sudden interruptions in internet connectivity, often further exacerbate already challenging situations for teachers.

III. CONTRIBUTIONS

We focused on the challenges faced by the need for teachers to change roles during online teaching, differing from papers that have discussed the effects and behaviors of students during online teaching.

Self-perceived satisfaction with online teaching has also not to date, been a focus.

IV. SURVEY DESIGN

Questionnaires were designed for teacher roles. The questionnaires had three main parts connected to teacher roles in public primary schools:

Basic information, teachers' gender, educational background and subjects of instruction.

Questions – 20 items, using a 5-point Likert scale, about roles in online teaching and open-ended questions.

The questionnaire was checked by three experts (two Chinese teachers and a Thai teacher) to verify its Index of Congruency (IOC): they rated congruence on a (1,0, +1) scale.

Because the participants were Chinese, we designed the questionnaire, both in Chinese and English, and then posted the bilingual text on Questionnaire Star [14]. We sent the website link or posted the QR code to WeChat groups, where participants were invited to complete the

online questionnaires – one for teachers and another for parents.

Ethical approval was not requested for this study because risks and harms to participants were not anticipated in a simple survey of a non-sensitive topic. Basic ethical principles were followed; no vulnerable groups (e.g., ethnic minorities, people with disabilities, children) were surveyed.

V. DATA COLLECTION

Questionnaires were sent to respondents who taught online, section one reports numeric data - means, standard deviations, and t-tests. Section two discusses data from the open-ended survey. We explored teaching activities and personal factors in the online teaching of primary school teachers and parents. The gender effect on role was checked in a t-test.

Numeric data from the questionnaires was scored as in >4.5-5.0 - strongly agree; in >3.5-4.5 - agree; in >2.5-3.5 - moderate; in >1.5-2.5 - disagree; and in 1.0-1.5 - strongly disagree.

VI. RESULTS

TABLE I. PARTICIPANT GENDER

Item	Number	Gender	Count	Fraction
Teachers	182	Female	107	59%
		Male	75	41%
Total	182		182	100%

VII. DATA ANALYSIS

Participants derived their feedback from learning activities, personal teaching experiences, or discussions. Teaching self-perception is the ultimate feedback in online teaching. Therefore, investigating self-perceived satisfaction with online teaching should help us better understand online teaching – see Table 2.

Responses used a 5-level Likert scale. Response normalizes were checked by Kolmogorov-Smirnov (K-S) and Shapiro-Wilk (S-W) tests: they were highly skewed, so standard deviations only provided a rough variance indication, and kurtosis better described the response distribution.

Note that in the following tables, the conventional $\alpha = 0.05$ was used as the criterion for accepting a hypothesis.

TABLE II. TEACHER RESPONSES: LEARNING ACTIVITIES IN ONLINE TEACHING (N = 182)

TL	Items	$\bar{x}$	S.D	K-S S-W	Skew	Level
1.	Lack of computer skills made it difficult for me to use online teaching	3.7	1.2	0.23 0.87	-0.66	Agree
2.	Lack of support for pupils with special needs	3.9	1.1	0.28 0.82	-1.04	Agree
3.	Lack of teacher-student interaction in online classes	4.0	1.1	0.25 0.83	-0.99	Agree
4.	Lack of innovative teaching methods	3.5	1.2	0.17 0.89	-0.24	Moderate

5.	Lack of interest and involvement during online teaching	3.7	1.2	0.22 0.87	-0.61	Agree
6.	Lack of work satisfaction while teaching online	3.7	1.1	0.22 0.87	-0.45	Agree
7.	Lack of technical issues affected the flow and pace of online teaching	3.8	1.2	0.23 0.86	-0.74	Agree
8.	Harder to organize students to participate or answer questions in online class	3.6	1.2	0.23 0.87	-0.63	Agree
Overall		3.7	1.2			Agree

Table 2 shows that for learning activities in online teaching, teachers generally agreed with the questions posed – TL1 – TL8, with mean responses, $\bar{x}=3.5$ to 4.0. The strongest response was TL3 “Lack of teacher-student interaction in online classes” ($\bar{x}=4.0$), the second problem was TL2 “Lack of support for pupils with special needs” ($\bar{x}=3.9$). In the schools surveyed, special needs students were not separated and there was a disproportionate response concerning their needs. However, teachers generally agreed that use of innovative teaching was lacking; this was the weakest response and teachers felt less strongly about this.

TABLE III. PERSONAL FACTORS IN ONLINE TEACHING (N = 182)

TL	Items	$\bar{x}$	S.D	K-S S-W	Skew	Level
1.	It was my first experience with online teaching	3.3	1.4	0.19 0.88	-0.23	Moderate
2.	I had some experience with online teaching	3.3	1.2	0.22 0.90	-0.34	Moderate
3.	I haven't had any experience with online learning	3.1	1.2	0.19 0.91	-0.24	Moderate
4.	As a teacher, I think online teaching was flexible	3.3	1.1	0.21 0.90	-0.40	Moderate
5.	I think online classes help me to use innovative teaching	3.3	1.1	0.19 0.91	-0.35	Moderate
6.	I can use wide range of tools for online teaching	3.3	1.2	0.17 0.91	-0.21	Moderate
7.	I can give feedback on students' progress in time	3.6	1.1	0.24 0.89	-0.58	Agree
8.	I can make the students want to cooperate with me	3.5	1.0	0.23 0.89	-0.51	Moderate
9.	It is difficult to keeping all pupils motivated and engaged	4.0	1.0	0.27 0.81	-1.16	Agree
10.	It is difficult to keep classes for longer duration during online classes	4.0	1.1	0.26 0.81	-1.19	Agree
11.	It is difficult to control group interaction during online classes	3.9	1.1	0.27 0.83	-0.97	Agree
12.	It is difficult to communicate with parents/caregivers	3.7	1.1	0.24 0.87	-0.69	Agree
Total		3.5	1.1			Agree

As Table 3 showed, for personal factors, which included teaching experience in online teaching, flexibility, communication and interaction, teachers generally agreed with the questions – PF1- PF12, mean responses, $\bar{x}=3.5$. The strongest response was for PF9, “It is difficult to

keeping all pupils motivated and engaged”, and PF10, “It is difficult to keep classes for longer duration during online classes” $\bar{x}=4.0$. Overall, many teachers felt it was difficult to maintain longer classes during online teaching, and to keep students motivated and engaged.

TABLE IV. T-TEST: TEACHER ROLES VERSUS GENDER (N=182)

Teacher role	Gender									
DV	IV		N	$\bar{X}$	S.D	Levene's Test		t	df	Sig.
						F	p			
PART 1	male	75	182	3.7	0.9	0.43	0.51	0.1	180	0.46
Learning activity online teaching	female	107	182	3.7	0.9					
Part 2	male	75	182	3.5	0.5	6	0.02	<0.01	121	0.5
Personal factors in online teaching	female	107	182	3.5	0.8					

n = number of students

$\bar{x}$ = mean

S.D. = standard deviation

Sig = significance level

Table 4 showed significant differences in teacher roles in online teaching versus gender in learning activities. Levene's test confirmed homogeneity of variance between the two groups ($F = 0.43$, $\text{sig} = 0.51 > \alpha$), so a t-test was appropriate, returning $p = 0.46 > \alpha$, so the null hypothesis (the two groups are the same) was accepted and we concluded that gender had no influence on learning activities. However, following the same steps, for personal factors, the t-test returned $p = 0.5$, implying that there was no significant gender difference.

VIII. FINDINGS

A. Lack of teacher-student interaction in online classes

Lewin et al. [15] used group dynamics theory to study the influence of different leadership styles on youth behavior in a small youth group and found that teacher leadership behaviors in the classroom could be divided into three categories: authoritative, democratic, and laissez-faire styles. In the authoritative style, teachers mainly relied on their own authority and used coercive means to manage students. They only allowed students to obey and did not allow different opinions. They were not respectful, enthusiastic, or even mean to students. Students were often afraid and hostile towards teachers, or blindly or superficially obeyed but violated behind, or openly refused. In the democratic style, teachers respected, loved, cared and trusted students, attracted and influenced students by their own virtues and talents, promoted democracy, so that students loved and admired teachers. In

the laissez-faire style, teachers were neither harsh, rude, loving or caring towards students, and usually adopted an indifferent and laissez-faire (leave things as they are) attitude. Students did not show any positive feelings towards teachers [16].

B. Lack of support for students with special needs or disabilities

Lim [17] found that, despite efforts to connect with students, using some digital tools of online teaching platforms, some basic functions became cumbersome without setting

them up in advance. A sticking point was that teachers mentioned conducting online practical classes, which was difficult during the lockdown, because it required a systematic demonstration of the whole process in front of the students. While some teachers were already competent in online teaching, including live streaming, pre-recorded teaching sessions, facilitating discussions on digital platforms, providing assessments, and receiving feedback, there is significant background preparation needed to prepare staff, students, and infrastructure for a smooth transition of courses to online learning.

C. It is difficult to keep all pupils motivated and engaged

All teachers expressed the opinion that student motivation was an important concern [18]. Martin [19] reported that, to help students better plan short-term tasks, teachers can show them, so that they can figure out what the task is in their own minds, take time to think about how to complete the task, and spend a little more time. The meeting records were planned before the start of the task and prepared for the plan. For medium and long-term tasks, they could encourage them: carefully consider the steps of preparing tasks, plan to complete the task timetable, and then formulate short-term strategies when performing this task. In addition to the plan, teachers could also help students monitor the answers and check progress.

Moreover, some challenges were structural (for example, equipment, learning platforms, and internet access); some were human resources (for example, teacher training); some were political resources (for example, national policies and local technical use policies), whereas others were symbolic (for example, the message from the supervisor's emergency remote learning). As a school leader, who is uncertain, we must focus on greater prospects. We must resist the impulse to solve the problem without paying attention to the core issues: increasing students' participation. By putting students first, we may find innovative methods to educate students, we have never previously considered [20].

In online teaching methods, teachers had difficulty motivating learners; they faced a problem to preserve the record of student progress, especially in online teaching, where there were larger numbers of students. In order to motivate online learners, the learning environment should be designed in an attractive manner; teachers should focus

on critical learning rather than knowledge -based learning. Even after facing all the challenges of online teaching, there were new technologies to motivate learning and find the best use of all resources for effective teaching [21].

A key item in parent personal factors was “You care about your child's physical and mental health.”

Schools should provide training for parents and learners so that they are familiar with new instructional models and theories of child psychology, to help children achieve the expected learning outcomes. Many studies found that mental health positively predicted academic performance [22], and that mentally healthy people [23] had better academic performance; on the other hand, some studies claimed that poor mental health was associated with higher academic achievement [23 24]. However, Marques [26] showed that mental health had no significant effect on academic performance. overall, de-spite conflicting studies about the relationship between mental health and academic performance, the purpose of this investigation was to determine whether mental health did indeed play a role during the online teaching [27].

IX. DISCUSSION

After collecting and analyzing the data obtained from 182 teachers, we set out the key finding in three sections answering the research questions:

RQ1: What are the teacher's roles in online teaching?

One of the early models of a teacher in the virtual environment was a character model of the lecturer. This model determined the function of the teacher from four different aspects: teaching, society, management, and technology [28]. The role is defined in the online discussion environment. The teaching role meant promoting learning in the discussion. Societal roles meant encouragement and promoting joint efforts. Management considered the logistics of the organization and the design discussion. Technical effects included providing learners with a transparent technical environment [29]. These roles were proposed when the teacher had just moved to the design of the main class activity to online discussion [30].

Abdous [31] reported that the teacher roles were preparation, planning, design, facilitation, interaction, providing or gathering feedback, and reflection. Bigatel et al. [32] identified teacher roles embodied in active learning, active teaching or responsiveness, administration or leadership, classroom decorum, policy enforcement, multimedia technology, and technical competence. Farmer & Ramsdale [33] found that the teacher's roles in online teaching were reflected in leadership and guidance, active teaching, community and netiquette, tools and techniques, and instructional design.

From face-to-face to online instruction, effective education systems depend on improvements in teacher professional roles during online teaching and follow-on

blended instruction. A United States survey showed that although there was a shortage of teachers before online teaching, less than 60% of teachers on average valued new knowledge and teaching computer technology to compensate for this lack [34]. In several countries, for example, Sweden, Spain, Vietnam, Singapore, the Philippines, or China, this proportion reached 100%. The role of the teacher was being updated and enhanced at an unprecedented rate to meet the needs of today's society [34].

RQ 2: Do gender affect their roles?

59% of participants were females in this study. Other research examined differences that stemmed from gender imbalances in primary schools, where teachers were predominantly female. Indian researcher, believed that the academic performance of students was related to the female teachers in the classroom. Male and female teachers had different views on learning ability, and the classroom of female teachers was particularly beneficial to language learning. In 2006, Dee found that the gender of teachers did have an impact on academic performance; that is, girls' grades improved more easily in classes with female teachers, whereas boys' learning abilities in language and other aspects were limited to some extent. At the same time, he found that students' interest in learning was also affected by gender factors. Female teachers were likely to think that girls were better disciplined, whereas boys did not pay enough attention in class. However, Dee's [35] views were questioned by Weaver, president of the American Education Association, who believed that teacher experience and the quality of textbooks were the main factors affecting grades. In this regard, Dee emphasized that his conclusions should not be oversimplified, and he hoped that more scholars would pay attention to and devote themselves to the research of this topic [35].

Research by UNESCO [36] demonstrated that female teachers teaching children had better results than male teachers. Female teachers were described as more patient, compassionate, gentle, and good at discussion with students [37]. Simpson & Erickson [38] also supported this, showing that female teachers gave students more verbal and non-verbal recognition than male teachers. Carrington & Skelton [39] believed that a teaching career helped to break down stereotypes and prejudices; men who were teachers may still face different issues, such as hostility and suspicion in their workplaces, because teaching is still largely perceived as a female task.

On the other hand, gender impacted teacher behavior. Antecol et al. [40] found that female teachers may affect student learning outcomes, as they may have higher math anxiety (particularly in elementary schools), which, in turn, may negatively influence students. In addition, female teachers may structure their classes differently, choose topics, and provide examples differently from male

teachers.

Challenges teachers faced in adapting to online teaching

One of the challenges faced by teachers during online classes was difficulty engaging students. Nowadays, students are compelled to switch to online education. It is a new method for students to learn. This made it challenging for teachers to engage students in online instruction. Students gained knowledge at home. Thus, even during the live meetings, people easily became distracted and lost focus.

Another difficulty of distance learning for both teachers and students was communication. Both parties should exchange information and communicate with all students efficiently. Students ought to be able to talk to you readily on the same day. They might then raise their own questions to obtain answers. By adhering to some communication etiquette on both sides, this obstacle can be managed easily. According to König et. al. [41] adaptive teaching was particularly regarded as a crucial component of high-quality learning.

Moreover, primary school students often could not keep up, thus time was also one of the challenges of online teaching. When they specified class times, they knew they should arrive at school at that time. They knew that if they did not, they would be punished. However, they did not follow the time schedule in online learning. Therefore, teachers should make sure they commit to time for communication. On the other hand, poor attendance was a challenge experienced by teachers [42].

Online teaching was almost devoid of body language communication. It is possible that students did not capture the correct meaning and information, which in turn produced poor performance or low-class participation. To overcome this, teachers needed to be flexible with students in terms of assignments and deadlines. Teachers needed to recognize the need to engage with students to get to know them and plan activities that help them achieve their goals. Discussions, problem-solving sessions, and practical assignments fostered student communication and interest [43].

X. CONCLUSION

The teacher's role delivery of technology-based online teaching.

Concerning the teacher's role in online teaching, we found that many teachers considered it there was a lack of teacher- student interaction in online classes and difficulty in keeping all students motivated. It meant that online teaching also required innovative teaching methods.

This study suggested that the teacher's roles were to facilitate the structure, process, beliefs, and strategies necessary for learner autonomy to become a reality. Finally, it helped teachers and staff responsible for service

delivery. They should use innovative teaching strategies to increase student engagement and interaction in online courses. Since female teachers experienced greater difficulty carrying out their professional responsibilities during online teaching, gender became a significant issue. These suggested possible research directions to better understand how to handle this issue in the event of future calamities.

The authors declare that they have no conflict of interest. Data will be made available on request.

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Development of Team Working in Higher Education with Project-based Learning for Designing Research Framework of Geospatial Artificial Intelligence (GeoAI) to Manage Natural Resources and Environment

*Note: Sub-titles are not captured in Xplore and should not be used

Yaowaret Jantakat
Department of Information and
Communication Technology Faculty of
Sciences and Liberal Arts Rajamangala
University of Technology Isan Nakhon
Ratchasima, Thailand
<https://orcid.org/0000-0002-4222-741X>

Chomphak Jantakat
Department of Business Administration
Vongchavalitkul University Nakhon
Ratchasima, Thailand chomphak_@vu.ac.th

Pongpun Juntakut
Security Science Institute National
Defense College
National Defense Studies Institute Royal
Thai Armed Forces Headquarters
Bangkok, Thailand
juntakut37@gmail.com

Abstract—The objective of this paper is (1) to achieve working together from participation of Master and Doctoral students with teaching method of Project-based Learning (PBL) and (2) to achieve the designed research framework of Geospatial Artificial Intelligence (GeoAI) to manage natural resources and environment. This study was worked by team of 6 Master and 2 Doctoral students in 3 institutions (Rajamangala University of Technology Isan (RMUTI), Vongchavalitkul University (VU) and National Defense Studies Institute of Royal Thai Armed Forces Headquarters (RTAFH)). Later, they were assigned to design the research framework together under research processes, including identifying the problem, evaluating the literature, creating hypotheses and designing research framework. Based on literature review, they were assigned to interview the related experts about the application of GeoAI for managing natural resources and environment. The results found that such participated Master and Doctoral students above can design and create the research framework and find answers for the assignment of lecturer to design the research framework together under such topics above. Consequently, this PBL and for lecturers and Master and Doctoral students must develop or improve and learn how to use more advanced AI technology (e.g., agentic AI) for implementing multi-disciplinary.

Keywords—*Project-based Learning, Higher Education, Research Framework, Artificial Intelligence, Geospatial data*

I. INTRODUCTION

Applied geo-information system technology (AGST) is a subject for Master and Doctoral students, which is part of the Master and Doctoral of Science Program in Applied Information and Communication Technology, Faculty of Sciences and Liberal Arts, Rajamangala University of Technology ISAN (RMUTI), Thailand. Therefore, lecturers and higher educators must develop or improve and learn advanced geospatial technology (AGT) especially using Geospatial Artificial Intelligence (GeoAI) in education, for example, Y. Liang and colleagues [1] proposed a family of GeoAI-enhanced unsupervised community detection methods called region2vec based on Graph Attention Networks (GAT) and Graph Convolutional Networks (GCN), C. Zhou [2] explored the historical path of GIS development and the integration of GIS with emerging technologies, such as cloud- native infrastructures, the Internet of Things, and GeoAI, G. Mai and colleagues [3] provided a quantitative analysis of the GeoAI literature from the spatial, temporal, and semantic aspects and highlighted several unique future research directions of GeoAI which are classified into two groups: GeoAI method, B. Fu and colleagues [4] presented an integrated analysis of current research hotspots in geography and the interdisciplinary approach of geography in tackling global challenges, including climate change, urbanization, and sustainable development is highlighted, S. Wang and colleagues [5] explored the relationship between subjective (human-perceived) and objective (measured) characteristics of the built environment through a pilot study conducted in the Melbourne

metropolitan area. Using street-level imagery from the Mapillary platform and deep learning techniques, we quantify perceived built environment characteristics across the “5D” urban design dimensions: Density, Diversity, Design, Distance to transit, and Destination accessibility, and P. Sibandze and colleagues [6] employed remote sensing data and a Convolutional Neural Network (CNN) to assess flood probability and risk in Port St Johns, South Africa, utilizing thirteen flood-influencing variables to minimize overfitting and extract robust features, addressing complex terrain and climate variability. These papers can conclude that the impact of GeoAI on teacher leadership depends on how it is implemented and integrated into the education system. It highlights the importance of continued research and training in this area to inform future education policies and practices.

Moreover, using approach of Project-based Learning (PBL) may be useful for promoting 21st century learning and skills in higher education. Thus, PBL can be described as a collaborative inquiry-based teaching method in which students integrate, apply, and construct their own knowledge while working together to create solutions to complex problems [7-9].

Therefore, this study focuses on a PBL teaching approach for developing critical thinking and team working in higher education by applying GeoAI to manage natural resources and environment in the AGST-subject. The objective intended (1) to achieve working together from participation of Master and Doctoral students with teaching PBL-method and (2) to achieve the designed research framework of GeoAI to manage natural resources and environment. Consequently, the teaching and learning outcomes of these higher educators will be taken to plan teaching in the courses of the AGST-subject further.

II. LITERATURE REVIEW

A. Project-based learning

Project-based learning (PBL) is a highly effective pedagogical approach designed to promote the development of practical skills and encourage deeper learning [10]. As a teaching mechanism that emphasizes active knowledge construction, it enables learners to respond to practical problems that arise, as well as to create, test, and realize solutions to such problems based on academic knowledge, which promotes creativity abilities [7, 11]. Moreover, two recent review articles show the state-of-the-art research on the importance of project-based learning in higher education [12]. Firstly, P. Guo and colleagues [7] found that studies have extensively focused on measuring ‘learners’ knowledge, strategies, and skills in applying academic knowledge in practice following project-based learning. These issues are consistent with teachers' perceptions of what kind of basic knowledge and

skills are necessary for students' readiness to be learners who are developed by critical thinking, team working, and communication skills. Secondly, Chen and Yang [13] explored a range of research on PBL as a strategy for enhancing students' academic achievements. This educational research found very few studies on the use of PBL at the graduate level and even fewer on PBL as a mechanism for bridging the gap within the social sciences and humanities. PBL possesses several characteristics that make it a very effective teaching method as Figure 1.



Figure 1: A nutshell PBL

Source: University of Dayton (2023)

B. Geospatial Artificial Intelligence (GeoAI)

GeoAI has emerged as a rapidly evolving, cutting-edge research domain within Spatial Data Science, as well as the broader fields of geography and geoscience in recent years [14]. The rapid development of GeoAI can be largely attributed to the increasing availability of high-quality geospatial data (e.g., location-based social media data, remote sensing imagery, geo-tagged ground-level images), significant advancements in machine learning (ML) hardware (such as NVIDIA's GPU and Google's TPU), and the advancement of AI and GeoAI models, including various geo- foundation models [3].

III. METHOD

This project required generating the designed research framework of GeoAI to manage natural resources and environment based on PBL. The 8 higher educators (6 Master and 2 Doctoral students from 3 institutions (Rajamangala University of Technology Isan (RMUTI), Vongchavalitkul University (VU) and National Defense Studies Institute of Royal Thai Armed Forces Headquarters (RTAFH)), was selected by method of purposive sampling. They were assigned to design the research framework

together under topics of research process steps such as Figure 2 and more details below:

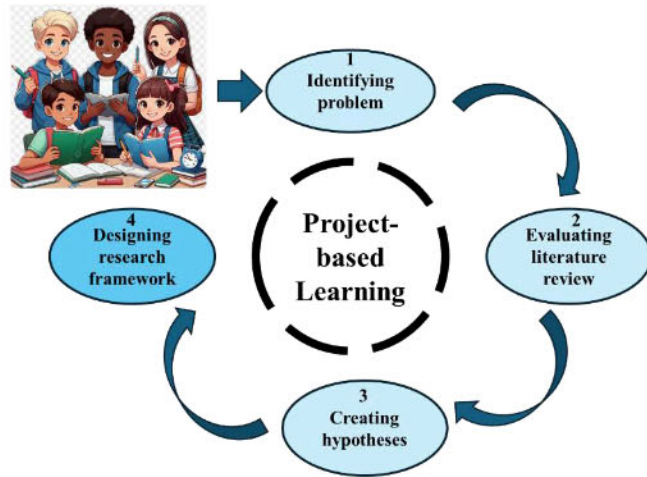


Figure 2: Steps for the designed research framework-based PBL

IV. RESULTS

Results of the research framework were designed by the purposive sampling of 8 higher educators for designing research framework of GeoAI to manage natural resources and environment based on PBL as Figure 3.



Figure 3: The Development of critical thinking and team working for higher educators in designing research framework with teaching method of PBL.

Their designed research frameworks were assigned by processes of teaching guidelines such as:

1. Definition of the problem: They were assigned by defining this research problem was studied from the preliminary survey, case studies, interviews with concerned experts, and observational survey, and questions were set to be guided for finding issues and scope of study respectively as follows:

- 1) What are GeoAI techniques for supporting natural resources and environmental management in Thailand?
- 2) What are the key functions and considerations to implement GeoAI?

3) What are studied data-based key functions and considerations to implement GeoAI from concerned sources?

4) How is GeoAI worked for managing natural resources and environment in Thailand?

2. Literature review: They were assigned by topics from guiding of teacher as below:

- 1) Background of natural resources and environmental management in Thailand
- 2) Examples of natural resources and environmental management in Thailand based on geoinformatics technology
- 3) The utilization of GeoAI for managing natural resources and environment in Thailand

3. Hypothesis: Writing in the margins has always been an essential activity for higher educators. Annotation helps in reading comprehension and in developing critical thinking and team working about course materials. Hypothesis enables students to continue this essential activity with online reading. Digital annotation also offers new advantages, enabling students to respond to text using different media and empowering them to collaborate on understanding and developing ideas about their readings. This study focused on hypotheses of such research questions above can explore as:

1) What are GeoAI techniques for supporting natural resources and environmental management in Thailand?

- Research Hypothesis: it is hypothesized which GeoAI techniques for supporting natural resources and environmental management in Thailand are.

2) What are the key functions and considerations to implement GeoAI?

- Research Hypothesis: it is hypothesized what the key functions and considerations to implement GeoAI are.

3) What are studied data-based key functions and considerations to implement GeoAI from concerned sources?

- Research Hypothesis: it is hypothesized what the studied data-based key functions and considerations to implement GeoAI from concerned sources are.

4) How is GeoAI worked for managing natural resources and environment in Thailand?

- Research Hypothesis: it is hypothesized how GeoAI worked for managing natural resources and environment in Thailand is.

4. The designed research framework

The research framework was designed by 8 higher educators from 3 Thai institutions (RMUTI, VU and RTAFH), can summarize as Figure 4.

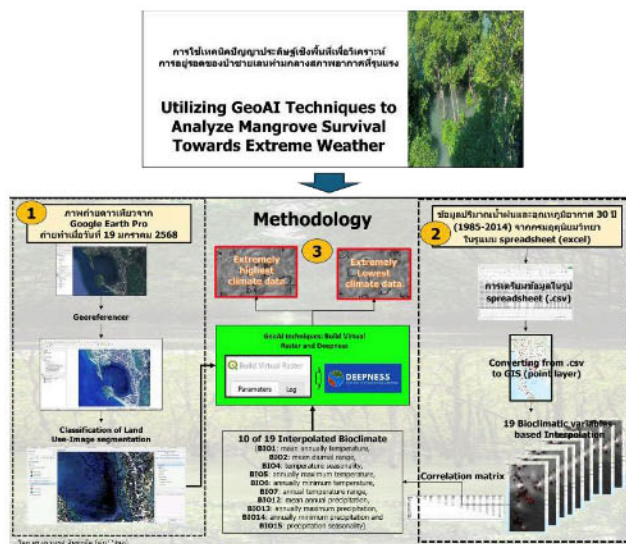


Figure 4: Results of the designing research framework of GeoAI to manage natural resources and environment based on method of PBL

V. CONCLUSIONS

The utilization of teaching method of PBL for designing research framework of GeoAI to manage natural resources and environment based on PBL. This study selected participation of 8-higher educator were determined by purposive sampling, they could generate the research framework. Moreover, they can find answers for the assignment of lecturer to design the research framework together under topics of research process steps such as identifying the problem, evaluating the literature, creating hypotheses and designing research framework.

Further research PBL should be recommended on the theories that can help explain and guide the development of higher educators' GeoAI knowledge and skills in both formal and informal education, and effective ways to incorporate the use of GeoAI thinking into teacher preparation programs. Furthermore, over the study, lecturers have faced advances in technology system in geospatial technology including cloud- based geospatial technology applications and increasingly sophisticated software, etc. Consequently, lecturers and higher educators must develop or improve and learn how to use advanced geospatial technology for research.

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ARChem: Augmented Reality Tool for Enhanced Visualization and Understanding of Atomic Structures in Pre-University Chemistry Education

Wan Nurhidayah A Karim
Centre for Foundation Studies in
Science,
Universiti Malaya
Kuala Lumpur, Malaysia
wannurhidayah@um.edu.my

Syazreen Nadia Sulaiman
Centre for Foundation Studies in
Science,
Universiti Malaya
Kuala Lumpur, Malaysia
syazreen@um.edu.my

Che Mohd Farhan Che Mat Dusuki
Centre for Foundation Studies in
Science,
Universiti Malaya
Kuala Lumpur, Malaysia
chean285@um.edu.my

Ahmad Danial Azzahari
Centre for Foundation Studies in
Science,
Universiti Malaya
Kuala Lumpur, Malaysia
ahmad_danial@um.edu.my

Mahfuzah Yusoff
Centre for Foundation Studies in
Science,
Universiti Malaya
Kuala Lumpur, Malaysia
mahfuzahyusoff@um.edu.my

Muhammad Farris Khyasudeen
Faculty of Electrical Engineering
Universiti Teknologi Mara
Selangor, Malaysia
farris4317@uitm.edu.my

Abstract— This study explores the integration of Augmented Reality (AR) into the teaching of atomic structures to pre- university students through a tool called ARChem. Traditional teaching methods often fail to effectively convey the three- dimensional nature of atomic orbitals (s, p, d), leaving students with conceptual gaps. ARChem addresses this issue by providing interactive, 3D visualizations developed using Apple's Reality Composer [1],[2]. The module includes scientifically accurate orbital models and accompanying student/teacher guides. Implemented with Life and Physical Science streams at the Centre for Foundation Studies in Science, Universiti Malaya, the approach was evaluated using pre- and post-tests and qualitative student feedback. Results indicate improved understanding, greater engagement, and adaptability to various learning styles [3],[4]. The findings suggest that ARChem is especially effective in high student-to-teacher ratio environments, providing a scalable and innovative teaching solution [5], [6].

Keywords— augmented reality, atomic orbitals, pre-university education, chemistry teaching, 3D visualization

I. INTRODUCTION

In recent years, advancements in technology have transformed educational methods, providing new tools for enhancing student engagement and comprehension [7], [8], [23]. Augmented Reality (AR) is an innovative technology that superimposes digital information such as images, videos, or 3D models onto the real-world environment through devices like smartphones, tablets, or AR glasses. AR creates an interactive and immersive experience that enhances the learning process by making abstract or complex concepts more tangible and easier to understand [7], [8], [19].

In education, AR has been increasingly adopted to teach subjects ranging from history to science, offering a

dynamic alternative to traditional teaching methods [9], [10], [18]. In the field of chemistry, understanding complex concepts like atomic structure and orbital shapes is crucial yet challenging, especially for pre-university students.

These orbital shapes (s, p, and d orbitals) is crucial to understand the way atoms interact and connect, but they can be difficult to grasp using only two-dimensional textbook pictures alone [11], [12]. Traditional methods using textbooks and static diagrams often fail to fully convey the three- dimensional nature of atomic orbitals, leading to difficulties in comprehension. The transition from classical to quantum mechanics poses a significant cognitive challenge for pre- university students [13], [14], [24].

II. OBJECTIVES

Hence, the purpose of this project is to leverage AR technology to teach pre-university students about atomic structure, specifically focusing on the shapes of s, p, and d orbitals [15]. By integrating AR into the curriculum, the project aims to:

- i. **Enhance Visualization:** Provide students with a clear, interactive, and three- dimensional visualization of atomic orbitals, making abstract concepts more concrete and understandable [1], [15].
- ii. **Increase Engagement:** Utilize the interactive and immersive capabilities of ARChem to make learning more engaging and enjoyable, tapping into students' familiarity with gaming and technology [6], [16].
- iii. **Improve Comprehension:** Facilitate a deeper understanding of atomic structures and orbital shapes

through hands-on and experiential learning, moving beyond the limitations of traditional textbooks.

iv. Adapt to Learning Styles: Cater to the diverse learning preferences of modern students, many of whom are visual and kinesthetic learners, by incorporating technology that supports these learning styles [20], [21].

By incorporating ARChem into the teaching of atomic structure, the goal is to create a more dynamic and effective educational experience that aligns with the technological tendencies of contemporary students, ultimately fostering a stronger grasp of fundamental chemistry concepts.



Fig. 1. The teaching session of atomic orbitals conducted with traditional approaches.



Fig. 2. The teaching session of atomic orbitals conducted with ARChem approach

Details of Content

In classical mechanics, students are taught that the electron orbits an atom in a way similar to how a planet orbits the sun. Students become familiar with this concept right up to Form 5 of schooling.

Upon entering pre-university level, they are introduced to a new school of thought based on quantum mechanics. In quantum mechanics, it is described that the electron takes the characteristics of both particles and waves (wave particle duality). The orbit thus becomes uncertain. However, the location of the electron can still be described

in terms of probability densities, and this takes the shape of atomic orbitals (contained within a region of 3D space as opposed to the 2D pathway in classical mechanics), and the shapes will vary depending on the principal quantum numbers.

Most pre-university students have a tough time and lack the academic maturity to transition from the mindset of classical mechanics to quantum mechanics.

A. Atomic structure ARChem module Development

Project Creation: In this work, 3D content was created using Apple's Reality Composer app. The selected models are scientifically accurate, representing the various types of atomic orbitals (s, p and d), tailored to the teaching syllabus for pre-university students [1],[2],[15], [29].

The 3D models, along with a description of how these objects behave into a file that can be added to the Reality Composer app. This composition can be exported as a lightweight AR experience that lets users (the students) place and preview content.

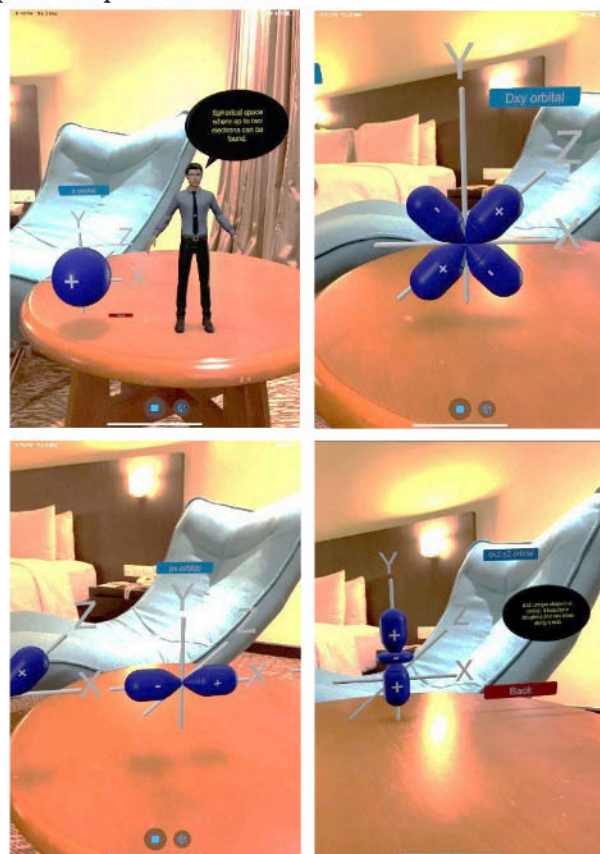


Fig. 3. Shows the various types of atomic orbitals in ARChem

B. Atomic structure ARChem manual for student and teachers.

Tutorials and Guides: Step-by-step tutorials and user guides that explain how to download the ARChem. To view a 3D model in AR using a USDZ file on an iPhone or iPad, start by opening the camera app and scanning the QR code

provided. A notification will appear, tap it to access the link and download the USDZ file.

Next, open the Files app and locate the USDZ file. Tap and hold (long-press) the file icon, and from the menu that appears, select "Quick Look." This will launch the file in AR mode. Your device's camera will activate, and you'll be asked to scan a flat surface, such as a table or floor. Once detected, the 3D model will appear in real environment. Move the device to view the model from different angles, zoom in, rotate, and explore the object as if it were physically in front [9], [28].

III. IMPLEMENTATION THE TEACHING METHODS

A. Teaching and guidance methods: initial setup for students.

- Customization and Exploration: Users start by choosing a real-world object that should anchor the scene, like a horizontal surface or floor. Then the virtual elements are positioned within the scene. Features such as zoom, rotate, and scale are included to facilitate detailed examination of the orbitals [3], [6].
- Interactive Learning: Interactive learning sessions were facilitated where students manipulated the AR models in real-time, asked questions, and engaged in discussions about the properties and significance of atomic orbitals [12], [16], [17].

B. Atomic Structure Module

- Training for Educators: Brief training sessions were conducted for participating educators to familiarize them with the AR tool and instructional materials.
- Identify Schools: A diverse range of schools and classrooms can be selected to participate in the module, ensuring representation from various educational settings. Specifically, in our work, the module was implemented with groups of Life Sciences 1, Life Sciences 2, Physical Sciences 1, and Physical Sciences 2 classes, all of which are part of the Centre for Foundation Studies in Science.
- Selection of classrooms: Life Sciences 2 and Physical Sciences 1 was selected as the control group (traditional approach). Life Sciences 1 and Physical Sciences 2 was selected as the group with the AR approach.

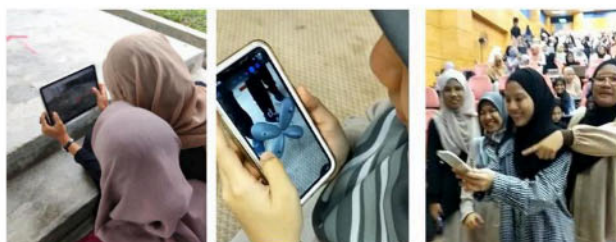


Fig. 4. Shows the implementation of ARChem activities

C. Evaluation and Assessment

- Measuring Learning Outcomes: Pre- and Post-Tests: Assessment tools, including pre- and post-tests, to measure students' understanding and retention of atomic orbitals before and after using the AR tool [4], [5], [25].

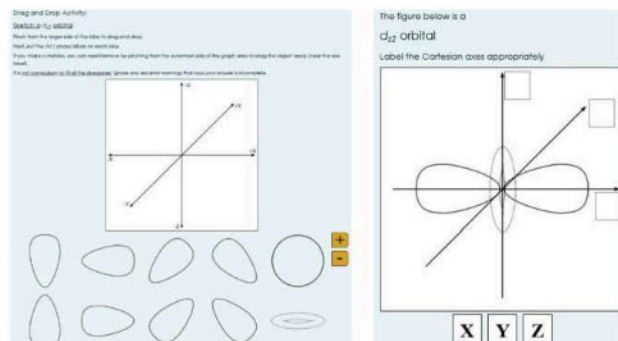


Fig. 5. Shows the examples of gamified drag and drop quizzes from UM SPECTRUM Moodle (modular object-oriented dynamic learning environment)

- Collect Feedback: qualitative feedback was gathered from students regarding their experiences with the AR tool. Surveys and classroom observations were used to collect data [11], [14].
- Data Analysis: The collected data was analyzed to assess the impact of the AR- enhanced learning module on students' comprehension and engagement.

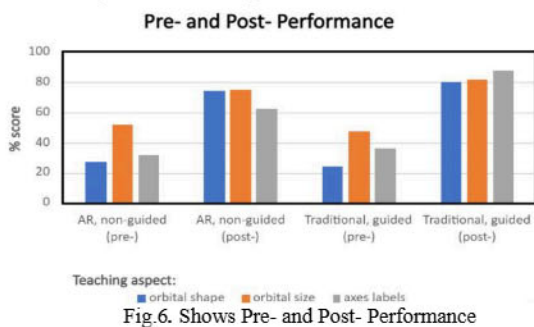
IV. REPORTING RESULTS

- Evaluation Report: An evaluation report was compiled to summarize the findings This includes quantitative data from assessments and qualitative feedback from participants.
- Recommendations: Feedback data from participants have provided recommendations for further development and wider implementation based on the evaluation results [26], selected feedback are as shown below:
 - Could see the shape of orbitals in 3D
 - AR Visualization helped me to imagine the shape
 - I had fun during the lecture!
 - Perfect and fun.

V. RESULTS AND BENEFITS OF IMPLEMENTING THE TEACHING/GUIDANCE METHODS:

By integrating both traditional teaching methods and augmented reality (AR) techniques for instructing atomic orbitals, students have experienced significant enhancements in their understanding and retention of crucial concepts. This combined approach has yielded

substantial improvements in students' comprehension, as evidenced by the following outcomes:



The integration of augmented reality (AR) techniques, especially without direct guidance during lectures, has proven highly effective in enhancing students' understanding of atomic orbitals. Specifically, students showed significant improvements in comprehending orbital shape, orbital size, and axis labels, with correct responses notably increasing across all categories. These findings highlight the success of both traditional teaching methods with guided instruction and the independent AR approach in bolstering students' grasp of complex scientific concepts, indicating the potential value of AR modules in educational environments with limited teacher resources [6], [20], [22], [27].

The effectiveness of our AR module, which requires minimal to zero teacher guidance, shows that it would be extremely beneficial when implemented in teaching environments where there is a high student to teacher ratio.

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The Digital PR Media via 360° VR System to Enhance Local Citizens' Public Perception: A Case Study of Thotsamintra Phirom Park

1st Kridsanapong Lertbumroongchai
Division of Computer Science, Faculty
of Science and Technology,
Rajamangala University of Technology
Thanyaburi
Pathum Thani, Thailand
kridsanapong_l@rmutt.ac.th

2nd Ruksarat Khanankhoaw*
Division of Computer Science, Faculty of
Science and Technology,
Rajamangala University of Technology
Thanyaburi
Pathum Thani, Thailand
ruksarat.k@rmutt.ac.th

3rd Vitsanu Nittayathamkul
Ratchasuda Institute, Faculty of
Medicine Ramathibodi
Hospital, Mahidol University
Nakhon Pathom, Thailand
vitsanu.nit@mahidol.ac.th

4th Prachyanan Nilsook
Division of Information and
Communication Technology for
Education, Faculty of Technical
Education, King Mongkut's University of
Technology North Bangkok
Bangkok, Thailand
prachyanunn@kmutnb.ac.th

5th Thakorn Yuvijit
Faculty of Science and Technology,
Rajamangala University of Technology
Suvarnabhumi,
Phra Nakhon Si Ayutthaya, Thailand
thakorn.y@rmutsb.ac.th

Abstract —Emerging immersive technologies, such as virtual reality (VR), offer public relations (PR) practitioners innovative opportunities to enhance audience engagement and message delivery. This study developed and evaluated digital PR media utilizing a 360-degree VR system to assess local citizens' perception and satisfaction regarding Thotsamintra Phirom Park, a prominent public space in Thailand. Guided by the ADDIE model, the media was produced in two formats: a browser-based version accessible on various devices and a stereoscopic view designed for VR headsets. The media was designed to maximize accessibility and user engagement. Expert evaluations demonstrated a high level of quality across five key dimensions: content ($M = 4.28$, $SD = 0.23$), typography ($M = 4.33$, $SD = 0.27$), visuals ($M = 4.42$, $SD = 0.16$), motion ($M = 4.33$, $SD = 0.24$), and audio ($M = 4.50$, $SD = 0.20$), with an overall mean score of 4.37 ($SD = 0.21$) out of 5. User assessments revealed strong agreement on two key variables. Public perception had a mean score of 4.19 ($SD = 0.56$), reflecting positive views toward the park following the VR experience. User satisfaction was higher, with a mean score of 4.33 ($SD = 0.68$), indicating favorable evaluations of the VR media. These findings support the effectiveness of immersive VR media, which provides a realistic and interactive experience, in delivering engaging content that promotes public spaces and fosters civic engagement. Future research should include pretest-posttest comparisons to investigate long-term behavioral impacts and develop personalized content strategies to further optimize user experience.

Keywords—3D Vista Virtual Tour Pro, interactive media, panoramic photography, spatial audio, Visual Studio

I. INTRODUCTION

In the digital communication era, the practice of public relations (PR) has evolved significantly, shifting from traditional mass media toward digital-first and interactive strategies. PR today emphasizes two-way engagement, immersive audience experiences, and real-time responsiveness—driven by the demand for more emotionally resonant and dynamic communication approaches [1], [2].

Among the most transformative developments in digital media is 360° virtual reality (VR). This technology enables users to explore immersive environments that simulate real-world spaces, fostering a deeper sense of spatial presence and emotional connection compared to traditional media formats [3]. Such immersive features have shown promising impacts in various communication contexts, including public engagement and tourism [4].

Public parks represent a critical yet often under-communicated public asset. While they provide recreational space, environmental value, and social identity, traditional communication methods may fail to capture their experiential richness. Incorporating VR into public relations efforts offers new possibilities to revitalize how such spaces are promoted and perceived by the public [5].

Thotsamintra Phirom Park, the central focus of this research, is a large-scale public park located in Thanyaburi District, Pathum Thani, Thailand. Established in 2022 to commemorate the 70th birthday of His Majesty King Maha Vajiralongkorn, the park spans over 400 rai (approximately 158 acres) and offers zones for fitness,

cycling, leisure, and community activities [6]. Despite its potential, the park remains relatively unknown due to limited digital communication and promotional strategies.

Developing an immersive VR simulation of the park offers an innovative public relations tool that can enhance both visibility and engagement. The simulated environment—accessible via smartphones, browsers, or VR headsets—enables users to interact with the park virtually, increasing their familiarity and interest before visiting physically. Prior research on immersive PR media confirms that such technologies significantly improve public attitudes, sense of place, and emotional engagement [7], [8].

Furthermore, digital citizens today expect more personalized and interactive content. In this context, immersive VR meets modern expectations and aligns with broader shifts in media behavior and digital participation [9], [10]. Technologically, integrating high-dynamic-range (HDR) panoramic imaging further enhances the visual realism and quality of VR experiences, as demonstrated in studies on virtual media production [11].

Therefore, this study aims to develop and evaluate digital public relations media using a 360° VR system to enhance local citizens' public perception and satisfaction with Thotsamintra Phirom Park. The research also assesses the quality of the media through expert review to support the development of effective, immersive PR communication.

II. RESEARCH OBJECTIVES

- 1) To develop the digital PR media via a 360° VR system to enhance local citizens' public perception.
- 2) To evaluate the quality of the developed digital PR media via a 360° VR system through expert review.
- 3) To assess local citizens' public perception after experiencing the developed media.
- 4) To assess local citizens' satisfaction with the developed media.

III. RESEARCH HYPOTHESES

- 1) Experts rate the developed digital PR media via a 360° VR system at a high level of quality (mean score ≥ 3.51).
- 2) Experiencing the developed digital PR media via a 360° VR system leads local citizens to report a high level of public perception (mean score ≥ 3.51).
- 3) Local citizens express a high level of satisfaction with the developed digital PR media via a 360° VR system (mean score ≥ 3.51).

IV. CONCEPTUAL FRAMEWORK

A. Theoretical Foundation

This research is grounded in four interrelated theoretical foundations that support the development, implementation, and evaluation of immersive digital public relations (PR) media aimed at promoting public engagement with Thotsamintra Phirom Park. These include:

1) **Public Relations Media:** Public relations (PR) refers to the strategic communication process that fosters mutually beneficial relationships between organizations and their publics. Traditional PR has emphasized mass media channels to disseminate information and build credibility. In the digital age, however, PR practice has expanded to incorporate two-way communication models and interactive media environments that enhance audience participation [1], [2]. Digital PR leverages web-based platforms and multimedia formats to engage audiences in more dynamic and personalized ways. Contemporary scholarship emphasizes the role of dialogic communication, audience co-creation, and message responsiveness in shaping public perception [1]. This theoretical approach underpins the rationale for developing digital media tools to promote civic spaces and foster community attachment.

2) **Virtual Reality Technology in Communication:** Virtual Reality (VR), particularly in the form of 360-degree video, represents an innovative communication medium that simulates real environments through immersive interaction. Unlike traditional audiovisual content, VR offers a sense of spatial presence, user autonomy, and embodied experience, which have been shown to increase audience engagement, emotional involvement, and behavioral intention [4], [12], [13]. Empirical research in tourism and social marketing has demonstrated the efficacy of 360° VR in shaping attitudes, enhancing message retention, and influencing decision-making behaviors [14], [15]. For instance, virtual tours of tourist destinations have been found to foster destination familiarity and perceived accessibility [14], while immersive narratives in social campaigns improve empathy and intention to act [16]. These features make VR a compelling medium for digital PR in the context of civic promotion.

3) **Public Parks as Civic and Cultural Spaces:** Public parks function as essential urban spaces that support environmental sustainability, community well-being, and civic participation. They are often associated with shared identity, cultural heritage, and public ownership. Promoting awareness and engagement with these spaces requires more than informational campaigns—it demands communicative strategies that foster emotional connection and social relevance [6], [13]. Virtual representations of public spaces have been used to democratize access, especially for those with physical, economic, or geographic barriers [16]. By allowing individuals to explore public parks virtually, digital media can create symbolic familiarity, stimulate visitation interest, and reinforce collective stewardship.

4) **Media Symbol Systems and Cognitive Processing:** According to media symbol system theory, the structure and sensory modality of media influence how individuals process and retain information. Immersive media formats such as 360° VR activate multiple sensory pathways—visual, auditory, and spatial—leading to deeper cognitive engagement and stronger memory encoding [7], [17], [18]. Research in education and digital communication shows that media with higher interactivity and realism enhance learning, increase attention, and promote reflective thinking [18], [19]. In particular, the experience of “presence” in VR facilitates emotional resonance and persuasive impact, making it a

powerful tool for public communication [19], [20].

B. Independent Variable

The independent variable in this study, classified as a manipulated variable, is the immersive digital public relations media developed using a 360-degree virtual reality (VR) system. Designed specifically to promote Thotsamintra Phirom Park, this VR media serves as the experimental treatment introduced by the researchers. It incorporates interactive panoramic video, spatial navigation, audiovisual storytelling, and dynamic user interfaces to simulate real-world experiences within a virtual environment. By enabling users to explore the park remotely, the media aims to enhance cognitive and emotional engagement—particularly awareness, interest, and perceived value of the public space.

C. Dependent Variables

Two dependent variables are assessed to evaluate the effectiveness of the developed VR-based PR media. These include:

1) **Public Perception of Thotsamintra Phirom Park:** This variable reflects the extent to which the immersive media influences the general perception of the park among local citizens. It encompasses multiple dimensions, such as perceived accessibility, attractiveness, relevance to the community, and emotional or symbolic value. Drawing from previous research, 360-degree VR media can positively affect public perception by enhancing spatial familiarity, emotional engagement, and cognitive understanding of the space [3], [12], [16].

2) **Public Satisfaction with the Digital PR Media:** This variable evaluates the degree of user satisfaction following their interaction with the 360-degree VR public relations media. Satisfaction is conceptualized across five key dimensions that collectively reflect the quality and effectiveness of the immersive media experience. These dimensions include: Content, referring to the clarity, relevance, and informativeness of the presented material; Typography, concerning the legibility, consistency, and visual harmony of textual elements; Visuals, encompassing the aesthetic quality, resolution, and coherence of the visual components; Motion, which assesses the smoothness, realism, and comfort of animated or interactive elements; and Audio, addressing the clarity, appropriateness, and immersive quality of the sound design.

V. RESEARCH METHODOLOGY

A. Research Design

This study employed a developmental research design (Type I) [22], focused on systematically designing and developing a media product, followed by evaluating its effectiveness. The process followed the ADDIE model—Analysis, Design, Development, Implementation, and Evaluation—commonly used in developmental research in media [23]. Prior to implementation, the VR media was reviewed by experts based on five key dimensions: content,

typography, visuals, motion, and audio. Revisions were made in response to their feedback to ensure the overall quality and coherence of the media. To evaluate its effectiveness, a one-group posttest-only design was employed, using user questionnaires to collect quantitative data regarding public perception of Thotsamintra Phirom Park and satisfaction with the digital PR media.

B. Target Groups

This study involved two main target groups:

1) **Expert Group:** The expert group consisted of three individuals selected through purposive sampling. The selection was based on academic and professional qualifications relevant to multimedia development and digital communication. Experts were selected according to the following criteria: (1) holding a doctoral degree or an academic title of at least Assistant Professor; (2) having no fewer than five years of experience in multimedia production, communication design, or related fields; and (3) having prior experience in evaluating or reviewing digital content. All selected experts were actively involved in higher education or relevant professional sectors. Their role was to conduct a formative evaluation of the VR media, assessing the quality of the content before implementation.

2) **User Group:** The second group consisted of 100 local citizens residing in Thanyaburi District, Pathum Thani Province, who expressed interest in visiting Thotsamintra Phirom Park. These individuals were selected using accidental sampling based on availability and willingness to participate during the data collection period. The inclusion criteria were as follows: (1) being 18 years of age or older; (2) possessing basic digital literacy, such as the ability to operate a smartphone or access web-based content; and (3) showing interest in using public parks or community green spaces, without requiring prior experience with virtual reality media. Participants in this group engaged with the VR media and completed a post-experience questionnaire. Their feedback contributed to the summative evaluation of the media's communication effectiveness and user satisfaction.

C. Research Procedure

This study applied the ADDIE model as a structured process for developing and evaluating VR public relations media, adapted from the work of Lertbumroongchai et al. (2025), who successfully implemented ADDIE in the design of immersive virtual experiences for educational communication. The research procedure consisted of five main stages:

1) **Analysis:** Communication objectives, target-user characteristics, and the physical-social context of Thotsamintra Phirom Park were identified through document analysis and on-site observation.

2) **Design:** Based on the analysis, content scopes, interactive features, and navigation logic were outlined. A detailed storyboard and flowchart were produced to guide production.

3) **Development:** A 360° VR environment was built

with panoramic photography, spatial audio, and interactive hotspots using Adobe Lightroom®, Photoshop®, Illustrator®, 3D Vista Virtual Tour Pro®, and Visual Studio®. Prototype iterations underwent formative evaluation by three experts, whose feedback informed revisions to ensure technical quality and usability.

4) Implementation: After expert validation, the finalized VR tour was deployed on a responsive web interface accessible via both mobile and desktop devices. Local citizens individually interacted with the system in scheduled sessions, each lasting approximately 30 minutes. Data collection was conducted gradually over a four-week period, from February 1 to February 28, 2024.

5) Evaluation: Following their virtual experience, 100 participants completed post-experience questionnaires measuring their perception of the park and satisfaction with the VR media, providing the data for the summative assessment.

D. Research Instruments

This study used three research instruments to assess the quality of the developed media, public perception of the park, and user satisfaction with the VR experience. All instruments were examined for content validity by three experts using the Item-Objective Congruence (IOC) method prior to implementation. The instruments are described as follows:

1) Expert Evaluation Form: This instrument was administered during the formative evaluation phase to assess the quality of the developed media. It consisted of 24 items across five key dimensions: 1) content (7 items), 2) typography (4 items), 3) visual elements (8 items), 4) motion and transitions (5 items), and 5) audio (4 items). A 5-point Likert scale was used for each item (5 = Very high quality, 4 = High quality, 3 = Moderate quality, 2 = Low quality, 1 = Very low quality). An open-ended section was also included for additional expert comments and suggestions.

2) Public Perception Questionnaire: This instrument measured local citizens' perception of Thotsamintra Phirom Park following their interaction with the 360-degree VR media. It comprised 5 items rated on a 5-point Likert scale (5 = Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly disagree). The items were designed to capture overall awareness, interest, and general impressions of the park without being divided into separate dimensions.

3) User Satisfaction Questionnaire: This instrument evaluated the satisfaction of local citizens with the developed VR media. It mirrored the structure of the expert evaluation form, containing 24 items organized into the same five dimensions. Responses were collected using a 5-point Likert scale (5 = Very satisfied, 4 = Satisfied, 3 = Neutral, 2 = Dissatisfied, 1 = Very dissatisfied). Open-ended questions were also provided to encourage additional user feedback and suggestions.

E. Data Analysis

Quantitative data from all three research instruments were

analyzed using the Jamovi statistical software. Descriptive statistics, specifically mean (M) and standard deviation (SD), were used for all variables: expert evaluations of media quality, public perception of Thotsamintra Phirom Park, and user satisfaction with the developed VR media.

Qualitative data from open-ended responses provided by both experts and local citizens were analyzed using content analysis. Responses were thoroughly reviewed and thematically grouped to identify common suggestions, comments, and concerns regarding the content and effectiveness of the VR media.

VI. RESULTS

A. The developed digital PR media via a 360° VR system

The digital PR media promoting Thotsamintra Phirom Park was developed using a 360-degree virtual reality (VR) system designed to deliver an immersive and interactive user experience. The media was created in two distinct display formats to maximize accessibility and engagement:

1) A browser-based version that users can access via standard web browsers on a wide range of devices, including desktops, laptops, tablets, and smartphones (Figs. 1–7). This ensures that users without specialized VR hardware can still explore and interact with the content seamlessly, using familiar interfaces and navigation controls optimized for both touchscreens and traditional input devices.

2) A stereoscopic view intended for VR headsets, providing a three-dimensional immersive experience with depth perception and spatial presence (Fig. 8). This version leverages the advanced capabilities of VR hardware to create a more realistic and emotionally engaging environment, enhancing users' sense of being physically present within the park.



Fig. 1. Homepage interface of the browser-based 360° VR media for Thotsamintra Phirom Park.



Fig. 2. 'About' section interface of the 360° VR media, presenting the background and purpose of Thotsamintra Phirom Park.

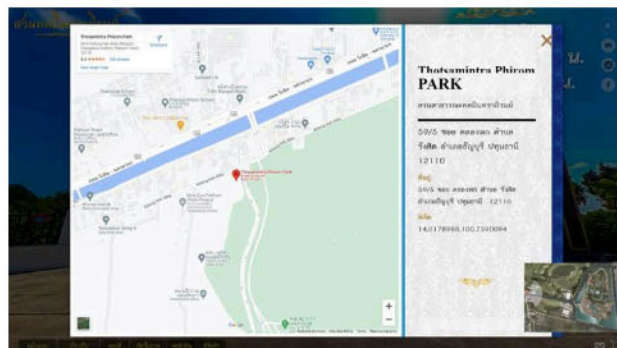


Fig. 3. 'Map' section interface displaying the location and geographic coordinates of Thotsamintra Phirom Park.

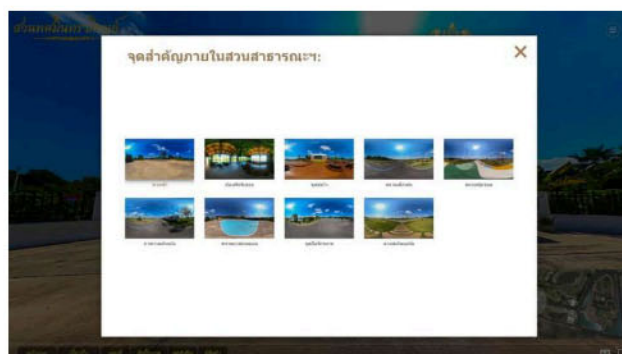


Fig. 4. 'Key Locations' section showcasing interactive hotspots within Thotsamintra Phirom Park.

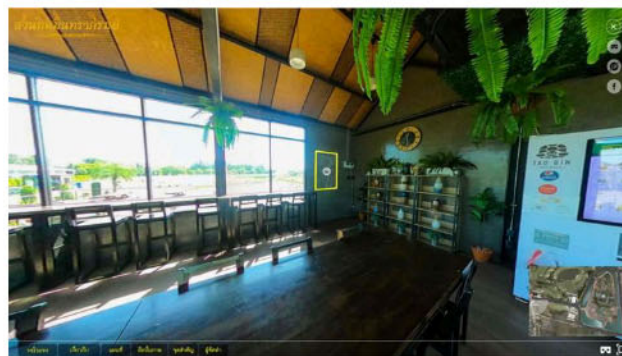


Fig. 5. Interior view of the resting pavilion in the 360° VR media, featuring digital interaction points and smart vending services.

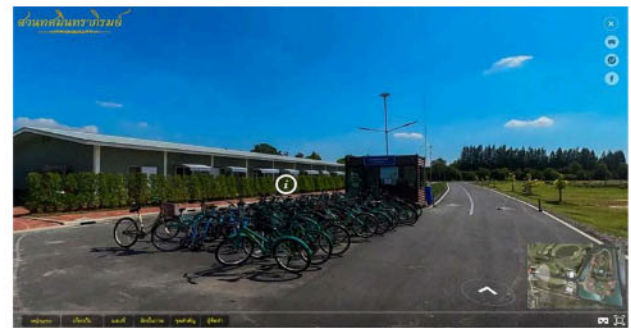


Fig. 6. Bicycle rental station and cycling route entrance in the 360° VR media of Thotsamintra Phirom Park.

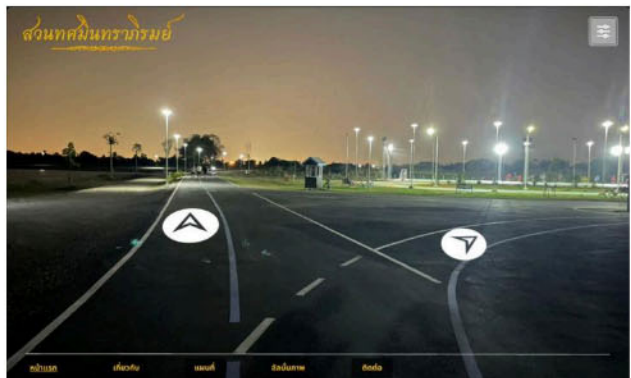


Fig. 7. Running trail path within the 360° VR media of Thotsamintra Phirom Park.



Fig. 8. Scenic viewpoints presented in stereoscopic view within the 360° VR media of Thotsamintra Phirom Park.

The homepage of the VR media features a main navigation menu with nine interactive components:

- 3) Home: Navigates users back to the virtual entrance of the park environment.
- 4) About: Provides a concise overview and background information about Thotsamintra Phirom Park.
- 5) Map: Displays a virtual map indicating the park's geographic location and surrounding context.
- 6) Gallery: Presents a curated collection of photographic images from various sections of the park.
- 7) Key Locations: Identifies significant landmarks within the park and enables users to navigate directly to these points of interest.
- 8) Credits: Lists the names and affiliations of the media developers and academic advisors involved in the project.

9) Fullscreen: Allows users to expand the interface to full-screen mode for a more immersive viewing experience.

10) More Tools: Provides access to additional interface functions and interaction settings.

11) Navigation Directions: Displays on-screen directional cues to assist users in moving through the virtual environment.

This media was developed not only to deliver information but also to stimulate public interest and strengthen emotional connection to the park through engaging and intuitive VR interaction.

B. The quality of the developed media as evaluated by experts

The developed digital PR media via a 360° VR system was evaluated by three experts. The results indicated that all aspects were rated at a high level of quality, with audio and visuals receiving the most favorable scores. The overall quality was also rated as high, confirming the media's readiness and effectiveness for public communication. A summary of the expert evaluations is presented in Table 1.

TABLE I. EXPERT EVALUATION RESULTS ON THE QUALITY OF THE DEVELOPED VR MEDIA

Dimension	M	SD	Quality Level
1. Content	4.28	0.23	High quality
2. Typography	4.33	0.27	High quality
3. Visuals	4.42	0.16	High quality
4. Motion	4.33	0.24	High quality
5. Audio	4.50	0.20	High quality
Overall	4.37	0.21	High quality

C. The public perception of Thotsamintra Phirom Park after experiencing the developed media

After interacting with the 360° VR media, a total of 100 local citizens completed a five-item public perception questionnaire. Descriptive statistics showed consistently favorable responses, with mean scores ranging from 4.12 to 4.25. As presented in Table 2, all items fell within the "Agree" level of interpretation, indicating that the developed media effectively enhanced local citizens' public perception of Thotsamintra Phirom Park.

TABLE II. LOCAL CITIZENS' PUBLIC PERCEPTION TOWARD THOTSAMINTRA PHIROM PARK AFTER EXPERIENCING THE VR MEDIA

Item	M	SD	Public Perception Level
1. Increased Awareness – I am more aware of Thotsamintra Phirom Park after experiencing the VR media.	4.12	0.56	Agree
2. Understanding of Purpose – I gained a better understanding of the park's purpose and function.	4.18	0.52	Agree

3. Interest in Visiting – I feel more interested in visiting the park in the future.	4.23	0.58	Agree
4. Positive Impression – The VR experience created a positive impression of the park.	4.25	0.52	Agree
5. Perceived Value – I believe the park is a valuable and meaningful public space.	4.18	0.59	Agree
Overall	4.19	0.56	Agree

D. The satisfaction of local citizens with the developed media

After experiencing the 360° VR media, 100 local citizens completed a 24-item satisfaction questionnaire covering five dimensions: content, typography, visuals, motion, and audio. As shown in Table 3, all aspects received high satisfaction ratings, with the highest scores in content and motion ($M = 4.40$), followed by typography ($M = 4.37$), visuals ($M = 4.36$), and audio ($M = 4.15$). The overall satisfaction level was high ($M = 4.33$, $SD = 0.68$), indicating that the developed media was well-received by the target audience.

TABLE III. USER SATISFACTION TOWARD THE DEVELOPED DIGITAL PR MEDIA VIA 360° VR SYSTEM

Dimension	M	SD	Satisfaction Level
1. Content	4.40	0.66	Satisfied
2. Typography	4.37	0.68	Satisfied
3. Visuals	4.36	0.71	Satisfied
4. Motion	4.40	0.65	Satisfied
5. Audio	4.15	0.73	Satisfied
Overall	4.33	0.68	Satisfied

VII. DISCUSSION

The findings of this study affirm the potential of 360° virtual reality (VR) as an effective medium for enhancing public relations (PR) outcomes, particularly in the context of civic space communication. The high evaluation scores received from both experts and local citizens support the integration of immersive media into digital PR strategies, aligning with contemporary communication theories that emphasize dialogic engagement, emotional resonance, and multimedia richness [1], [2]. The successful implementation of this VR system demonstrates how digital PR media can bridge the gap between information dissemination and experiential engagement, fostering both awareness and affective connection to public spaces. The results clearly support the first research hypothesis, as experts rated the overall quality of the developed VR media at a high level ($M = 4.37$), well above the threshold of 3.51.

The high expert ratings across all five dimensions—content, typography, visuals, motion, and audio—reflect the technical quality and communicative coherence of the developed media. These results are consistent with Lertbumroongchai's findings that HDR panoramic imaging and high-quality interface design enhance user immersion and perceived realism in virtual tours [11]. The iterative design process guided by the ADDIE model further contributed to this outcome, ensuring that expert

feedback informed continual refinements, in line with established media development practices [23]. Additionally, the positive evaluation of multisensory elements reinforces theories of media symbol systems and cognitive processing, which argue that immersive, multi-channel input improves message retention and conceptual understanding [18], [19], [23].

In terms of user experience, participants reported a high level of public perception after engaging with the VR media, with a mean score of 4.19 across five key indicators. This outcome confirms the second hypothesis that the immersive VR experience would lead to a high level of public perception (≥ 3.51). Respondents noted increased awareness, understanding, interest, and emotional connection to Thotsamintra Phirom Park. This supports prior research by Fraustino et al. and Dutta et al., who found that immersive VR enhances spatial familiarity, positive impressions, and behavioral intentions in public and tourism communication contexts [3], [14]. Furthermore, the symbolic representation of the park through virtual navigation allowed users to develop a sense of place, consistent with Frechette et al.'s assertion that VR can act as a powerful social marketing and engagement tool [16].

User satisfaction was also reported at a high level ($M = 4.33$), confirming the third research hypothesis. The results suggest that the media not only met technical standards but also successfully addressed users' expectations in terms of relevance, design, and engagement. However, a notable divergence emerged between expert and user evaluations regarding the audio dimension. While experts rated the audio quality the highest among all dimensions ($M = 4.50$), users gave it the lowest score within their group of ratings ($M = 4.15$). This discrepancy may reflect differences in listening environments, device quality, or expectations between evaluators trained in multimedia production and general users. It also suggests the need for further optimization of audio delivery across diverse platforms and use contexts. Nevertheless, the audio score remained within the "satisfied" range.

Thus, all three hypotheses were empirically supported. The developed digital PR media via a 360° VR system was rated highly by experts, significantly improved public perception of the park, and elicited strong satisfaction among users. These findings affirm the conceptual and theoretical foundations of the study and demonstrate the effectiveness of immersive media as a tool for public communication. As Cummings and Ingber have argued, immersive experiences now play a vital role in shaping digital citizenship and participatory engagement [10]. This research not only contributes to the academic discourse on VR in communication but also provides a practical framework for deploying immersive public relations strategies in other civic, cultural, or environmental initiatives.

VIII. CONCLUSION

This study aimed to develop and evaluate a 360° virtual reality (VR)-based digital public relations (PR) medium to enhance local citizens' perception and satisfaction toward Thotsamintra Phirom Park. Guided by the ADDIE instructional design model and a developmental research framework, the study resulted in an immersive platform that integrates panoramic visuals, interactive components, and spatial storytelling, accessible via both web and mobile devices.

Results from expert evaluations and user assessments indicate that the VR media achieved high levels of technical quality, communicative effectiveness, and audience impact. Experts evaluated the system as robust and well-designed, while local citizens reported increased awareness, emotional connection, and favorable impressions of the park following the virtual experience. These findings underscore the critical role of immersive PR tools in promoting public spaces and fostering civic engagement.

A notable insight from the evaluation is the divergence in audio assessments: while experts rated the sound dimension most highly, users rated it comparatively lower. This discrepancy highlights the need for future improvements in audio optimization to ensure consistent experiences across diverse devices and settings. Nevertheless, all components remained within satisfactory thresholds, reaffirming the effectiveness of multisensory integration in immersive media.

Overall, this study supports the theoretical proposition that VR serves as a transformative medium bridging information delivery with emotional and spatial engagement. It offers empirical contributions to the fields of immersive communication, public relations, and civic media design. Moreover, the findings present a replicable framework for utilizing VR in the promotion of cultural, environmental, and community-based assets in an increasingly digital society.

While the study yielded promising results, one limitation lies in the research design itself. As a one-group posttest-only study, the absence of a pretest or control group limits the ability to make strong causal inferences about changes in perception or satisfaction. Future research should consider adopting experimental or quasi-experimental designs that include pretests or comparison groups to better isolate the effects of the VR media. Additionally, further work should expand on the process-oriented aspects of immersive media development—such as participatory content design, iterative testing, and multi-platform adaptation. Personalization strategies may also enhance the relevance and accessibility of immersive content across broader user demographics.

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Digital Game Developer Skills in the Generative AI Era: Research Trends

1st Apiradee Dechphongsumrit*
Dept. Learning Innovation and
Technology, King Mongkut's University
of Technology Thonburi (KMUTT),
Bangkok, Thailand
apiradee.dech@kmutt.ac.th

2nd Daruwan Srikaew
Dept. Learning Innovation and
Technology, King Mongkut's University
of Technology Thonburi (KMUTT),
Bangkok, Thailand
daruwan.sri@kmutt.ac.th

3rd Sorakrich Maneewan
Dept. Learning Innovation and
Technology, King Mongkut's University
of Technology Thonburi (KMUTT),
Bangkok, Thailand
sorakrich.man@mail.kmutt.ac.th

4th Vitsanu Nittayathamkul
Ratchasuda Institute, Faculty of
Medicine Ramathibodi Hospital,
Mahidol University Nakhon Pathom,
Thailand
vitsanu.nit@mahidol.ac.th

5th Chacharin Lertyosbordin
Faculty of Industrial Education and
Technology, King Mongkut's University
of Technology Thonburi
Bangkok, Thailand
lertyosbordin@outlook.com

Abstract—In response to the rapid advancements in educational technology and the growing influence of generative artificial intelligence (AI), the skill requirements for digital game developers have expanded significantly. This study pursues objective to explore the research trends and thematic evolution in game development skills studies. Drawing on a synthesis of 28 academic articles, the findings highlight five major themes. First, there is a recognized division between hard skills such as programming, game engine operation, and AI integration and soft skills, including creativity, adaptability, communication, and collaboration. Second, studies reveal a persistent mismatch between academic curricula and industry needs, indicating a gap in preparing students for real-world game development. Third, game-based and design-based learning frameworks are increasingly employed to foster active engagement and enhance soft skills through project-based experiences. Fourth, the integration of AI-powered tools and automation is reshaping developer competencies, demanding not only technical expertise but also creative and aesthetic abilities. Lastly, the adoption of agile methodologies and interdisciplinary teamwork is emerging as a critical strategy for developing innovation, problem-solving, and adaptability throughout the game development process. These insights suggest the urgent need for educational models that align with industry expectations and equip learners with a balanced, future-ready skillset.

Keywords—*Digital Game Developer, Generative AI, Hard Skills, Soft Skills, Under-graduate Curriculum, Under-graduate Curriculum*

I. INTRODUCTION

According to the World Economic Forum (OECD Future of Education and Skills 2030), approximately 85 million jobs may disappear in the future labor market due to the redistribution of tasks between humans, machines, and artificial intelligence technologies. This transformation in the workforce landscape has led to the emergence of new

skill demands. These required skills were aligned with Thailand's 20-Year National Strategy (2017–2037), which aims to strengthen the country's economic and social foundations. A core focus of this strategy is to raise the national education standards by emphasizing 21st-century education, particularly the development of various learner competencies. These include learning and innovation skills, commonly called the 4 Cs: Critical Thinking, Communication, Collaboration, and Creativity.

Occupation	Description	Examples of Skills	Examples of Knowledge	Example of Attitudes and Values
Robotics Engineers	Research, design, develop, or test robotic applications.	Critical Thinking; Complex Problem Solving; Quality Control Analysis.	Engineering and Technology; Robotics; Design.	Exploration; precision; observation
Biostatisticians	Develop and apply biostatistical theory and methods to the study of life sciences.	Inductive Reasoning; Oral Expression; Mathematical Reasoning.	Mathematics, English Language, Education and Training.	Project/program management; execution; inquisitiveness.
Fuel Cell Engineers	Design, evaluate, modify, or construct fuel cell components or systems for transportation, stationary, or portable applications.	Judgment and Decision Making; Writing; Critical Thinking.	Physics, Mathematics, Chemistry.	Focus; reliability; feedback.
Solar Sales Representatives and Assessors	Contact new or existing customers to determine their Solar equipment needs. Suggest Systems or equipment, or estimate costs.	Active Listening; Persuasion, Social Perceptiveness.	Sales and Marketing, Engineering and Technology, Customer and Personal Service.	Accountability; focus; results orientation.
Video Game Designers	Design core features of video games. Specify innovative game and role-play mechanics, story lines, and character biographies. Create and maintain design documentation. Guide and collaborate with production staff to produce games as designed.	Programming; Critical Thinking; Complex Problem Solving.	Design; Communications and Media; Psychology.	Inquisitiveness; playfulness; passion.

Fig 1. OECD 2030 Example of New and Emerging Jobs (Berger & Frey, 2015)

The Job Market in the Game Industry: A Skills-Oriented Perspective

The job market in the game industry currently presents a relatively high demand for employment opportunities, accompanied by a low level of competition. This is primarily due to the specialized nature of the required skills. As illustrated in Figure 1, within the context of career paths in game design, there is a demand for individuals equipped with comprehensive knowledge and capabilities in game development.[13][22][23] These competencies, collectively referred to as game developer

skills, encompass both soft skills and hard skills. Primary soft skills include the ability to generate original and diverse concepts, adopt new perspectives unrestricted by conventional frameworks, and demonstrate adaptability in response to dynamic environmental conditions. On the technical side, hard skills encompass proficiency in both current and emerging game development technologies and methodologies, particularly within the context of the game industry in the Generative AI era.

Curriculum Development to Integrate Soft and Hard Skills in Game Development Education

Higher education institutions should develop integrated learning approaches that combine both soft skills and hard skills to meet the demands of the game development job market. This can be achieved through the design of curricula that blend theoretical knowledge with practical experience. Emphasis should be placed on project-based learning, internships in the game industry, and problem-based learning approaches.[3] Additionally, it is essential to collaborate teamwork through group activities, game design competitions, and the establishment of networks with industry professionals, allowing students to gain real-world experience and better understand market needs.

It is therefore necessary to prepare students by equipping them with both soft and hard competencies as they transition into the game industry. The findings of this research can serve as a guideline for the development and improvement of undergraduate curriculum particularly in defining Program Learning Outcomes (PLOs) and in creating innovative learning methods that enhance the digital game development skills of future graduates, and there is educational models that reflect real-world. [8][16][18][27]

II. OBJECTIVE

This research objective to explore the research trends and thematic evolution in game development skills studies.

III. RESEARCH METHODOLOGY

In this research, the researcher employed a methodology that involved studying relevant documents and research papers from academic databases such as Google Scholar, ERIC, and Scopus for research related to computer science and game development. Additionally, the ThaiLIS database, which contains theses and dissertations from Thailand, was consulted. The sources also included peer-reviewed journals and documents from organizations such as the World Economic Forum and the OECD Future of Education and Skills 2030 report.

A. Inclusion and exclusion criteria

As the setting under review is relatively new and one of the objectives was to find gaps in research, the review considered studies that explored digital game developer skills, soft and hard skills.

1) Inclusion: Peer-reviewed articles focusing on educational technology and game-based learning. Studies that assess skill development outcomes. Publications in English.

2) Exclusion: Studies not directly related to educational outcomes or skill development. Articles lacking empirical data or methodological rigor.

B. Search strategy

The literature review involved a thorough examination of relevant academic works, including articles, books, theoretical frameworks, and related documents. Keywords and key phrases were carefully selected, with specified search fields, Boolean connectors, publication date ranges, and search filters to refine the scope. The search was limited to peer-reviewed journals and conference proceedings, using references cited in relevant studies.

The search terms focused on descriptions related to skills in the generative AI era, game developer skills and were categorized into main keyword groups as follows: game developer skills, soft skills, hard skills, game development skills, game development enhance, knowledge-based skills, game development

Keywords within each group were combined using the Boolean operator OR, while the three keyword groups were linked using AND. Additional filters such as analysis and education were applied to further refine the search results. The final search query was structured as follows: TS = (game developer OR game development) AND TS = (skills OR enhance) AND TS = (competence OR game creation) AND TS = (game developer skills OR game developers) The outcome of this search process led to the identification of key components and indicators relevant to the analysis.

C. Data analysis

This systematic review, guided by the PRISMA methodology, examines the role of educational technology and game-based learning in enhancing skill development among students and professionals. Focusing on interventions such as serious games, game strategies, and game development methodologies, the review compares these with traditional educational approaches. Studies were selected based on their empirical focus on skill outcomes including critical thinking, problem-solving, soft skills, and programming across a variety of study designs such as qualitative research and case studies.

A summary of the search and selection process is presented in Fig. 2 and is based on the PRISMA statement. The Boolean search query in the three databases resulted in 146 studies, 84 were duplicates. This resulted in 62 studies which were screened based on the title and the abstracts. This identification and screening phase has been completed by the first three authors, independently from each other. It was checked in more detail whether the study involved game development setting, yet in many cases this was not yet clear from the abstract and then these studies were selected for full text screening. In total 41 manuscripts remained for further assessment through reading the full text. Many studies were removed ($n = 19$) as they did not meet the selection criteria. Based on the identification of the reference lists of the remaining studies, 11 additional studies were found. This resulted in 28 studies which were analyzed to answer the two research questions (see Table 1).

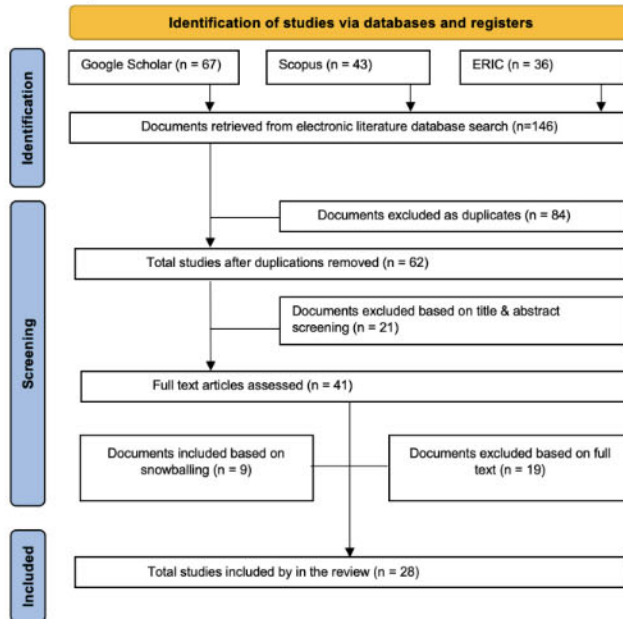


Fig 2. Overview of the search conducted in March 2025 based on PRISMA statement

Using data sets containing publication year, title, author, journal, citation, and keywords in Plain Text format were extracted from the Google Scholar, ERIC, and Scopus database spanning from 2007 to December 2024, using Inciteful application (inciteful.xyz), which utilized, clustering and mapping Litmaps application methods for analysis and map creation, as an alternative to the multidimensional scaling (MDS) approach[24], shares the objective of accurately representing the relatedness and similarity of items, a total of 28 peer-reviewed articles were analyzed. Inclusion criteria ensured relevance to educational outcomes, while exclusion criteria filtered out non-empirical or tangential studies.

In this research, visualization techniques provided by Litmaps application are employed to facilitate comprehensive bibliometric analyses, including keyword,

citation analysis, and co-citation mapping. Keyword analysis is utilized to trace the thematic evolution of the research field over time, thereby enabling the identification of prominent themes across various academic disciplines [19]. Citation analysis plays a crucial role in identifying influential research topics, emerging trends, and methodological orientations, offering valuable insights into the theoretical underpinnings and central concerns of the domain.[25] Moreover, co-citation analysis, grounded in network theory, is applied to reveal the structural relationships among frequently cited documents. The thematic analysis of the included studies yielded four significant findings. First, a recurring gap was observed between academic curricula and industry expectations in game development education. Second, serious games were found to effectively enhance learners' soft and hard skills and overall engagement. Third, game-based learning environments were reported to positively influence learners' motivation and facilitate the acquisition of complex skills. Lastly, design-based learning approaches particularly those involving student-created games were shown to enhance deeper learning and skill integration. These findings underscore the potential of game-based educational strategies to support the development of 21st-century skills and to bridge the gap between academic preparation and professional demands.

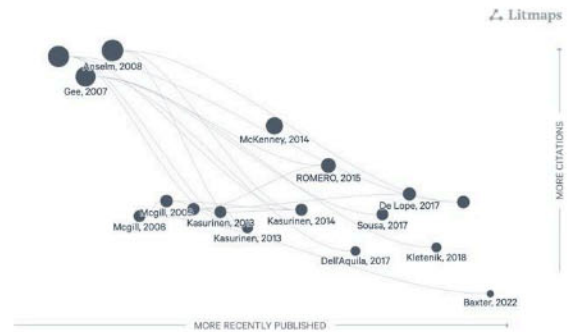


Fig 3. the concept map showing the relationships between game development skills, educational strategies, and industry needs in the AI era.

From fig 3, the structure explicates the integration of both soft and hard skills in game development into comprehensive educational systems, advancements in technology, and the gaps that are evident between educational institutions and industry requirements.

IV. RESULTS

A. To synthesize the key components of soft and hard skills, and emerging directions in digital game developer skills in the era of Generative AI. Table 1, summarizes the results of this analysis the literature review, for justifying the research framework.

TABLE 1: THE SYNTHESIS OF DIGITAL GAME DEVELOPER SKILLS IN THE GENERATIVE AI ERA: FOCUSING ON SOFT AND HARD SKILLS.

<i>Author(s) & Year</i>	<i>Key</i>	<i>Focus</i>	<i>Findings</i>
McGill (2008, 2009); Kasurinen et al. (2013, 2014); Giannakos & Jaccheri (2018)	Skill Gaps in Game Development	Discrepancy between industry needs and academic training	Industry requires both hard (e.g., programming, testing) and soft skills (e.g., teamwork, communication), but curricula often emphasize only technical skills.
Dell'Aquila et al. (2017); Sousa & Rocha (2017); Robertson & Howells (2008); Yang (2012); Ke (2014)	Game-Based & Design-Based Learning	Learning through making games; enhancing problem-solving & creativity	Hands-on game creation enhances learning motivation, creativity, and critical thinking; supports development of 21st-century skills.
Romero et al. (2015); Baxter et al. (2022); Li (2012); De Vries (2006)	Soft Skills & Collaboration	Importance of teamwork, adaptability, and communication	Soft skills are essential for team-based game development; role-play and collaborative activities foster these skills effectively.
Kasurinen et al. (2013, 2014); Wu (2012); Schoenau-Fog et al. (2015); Kletenik & Sturm (2018)	Technological Adaptation & Tools	Integration of new tools like AI, testing, analytics, game engines	Developers must be adaptable to evolving technologies; tool proficiency and narrative/aesthetic design are increasingly important.
Schwaber (1980); Reng et al. (2017); Jenkins et al. (2009); Lope & Medina (2017)	Agile and Interdisciplinary Practices	Educational models that reflect real-world workflows and collaboration	Agile methods and interdisciplinary teams (art, code, design) prepare students for industry-style development environments.
Anselm & Strauss (2008); Brodsky (1968); Keller (2010); Stebbins (2001)	Grounded Theory & Motivational Design	Learning theories underpinning game-based education	Grounded and motivational approaches support learner engagement and iterative knowledge construction through game design.

From a synthesis of the 28 selected academic articles, it becomes evident that the skills required of digital game developers in the era of rapidly evolving educational technology and generative AI are both diverse and dynamic.

Researchers have increasingly emphasized the differentiation between soft skills including creativity, collaboration, communication, and adaptability and hard skills, such as programming, operation of game engines, visual design, and integration of AI technologies. Several studies [23][13][14] consistently reveal a mismatch between educational curricula and actual industry expectations. This “expectation gap” suggests that current academic programs may not sufficiently prepare students for the complexities of real-world game development, where both technical capabilities and interpersonal skills are indispensable.

In response to this challenge, numerous scholars [3][21][22] have explored the potential of game-based learning and educational role-playing games as effective tools for soft skills training. These learning models,

supported by grounded theory methodologies, [1][17] enhance active engagement, problem-solving, and teamwork by immersing learners in authentic, collaborative environments. Furthermore, scholars such as [9][29][30] argue that design-based learning frameworks empower students to internalize core concepts and skills through the iterative process of creating and testing games. This approach aligns well with constructivist educational theories.

Technological trends have also significantly influenced game development education. The emergence of AI-powered design tools and automated content generation has shifted the skillset required of modern developers.[5][13] highlight the need for familiarity with specialized testing and design software, [7][13] focus on the growing importance of visual storytelling and narrative design, which are now increasingly supported by generative AI technologies. This evolution necessitates not only technical literacy but also an aesthetic sensibility that can integrate human creativity with machine-generated content.

In conclusion, a recurring theme across the reviewed literature is the urgent need to bridge the gap between academic theory and professional practice. Studies on agile methodologies [16] and purposeful game production [18][20] highlight the benefits of interdisciplinary approaches and project-based learning in fostering adaptability, innovation, and collaborative problem-solving. As the field continues to evolve, future research should focus on how educational programs can equip aspiring game developers with a holistic skillset that integrates both soft and hard skills, while also encouraging continuous learning and creative experimentation in the context of AI-enhanced game development.

B. To explore the research trends and thematic evolution in game development skills studies.

1) Between soft and hard skills

A growing body of literature emphasizes the dual importance of hard and soft skills in game development. While early research focused heavily on technical competencies such as programming, game engine operation, and AI integration, recent studies (e.g., McGill, Kasurinen) highlight an increasing recognition of soft skills—like creativity, teamwork, adaptability, and communication—as essential for modern game developers.

2) Mismatch between education and industry needs

A recurring theme is the expectation gap between what academic programs offer and what the game industry demands. Studies consistently point out that many universities curricula lag in incorporating practical, cross-disciplinary experiences that reflect real-world game development environments.

3) *Rise of game-based and design-based learning*

Educational innovations such as game-based learning (GBL), educational role-playing games, and design-based learning are increasingly being adopted to enhance engagement and develop complex skills. These methods are grounded in constructivist theory and support learning through authentic, project-based activities.

4) *Integration of generative AI and emerging technologies*

With the advent of AI-driven tools and automation in content creation, developers are expected to not only understand traditional design processes but also to co-create with intelligent systems. Skills in visual storytelling and narrative design are now supported by generative AI, reshaping the competencies needed in the field.

5) *Shift Toward Agile and Interdisciplinary Approaches*

Agile methodologies and interdisciplinary teamwork are emerging as key pedagogical and professional strategies. These support the development of both technical and adaptive expertise, encouraging innovation and iterative problem-solving throughout the game development lifecycle.

V. SUGGESTIONS

The study of game development represents a facet of the "creative industry" that integrates both soft and hard skills. It should be actively supported by educational institutions, which serve as hubs of learning and capability enhancement. Moreover, the discipline provides a basis for the development and refinement of curricula or learning programs, each defined by its unique identity and aligned with the specific employment needs in game development. This is particularly critical when establishing Program Learning Outcomes (PLOs) as a pathway to professional careers. Ultimately, this integration underscores the necessity of concurrently fostering both soft and technical skill sets.

VI. RECOMMENDATIONS FOR FUTURE RESEARCH

- 1) The development of indicators for digital game developer skills in the creative AI era, encompassing social and technical skills—should be undertaken, for instance, through confirmatory factor analysis.
- 2) Research should employ advanced statistical methods, such as the design of structural equation models.
- 3) Correlational studies be undertaken to explore the relationship between soft and hard skills.

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The SVEI Model: A Concept for Enhancing Career Decision-Making Competency in Vocational Education Through an Integrated Immersive Technology Framework

Chanchai Yothasoot
King Mongkut's University
of Technology Thonburi
Bangkok, Thailand
chanchai.yoth@kmutt.ac.th

*Surapon Boonlue
King Mongkut's University
of Technology Thonburi
Bangkok, Thailand
surapon.boon@kmutt.ac.th

Saranya Chuathong
King Mongkut's University
of Technology Thonburi
Bangkok, Thailand
saranya.chu@kmutt.ac.th

Sutiwat Supaluk
King Mongkut's University
of Technology Thonburi
Bangkok, Thailand
sutiwat.sup@kmutt.ac.th

Abstract—This manuscript explains the SVEI Training Model, an innovative framework designed to improve the career decision-making skills of first-year vocational education students. Facing economic uncertainty and a strong desire for meaningful work, Generation Z learners in technical fields need career guidance that goes beyond traditional information-sharing methods. The SVEI model features a four-step, technology-enhanced process: (1) Self-Appraisal, using validated psychometric tools to build basic self-awareness; (2) Vocational Training, employing project-based inquiry and digital resources for informed exploration; (3) Ecosystem Learning, incorporating Virtual Field Trips and social media to provide contextual understanding; and (4) Immersive Learning, using Virtual Reality simulations based on Kolb's Experiential Learning Cycle to offer safe, repeatable mastery experiences. The model is based on Social Cognitive Career Theory (SCCT). The goal is to systematically boost career decision-making self-efficacy by addressing the barriers identified in Gati's taxonomy. By combining self-reflection and experiential learning, the SVEI model offers a structured approach that enables students to align their career choices with their skills and values, thereby preparing them for long-term success and fulfillment in their future careers.

Keywords—Career decision-making, immersive learning, self-efficacy, vocational education, virtual reality.

I. INTRODUCTION (THE EVOLVING LANDSCAPE OF CAREER GUIDANCE FOR VOCATIONAL STUDENTS)

The transition to vocational careers is a significant developmental stage for adolescents. Generation Z faces unique pressures in making this choice. They confront economic uncertainties and high living costs, making skilled trades an attractive option [1]. The financial strains of living expenses are a major societal concern, often consuming a substantial part of individuals' income. In

contrast, Generation Z prioritizes meaningful pursuits, emphasizing work-life balance, mental well-being, and alignment with personal values over financial gain alone [2]. A significant portion of this group is inclined to reject job offers or affiliations that do not align with their ethical beliefs on ecological and social issues [3]. The challenge in career development lies in reconciling economic security with the pursuit of personal fulfillment. Traditional career counseling methods, which rely on outdated tools such as pamphlets and standardized tests, are inadequate for meeting the needs of today's workforce [4]. Such methodologies may lead to ineffective information transmission and insufficient experiential understanding for informed decision-making. There is a significant gap between students' frequent use of digital tools for informal career exploration and the outdated formal guidance provided by educational institutions [5]. This disparity is particularly pronounced in vocational education, especially in technical fields like automotive mechanics, electrical engineering, and industrial technology. For these individuals, career paths appear fixed, potentially limiting exploration and leading to dissatisfaction if their decisions stem from insufficient information, external pressures, or a shallow grasp of the profession's actual conditions [6]. This context highlights an urgent need for innovative career development strategies specifically tailored for contemporary vocational students. The SVEI Training Model proposes a structured, four-phase approach that leverages digital technologies to enhance Career Decision-Making Competency while aiding students in finding meaningful alignment within a stable career path [2]. Nonetheless, acknowledging that mere employment security does not adequately fulfill their quest for meaningful engagement and guidance [1]. The model specifies tailored

interventions for individual requirements, with the initial Self-Appraisal phase facilitating students' expression of their core values and interests. The final Immersive Learning phase, utilizing Virtual Reality (VR), enables practical engagement with professional responsibilities and problem-solving challenges [3]. This provides immediate, empirical confirmation of "fit" that no promotional material or presentation can replicate [7]. The SVEI model serves as a crucial mechanism, guiding students drawn to a field for its reliability toward a point where they can affirm that it aligns with their personal values and aspirations for self-fulfillment.

II. THEORETICAL UNDERPINNINGS OF THE SVEI MODEL

The SVEI model constitutes a cohesive framework grounded in established empirical theories from career development psychology and educational science, integrating principles from Social Cognitive Career Theory, Gati's career challenge classification, and Kolb's Experiential Learning Cycle to create a theoretically sound intervention.

A. Social Cognitive Career Theory (SCCT) and Self-Efficacy

The SVEI model is fundamentally anchored in the psychological construct of career decision-making self-efficacy (CDMSE), which is defined as an individual's confidence in their ability to effectively engage in the necessary processes for making informed career choices [8]. Rooted in Bandura's extensive Social Cognitive Theory, Social Cognitive Career Theory (SCCT) posits that career development is shaped by the intricate interplay of self-efficacy beliefs, expected outcomes (perceptions of probable consequences of one's actions), and personal ambitions [11]. Empirical research consistently demonstrates that individuals with high self-efficacy are more likely to engage in career exploration, display enhanced resilience in the face of obstacles, and ultimately make more informed and appropriate career choices [9]. According to Bandura, mastery experiences, defined as successful task execution, are paramount for self-efficacy, as each success reinforces belief in one's abilities, thus improving confidence for future tasks; the SVEI model is designed to provide scaffolded mastery experiences, guiding students from minor accomplishments in research projects during Vocational Training to complex problem-solving in VR simulations in the Immersive Learning stage, thereby systematically enhancing their confidence and skills.

B. Gati's Taxonomy of Career Decision-Making Difficulties

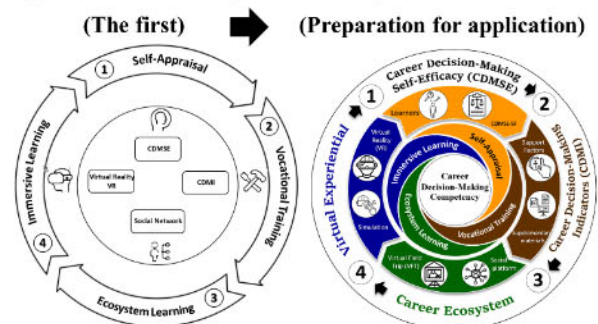
The SVEI model addresses career decision-making challenges by employing Gati, Krausz, and Osipow's taxonomy, which classifies student obstacles into three categories: (1) Insufficient Readiness, (2) Insufficient Information, and (3) Discrepant Information, with its four stages designed to systematically and sequentially resolve these issues.

C. Kolb's Experiential Learning Cycle

The foundational theory for the model's innovative phase, Immersive Learning, is based on David Kolb's four-stage experiential learning framework [10]. Kolb's theoretical framework posits that profound, transformative learning is characterized not by passive assimilation of knowledge, but rather by active engagement that traverses four distinct phases. Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), Active Experimentation (AE). The virtual reality simulations integrated within Stage 4 of the SVEI model are strategically crafted to enhance learners' progression through a transformative educational cycle, wherein students are not merely participants in a game, but are methodically steered through a deliberate instructional framework that includes action, reflection, conceptualization, and iterative strategy improvement, ultimately fostering profound and lasting knowledge acquisition [12]. The integration of theoretical frameworks produces a strong synergy; the SVEI model embeds Kolb's micro-learning cycle within the SCCT psychological paradigm to systematically develop self-efficacy, aiming to improve Career Decision-Making Competency with self-efficacy as the core psychological impetus [13]. The Social Cognitive Career Theory (SCCT) asserts that mastery experiences are the most effective means of bolstering self-efficacy. The VR activities in Stage 4, aligned with Kolb's experiential learning cycle, generate mastery experiences through a recursive process that enhances self-efficacy in career decision-making.

III. EVOLUTION AND REFINEMENT OF THE SVEI MODEL

Figure 1: The Development Journey of the SVEI Model



The SVEI model has undergone a developmental process that is iterative, progressing from the basic concept to its current form through systematic refinements and expert reviews before implementation.

THE SVEI TRAINING MODEL: A FOUR-STAGE FRAMEWORK

The SVEI Training Model is a systematic framework designed to guide vocational learners from uncertainty to confident career decision-making, beginning with a pre-test to establish a baseline and concluding with a post-test to evaluate growth. This model comprises four interconnected phases: Self-Appraisal, Vocational Training, Ecosystem Learning, and Immersive Learning, each with defined objectives and specific activities that build upon the progress of prior phases, as summarized in Table I.

TABLE I. SUMMARY OF A PHASED METHODOLOGY: OBJECTIVES, ACTIVITIES, AND TECHNOLOGIES

Stage	Objective	Key Activities	Primary Tools/Technologies
1. Self-Appraisal	To foster foundational self-awareness of career-related abilities, interests, and confidence levels.	Guided reflection on pre-test results; data visualization; personal learning and exploration plan formulation (SMART goals).	CDMSE-SF, data visualization tools (e.g., radar charts).
2. Vocational Training	To equip students with essential knowledge about specific vocational fields and labor market demands.	Project-based inquiry linked to CDMI indicators; career path comparison projects; case study analysis.	CDMI, Thai MOOCs, online career databases, industry reports, and supplementary materials.
3. Ecosystem Learning	To build an understanding of the social and cultural context of a profession and develop a professional network.	Contextual analysis of workplaces; informational interviews with professionals and alumni.	Virtual field trips using 360-degree video, a curated social platform for professional networking.
4. Immersive Learning	To provide direct, hands-on experience of core professional tasks in a safe, simulated environment to build mastery and validate 'fit'.	Problem-solving scenarios are structured by Kolb's Learning Cycle (concrete experience, reflective observation, abstract conceptualization, active experimentation).	Interactive virtual reality (VR) simulations; virtual tools and environments.

Stage 1: Self-Appraisal for Foundational Self-Awareness

The SVEI model initiates with the Self-Appraisal phase, aimed at facilitating students' transition from vague awareness to a structured, evidence-based comprehension of their career-related attributes, effectively addressing the "Lack of Readiness" as per Gati's taxonomy by mitigating indecisiveness and fostering motivation through self-exploration, which begins with two validated psychometric assessments in a pre-test format, namely the Career Decision-Making Self-Efficacy Scale - Short Form (CDMSE-SF), designed to evaluate students' confidence in executing career-specific tasks such as assessing personal competencies, acquiring occupational insights, establishing goals, and devising future strategies [11]. This evaluation holds significant importance, as diminished self-efficacy is a thoroughly substantiated impediment to proficient career investigation and dedication [8]. The model's application in Thailand is enhanced through a culturally and linguistically validated adaptation of the CDMSE-SF for vocational students, complemented by the implementation of the Career Decision-Making Indicators (CDMI), which assesses the specific challenges faced by students across nine decision-making dimensions based on Gati's foundational research [14]. This tool functions as a

diagnostic framework, identifying the specific domains in which individual learners require the most assistance, thereby facilitating a more targeted approach to intervention. The evaluations generate primary artifacts of a structured workshop designed to inspire reflection and action, employing data visualization techniques to present complex psychometric data in accessible formats such as radar charts for adolescent learners; subsequently, a facilitator guides a structured reflection session with probing questions that link quantitative data to qualitative life experiences, fostering metacognitive development and leading to the creation of a "Personal Learning and Exploration Plan" with SMART objectives for ongoing growth in the SVEI program.

Stage 2: Vocational Training for Informed Exploration

Following the development of essential self-awareness, the theoretical framework progresses to the Vocational Training phase. The central aim at this juncture is to methodically tackle the "Deficiency of Information" pertaining to various professions and the intricacies of career planning [6]. This phase surpasses traditional passive teaching methods by utilizing a dynamic, project-based inquiry model, with educational tasks aligned to the nine difficulty indicators of the CDMI, ensuring that the knowledge acquisition process is relevant to the challenges highlighted in student assessments. Online Learning Platforms, Professional Databases, and Reports. The meticulously designed activities are both practical and intellectually enriching, such as the "Career Path Comparison Project," where an automotive technology student examines the roles of a general mechanic versus an electric vehicle specialist, analyzing differences in training, responsibilities, salary, and career paths; additionally, the "Case Study Discussion Forum" allows students to critically analyze real-world professional case studies, enhancing their critical thinking and bridging theoretical knowledge with practical application.

Stage 3: Ecosystem Learning for Contextual Immersion

The tertiary phase, termed Ecosystem Learning, seeks to bridge the gap between theoretical knowledge and the dynamic professional environment by helping students understand the implicit workplace curriculum, including cultural norms and communication styles, while simultaneously cultivating social capital through technologies that enable vicarious learning and professional networking. The Virtual Field Trip (VFT) serves as a primary educational tool that utilizes 360-degree video technology and interactive digital platforms to allow learners to engage with genuine professional environments, such as modern automotive manufacturing sites, active electrical substations, or industrial design studios, while circumventing the logistical and safety constraints of physical visits [16]. Empirical studies demonstrate that Virtual Field Trips (VFTs) are powerful tools for vocational exploration, enhancing student

involvement, facilitating knowledge acquisition, and providing significant exposure to authentic professional environments [15]. The second instrument is a regulated digital platform that fosters connections between students and a curated network of industry professionals, including alumni, thus aligning with modern digital career counseling practices that prioritize student-employer relationships [5]. The activities in this phase are marked by interactivity and reflection. After a Virtual Field Trip (VFT), students engage in a "Context Analysis" assignment to critically assess workplace culture, safety protocols, team dynamics, and challenges, while the "Informational Interview" activity instructs them on reaching out to professionals, formulating questions, and conducting interviews to acquire essential insights into career paths, daily roles, and advice, thereby enhancing communication skills and fostering professional networking.

Stage 4: Immersive Learning for Experiential Competence

The apex of the SVEI framework is epitomized by the Immersive Learning phase, which aims to provide students with secure, experiential engagement in core tasks and common professional challenges through virtual reality simulations, thereby fostering mastery experiences, enhancing self-efficacy, and enabling a visceral assessment of professional compatibility. The paramount technological innovation examined is Virtual Reality (VR) Simulation, which has been empirically validated to enhance knowledge retention, learner self-efficacy, and focus, while simultaneously reducing error rates and training duration in vocational and technical education [17]. Empirical studies by leading technology firms, such as Siemens, corroborate these benefits, revealing a 40% reduction in error rates and a 66% decrease in training time after implementing virtual reality training techniques for intricate machinery operations [18].[19].[20]. The endeavors encompassed within this phase are meticulously organized in accordance with Kolb's Experiential Learning Cycle to optimize their educational efficacy. Concrete Experience (CE): The scholar utilizes a virtual reality headset to engage in a complex simulation relevant to their field, such as diagnosing engine issues for automotive studies or assembling control panels for electrical engineering, employing virtual tools to complete specified tasks [10]. Reflective Observation (RO): Following task completion, the student exits the simulation, after which a structured debriefing occurs, facilitated by an instructor, peer discussion, or an integrated feedback system within the virtual reality program to analyze their actions and highlight errors, prompting the student to reflect on their performance, its effectiveness, and potential alternative strategies [21]. Abstract Conceptualization (AC): During this phase, the learner synthesizes experiential knowledge from simulations with theoretical models from Stage 2, engages in critical self-assessment, identifies core principles, and formulates an innovative hypothesis or refined approach to tackle the identified issue [22]. Active

Experimentation (AE): The learner actively revisits the virtual reality simulation to apply their newly devised strategic method, thereby perpetuating a cyclical process of practice and reflection that enhances technical skills and fosters confidence in problem-solving [12]. This structured progression through four defined stages exemplifies a method of "scaffolded reality-testing," systematically dismantling the conventional understanding of an adolescent's "career." Beginning with abstract cognitive and emotional exploration, the approach advances to tangible textual analysis, followed by experiential learning through Virtual Field Trips, ultimately culminating in active engagement within simulated professional contexts, thereby enhancing the student's readiness for real-world challenges in their chosen field.

IV. DISCUSSION: IMPLICATIONS AND FUTURE DIRECTIONS

The SVEI Training Model serves as a conceptual framework that significantly enhances career counseling in vocational education by deliberately integrating its four distinct stages. This model, tailored for Generation Z learners, effectively addresses their unique challenges by leveraging technology to create relevant and engaging learning experiences that align with their aspirations for meaningful employment and economic stability [1]. The SVEI model serves as a dual-purpose intervention, functioning as both a career guidance tool and a skills training accelerator, exemplified by Stage 4's virtual reality simulations that enhance students' career decision-making confidence while simultaneously allowing them to develop essential technical skills, thereby providing vocational institutions with a compelling return on investment through improved career and job readiness. The implementation of this model marks a pivotal transition in vocational education, shifting from traditional, information-driven career guidance to integrated, experiential, and technologically advanced teaching methods. This transition necessitates the evolution of vocational educators into facilitators of reflective practice and adept users of advanced learning technologies, thereby requiring targeted professional development and institutional support. The SVEI model's primary limitation as a conceptual framework lies in its absence of empirical validation, necessitating future research to focus on its pilot implementation and thorough evaluation in authentic vocational education contexts

- To what degree does engagement in the comprehensive SVEI framework result in a statistically substantial enhancement in students' career decision-making self-efficacy (CDMSE) and a reduction in their career decision-making challenges, as evaluated through pre- and post-test assessments utilizing the CDMSE-SF and CDMI?
- What is the proportional impact of each of the four stages on the comprehensive transformation in

students' career decision-making processes and their self-assurance?

- Is there a relationship between student involvement in the SVEI model and their academic achievement, as well as retention rates in their fundamental vocational disciplines?
- In what manner can the model be effectively modified and expanded to accommodate a broader spectrum of vocational trades (for instance, hospitality and healthcare) as well as diverse cultural and socioeconomic environments?

Conducting empirical research to address these inquiries will be imperative for substantiating the SVEI model and enhancing its applicability on a larger scale. Should its efficacy be demonstrated, the model may provide a significant, evidence-oriented framework for equipping the forthcoming generation of adept professionals for vocations that are both economically sustainable and intrinsically rewarding.

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The Development of a Blended Learning Model According to the Whole Language Approach Combined with Artificial Intelligence to Enhance the English Communication Skills of Grade 4 Students in Schools Under the Bangkok Metropolitan Administration

Supatra Suriwong
Faculty of Education Silpakorn
University
Bangkok, Thailand
s.supatra123@gmail.com

Anirut Stiman
Faculty of Education Silpakorn
University
Bangkok, Thailand
sanirut@gmail.com

Abstract— The aim of this research is to develop a blended learning model based on the Whole Language Approach combined with Artificial Intelligence (AI) to improve the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration. The study is divided into three phases 1. To study the conditions and needs of the blended learning model according to the Whole Language Approach combined with AI for enhancing the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration. 2.To develop the blended learning model according to the Whole Language Approach combined with AI to improve the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration. 3.To present the developed blended learning model according to the Whole Language Approach combined with AI for enhancing the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration with feedback from 9 experts for evaluating the appropriateness of the model. The research sample consists of English teachers with over 5 years of experience in schools under the Bangkok Metropolitan Administration and the Office of the Basic Education Commission as well as Grade 4 students from these schools. The research tools included 1. A questionnaire on the opinions of English teachers regarding the blended learning model to develop English communication skills in schools under the Bangkok Metropolitan Administration and the Office of the Basic Education Commission. 2. A questionnaire on the opinions of students regarding the blended learning model to develop English communication skills in schools under the Bangkok Metropolitan Administration and the Office of the Basic Education Commission. 3. An evaluation form assessing the appropriateness of the draft blended learning model based on the Whole Language Approach combined with AI to enhance the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration.

The research utilized statistical methods including averages and standard deviations. The findings revealed that the blended learning model based on the Whole Language Approach combined with AI consists of seven components 1. Curriculum planning and design 2. Face-to-face learning 3. Online teaching 4. Problem-solving in learning 5. Motivation and engagement 6. Support and improvement 7. Assessment and feedback

The model follows 5 stages 1. Let's Start 2. Let's Learn 3. Let's Practice 4. Let's Use 5. Let's Check and Give Feedback

The results of the evaluation by the 9 experts showed that the model received an overall appropriateness score of 4.41 indicating a high level of suitability with a standard deviation of 0.70.

Keywords— *Blended Learning Model, Whole Language Approach, AI Language Tools, English Communication Skills, Listening, Reading, Speaking, Writing*

I. INTRODUCTION

In the present day, the world is experiencing rapid and continuous advancements in Information Technology (IT). Innovations and various scientific fields are developing, and digital innovations are being widely applied. As a result, digital information has become a critical component driving various sectors including the economy society and education. These advancements in IT have also facilitated the convenient fast and widespread access to information and knowledge. The digital youth, who have grown up with digital technology are particularly adept at quickly learning how to use IT tools in their daily activities such as researching information online using electronic devices like smartphones tablets and computers and communicating through digital platforms such as social media learning applications and video conferencing

systems. The use of these technologies plays a vital role in promoting learning developing individual skills and fostering interactions in the digital society.

Thailand's policy on Information and Communication Technology (ICT) recognizes the importance of technology in supporting the development of the economy society education and the quality of life of its citizens. The policy emphasizes the widespread and equitable application of digital technology in various sectors to reduce disparities across all groups and ages particularly in education. This involves using digital technology to develop curricula teaching and skills training that align with future labor market needs as well as promoting lifelong learning through online education systems creating opportunities for access to quality education for citizens in all areas especially in remote regions. This aims to support human resource development and improve the quality of life enabling people to keep pace with the changes of the digital age sustainably.

In education, there is a need to adapt to these changes by updating educational practices to match the growing knowledge and increasing data worldwide. The focus must be on developing skills that are essential for life and work in the future such as critical thinking problem-solving collaboration and the effective use of technology. Every learner should be given the opportunity to gain knowledge and experiences that will allow them to apply critical thinking to solve problems analyze synthesize knowledge and keep up with the requirements of 21st-century learning.

Traditional teaching models, which often rely heavily on the teacher as the primary source of knowledge transmission must evolve. With the rapid pace of technological advancement, there is a need to change the learning approach. Teachers should no longer be merely transmitters of knowledge but also creators of a learning environment that encourages student participation. This can be achieved by integrating information technology with traditional teaching methods to improve learning efficiency and make it easier and more accessible for students to engage with course content. This integrated approach to teaching and learning is called "Blended Learning" which is an educational innovation that combines different teaching methods. Teachers can select a variety of teaching methods such as online learning and face-to-face instruction. The integration of technology and these teaching methods can help meet the diverse learning needs of students.

The Office of the Basic Education Commission of the Ministry of Education has set guidelines for organizing learning in the 2008 revised Basic Education Core Curriculum (revised in 2017) which places English as a foreign language subject throughout the curriculum. The goal is to help students use English to communicate in various situations seek knowledge pursue careers, and continue their education at higher levels. Foreign languages, particularly English have become essential

tools for communication among people in many countries for acquiring knowledge pursuing careers and fostering an understanding of global culture and diversity.

English communication skills including listening speaking reading and writing are fundamental. Speaking is the fastest communication skill especially in daily life. Speaking not only involves pronouncing words correctly and using appropriate vocabulary but also requires the ability to apply correct grammar suited to different contexts understand vocabulary grasp the cultural context of the language use appropriate body language and communicate effectively with words—skills that differ from written grammar use.

The development of English communication skills requires a teaching process where all skills are interconnected and complement each other aligning with real-life situations to enable students to use the language to communicate and create meaning in different contexts effectively. This includes the Whole Language Approach, which integrates all four skills listening speaking reading and writing—in teaching. This helps language learning occur in a natural context connected to real-life language use and relevant to the students' experiences and interests thereby motivating and engaging students. This teaching approach does not emphasize teaching each skill separately but integrates all skills so students can communicate effectively.

Based on these premises, the researcher has integrated the Whole Language Approach with Artificial Intelligence (AI) as a framework to develop a blended learning model to improve the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration. The development of English communication skills is essential for students providing them with a solid foundation for learning languages at higher levels and enabling them to confidently use English in everyday life in education in the workplace and in a future society rich in cultural diversity.

II. OBJECTIVES

1. To study the conditions and needs of blended learning (Blended Learning) according to the Whole Language Approach combined with Artificial Intelligence (AI) to enhance the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration.

2. To develop a blended learning model according to the Whole Language Approach combined with Artificial Intelligence to improve the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration.

3. To present the blended learning model based on the Whole Language Approach combined with Artificial Intelligence to develop the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration.

III. METHODOLOGY

1. To study the conditions and needs of blended learning (Blended Learning) according to the Whole Language Approach combined with Artificial Intelligence (AI) to enhance the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration.

2. To develop a blended learning model according to the Whole Language Approach combined with Artificial Intelligence to improve the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration.

3. To present the blended learning model based on the Whole Language Approach combined with Artificial Intelligence to develop the English communication skills of Grade 4 students in schools under the Bangkok Metropolitan Administration.

IV. DATA ANALYSIS

A. Survey Results on the Conditions and Needs of Blended Learning for Teachers

A survey on the conditions and needs for blended learning in English teaching was conducted with 10 teachers from 10 different schools. The survey was divided into 2 sections

1. Personal information of the respondents

2. General conditions regarding content activities teaching techniques blended learning tools assessment methods and factors supporting blended learning followed by suggestions for promoting English communication skills.

1.1 General Conditions Regarding Content in English Teaching

1.1.1 66.7% of teachers use lecture-based teaching in class while 33.3% use online video lectures.

1.1.2 14.3% of teachers use individual activities 28.6% use pair activities 19.1% use small group activities and 38.1% use whole-class activities.

1.1.3 19.1% of teachers focus on practical learning 38.1% use language for communication in real-life situations 23.8% promote critical thinking and collaboration and 19.1% emphasize experiential learning.

1.2 General Conditions in Teaching

1.2.1 14.3% of teachers set teaching time allocation 23.8% define learning objectives 28.6% design content and activities 19.1% select technologies and tools and 19.1% plan assessment.

1.2.2 9.5% of teachers analyze learners and context 19.1% design lessons 23.8% prepare materials and resources 33.3% test systems and rehearse and 14.3% explain the learning model.

1.2.3 14.3% of teachers use course standards 19.1% set content to be taught 28.6% design activities and 23.8% set evaluation criteria.

1.3 General Conditions in Assessment and Evaluation

1.3.1 47.6% of teachers use pre-tests 33.3% use midterm assessments and 33.3% use final exams.

1.4 Tools Used for Blended Learning

1.4.1 28.6% of teachers use PowerPoint 47.6% use YouTube and 28.6% use Google Classroom for content presentation.

1.4.2 52.4% use Google Forms for assessment and 23.8% use Quizizz and Kahoot for blended learning evaluation.

1.5 Needs Regarding Blended Learning Tools

1.5.1 AI Tools for Teaching and Learning 33.3% of teachers use ChatGPT 4.8% use Google Bard 17.3% use Microsoft Copilot 4.8% use Quizlet AI

B. Suggestions for Teaching to Develop English Communication Skills for Grade 4 Students Problems

1. Access to Technology: Some students may face difficulties accessing online learning devices or experience unstable internet connections.

2. Lack of Confidence in Using Technology: Some students may not be familiar with using online learning platforms preventing them from fully benefiting from the lessons.

Needs

1. Technology Skills Training: Students need training to use the various tools and technologies used in online learning.

2. Internet Speed: When sharing screens or using collaborative applications in online classrooms higher internet speeds may be needed to avoid connectivity issues.

Other Suggestions

1. Basic training should be provided for both students and parents on how to use online learning platforms and tools.

2. A variety of teaching materials should be prepared such as video clips online activities or downloadable teaching resources to ensure smooth learning experiences.

2. Survey Results on the Condition and Needs of Blended Learning Instruction for Students

The survey on the condition and needs of blended learning instruction for students studying English was conducted with questions divided into 2 parts: 1) personal information of the respondents and 2) general conditions related to content, teaching activities teaching techniques blended learning tools assessment and evaluation and factors supporting blended learning.

Part 3 includes suggestions for teaching and learning to develop English communication skills for Grade 4 students.

2.1 General Conditions Regarding Learning Content

2.1.1 Before teaching, teachers' methods related to English language instruction 31.0% of students stated that teachers explained the learning format 20.7% indicated that a knowledge test was conducted before the lesson and 48.3% observed that teachers monitored students' behavior and personality.

2.1.2 Teachers' methods for setting instruction: 13.8% of students noted that the teacher explained the course details 3.5% said the teacher stated the learning objectives 24.1% mentioned that the teacher explained the content to be taught 17.2% indicated the teacher explained the evaluation criteria 34.5% mentioned the teacher explained the learning activities and 6.9% noted that the teacher clarified the time allocation for lessons.

2.1.3 Teachers' preparation for lessons 37.9% of students reported that teachers communicated students' and instructors' roles 13.4% stated that teachers asked questions to test students' understanding 20.7% mentioned a trial of online system usage and 27.6% indicated that teachers informed about assessments in class.

2.1.4 Teachers' teaching procedure design: 10.3% of students noted that the teacher communicated learning objectives 24.1% observed instructional design 27.6% mentioned that the teacher analyzed students 17.2% stated that the teacher defined learning assessments and evaluations and 20.7% mentioned that teachers presented students' work.

2.1.5 Defining learning activities in the English course: 65.5% of students observed that teachers taught via lectures in class and 34.5% noted that teachers used online video lectures.

2.1.6 Organizing learning activities in the English course: 20.7% reported that teachers organized individual activities 27.6% noted pair activities 17.2% mentioned small group activities and 34.5% observed that teachers arranged class-wide activities.

2.1.7 Designing teaching activities in the English course: 27.6% of students stated that teachers provided practical learning experiences 13.8% mentioned that teachers encouraged language use in real-life communication 37.9% noted that teachers promoted critical thinking and collaborative work and 20.7% stated that students learned through activities or direct experience.

2.2 General Conditions Regarding Teaching Techniques

2.2.1 Teaching methods in the English course: 24.1% used games and recreational activities 13.8% gave rewards or extra points 41.4% used interesting and modern media and 20.7% connected lessons to real-life situations.

2.2.2 Innovative teaching methods previously used in the English course 34.5% had brainstorming sessions 13.8% used cooperative learning 24.1% used storytelling and 27.6% applied competitive learning.

2.3 General Conditions Regarding Learning Assessment and Evaluation

2.3.1 Assessment plans for English learning 17.2% of students selected pre-test assessments 34.5% chose ongoing semester evaluations and 48.3% opted for final semester exams.

2.4 Student Needs Regarding Learning Tools

2.4.1 Tools used by students for searching: 75.9% used Google Chrome 10.3% used Firefox 1% used Bing 34.5% used ChatGPT and 41.4% used Gemini.

2.4.2 Tools used by students for content presentation in the English course 10.3% used PowerPoint 93.1% used YouTube 3.4% used Canva and 86.2% used Google Classroom.

2.4.3 Tools students prefer for knowledge creation in the English course 39.3% used Google Docs/Sheets 17.9% used Microsoft OneNote 17.9% used Adobe and 71.4% used Microsoft Word.

2.4.4 Tools students prefer for assessing English course performance 93.1% selected Google Forms 58.6% used Quizizz and 69.0% used Kahoot.

C. *Suggestions for Blended Learning Instruction Based on the Whole Language Approach Combined with Artificial Intelligence to Enhance English Communication Skills of Grade 4 Students*

Current Situation

A variety of activities should be used including whole- class small-group and pair activities. This approach allows teachers to adjust according to the situation and better develop students' skills.

Problems:

Some tools may not be suitable or ready for use in blended learning environments, which creates challenges for both teachers and students in utilizing them effectively.

Needs:

Teachers require training to enhance their skills in using online teaching tools and new technologies such as AI (e.g., ChatGPT) to support teaching and learning.

Teachers need additional training on how to use online teaching platforms and design blended learning instruction.

Based on the synthesis of theoretical studies and the survey of current teaching and learning conditions a draft for the development of a blended learning model based on the Whole Language Approach combined with Artificial Intelligence has been created to improve the English communication skills of Grade 4 students.

C. Results of the Development (Draft) of a Blended Learning Model Based on the Whole Language Approach Combined with Artificial Intelligence to Enhance English Communication Skills for Grade 4 Students This model consists of 7 components

1. Curriculum Planning and Design
2. In - Class Learning
3. Online Instruction
4. Addressing Learning Issues
5. Motivation and Engagement
6. Support and Improvement
7. Assessment and Feedback

Component 1: Curriculum Planning and Design

This focuses on creating a learning experience for students by integrating classroom learning and online learning. The curriculum design should be flexible adaptable to students' needs and interests and aimed at developing English communication skills through

activities that promote learning with the use of technology and Artificial Intelligence (AI). This supports the continuous development of listening speaking reading and writing skills which can be applied in real-life situations. Progress should be tracked and feedback should be provided according to each student's ability including the use of diverse teaching materials.

Component 2: In-Class Learning

Creating a learning environment that encourages interaction between the teacher and students is key. Students can practice various skills through activities that promote real-life language use such as group discussions role-playing and collaborative projects. Teachers can monitor students' progress in real-time offering guidance and quick corrections to improve language use and resolve any misunderstandings.

Component 3: Online Instruction

Using technology and online platforms such as Google Classroom or Learning Management Systems (LMS) allows students to access learning content anytime, anywhere. Students can learn independently through diverse teaching materials like videos online lessons, and exercises. Teachers can create activities and quizzes that provide instant feedback on students' understanding. AI can be used for assessment and feedback based on each student's performance, enabling continuous language learning especially in digital environments. Opportunities for speaking and writing can also be provided through online forms or chatbots that create an engaging and natural English practice environment.

Component 4: Addressing Learning Issues

Students may face challenges in the learning process, such as difficulty understanding difficult vocabulary incorrect grammar usage or lack of confidence in speaking. Technology and AI can serve as tools to address these issues. AI can analyze errors and offer personalized suggestions such as recommending related vocabulary correcting sentence mistakes, or practicing speaking via real-time chatbots. Continuous assessment helps teachers identify problems and adjust teaching plans promptly. Online learning and exercises along with teacher feedback boost students' confidence in addressing learning obstacles fostering a continuous and flexible learning process tailored to individual needs.

Component 5: Motivation and Engagement

Motivating students helps encourage their commitment to learning and increases their interest in educational activities. Technology and educational games via online platforms can be used such as reward systems or point accumulation for completing successful activities. This creates excitement and encourages student participation. Furthermore, using diverse activities including solo pair and group tasks or competitive online educational games helps students find learning English enjoyable and

valuable. Providing opportunities for expression enhances students' confidence and participation in the learning process.

Component 6: Support and Improvement

AI can assist teachers in evaluating students' learning and providing suggestions during the learning process. This support helps students continue learning with confidence improving their English skills through personalized adjustments. AI can create lessons that match students' levels of ability and offer challenging activities. A blended learning environment should allow students to ask questions and receive immediate guidance, supporting skill development. Monitoring students' progress and giving continuous feedback ensures that they can continuously improve their English skills.

Component 7: Assessment and Feedback

Appropriate assessment methods help students understand their progress and areas for improvement. This can be done through online assessments such as quizzes or activities with immediate results as well as in-class assessments that allow teachers to observe students' language use directly. Discussions or role-playing activities can also be used for assessment. Feedback should be specific consistent and help students identify strengths and areas for development in their English language use. Immediate feedback helps students quickly improve their skills and feedback should be diverse and adjusted to each student's needs for maximum learning effectiveness.

D. Steps in the Teaching Model

Let's Start

- The teacher explains the learning objectives to the students, specifying what skills will be learned in each step such as vocabulary sentence structure and real-life speaking practice.
- Students understand the learning objectives to prepare for classroom activities and gain an understanding of what they will learn and how they can apply it in real life.

Let's Learn

- The teacher teaches vocabulary and sentences used in the lesson.
- Students learn the vocabulary and sentences taught by the teacher.
- Students listen to and understand the use of language in various situations.

Let's Practice

- The teacher divides the students into groups and has them practice role-playing in real-life scenarios.
- Students practice using the vocabulary and sentences in the role-playing activity.
- The teacher observes and provides guidance to the students.

Let's Use

- The teacher encourages students to continually practice their English skills.

- The teacher provides opportunities for students to practice using English to build confidence.

Let's Check and Give Feedback

- The teacher assesses the students' language use and provides feedback.
- Students receive feedback from the teacher and their peers in the classroom.

F. Evaluation Results of the (Draft) Blended Learning Model Based on the Whole Language Approach Combined with Artificial Intelligence for Developing English Communication Skills of Grade 4 Students in Bangkok Metropolitan Administration Schools

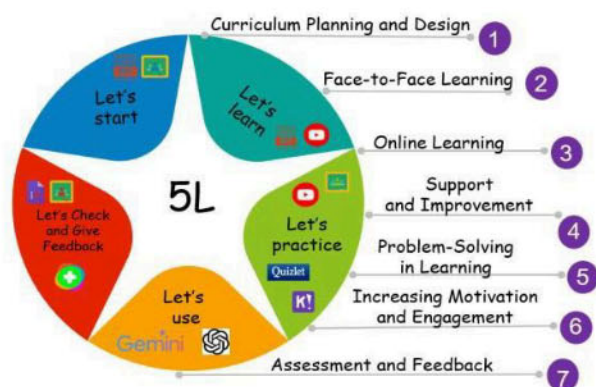


Diagram: 5L Model (Draft) Blended Learning Model Based on the Whole Language Approach Combined with Artificial Intelligence for Developing English Communication Skills of Grade 4

V. DISCUSSION

The Blended Learning model based on the Whole Language Approach combined with Artificial Intelligence for developing English communication skills of Grade 4 students in Bangkok Metropolitan Administration schools, which was developed and reviewed by 9 experts, was found to be highly appropriate and well-aligned. The Blended Learning model has been systematically developed, considering both the learning and teaching conditions of students and teachers. It synthesizes theoretical content and research related to developing a blended learning model that integrates the Whole Language Approach with Artificial Intelligence. The system for teaching and learning was studied to align with current language learning scenarios. The teaching and learning management components are prepared with seven elements:

1. Curriculum planning and design
2. Face-to-face learning
3. Online teaching
4. Problem-solving in learning
5. Motivation and engagement
6. Support and improvement
7. Evaluation and feedback

The steps of the model based on the Whole Language Approach combined with Artificial Intelligence include five stages:

1. Let's Start
2. Let's Learn
3. Let's Practice
4. Let's Use
5. Let's Check and Give Feedback

These stages align with the findings of Kriangkrai Silapapibul's research, which showed that the use of the Whole Language Approach combined with technology significantly enhances students' English communication skills. Additionally, research by Garrison & Kanuka found that using the Blended Learning model increases the effectiveness of students' learning, especially in the area of English communication.

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Developing a Blended Instructional Model through Active Learning with Digital and AI Tools to Promote Digital and AI Competencies for Educational Innovation among Pre-service Teachers at Muban Chombueng Rajabhat University

Wannasiri Thurapaeng
Department of Computer Education,
Faculty of Science and Technology,
Muban Chombueng Rajabhat
University,
Ratchaburi, Thailand
thurapaeng.wannasiri@gmail.com

Anirut Satiman
Department of Educational
Technology, Faculty of Education,
Silpakorn University,
Nakhon Pathom, Thailand
sanirut@gmail.com

Abstract— This research aimed to develop a blended instructional model integrating active learning with digital tools and artificial intelligence (AI) to enhance digital and AI competencies for fostering educational innovation among pre-service teachers at Muban Chombueng Rajabhat University. The study was conducted in three phases: (1) investigating current conditions and needs for blended instruction that integrates active learning with digital and AI tools, (2) developing the instructional model, and (3) validating the model's appropriateness with six experts. The sample comprised 12 instructors teaching GE66201 "Application of Digital Technology" and 156 first-year Bachelor of Education students in the second semester of the 2024 academic year, selected through purposive sampling. Additionally, four instructors were interviewed for qualitative insights. The research employed four instruments: (1) instructor questionnaires, (2) student questionnaires, (3) expert interview forms, and (4) a model evaluation form. Data were analyzed using mean and standard deviation. Findings revealed that the developed model was rated at a very high level of appropriateness ($\bar{x} = 4.55$, $SD = 0.60$). The model includes five key components: 1. Blended Learning Context ($\bar{x} = 4.47$, $SD = 0.69$) 2. Active Individual and Collaborative Learning ($\bar{x} = 4.60$, $SD = 0.57$) 3. EdTech-AI Empowered Learning ($\bar{x} = 4.40$, $SD = 0.74$) 4. Ongoing & Competency-Based Assessment ($\bar{x} = 4.57$, $SD = 0.65$) 5. Ed-Innovation Competency Focus ($\bar{x} = 4.57$, $SD = 0.62$) The instructional process comprises six steps, all rated at a very high level: 1. Inspiration and Goal Setting ($\bar{x} = 4.57$, $SD = 0.65$) 2. Planning and Project Design ($\bar{x} = 4.50$, $SD = 0.54$) 3. Implementation ($\bar{x} = 4.67$, $SD = 0.50$) 4. Knowledge Construction ($\bar{x} = 4.60$, $SD = 0.52$) 5. Presentation of Work ($\bar{x} = 4.57$, $SD = 0.52$) 6. Evaluation and Reflection ($\bar{x} = 4.59$, $SD = 0.54$) Overall, the blended instructional model was evaluated as highly appropriate and is considered effective for enhancing the competencies required for educational innovation in pre-service teacher education.

Keywords—blended learning, active learning, digital competence, AI competence

I. INTRODUCTION

In the 21st century, digital technology and artificial intelligence (AI) have become critical forces driving educational transformation and the development of learners' essential skills. These technological advances influence various sectors and pose new challenges for countries like Thailand, which is undergoing digital transformation, transitioning to Industry 4.0, and striving to achieve the United Nations Sustainable Development Goals (SDGs) by 2030 [5]. AI in education has redefined instructional methods and teacher competencies by enabling personalized learning through AI tutoring systems and adaptive learning platforms [3]. In line with national strategies, the Higher Education, Science, Research, and Innovation Policy and Strategy (2023–2027) emphasizes the integration of disruptive innovations, especially AI, to shape the future [1].

The development of digital and AI competencies is therefore essential for pre-service teachers to effectively apply these technologies in instructional practices and educational innovation. Blended learning is a strategic approach that combines traditional and online instruction, allowing for greater flexibility and learner autonomy. It supports active learning through diverse methods such as hands-on practice, peer collaboration, and the use of various digital resources. Active learning encourages learners to construct knowledge through participation, dialogue, and problem-solving, promoting stronger engagement between instructors and students [2][4]. The integration of digital tools and AI further enhances instructional efficiency and personalization, supporting

continuous learning. However, it also requires consideration of safety, ethics, and critical thinking.

Muban Chombueng Rajabhat University plays a pivotal role in preparing future educators equipped with digital and AI competencies. Consequently, the development of a blended instructional model that integrates active learning with digital tools and AI is crucial for enhancing technological and innovative competencies among pre-service teachers. In response to this context, the researcher aims to design a model that empowers pre-service teachers to become educational innovators capable of developing instructional strategies and media aligned with the demands of the digital era. This initiative serves as a strategic mechanism to transform teaching and learning in alignment with emerging technological advancements.

II. OBJECTIVES

- A. *To investigate the current state and needs regarding blended learning using active learning methods combined with digital and AI tools to enhance digital and AI competencies for educational innovation among pre-service teachers at Muban Chombueng Rajabhat University.*
- B. *To develop a blended instructional model utilizing active learning approaches and incorporating digital and AI tools to enhance digital and AI competencies for educational innovation among pre-service teachers at Muban Chombueng Rajabhat University.*
- C. *To present the blended instructional model that integrates active learning with digital and AI tools to promote digital and AI competencies for educational innovation among pre-service teachers at Muban Chombueng Rajabhat University.*

III. RESEARCH METHODOLOGY

This study employed a Research and Development (R&D) approach, following a basic pre-experimental design. The research process consisted of the following steps:

- A. *Review of relevant theories, principles, and previous research on blended learning, active learning, digital tools, and AI in education.*
- B. *Analysis of the current situation and needs by designing questionnaires for instructors and students.*
- C. *Development of evaluation tools and determination of Item-Objective Congruence (IOC) for questionnaire validity.*
- D. *Conduct interviews with experts to further refine the instructional model.*
- E. *Design and validate interview protocols through IOC analysis.*
- F. *Draft the initial version of the blended instructional model.*

G. *Create an evaluation tool to assess the suitability of the drafted model.*

H. *Validate the draft model with 9 experts to gather suggestions for revision and improvement.*

IV. DATA ANALYSIS RESULTS

A. *Results of the Survey on the Current State and Needs for Blended Learning among Instructors*

The survey conducted among 12 instructors who taught the course GE66201: Applications of Digital Technology at Muban Chombueng Rajabhat University during the second semester of the 2024 academic year provided comprehensive insights into instructional practices, needs for blended learning tools, and future directions for pedagogical innovation. The respondents represented diverse faculties, predominantly from the Faculty of Science and Technology, and the majority had experience in both online and blended learning formats, with familiarity in utilizing various digital tools and artificial intelligence (AI) applications in teaching.

In terms of instructional practices, most instructors updated their content to align with technological trends and emphasized relevance, flexibility, and integration of theory and practice. Instructional activities focused on student engagement, creativity, hands-on learning, and real-world application. A wide range of instructional techniques were employed, all of which followed structured pedagogical guidelines and promoted participation, critical thinking, and creativity. Assessment practices were diverse and emphasized authenticity, technology integration, and AI competency. Supporting factors included access to digital infrastructure, training, technical assistance, and policy frameworks, although there were identified needs for enhanced support in media development and external collaboration.

Regarding the instructional tools required for effective blended learning, instructors reported high demand for classroom hardware (e.g., projectors, smartboards), learning management systems such as Google Classroom and Moodle, and various online tools for communication, content creation, collaboration, and assessment. Notably, the use of AI tools such as ChatGPT, Canva, Gemini, and personalized learning platforms was prevalent, along with multimedia production tools and data analysis software. The preferred ratio for blended learning varied, with the most favored model being 60% online and 40% offline.

Suggestions from the instructors highlighted several key priorities: the integration of AI and digital tools into curricula; the promotion of hands-on, project-based learning; the development of critical thinking, problem-solving, and innovation skills; the redefinition of instructor roles as facilitators; and the establishment of supportive systems and policies. These findings suggest a strong foundation and readiness for the implementation of blended instructional models that integrate active learning with AI and digital technologies to foster educational

innovation and future-ready competencies among pre-service teachers.

B. Results of the Survey on the Current State and Needs for Blended Learning among Students

A survey of 156 students enrolled in GE66201: Applications of Digital Technology at Muban Chombueng Rajabhat University in the second semester of the 2024 academic year revealed key insights into learners' experiences, perceptions, and instructional needs within the context of blended learning. The majority of respondents were female and under the age of 20, predominantly from the Faculty of Education and the Faculty of Humanities and Social Sciences. Most students had prior experience with online learning and were familiar with blended learning approaches. Commonly used platforms included Google Meet, Google Classroom, and Zoom, while AI tools such as ChatGPT, Canva, and Gemini were also widely utilized.

In terms of current instructional conditions, students reported a high level of satisfaction with content delivery. They noted that the course materials were current, relevant to real-world applications, and well-aligned with digital and AI competencies. Instructional activities were described as diverse, engaging, and supportive of active participation, collaboration, and analytical thinking. Students also appreciated the integration of AI into learning tasks and the promotion of self-directed learning and communication skills.

Instructional techniques employed by instructors were perceived as varied and appropriate, particularly those that emphasized group discussion, problem-solving, and creativity. Students expressed high satisfaction with the digital tools used, particularly for collaboration, assessments, and content creation. Evaluation practices were reported to be diverse, relevant, and inclusive, with timely feedback and alignment with real-world tasks and higher-order thinking skills.

Regarding instructional tool preferences, students indicated a strong need for modern classroom devices, online communication platforms, and digital content creation tools. They favored the use of interactive tools like Kahoot and Quizizz, multimedia software, and AI-assisted platforms such as ChatGPT and Gradescope. For learning management, Canvas and Moodle were the most preferred systems. A majority of students favored a balanced blended learning ratio of 50% online and 50% offline.

Students also provided valuable suggestions for instructional improvement. These included the need for slower-paced, step-by-step instruction with hands-on practice, expanded offline learning opportunities, and more explicit integration of technology and AI training into the curriculum. There was also a call for experiential learning opportunities that allow students to apply AI and digital tools in creating innovative educational products.

Finally, students emphasized the importance of aligning the curriculum with future technological trends

and ensuring that ethical considerations in AI usage are embedded within instructional content. These findings highlight the importance of responsive, flexible, and student-centered approaches in blended learning, particularly in the context of developing future-ready teachers equipped with digital and AI competencies.

C. Results of Expert Interviews on the Development of the Blended Instructional Model

The interviews with educational experts yielded valuable insights into the development of a blended instructional model that integrates active learning with digital and artificial intelligence (AI) tools to enhance digital and AI competencies among pre-service teachers for educational innovation. Experts emphasized that learning should occur both in-class and online, with the learning environment playing a crucial role in fostering student engagement. Digital tools were noted to enhance instructional effectiveness, especially when combined with active learning strategies and appropriate assessment practices. Furthermore, content must remain central to instruction, and AI-supported techniques should be leveraged to support the delivery of knowledge. Importantly, instructors must guide students in verifying the accuracy of AI-generated information and promote reflective learning for deeper understanding.

Experts recommended that the instructional model should balance in-class and out-of-class activities. Online components such as group discussions, educational games, and forums complement in-class sessions that focus on content synthesis and collaborative reflection. AI tools should be used to support information retrieval and critical analysis. Digital tools—including Google Workspace, Microsoft Office, Kahoot, YouTube, LINE, Facebook, MOOCs, AR/VR, and AI platforms like ChatGPT and DeepSeek should be selected based on content, learner needs, and objectives, with flexibility and adaptability as key selection criteria.

For assessment, digital tools like Google Apps and MOOCs enable real-time progress tracking and diverse activity formats. When combined with rubrics, these tools promote transparency and competency-based evaluation. Teachers should be equipped with the knowledge to integrate these tools into standardized assessment frameworks effectively.

AI tools were also viewed as facilitators of active learning. Platforms like ChatGPT and DeepSeek assist in generating ideas, explanations, and answers. However, students must be trained to critically evaluate AI-generated content. Learning activities should encourage inquiry, comparison, and analytical reasoning. AI has the potential to develop problem-solving skills when used within structured, theory-driven instructional design, supported by case-based tasks and appropriate assessment rubrics.

The essential competencies for pre-service teachers include ethical and effective use of digital and AI tools, the ability to evaluate content, manage data, and exercise

critical information literacy. Teachers must also serve as role models in creating and sharing digital content. Active learning strategies should cultivate media literacy, ethical AI use, and data analysis capabilities, with AI functioning as a support tool rather than a replacement for core instructional objectives.

Key traits of educational innovators were identified as critical and creative thinking, design innovation, adaptability, lifelong learning, and visionary leadership. These should be fostered through project-based learning and technology-integrated modules. Institutions must also provide enabling conditions, including digital infrastructure, flexible learning spaces, and interdisciplinary curricula. Ultimately, universities are encouraged to promote community-based learning and invest in teacher development to prepare pre-service teachers to design and implement instructional innovations effectively using AI and digital tools.

D. Synthesis of Data from Questionnaires and Interviews

Synthesis of the Blended Instructional Model Integrating Active Learning with Digital and AI Tools for Pre-service Teacher Education

The development of a blended instructional model for pre-service teachers at Muban Chombueng Rajabhat University was based on a synthesis of instructor and student questionnaires and expert interviews. The aim was to enhance digital and AI competencies in line with educational innovation and 21st-century learning demands.

- **Instructional Context and Needs** Instructors predominantly employed lecture-based methods with supplemental demonstrations and discussions. A significant number had experience integrating digital tools and AI applications such as ChatGPT, Canva, and Gemini. They expressed the need for improved digital infrastructure, including smartboards, LMS platforms, and AI teaching tools. Instructors advocated for purposeful AI integration, project-based learning, and redefining their role from lecturer to facilitator. Students reported high engagement with digital platforms and AI tools and preferred hands-on, practical instruction with clear, structured guidance. They favored a balanced hybrid learning model, emphasizing contextual learning and meaningful AI use. Experts reinforced the importance of integrating blended and active learning with responsible AI use. They emphasized project-based learning, innovation creation, and competency-based assessment. Moreover, they identified five key traits essential for educational innovators: analytical and creative thinking, innovation design, adaptability, lifelong learning, and visionary leadership.
- **Model Structure and Components.** The model comprises five core components: Blended Learning Context, Active Individual and Collaborative Learning, EdTech-AI Empowered Learning,

Ongoing & Competency-Based Assessment and Ed-Innovation Competency Focus

- **Instructional Process Design.** The model outlines a dual-mode instructional process: Online Mode includes stages of analysis and planning, design, development, implementation, and evaluation using digital and AI tools. And Offline Mode consists of orientation, introduction, content delivery, conclusion, and assessment supporting interactive, reflective, and collaborative learning.
- **Implementation Framework.** The instructional flow follows six PBL-based steps: Inspiration and goal setting, Project planning and design, Project implementation, Knowledge construction through reflection, Presentation using digital platforms and Evaluation and reflection
- **Core Competencies for Educational Innovators.** The model identifies five key competencies for pre-service teachers: Critical and creative thinking, Innovation design using digital tools, Instructional adaptability, Ethical and continuous digital learning and Visionary and risk-taking leadership
- **Technological Toolsets.** The model incorporates 12 categories of digital and AI tools divided into: Digital Learning Management Tools: Google Classroom, Google Meet, Google Forms, Canva, Quizizz, Google Analytics, etc. AI Tools: ChatGPT for Q&A and content generation; Canva with AI for design. And Virtual and Communication Tools: Physics Lab for simulations; LINE for interaction and engagement.

SUMMARY

The blended instructional model integrating active learning with digital tools and artificial intelligence (AI) was developed to enhance digital and AI competencies for educational innovation among pre-service teachers at Muban Chombueng Rajabhat University. This model was evaluated by six experts and received a high appropriateness rating (mean = 4.55, SD = 0.60). It was systematically designed based on current educational needs, gathered through instructor and student questionnaires and expert interviews, and grounded in theoretical and empirical studies on blended learning, AI in education, and instructional innovation.

The model consists of five core components: (1) a blended learning context that integrates online and offline learning environments; (2) active individual and collaborative learning strategies that promote inquiry and teamwork; (3) the use of EdTech and AI to support personalized and effective instruction; (4) ongoing and competency-based assessment emphasizing real-world skills; and (5) a focus on developing educational innovation competencies.

The learning process follows six project-based steps: inspiration and goal setting, planning and project design, implementation, knowledge construction, presentation of work, and evaluation and reflection. Instruction is distributed across 15 weeks, totaling 60 hours—48% online and 52% offline—blending digital pedagogy, AI tools, and active learning strategies to promote reflective and student-centered learning.

Successful implementation requires instructors to manage hybrid environments, integrate appropriate technologies, and guide learners through active and collaborative tasks. Students must demonstrate digital literacy, set clear goals, and take responsibility for self-directed learning. A systematic six-step instructional framework aligns each learning phase with specific instructor and student roles and time allocations, ensuring a balance of online and offline modalities.

Recommended improvements include enhancing formative assessment strategies to monitor competency development over time and incorporating real-world contexts—such as community or national issues—into learning tasks to increase relevance. These enhancements aim to better prepare pre-service teachers as adaptable, innovative educators equipped for the demands of digital-era education.

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Success in Transition: A Systematic Review of Multilevel Factors Influencing Industrial Vocational Students in Thailand's Shift to the New Industrial Era

PANUTCHAYA KUNPAKDEE

*Learning Innovation and Technology Program
Faculty of Industrial Education and Technology
King Mongkut's University of Technology Thonburi, Thailand
Panutchaya.kunp@kmutt.ac.th*

SANTIRAT NANSARNG

*Department of Production Technology Education
Faculty of Industrial Education and Technology
King Mongkut's University of Technology Thonburi, Thailand
santirat.nan@kmutt.ac.th*

Abstract: Thailand's "Thailand 4.0" policy positions vocational education and training (TVET) as central to its industrial transformation. Yet, critical mismatches remain between existing TVET structures, and the competencies demanded by Industry 4.0. Current research often isolates themes such as curriculum, digital skills, or industry linkage, without addressing the multilevel systemic factors shaping vocational student success—here defined as the interplay of employability, engagement, and equity. This study systematically reviewed 50 empirical and conceptual articles from Scopus, applying PRISMA 2020 guidelines and a full-text framing matrix across seven research questions. Thematic synthesis, grounded in complexity-informed systems thinking, revealed five key domains: future-ready competencies, digital technology integration, curriculum innovation, work-based learning, and equitable personalization. Findings emphasize recursive interactions across personal, institutional, industrial, and societal systems. A conceptual framework was developed to illustrate these interrelations. Critical gaps were identified in AI-personalized learning, cognitive skill assessment, and rural-urban digital divides. Recommendations support synchronized reforms in policy, pedagogy, and partnerships—particularly for underserved groups—toward inclusive, resilient TVET ecosystems aligned with Industry 4.0 and 5.0.

Keywords: *Vocational Education and Training (TVET), Industry 4.0 Transition, Future-Ready Competencies, Systemic Educational Reform, Work-Based Learning, Digital Equity in Education, Industrial Collaboration*

I. INTRODUCTION

Industry 4.0 has not only introduced new technologies such as smart manufacturing, artificial intelligence (AI), and robotics—it has redefined how educational systems frame "success," shifting from static skillsets toward adaptive, equity-aligned competencies. In Thailand, the "Thailand 4.0" national policy places vocational education and training (TVET) at the heart of this transformation, positioning it as both an economic accelerator and a social equalizer [10]. TVET learners stand at the frontline of this industrial transition, yet legacy training models-focused

predominantly on technical skill development in isolation—are no longer sufficient. Today's industrial ecosystems demand a hybrid of technical proficiency, digital fluency, and transversal competencies such as adaptability, self-regulation, and systems thinking [16; 6]. Moreover, equity issues—such as digital divides and access disparities—amplify risks of exclusion if institutional reforms do not address them systemically. While initiatives exist to modernize TVET in curriculum, technology integration, and industry partnerships, research remains fragmented, rarely examining how personal, institutional, industrial, and societal forces dynamically interact. Success is often treated as employability alone, without fully acknowledging learner agency, equitable access, and career resilience as equally vital outcomes. This study addresses that gap through a systematic review of empirical and conceptual literature to examine how multilevel factors converge to shape vocational student success in Thailand's new industrial era. Using a PRISMA-guided methodology and a framing matrix aligned with seven research dimensions, this review proposes a conceptual framework to support strategic reforms in Thailand's TVET sector.

II. OBJECTIVES

This study aims to systematically synthesize empirical and conceptual literature related to factors influencing the success of industrial vocational students during Thailand's transition to Industry 4.0 and beyond.

Specifically, the objectives are:

1. To identify personal, institutional, industrial, and societal factors influencing vocational student success, with particular attention to digital equity and access disparities.
2. To synthesize emerging models and practices supporting future-ready competencies, curriculum innovation, work-integrated learning, and inclusion in TVET systems.

3. To develop a systems-thinking-based conceptual framework that illustrates recursive multilevel interactions shaping vocational student readiness, equity, and resilience.

4. To generate policy recommendations and research directions that strengthen Thailand's TVET system in alignment with Industry 4.0 and 5.0 imperatives.

III. RESEARCH QUESTIONS

This review is guided by the following research questions:

- RQ1: What personal factors (e.g., adaptability, lifelong learning competencies, self-regulation) influence vocational student success during the industrial transition?
- RQ2: How do institutional factors (e.g., curriculum, pedagogy, leadership) interact to support vocational student readiness and resilience in the Industry 4.0 era?
- RQ3: What societal factors (e.g., digital equity, community support, socioeconomic background) affect vocational education outcomes?
- RQ4: How do personal, institutional, industrial, and societal factors interact systemically to influence student success?
- RQ5: What policy recommendations emerge from current research to strengthen Thailand's TVET system in response to Industry 4.0 transformations?
- RQ6: What future research directions are needed to address critical success gaps and systemic blind spots in Thailand's vocational education landscape?
- RQ7: What future research directions are needed to address critical success gaps and systemic blind spots in Thailand's vocational education landscape?

IV. METHODOLOGY

A. Search Strategy

and indexing of peer-reviewed journals relevant to technical and vocational education and training (TVET). The search utilized the following Boolean string: TITLE-ABS-KEY ("vocational student" AND ("Industry 4.0" OR "technical college") AND ("academic achievement" OR "employability" OR "retention" OR "engagement") AND (factor OR support)) AND PUBYEAR > 1999. No year restrictions were imposed, and the search included all records available until January 2025. Only English-language, peer-reviewed articles were included.

B. Eligibility Criteria

Studies were included if they satisfied the following four criteria:

1. Population: Vocational, technical, or industrial education students, educators, or institutional systems
2. Context: Industry 4.0-related transformations, smart education, digital pedagogy
3. Outcomes: Employability, engagement, skill development, or curriculum reform
4. Study Type: Empirical (quantitative, qualitative, or mixed-methods) or high-level conceptual/theoretical models.

C. Screening Process

Screening was conducted in two phases:

Phase1: Abstract Screening - 581 records were screened after duplicate removal. → 529 records were excluded due to misalignment with TVET focus or context.

Phase2: Full-text Screening - 52 full-text articles were assessed using a custom-built Full-text Framing Matrix aligned with seven research questions (RQ1-RQ7). → 50 articles were retained; 2 were excluded for failing to address at least three framing dimensions.

Two reviewers independently screened all abstracts and full texts using a shared coding protocol. Discrepancies were resolved through consensus. Screening was documented using structured spreadsheets.

D. Framing Matrix

Articles were included if they addressed either:

- Four or more core research questions (RQ1–RQ5), or
- Three core RQs plus either RQ6 (policy) or RQ7 (research gap)

Each article was coded across five thematic categories: Future-Ready Competencies, Curriculum Innovation, Industrial Linkages, Digital Equity, and Systemic Integration. These codes were developed deductively from the research questions and grounded in complexity-informed systems thinking (Meadows, 2008; Capra & Luisi, 2014), allowing for the recognition of recursive and multilevel interactions.

E. Prisma Transparency

The entire screening process adhered to PRISMA 2020 guidelines (Page et al., 2021). A PRISMA Flow Diagram was generated to document article identification, screening, eligibility, and inclusion. All exclusion decisions were recorded, including rationale (e.g., population mismatch, insufficient conceptual focus). A completed PRISMA 2020 Checklist is available in the supplementary materials.

V. RESULTS

A. Screening Overview

The systematic search process initially yielded 581 records from the Scopus database. No duplicates were identified based on manual verification and deduplication using Scopus's export filters. Screening proceeded in two stages:

- **Abstract Screening:**

A total of 581 abstracts were evaluated against predefined eligibility criteria. 529 records were excluded due to misalignment with population (non-vocational focus), context (non-Industry 4.0 relevance), or outcomes (lacking employability/skill development focus).

- **Full-text Screening:**

The remaining 52 full-text articles were assessed using a structured Full-text Framing Matrix aligned with seven research questions (RQ1–RQ7). Two full-text articles were excluded: one due to population irrelevance and another due to insufficient outcome data.

Thus, 50 studies were included in the final qualitative synthesis. The review adhered to PRISMA 2020 guidelines with complete exclusion logs recorded, ensuring rigor and reproducibility. A PRISMA Flow Diagram (Figure 1) illustrates the full screening pathway.

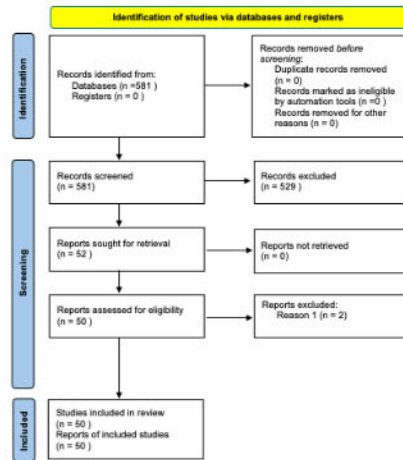


Fig. 1. PRISMA diagram. Diagram adapted under Creative Commons license from the PRISMA 2020 toolkit (Page et al., 2021).

B. Thematic Synthesis

Thematic analysis of the 50 included studies yielded five overarching themes that reflect the systemic and multidimensional nature of vocational student success during Thailand's industrial transition. These themes were identified through deductive coding informed by systems-thinking logic and recursive mapping across the seven research questions.

TABLE I. TYPE STYLES

Theme	Description	References
Future-Ready Competencies	Transversal skills such as critical thinking, adaptability, communication, and lifelong learning	Kamaruzaman (2025), Solak Berigel (2025), Gozali (2021)
Digital and Technological Integration	Adoption of AI, VR, and simulation technologies in vocational curricula	Nurulfajar (2024), Romero Gázquez (2021), Arifin (2020)
Pedagogical Innovation and Curriculum Reform	Student-centered models including TAWOCK, Heutagogy, modular learning	Gozali (2021), Rufaidah (2025), Akgunduz (2024)
Work-Based Learning and Industrial Collaboration	Internships, teaching factories, dual systems	Widarto (2023), Pianda (2024), Arifin (2020)
Equity and Personalization in TVET Ecosystems	Addressing digital equity, marginalized learners, personalized access	Rufaidah (2025), Zhang (2024), Villarroel (2024)

These themes form the foundation for the conceptual framework in Section C. (Conceptual Framework), representing recursive and multilevel dynamics shaping vocational success.

C. Conceptual Framework

Findings from the thematic synthesis informed the development of a systems-based conceptual framework illustrating how multilevel factors converge to influence vocational student success during Thailand's industrial transformation. Rather than additive, each domain in the framework is a mutually reinforcing sub-system. Success is contingent not on isolated contributions but on recursive synergies between levels. Four primary domains were identified (Table 2):

TABLE II. FRAMEWORK COMPONENTS

Domain	Core Dimensions	Influence on Student Success
Personal Factors	Future-ready skills: adaptability, self-regulation, resilience	Support career sustainability and learning engagement
Institutional Factors	Curriculum innovation, technology-enhanced pedagogy	Enable 21st-century competencies and digital fluency
Industrial Linkages	Work-based learning pathways, co-ops, teaching factories	Align classroom learning with labor market realities
Societal Factors	Digital access, economic support, equity mechanisms	Ensure inclusive participation and opportunity
Equity and Personalization in TVET Ecosystems	Addressing digital equity, marginalized learners, personalized access	Rufaidah (2025), Zhang (2024), Villarroel (2024)

D. Responses to Research Questions (RQ1–RQ7)

RQ1: What personal factors influence vocational student success?

Findings confirm that transversal competencies—critical thinking, adaptability, digital literacy, and self-directed learning—serve as predictors of vocational success in dynamic labor contexts [6].

RQ2: How do institutional factors impact student readiness?

Institutional transformation via TAWOCK, Heutagogy, and modular frameworks enhances learner adaptability and responsiveness to Industry 4.0 shifts [14].

RQ3: How do industrial linkages enhance employability?

Work-integrated learning models strengthen employability by contextualizing technical skills through real-world exposure and mentorship [12; 18].

RQ4: What societal factors shape outcomes?

Digital inequity remains a key constraint. Students in rural or low-income settings face systemic barriers to engagement unless supported by infrastructural and community interventions [19; 7].

RQ5: How do all factors interact systemically?

Success emerges from the dynamic integration of all four domains. Isolated reforms (e.g., curriculum-only updates) are insufficient. Systemic coherence is essential. This insight directly informs the framework in Section C. (Conceptual Framework).

RQ6: What policy recommendations are derived?

Recommendations include:

- Mandating future-oriented curriculum standards
- Incentivizing dual education partnerships
- Expanding rural digital infrastructure
- Implementing national equity-monitoring systems

RQ7: What research gaps remain? Critical gaps include:

- Limited research on AI-driven personalization in TVET
- Sparse longitudinal studies tracking cognitive development
- Lack of integration between affective and technical domains

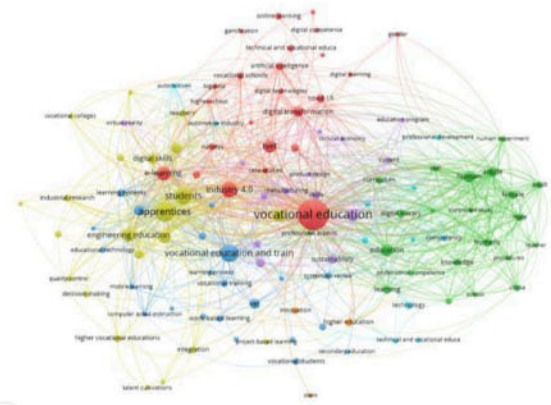


Fig. 2. Keyword Co-occurrence Map Before Screening (n = 581 studies) (This map, created using VOSviewer, displays the co-occurrence of keywords from all initially retrieved articles, illustrating a broad thematic range prior to eligibility screening.)

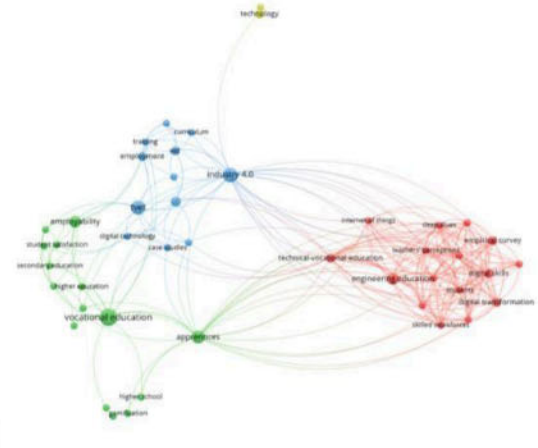


Fig. 3. Keyword Co-occurrence Map After Screening (n = 50 studies) (This refined co-occurrence map reveals focused thematic clusters from the 50 included articles, confirming alignment with the synthesized factors in this review.)

E. Visualizing Thematic Structures via VOS viewer

To triangulate the thematic synthesis, keyword co-occurrence analysis was performed using VOS viewer with a minimum threshold of 5 keyword appearances. The LinLog layout algorithm and fractional counting method were applied to ensure cluster validity and semantic clarity.

- Figure 2 shows the fragmented pre-screening landscape-dominated by generic terms (e.g., “higher education”, “e-learning”)
- Figure 3 reveals post-screening cohesion around terms such as “TVET”, “work-based learning”, and “Industry 4.0”

This shift demonstrates the effectiveness of the framing matrix in distilling relevant themes and improving conceptual convergence. It also provides visual confirmation of the multilevel structure modeled in Section 5.3.

VI. DISCUSSION

A. Multilevel Factors Shaping Vocational Student Success

The findings confirm that vocational student success in Thailand's transition to the new industrial era is not the result of isolated pedagogical innovations or technological upgrades but rather emerges through recursive, multilevel interactions across personal, institutional, industrial, and societal domains. This aligns with the conceptual model developed in Section 5.3, which frames student outcomes as systemically co-produced phenomena. At the personal level, transversal competencies such as adaptability, critical thinking, and digital fluency are no longer optional—they are foundational to career resilience in volatile labor markets [6]. At the institutional level, innovations in curriculum and pedagogy—including TAWOCK models, Heutagogy, and modularized learning—must be embedded within institutional cultures, not implemented as isolated initiatives [14]. Industrial linkages act as accelerators, but their impact is contingent on formalized partnerships, consistent mentoring structures, and shared governance models. Lastly, societal factors—including digital equity, parental support, and socioeconomic scaffolding—directly mediate the inclusivity of TVET outcomes. Without equity-focused infrastructure, the promise of Industry 4.0 risks being realized only for privileged groups.

B. Systemic Interaction and the Failure of Isolated Reforms

Despite well-intentioned reforms, the review reveals that piecemeal or sector-siloed interventions repeatedly fail to generate long-term student success. Curricular modernization without industrial coordination, or digital literacy efforts without addressing infrastructure gaps, generate misaligned systems that undermine learner outcomes. This echoes Romero Gázquez et al. (2021), who argue that innovation without systems alignment is a form of educational short-circuiting. Vocational success must therefore be reframed as a shared accountability process, requiring co-design among ministries, industry partners, local communities, and learners themselves. Policy fragmentation and incentive misalignment remain critical barriers. The evidence suggests that unless multi-stakeholder platforms for reform coordination are institutionalized, system gains will remain uneven and fragile.

C. Strategic Implications for Vocational Education Reform

Synthesizing across themes and research questions, three strategic imperatives emerge:

- **Transition from Curriculum-Centric to Ecosystemic Reform**
Rather than treat curriculum updates as panacea, educational reform must cultivate entire ecosystems that support emotional agility, digital resilience, and self-directed lifelong learning. These ecosystems should

integrate real-time labor intelligence, regional equity audits, and student voice mechanisms.

- **Elevate Digital Equity to Infrastructure Status**
Digital access must be reclassified as foundational infrastructure akin to electricity or roads. Without universal access, digital pedagogy and AI-personalization will amplify inequality. Targeted investment in rural broadband, multilingual content, and device access is essential.
- **Institutionalize Work-Based Learning as a Systemic Norm**
Co-op models, Teaching Factories, and dual training systems must be embedded within national policy—not as pilot programs but as mandatory co-governed features of TVET delivery. Public-private incentives should reward sustained engagement, not short-term placements.

D. Implications for Thai Vocational Students in Industrial Transition

For Thai industrial vocational students, the implications are structural, not just pedagogical. Their success is inseparable from the national Thailand 4.0 policy, which demands a digitally competent, innovation-oriented, and resilient workforce (NESDC, 2021). Yet this vision remains fragile without systemic readiness. Students must be prepared not only for technical work but for meta-adaptability—learning how to learn, unlearn, and co-create within evolving systems. Curriculum frameworks like TAWOCK [1] and AI-personalized learning environments [9] offer prototypes, yet remain under-deployed. Findings from Widarto et al. (2023) and Pianda et al. (2024) reveal that structured industrial immersion consistently elevates employability. However, these models require coordinated policy mandates, not ad hoc institutional enthusiasm. Moreover, rural and underserved students—who already face infrastructure and opportunity gaps—must not be further excluded in Thailand's high-tech transformation. Equity cannot remain a rhetorical ideal; it must be operationalized through investment, accountability, and inclusion mechanisms that elevate marginalized voices within reform agendas. Students must be treated not only as passive recipients but as active agents in co-shaping their learning ecosystems. Comparative evidence from regional peers (e.g., Singapore's Skills Future, Malaysia's TVET-4IR model) demonstrates the feasibility of such transformations.

E. Reflection on Research Gaps

Despite robust patterns across the 50 studies, critical gaps persist. Empirical research remains limited on AI-personalized learning pathways in TVET, especially in real-world classroom contexts. Longitudinal tracking of transversal competencies such as self-regulation, social-emotional learning, and entrepreneurial mindset remains underdeveloped. Methodologically, future studies must go

beyond cross-sectional snapshots. Systemic, mixed-method, and longitudinal research designs that account for context, learner agency, and institutional variation is essential. Research must also probe affective dimensions of vocational identity formation and how students navigate tensions between industrial logic and personal aspirations. Finally, future inquiries should embrace ethics and inclusion as first-order research objectives, not merely contextual variables. What kinds of futures are being imagined, for whom, and with what consequences? Until such questions are central to vocational education research, Thailand's transition risks privileging efficiency over justice.

VII. CONCLUSION

The transition to Industry 4.0 redefines the architecture of vocational education, demanding a fundamental shift from fragmented, input-based interventions to coordinated, ecosystem-level transformation. In the context of Thailand's industrial modernization under Thailand 4.0, this systematic review affirms that vocational student success is a multilevel, systemically co-produced phenomenon-emerging from the intersection of personal competencies, institutional innovation, industrial collaboration, and societal equity. Isolated reforms-curriculum updates, digital training, or pilot industry partnerships-fail when detached from each other. The review identifies five interrelated domains (see Section 5.2) that must operate in synchrony to produce sustainable learner outcomes. Future-ready competencies, teaching factories, AI-enabled learning, and inclusive digital infrastructure must not compete for reform priority- they must converge. The key takeaways are fourfold:

- Empower students beyond technical skill by embedding transversal, lifelong, and meta-learning competencies within core TVET structures;
- Reframe institutional roles from static delivery agents to dynamic hubs of innovation, pedagogy, and co-governance with industry;
- Normalize industry integration through national frameworks that codify work-based learning as a structural requirement, not an experimental add-on;
- Close digital and equity gaps by reclassifying digital infrastructure and support services as national education assets.

Moreover, the review underscores a major epistemic gap: the lack of longitudinal, system-level research on the effects of AI-personalized instruction, identity formation, and equity-sensitive innovation in vocational contexts. Addressing this void is not simply academic-it is essential for designing evidence-based, future-proof policies. In conclusion, Thailand's economic and educational futures are intertwined. The capacity to produce not just employable graduates, but adaptive, ethically grounded,

and innovation-driven vocational learners will determine the nation's ability to thrive amidst global disruption. This transformation will not arise from isolated excellence-it will require a new paradigm of integrated educational ecosystems, forged through coordinated action across policy, practice, and society.

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Design and Development of Augmented Reality Learning Media on Economics in Daily Life

**Note: Sub-titles are not captured in Xplore and should not be used.*

Naruemon Saengduangkhae
Faculty of Industrial Education and
Technology Rajamangala University of
Technology Srivijaya
Songkhla, Thailand
ajarn.naruemons@gmail.com

Angkana Jaemsai
Faculty of Science and Technology
Rajamangala University of Technology
Srivijaya
Nakhonsithammarat, Thailand
angkana.ja@rmutsvmail.com

Abstract—The topic of "Economics in daily life" is included in the course for Prathomsuksa or grade 3 students. For making learning interesting, this research aimed to design and development an augmented reality learning media on "Economics in daily life". The design and development process of learning media used the ADDIE Model, presented with augmented reality technology in the form of videos with Thai narration, and published the learning media video via the YouTube website. The research results found that the learning media designed and developed with augmented reality technology on "Economics in daily life", presented correctly via a web browser, and published via YouTube, can provide knowledge very well to the sample group of students, namely Prathomsuksa 3 students at Wat Khao Noi School, Ron Phibun District, Nakhon Si Thammarat Province, and the general public.

Keywords—learning media, augmented reality technology, economics in daily life

I. INTRODUCTION

The topic "Economics in daily life" is one of the subjects in the basic social studies, religion, and culture curriculum under the Ministry of Education's core curriculum for Prathomsuksa 3 students. However, many schools still lack teaching materials that engage students. The introduction of augmented reality technology, which combines the real world with the virtual world through hardware devices and various software, allows for the visualization of objects on screens as 2D objects floating above real surfaces. This technology provides dynamic and exciting visual displays, capturing students' interest in the lesson content, encouraging them to learn new things, and creating novel experiences in teaching [1]. The research team thus conceived the idea of designing and developing augmented reality learning materials on "Everyday Economics" to make learning enjoyable and engaging, thereby enhancing learning efficiency [2]. This enables students to apply what they learn to manage their finances in daily life.

II. RESEARCH OBJECTIVE

To design and develop learning media using augmented reality technology on the topic of Economics in daily life.

III. RESEARCH METHODOLOGY

This research project employed the design and development of augmented reality learning media on economics in daily life according to the ADDIE Model [2], starting with system analysis, system design, system development, implementation, and evaluation.

A. Analysis

Content analysis for the design of learning media on "Economics in daily life" has begun with the research team collecting data and content details from textbooks and gathering information through in-depth interviews with teachers from Wat Khao Noi School in Nakhon Si Thammarat Province, as well as relevant research, documents, and books. This data will be studied, analyzed, and understood to design learning media within the following research scope.

1) Scope of content.

The research team collected research data with content scope according to the lesson on everyday economics in the basic social studies, religion, and culture curriculum under the Ministry of Education's basic education core curriculum for Prathomsuksa 3 students. The subtopics include 1) Goods and services in daily life 2) Planning personal spending 3) Planning for appropriate and honest income 4) Taxes related to daily life 5) Production and commercial competition.

2) Scope of content presentation for the learning media

The research team aims to design and develop learning media on the topic of economics in daily life. The learning media is presented in video format and can be displayed using augmented reality technology on a web AR platform, and the videos are published on the YouTube website.

B. Design

From the content analysis phase, the research team proceeded to design the structure of the learning media by starting with scriptwriting and creating storyboards, writing the content and sketching the images in sequence from beginning to end.



Fig. 1 Storyboard in subtopic "Goods and services in daily life"

C. Development

After the design was completed, in the development phase of the learning media, the research team designed and developed animated video media using Adobe Illustrator in conjunction with Canva, Botnoi Voice using for voice narration, Audacity for audio editing, CapCut for video editing, and developed augmented reality media using WebAR.



Fig. 2 Animation Screen in subtopic "Goods and services in daily life"

D. Implementation

At this phase, the research piloted the developed learning materials with teachers and students from Wat Khao Noi School in Nakhon Si Thammarat Province.

1) User training and technical support : the research team educated teachers and students on using the AR application and provided assistance for any technical issues during use.

2) Curriculum integration : the AR and VDO content was aligned with existing lesson plans in the classroom.

E. Evaluation

The evaluation of the use of augmented reality learning media on economics in daily life required the sample users to assess their satisfaction with the application. The tool for evaluating the application is a questionnaire consisting of closed-ended questions based on the Likert scale [3], which divides the rating scale into 4 levels. The sample groups used in the research include 7 experts assessing the effectiveness of the learning media and content, and 33 users assessing the satisfaction with the learning media,

specifically selected (Purposive Selection) from teachers and students from Wat Khao Noi School in Nakhon Si Thammarat Province.

The statistics for analyze the effectiveness and satisfaction that impact the development of augmented reality learning media on economics in daily life used mean and standard deviation (S.D.).

IV. RESEARCH RESULT

The augmented reality learning media on economics in daily life, used as the innovative learning in classroom. This media was created dynamic and interactive educational content. Moreover, this learning media was rated the positive impact and can be enhanced student outcomes and engagement.

The AR learning media was designed and developed to be accessible by scanning a QR code from the printed materials.



Fig. 3 The posters with QR code for accessing the developed learning materials



Fig. 4 Scanning QR code for accessing to the learning media from the student



Fig. 5. The Augmented Reality media in subtopic "Goods and services in daily life"

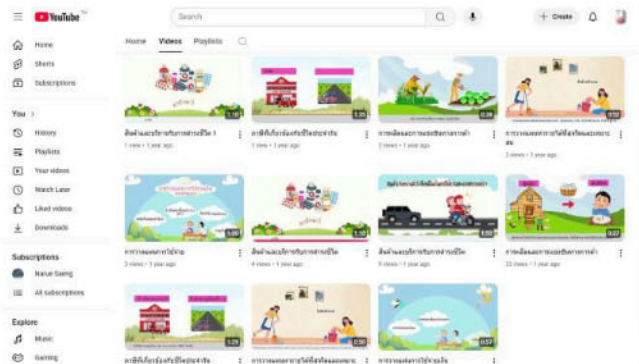


Fig. 6. The learning media on YouTube

The evaluation results of the sample group's satisfaction with the use of augmented reality learning media technology, in terms of content and information, utility, and media design, can be presented in Tables 1 to 3.

TABLE I. RESULTS OF THE ANALYSIS OF SATISFACTION WITH CONTENT AND INFORMATION

Evaluation item	Table Column Head		
	Mean	S.D.	Level of satisfaction
The completeness and accuracy of the content	3.73	0.45	Highest
The consistent and relevant between the illustrations and the content	3.79	0.42	Highest
Content organization easy to understand	3.76	0.44	Highest
Language correction	3.67	0.48	Highest
Overall	3.73	0.44	Highest

The table reflects a high level of user satisfaction across all dimensions, supporting the quality and effectiveness of the evaluated content.

TABLE II. RESULTS OF THE ANALYSIS OF SATISFACTION WITH THE UTILIZATION

Evaluation item	Table Column Head		
	Mean	S.D.	Level of satisfaction
The content is interesting and useful	3.82	0.39	Highest
Used as a medium for spreading knowledge	3.88	0.33	Highest
Overall	3.85	0.36	Highest

The highest mean score is for the item "Used as a medium for spreading knowledge" (Mean = 3.88), suggesting that respondents strongly agree with the content's effectiveness in knowledge dissemination. The table clearly demonstrates very high satisfaction with content utilization, particularly for its role in spreading knowledge and being engaging and useful.

TABLE III. RESULTS OF THE ANALYSIS OF SATISFACTION WITH MEDIA DESIGN

Evaluation item	Table Column Head		
	Mean	S.D.	Level of satisfaction
Ease of use	3.61	0.50	Highest
The interest of the learning media	3.76	0.44	Highest
Clarity and consistency of text and illustrations	3.79	0.42	Highest
Presenting content clearly and in line with learning objectives	3.67	0.48	Highest
Overall	3.70	0.46	Highest

This table presents respondents' satisfaction regarding media design, including layout, clarity, usability, and alignment with instructional goals. The media design was received very positively, achieving an overall Mean score of 3.70 with a Standard Deviation of 0.46. As with the previous analyses, all items, including the overall score, are rated at the "Highest" level of satisfaction, confirming that the design elements are a significant strength of the learning media.

V. CONCLUSION

The design and development of augmented reality learning media on the topic of economics in daily life used the ADDIE model for design and development. The augmented reality learning media was accessed through QR code scanning and video dissemination via YouTube. From the usage of the learning media by the sample group, it was found that the satisfaction level of the sample group towards the media was at the highest level. The developed learning media helped learners understand the lessons more easily and increased the interest in the content of economics in daily life. This aligns with the policy to promote the use of information technology for education and learning management [4] and is consistent with the research of Tatcha Suttasan [5] on the application of digital technology in designing economics courses by integrating Artificial Intelligence (AI) with Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) technologies to create learning environments in economics courses, helping learners to practice in real situations and enhancing their data analysis skills with these tools.

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Generative Artificial Intelligence in the Global Classroom: Unpacking Perceptions and Relational Dynamics in Thai International Schools

Ruoqi Jiang

*School of Industrial Education and Technology
King Mongkut's Institute of Technology Ladkrabang
Bangkok, Thailand
65036080@kmitl.ac.th
orcid.org/0009-0001-8869-2966*

Poonsri Vate-U-Lan

*School of Industrial Education and Technology
King Mongkut's Institute of Technology Ladkrabang
Bangkok, Thailand
poonsri.va@kmitl.ac.th
orcid.org/0000-0002-4200-0469*

Abstract—This study investigated perceptions and attitudes towards Generative Artificial Intelligence (GenAI) among 74 teachers and 112 students in Thailand's international schools. Employing a quantitative online survey as its research instrument, the study aimed to explore existing attitudes and analyze the relationships between key variables influencing AI acceptance. The survey instrument demonstrated strong reliability, with a Cronbach's alpha coefficient of 0.923, underscoring the consistency and dependability of the data collected. Participants held positive attitudes towards GenAI. Teachers valued its potential for accelerated learning, while students were more confident in their ability to achieve learning objectives and reported it was easier to use than teachers did. Statistical analysis revealed that Social Influence (SI) was the strongest predictor of Behavioral Intention (BI) to use GenAI, followed by Attitude (ATT) and Educational Compatibility (EC). Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) also showed moderate correlations with BI, highlighting their interconnectedness. These findings emphasize the crucial roles of social influence, positive attitudes, and alignment with educational goals in successfully integrating GenAI into international school curricula in Thailand.

Keywords—*Perceived Usefulness, Perceives Ease of Use, Educational compatibility, Social Influence, Attitude, Behavioral Intention*

I. INTRODUCTION

The rapid integration of Artificial Intelligence (AI) in education is transforming teaching and learning, particularly in international schools [1], [2]. Generative Artificial Intelligence (GenAI), which can create text, images, and code, offers significant potential for personalized learning, real-time feedback, and administrative efficiency [3], [4]. Despite growing interest, limited research exists on how teachers and students perceive and respond to GenAI, especially in international school contexts [5]. This study addresses this gap by investigating GenAI acceptance in two international schools in Thailand, using the Technology Acceptance Model (TAM) as its foundation. TAM highlights Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) as key predictors of technology adoption [6]. To provide a broader

understanding, the study also includes Educational Compatibility (EC), Social Influence (SI), Attitude (ATT), and Behavioral Intention (BI), drawing from Unified Theory of Acceptance and Use of Technology (UTAUT) and related frameworks [7].

The conceptual model (Figure 1) uses path analysis to examine how PU, PEOU, EC, and SI influence ATT, which in turn affects BI. This correlational approach aims to understand the interrelationships among these variables rather than determine causality. Prior studies, such as Al Darayseh, support this framework and emphasize the need for clear guidelines when integrating AI into classrooms—an idea central to this study's focus on GenAI in science education [8].

By examining perceptions (users' understanding of usefulness and usability) and attitudes (emotional responses to adoption), the study identifies key factors that support or hinder GenAI integration [6], [9]. The two research sites—one in Chiang Mai and one in Bangkok—both follow the International General Certificate of Secondary Education (IGCSE) curriculum and serve diverse student and teacher populations, providing a rich context for exploring GenAI acceptance in multicultural, academically demanding settings [10]. Motivated by the transformative potential of GenAI, this study contributes to ongoing global discussions about AI in education [1], [2]. It offers practical insights for educators, policymakers, and administrators, emphasizing the importance of stakeholder perceptions in developing effective and ethical AI integration strategies for international schools [3].

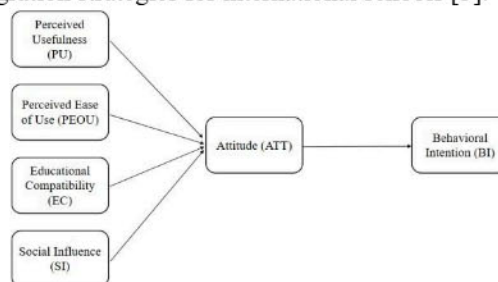


Fig 1. Research Conceptual Framework

II. RESEARCH OBJECTIVE

This study addresses a critical gap in understanding GenAI's perception and adoption within international educational settings. It aims to answer the following research question: What are the perceptions and attitudes towards GenAI among teachers and students in international schools in Thailand, and how do these factors interrelate?

To achieve this, the objectives are:

- To investigate the perceptions and attitudes towards GenAI in Thailand's international schools.
- To explore the relationships between these perceptions and attitudes concerning GenAI.

III. LITERATURE REVIEW

The adoption of emerging technologies in education has been a subject of increasing interest among researchers. This literature review synthesizes findings from various studies examining factors influencing the adoption of GenAI technologies among students and teachers in international school settings in Thailand.

A. GenAI in Education: Applications and Impacts

Recent studies demonstrate the substantial influence of GenAI on teaching and learning. Maity and Deroy describe how GenAI-powered Intelligent Tutoring Systems (ITS) create individualized content and feedback, enhancing adaptability and learning outcomes [11]. Yan et al. identify over fifty applications of Large Language Models (LLMs) in education, from automated question generation to personalized feedback, while highlighting challenges such as transparency and bias [12]. Łodzikowski, Foltz, and Behrens reflect on GenAI's societal implications and the need for ethical and curriculum redesign [13]. Evidence from such investigations shows GenAI's potential to enrich learning experiences and reduce teacher burden—but also warns of pitfalls like inaccurate outputs and lack of explainability [12], [13]. Several empirical reviews underscore GenAI's benefits in personalized learning. A Frontiers study of ChatGPT in grades 4–6 in Uruguay showed enhanced engagement and creative expression, although issues like misinformation persisted [14]. Similarly, a systematic review by Li indicates improved accessibility and motivation, offset by concerns about bias and plagiarism [15]. These outcomes highlight not only GenAI's promise for tailored pedagogy but also underline the importance of structured integration and guideline development—a major rationale for this study's focus in international settings.

B. Technology Acceptance Model in Education

The TAM remains a foundational theory for understanding technology adoption, emphasizing PU and PEOU as primary determinants of ATT and BI [6]. Extensions such as TAM2, TAM3, and UTAUT further incorporate SI, facilitating conditions, hedonic motivation,

and trust constructing up to 70% of variance in BI [7], [16]. Recent AI-centered TAM studies in education confirm the model's predictive power. A German study on pre-service teachers using AI-based learning apps found PU ($\beta = 0.50$) and PEOU ($\beta = 0.30$) significantly predicted BI, evidencing TAM3 effects [17]. A study on ChatGPT in metacognitive learning identified additional factors like trust, enjoyment, social influence, and competence influencing BI [18]. Another scientific study investigation with college students established that PU and PEOU significantly predicted actual use of AI systems, influenced by learning motivation [15]. Moreover, Recent theoretical and empirical work emphasizes the importance of EC and SI in predicting GenAI acceptance. Sharples argues that GenAI systems should be integrated with educational objectives and social pedagogies to foster meaningful adoption [19]. Supporting this, Ghimire et al. found that educators perceived usefulness and intention to adopt GenAI were significantly shaped by social cues, such as peer usage and institutional endorsement [20]. Such extensions guided this study's inclusion of EC and SI alongside TAM variables.

C. Stakeholder Perceptions: Teachers vs. Students

User perception of GenAI can differ significantly between teachers and students. Students often report optimism towards AI tools, valuing ease of use and learning benefits. For instance, Cervantes and Navarro found business students rated PU highly and expressed strong BI toward GenAI [21]. A Romanian survey at Bucharest Polytechnic University also reported positive attitudes and perceived effectiveness of AI for academic achievement [22]. In contrast, teachers frequently express concerns about academic integrity, accuracy, bias, and workload. A study highlighted increased teacher workload in detecting AI-authored assignments [23]. Ethical concerns also affect adoption: researchers in academia raised issues of fairness and misuse [24]. Frontiers noted risks like misinformation and credential misuse in ChatGPT-assisted learning [25]. These discrepancies between student enthusiasm and teacher caution underscore the need to simultaneously investigate both groups, especially in multicultural, rigorous international school settings.

D. Identified Gaps and Rationale for the Present Study

Despite a growing body of research, two important gaps remain in literature:

- Contextual gap—International School Settings

Most AI-adoption research has focused on higher education and domestic primary/secondary schools, leaving international settings (e.g., IGCSE-based schools) underexplored. These multicultural, academically demanding environments present unique social and pedagogical dynamics that may influence GenAI acceptance differently.

- Theoretical gap—Inclusion of EC and SI

Many studies rely solely on TAM's core constructions, omitting contextual factors like EC and SI that UTAUT emphasizes. However, works by Sharples and Ghimire et al. indicate that EC and SI significantly deepen understanding of AI tools' educational adoption, particularly those involving social norms and curriculum alignment [19], [20].

Moreover, while individual variables like trust, ethics, and anxiety have been studied, there is limited research mapping interconnections among PU, PEOU, EC, SI, ATT, and BI in a single framework—especially within international school contexts [16], [24]. This correlational approach, using path analysis, enables uncovering the relational dynamics among these factors without assuming causality.

Finally, the urgency for guideline development is a recurring theme. Al Darayseh stressed structured implementation frameworks, and policy recommendations from U.S. and international agencies reinforce the need for evidence-based strategies [8]. This study seeks to contribute by generating empirical insights specifically tailored to GenAI integration within IGCSE-based international schools, addressing ethical, pedagogical, and social considerations.

This literature review establishes a robust foundation for the current investigation. First, extensive applications of GenAI in education show both promise and challenge. Second, the inclusion of extended TAM variables (EC, SI, trust) is well-founded by recent empirical studies. Third, divergent teacher and student perspectives highlight the necessity of balanced stakeholder analysis. Finally, an identified gap in international school contexts affirms the originality and importance of the current research. By exploring six interconnected variables through path analysis, this study aims to fill these gaps and inform practical, ethical, and culturally responsive strategies for GenAI adoption.

IV. RESEARCH METHODOLOGY

A. Population and Sample

This study investigated perceptions and attitudes toward GenAI in two international schools in Thailand during September 2024. The total population comprised 77 teachers and 121 students, with School A (Chiang Mai) contributing 71.4% of the teachers and 82.6% of the students, and School B (Bangkok) the remaining proportions. These schools were purposively selected for their IGCSE curriculum, cultural diversity, and advanced technology integration, making them representative of similar international school contexts. Using Krejcie and Morgan's sampling formula, the final sample included 74 teachers and 112 students, yielding high response rates of 96.10% and 92.56%, respectively [26].

B. Research Instrument

A quantitative research design was adopted, utilizing self-administered online surveys to gather data from both teachers and students. Two distinct questionnaires were developed: a 37-item version for teachers and a 36-item version for students. Each instrument comprised three sections: (1) demographic profiles, (2) items grounded in the TAM, addressing PU, PEOU, EC, SI, ATT, and BI, and (3) items exploring the perceived impact and challenges of GenAI in high school education. This structure ensured thorough coverage of all variables aligned with the study's aims.

C. Collection of Data

The questionnaires were administered online, enabling participants to respond at their convenience and promoting candid, reflective answers free from interviewer's influence. Demographic data allowed for participant segmentation, while the TAM-based and GenAI impact items provided a comprehensive analysis of perceptions and attitudes. The data collection process strictly followed ethical standards, ensuring confidentiality and voluntary participation.

D. Validity and Reliability of the Instrument

The primary instrument used in this study is a carefully designed online survey aimed at ensuring both validity and reliability. It begins with a consent section and includes 19 items measuring six key constructs: PU- 4 items, PEOU- 4 items, SI- 4 items, EC- 2 items, ATT- 2 items, and BI- 3 items. To produce credible results, the instrument was rigorously validated by a panel of experts to confirm its alignment with the theoretical framework and appropriateness for data collection. Reliability was assessed through Cronbach's Alpha, a standard measure of internal consistency, with values above 0.7 deemed acceptable [27]. The adapted survey demonstrated excellent reliability, achieving Cronbach's Alpha of 0.923 from 186 respondents, indicating strong internal consistency and affirming the instrument's suitability for this research.

E. Data Analysis

Descriptive statistics—such as mean, median, standard deviation, variance, and frequency analysis—were applied to fulfill the first research objective. To investigate the relationships between variables for the second objective, Pearson's product-moment correlation coefficient was utilized. This approach enabled a comprehensive analysis of GenAI acceptance and its influencing factors within the chosen school contexts.

V. RESEARCH RESULTS

The study involved two international schools, with a total of 186 participants, comprising 74 teachers and 112 students. As presented in Table I, School A achieved high

response rates—98.18% of teachers, with 54 respondents from a population of 55, and 93% of students, with 93 respondents from 100. Similarly, School B showed strong participation, with 90.91% of teachers (20 respondents from 22) and 90.48% of students (19 respondents from 21). Overall, the response rates were 96.10% for teachers and 92.56% for students across both schools. These strong response rates enhance the credibility and representativeness of the study's findings within the selected international schools.

TABLE I. The Sample from Each School

Table Head	School Name	Teachers Population	Teachers Sample	Students Population	Students Sample
	A	55	54	100	93
	B	22	20	21	19
Total		77	74	121	112

Table II shows the demographics of 74 teachers, with more females (58.1%) than males (41.9%). Most held master's (50%) or bachelor's (45.9%) degrees, while 4.1% had doctorates. Most teachers (60.8%) had 5-10 years of experience; 37.8% had less than 5 years. All teachers (100%) were aware of and used GenAI tools, with ChatGPT being the most used (79.7%), followed by Jenni AI and Perplexity (both 43.2%), and Google Gemini (37.8%). The average teacher age was 41. Among 112 students, males slightly outnumbered females (58.1%). Grades were almost evenly split Grade 12 (49.1%) and Grade 13 (50.9%). Most students knew about GenAI (93.75%) and used it (90.2%). ChatGPT (58%) and Google Gemini (56.3%) were most popular, followed by Claude (47.3%), Jenni AI (37.5%), Perplexity (31.3%), and Copilot (21.4%). Their average age was 18.5. These results highlight high GenAI awareness and usage among both groups.

TABLE II. Demographic Profile of Teachers (n=74) and Students (n=112)

Table Head	Demographic Information	Teacher	Percent age	Student	Percentage
Gender	Male	31	41.9	65	58.1
	Female	43	58.1	47	41.9
	Prefer not to say	0	0	0	0
Education/Grade	Bachelor/Grade 12	34	45.9	55	49.1
	Master/Grade 13	37	50	57	50.9
	PhD	3	4.1		
	Other	0	0		
Teaching Experience	Less than 5 years	28	37.8		
	5-10 years	45	60.8		
	11-20 years	1	1.4		
	21 years or above	0	0		
Knowing Generative AI	Yes	74	100	105	97.35
	No	0	0	7	6.25
Usage of	Yes	74	100	101	90.2

Generative AI	No	0	0	11	9.8
AI Name	Copilot	24	32.4	24	21.4
	ChatGPT	59	79.7	65	58
	Jenni AI	32	43.2	42	37.5
	Google Gemini	28	37.8	63	56.3
	Claude	23	31.1	53	47.3
	Perplexity	32	43.2	35	31.3
	Other	0	0	0	0

Descriptive statistics presented in Table III reveal an overall positive perception of GenAI among high school students and teachers, with notable variations in perceived benefits, risks, and usability. Regarding practical experience, the highest agreement centered on GenAI's role in supporting self-directed learning ($M = 3.95$), followed by strong endorsement of the need for teacher training to address AI-related challenges ($M = 3.87$). GenAI was also positively rated for its ability to enhance conceptual understanding through simulations ($M = 3.86$) and its potential to assist in essay and research writing ($M = 3.73$). However, participants also expressed concerns about the reliability of AI-generated content ($M = 3.81$) and the risk of misuse in plagiarism ($M = 3.71$). Although the need to adapt assessment systems to AI use was acknowledged ($M = 3.72$), the lowest-rated item in this section involved skepticism about the value of AI-student collaboration ($M = 3.64$), reflecting caution about GenAI as a co-learning partner.

Results based on the TAM further demonstrated differentiated perceptions across constructs. In the PU domain, the belief that GenAI facilitates quicker learning received the highest score ($M = 3.83$), while its capacity to make learning easier was rated lowest ($M = 3.55$). For PEOU, clarity and understandability stood out ($M = 3.66$), whereas confidence in becoming skillful users was relatively low ($M = 3.59$). SI was led by the perceived use of GenAI among peers ($M = 4.02$), while lecturer endorsement was least influential ($M = 3.55$). EC was strongest where GenAI aligned with student learning preferences ($M = 3.83$), but less so with institutional teaching aims ($M = 3.71$). ATT was most favorable toward the concept of mobile GenAI use ($M = 3.89$), while pleasantness of use received slightly lower ratings ($M = 3.82$). In the BI construct, future use intentions were high ($M = 3.88$), but the idea of using GenAI all the time was less supported ($M = 3.70$), indicating selective and task-specific acceptance.

Together, these results from Table III highlight broad acceptance of GenAI in educational contexts, tempered by concerns about misuse, skill development, and institutional alignment. The findings point to the need for structured guidance, critical engagement, and thoughtful integration to support effective adoption.

TABLE III. Descriptive Statistics of Student and Teacher Perceptions Toward GenAI

Table Head Items	Student (n=112) Mean (S.D.)	Teacher (n=74) Mean (S.D.)	Average (n=186) Mean (S.D.)	Interpretation
1.AI will not replace teachers.	3.98 (1.200)	3.49 (1.010)	3.78 (1.152)	Positive
2.GenAI can be valuable for self- directed learning in high school subjects.	4.09 (1.000)	3.74 (1.228)	3.95 (1.107)	Positive
3. Using GenAI for creating simulations can improve students' understanding of complex topics.	3.97 (1.026)	3.69 (1.033)	3.86 (1.035)	Positive
4. GenAI can be a helpful assistant for writing essays and research papers, but it should not replace students' efforts	3.85 (1.084)	3.55 (1.075)	3.73 (1.087)	Positive
5. I am concerned that GenAI could be misused for plagiarism in high school assignments	3.77 (.977)	3.62 (.917)	3.71 (.954)	Positive
6. The accuracy of information Generation by AI can sometimes be unreliable	3.95 (1.114)	3.61 (1.044)	3.81 (1.096)	Positive
7.Over-reliance on GenAI could hinder the development of critical thinking skills in high school students	3.63 (1.147)	3.85 (1.257)	3.72 (1.193)	Positive
8. High school assessments need to be adapted to account for the potential use of GenAI by students	3.80 (1.047)	3.59 (1.181)	3.72 (1.104)	Positive
9.Effective collaboration between students and GenAI tools can enhance the learning experience	3.69 (1.074)	3.57 (1.048)	3.64 (1.063)	Positive
10. High school teachers need to be trained in how to identify and address potential issues arising from the use of GenAI	4.05 (.994)	3.58 (1.073)	3.87 (1.049)	Positive
subjects are taught and learned				
PU1: GenAI helps/will help students learn more quickly	3.79 (1.061)	3.91 (1.229)	3.83 (1.129)	Positive
PU2: GenAI enables/will enable the achievement of learning goals	3.71 (1.110)	3.50 (1.101)	3.63 (1.109)	Positive
PU3: GenAI makes/will make learning easier	3.53 (1.123)	3.59 (1.006)	3.55 (1.075)	Positive
PU4: GenAI was/will be useful for learning	3.52 (1.170)	3.64 (.959)	3.56 (1.190)	Positive
PEOU1: I think it is/will be easy to use GenAI	3.65 (1.129)	3.55 (1.036)	3.61 (1.091)	Positive
PEOU2: I think it is/will be easy to learn how to use GenAI	3.48 (1.147)	3.78 (1.388)	3.60 (1.253)	Positive

Table Head Items	Student (n=112) Mean (S.D.)	Teacher (n=74) Mean (S.D.)	Average (n=186) Mean (S.D.)	Interpretation
PEOU3: I think using GenAI is/will be clear and understandable	3.67 (1.158)	3.64 (1.054)	3.66 (1.115)	Positive
PEOU4: I think it is/will be easy to become skillful at using GenAI	3.53 (1.215)	3.69 (1.072)	3.59 (1.160)	Positive
SI1: Students I know think it should be used in teaching	3.71 (1.196)	3.73 (1.076)	3.72 (1.147)	Positive
SI2: Lecturers I know think it should be used in teaching	3.54 (1.177)	3.57 (.966)	3.55 (1.095)	Positive
SI3: Please rate the extent to which your acquaintances use or have used GenAI	4.13 (1.100)	3.85 (1.106)	4.02 (1.108)	Positive
SI4: My school supports the use of GenAI in teaching	4.09 (1.078)	3.62 (1.043)	3.90 (1.086)	Positive
EC1: I think GenAI fits well with how students like to learn	3.92 (1.075)	3.70 (.989)	3.83 (1.045)	Positive
EC2: GenAI as a technology is compatible with my school's learning/teaching aims	3.90 (1.039)	3.42 (1.047)	3.71 (1.066)	Positive
ATT1: I Believe that using mobile GenAI is a good idea	4.10 (1.074)	3.57 (1.035)	3.89 (1.087)	Positive
ATT2: I think that using GenAI is pleasant	3.85 (1.141)	3.78 (1.231)	3.82 (1.174)	Positive
BI1: I would like to use GenAI in the future	4.04 (1.060)	3.62 (1.003)	3.88 (1.056)	Positive
BI2: I want to use GenAI all the time	3.87 (1.197)	3.46 (.996)	3.70 (1.136)	Positive
BI3: I plan to utilize GenAI extensively for my upcoming projects.	4.07 (1.088)	3.46 (1.049)	3.83 (1.111)	Positive

Table IV displays the correlation coefficients among the TAM variables and behavioral intention (BI) for the overall sample ($n = 186$). Perceived usefulness (PU) was moderately correlated with BI ($r = 0.509^{**}$, $p < 0.01$), while perceived ease of use (PEOU) also showed a significant positive correlation ($r = 0.500^{**}$, $p < 0.01$). Among all variables, social influence (SI) exhibited the strongest correlation with BI ($r = 0.699^{**}$, $p < 0.01$), followed closely by educational compatibility (EC) ($r = 0.663^{**}$, $p < 0.01$) and attitude (ATT) ($r = 0.678^{**}$, $p < 0.01$). Additionally, strong interrelationships were found among the TAM constructs themselves, particularly between PU and PEOU ($r = 0.702^{**}$, $p < 0.01$), SI and EC ($r = 0.633^{**}$, $p < 0.01$), and ATT with both PEOU ($r = 0.568^{**}$, $p < 0.01$) and EC ($r = 0.627^{**}$, $p < 0.01$). These findings underscore the importance of SI, EC, and ATT as key predictors of individuals' behavioral intentions to adopt GenAI technologies in educational contexts.

TABLE IV. Correlation Analysis between TAM Variables and Behavioral Intention (n=186)

Table Head	PU	PEOU	SI	EC	ATT	BI
PU	1					
PEOU	0.702**	1				
SI	0.646**	0.665**	1			
EC	0.475**	0.605**	0.633**	1		
ATT	0.458**	0.568**	0.609**	0.627**	1	
BI	0.509**	0.500**	0.699**	0.663**	0.678**	1

** $p < 0.01$ (Correlation is significant at the 0.01 level (2-tailed))

These results address the second objective by highlighting the intricate links among perceptions and attitudes toward GenAI. Social influence, attitude, and educational compatibility emerge as the strongest predictors of behavioral intention to adopt GenAI in international schools. This indicates that effective adoption strategies should prioritize supportive social norms, positive user attitudes, and alignment with current educational practices. Moreover, the moderate associations of perceived usefulness and ease of use with behavioral intention suggest that these factors alone are insufficient, underscoring the need for a holistic approach to GenAI integration in education.

VI. DISCUSSION

A. Objective 1: Investigating Perceptions and Attitudes towards GenAI

The findings indicate that both students and teachers in Thailand's international schools hold generally positive perceptions and attitudes toward the adoption of GenAI in education. This aligns with prior studies emphasizing that PU and PEOU are critical determinants of technology acceptance [9], [28]. The moderate to high mean scores for PU1–PU4 and PEOU1–PEOU4 echo earlier evidence that AI tools can enhance learning efficiency and accessibility [1], [29].

Furthermore, the positive SI factors observed are consistent with the TAM 3 [30], which asserts that subjective norms shape BI. This is particularly relevant in Asian educational contexts, where institutional and peer support strongly affect technology adoption [28], [31]. The result that respondents see GenAI as compatible with current pedagogical practices resonates with Kim, who found that AI integration aligns well with student-centered learning [32].

Interestingly, the favorable ATT and BI mirror findings by Chen et al., who highlighted that students' willingness to use AI-driven tools increases when they perceive clear academic benefits [33]. Similarly, Aoun emphasized the importance of AI literacy and the need for educators to adapt pedagogical strategies [34]. However, as Holmes et al. caution, overreliance on AI may risk diminishing critical thinking if not guided properly [2].

Finally, these positive attitudes suggest that Thailand's international schools are relatively open to AI innovation,

like trends identified in cross-cultural studies [3]. Yet, institutional policies and teacher training remain pivotal to sustainable adoption [35]. Therefore, future research should investigate how training, policy frameworks, and ethical considerations can reinforce these initial positive perceptions.

B. Objective 2: Exploring Correlations Between Perceptions and Attitudes

This study explored the relationships among perceptions and attitudes toward GenAI using the TAM. The correlation results confirm key TAM propositions. For both teachers and students, PU was strongly related to PEOU ($r = 0.662^{**}$ and 0.733^{**} , respectively), supporting Davis's finding that ease of use enhances usefulness [6]. SI showed the strongest link with BI, especially among teachers ($r = 0.748^{**}$), highlighting the importance of peer and organizational support [9], [36]. This aligns with Teo, who found that subjective norms significantly shape teachers' intentions to adopt educational technology [28].

EC was also strongly correlated with PEOU ($r = 0.807^{**}$ for teachers), indicating that access to resources and training facilitates adoption [37], [38]. Similarly, ATT was positively associated with BI in both groups ($r = 0.710^{**}$ for teachers; $r = 0.645^{**}$ for students), reinforcing findings that attitude remains a consistent predictor of intention [39], [40].

Overall, these results show that individual perceptions interact closely with social and institutional contexts when adopting GenAI [7]. Encouraging supportive peer environments and providing adequate resources are thus crucial for successful implementation.

VII. RECOMMENDATION

A. Recommendation for Implications

This study explores how teachers and students in Thai international school's view and use GenAI, offering insights relevant to global IGCSE contexts. To integrate GenAI effectively, policymakers should include practical and ethical AI training in teacher development, supported by peer networks. Curriculum designers can embed AI tools into interdisciplinary and flexible lessons that suit diverse teaching and learning styles. Encouraging peer-led activities can also foster a positive culture of AI use among students. Together, these measures help build a global model for responsible and effective AI adoption in education.

B. Recommendation for Further Research

Future research should expand to IGCSE schools in various countries for cross-context comparisons and best practice insights. Comparing AI use in other curricula like the International Baccalaureate or Advanced Placement could also be valuable. Longitudinal and mixed-methods studies can track changing attitudes and adoption. More work is needed on GenAI's impact on student performance, data privacy, academic integrity, and teacher training to

ensure ethical and effective use aligned with academic standards.

C. Conclusion and Suggestions

By analyzing PU, PEOU, EC, SI, ATT, and BI, this study deepens insights into GenAI adoption in IGCSE schools. The results inform strategies to boost teacher readiness, align curricula, and engage students. Ongoing research remains vital for developing ethical and effective global GenAI integration in education.

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Warrant-Z : Digitalization of Warranty for Enhanced Efficiency and Customer Experience

1st Dr. U. Ganesh Naidu
Asst. Prof., Dept. of CSBS
B V Raju Institute of Technology
Narsapur, Medak
ganesh613@gmail.com

2nd Boorla Asritha
Student, Dept. of CSBS
B V Raju Institute of Technology
Narsapur, Medak
22211a3209@bvrit.ac.in

3rd Tirumalaraju Srujay
Student, Dept. of CSBS
B V Raju Institute of Technology
Narsapur, Medak
22211a3258@bvrit.ac.in

4th Dasari Rini Ruha
Student, Dept. of CSBS
B V Raju Institute of Technology
Narsapur, Medak
22211a3212@bvrit.ac.in

5th B. Sourav
Student, Dept. of CSBS
B V Raju Institute of Technology
Narsapur, Medak
22211a3263@bvrit.ac.in

Abstract—Despite us living in a digital age where product warranties and service documentation can be stored efficiently, consumer management often remains a manual, disjointed, and overlooked task. Lost receipts, faded bills, and missed warranty expiration dates lead to purchasing unnecessary items and loss of faith in post-purchase service. With this research paper, we introduce Warrantz - a mobile-first application that consolidates and streamlines users' warranty management via a combination of cloud storage, Optical Character Recognition (OCR), and an AI powered chatbot assistant called WarrBot. This application allows users to securely upload or scan receipts, auto-fetch e-commerce invoices, receive timely notifications prior to warranty expiration dates, and even create support tickets within the application. WarrBot uses Natural Language Processing (NLP) to assist users in a user-friendly way, answer questions about product specific warranties, and direct users through the process of claiming or transferring warranty coverage. Warrantz creates a post purchase experience built on smart automation, and ready access to information to help consumers decrease losses related to warranty inaction. In this paper we also outline the architecture of the Warrantz App, key features, implementation challenges, and future possibilities.

Keywords— *Warranty management, optical character recognition (OCR), natural language processing (NLP), AI chatbot, cloud storage, mobile application, smart notifications, Email invoice parsing, AI based customer support.*

1. INTRODUCTION

Today's digital-focused lifestyle, consumers own a diverse range of products, everything from electronics and home appliances to cars and personal electronics. With every one of these purchases comes the warranty and servicing obligations. Still, dealing with and keeping records of these warranties remains largely manual, based on physical receipts or email records easily lost, destroyed, or misplaced. This results in recurring problems like lost

warranty claims, unused service periods, and product resale or support challenges.

Though there are various digital solutions available for storing bills and documents, they usually do not incorporate warranty-specific intelligence, automation, and user interaction. There is no single platform that has features such as invoice scanning, intelligent reminders, and customized support assistance specifically designed for warranty management. This necessitates an urgent requirement for a centralized and intelligent solution that can help users manage and optimize their post-purchase experience. To meet this challenge, we introduce Warrantz, a mobile first platform that digitalizes and keeps all the warranty data in one place.

It allows users to safely upload and keep receipts, auto import purchase information from email, monitor warranty timeframes, and be reminded of impending expiries. An important aspect of Warrantz is its native AI chatbot assistant, Warbot, which integrates NLP to assist users through warranty-related questions, claim procedures, and support conversations.

The aim of this study is to show how merging innovative technologies like OCR, cloud storage, and AI-powered chatbots can result in a smarter and more effective solution for warranty management. The suggested system not only streamlines a traditionally neglected element of customer behavior but also boosts post-purchase interaction and digital ease.

2. Literature Review

The growing reliance on consumer electronics and high-value items has turned warranty services into an integral component of the post-purchase experience. Nevertheless, evidence indicates that most users either lose physical receipts or do not make use of their warranty rights for lack

of reminders or inadequate documentation [1]. The necessity of smart warranty tracking systems has also received attention over the past few years, with efforts to make warranty documents electronic by using cloud storage and mobile apps.

2.1. Warranty Management Applications

The majority of current applications addressing receipts and warranty tracking, e.g., Evernote, Genius Scan, or Dropbox, are mainly document storage oriented. They do not contain feature-specific support for monitoring warranty periods, reminding, or claim assistance. A few apps such as Binery or Bobby contain subscription monitoring and reminding but no support for invoice scanning, interpreting warranty lengths, or AI-powered user interaction.

A study by Li and Gao [4] highlights the necessity of lifecycle asset tracking systems for managing consumer goods and how digitalization can facilitate greater user participation and loss due to asset management inefficiencies. Nonetheless, they recognize the paucity of consumer-oriented platforms dedicated to the specific areas of warranty coverage and lifecycle tracking of purchased items.

A few online stores such as Amazon auto-track warranties on purchases done via their platform, but the facility does not include offline or third-party purchases. This void emphasizes the absence of an overarching, central platform for managing warranties that brings both online and offline purchases within its scope.

2.2. Use of Optical Character Recognition (OCR)

OCR technology has been widely utilized in mobile apps to scan physical text, particularly in use cases such as scanning receipts, identification documents, or forms. A study by Smith et al. [2] points out the application of Tesseract OCR for real-time parsing of invoices and documents. Nevertheless, OCR by itself is not always adequate when the document structures are quite different—warranty receipts from various brands are very inconsistent in form and need intelligent post-processing and data extraction rules.

Patel and Gupta [5] also describe the limitations of OCR in mobile scenarios and highlight the necessity of deep learning-based extensions to enhance accuracy and context-aware data extraction.

2.3. AI Chatbots in Mobile Applications

AI-powered chatbots are increasingly being adopted in various domains, including customer support, finance, education, and healthcare. A study by Jain et al. [3] demonstrated the use of Natural Language Processing (NLP) in mobile apps for simplifying user interaction and automating FAQs. Tools such as Dialog flow, Rasa, and OpenAI's GPT models offer frameworks for building conversational assistants that can understand user intent and provide dynamic responses.

Kumar and Bhatia [6] point out that conversational AI not only enhances usability but also decreases user dropout rates in mobile apps by providing instant support and customized feedback.

Integrating such AI-powered agents into warranty management can not only increase user experience but also help decrease reliance on human support for mundane questions such as warranty period, claim process, and documentation requirements.

2.4. Summary of Research Gap

Although significant progress has been achieved in document scanning and AI-based chat systems, there is a dearth of research merging these technologies into a unified application for managing the warranty lifecycle. There is no current solution providing an end-to-end experience that encompasses document scanning, cloud storage, AI-powered support, reminder notifications, and claim assistance integrated into one system. This research gap serves as the foundation for creating Warrantz.

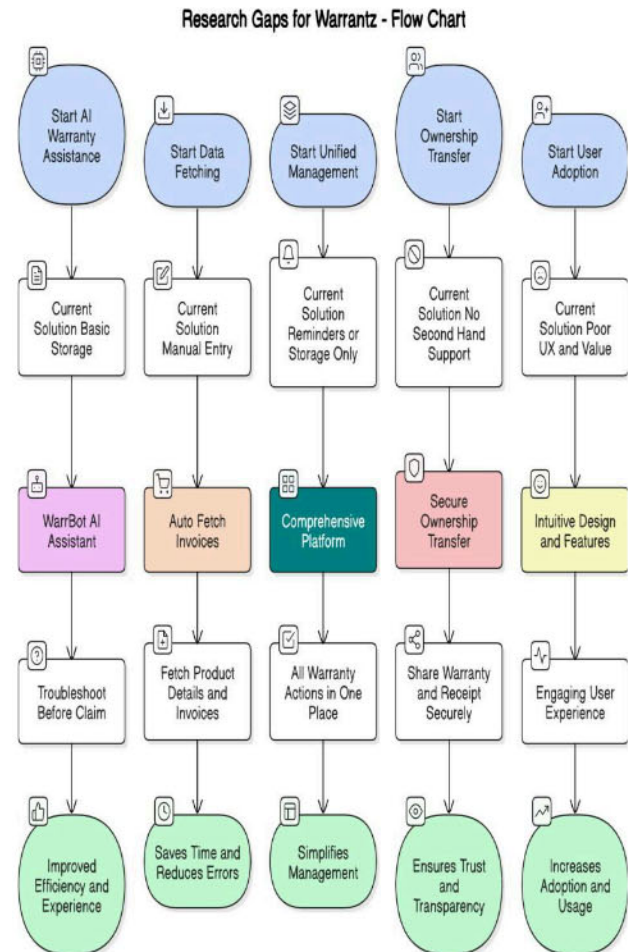


Fig. 1: Research Gaps for Warrantz- Flow Chart

3. Proposed System

The proposed system, Warrantz, is an integrated mobile application designed to overcome the inefficiencies of conventional warranty management practices. The system

combines several cutting-edge technologies—like Optical Character Recognition (OCR), cloud storage, AI-powered conversational agents, and push notification services—to provide a streamlined, intelligent, and user-centric warranty lifecycle management solution.

3.1 System Overview

Warrantz enables users to upload and scan purchase receipts, obtain warranty information using OCR, safely store documents in the cloud, get reminders for warranty expiry on time, and communicate with an AI-driven chatbot for instant assistance. The centralized system intends to bridge the gaps of lost warranty cards, forgotten expiry dates, and limited support while making a claim.

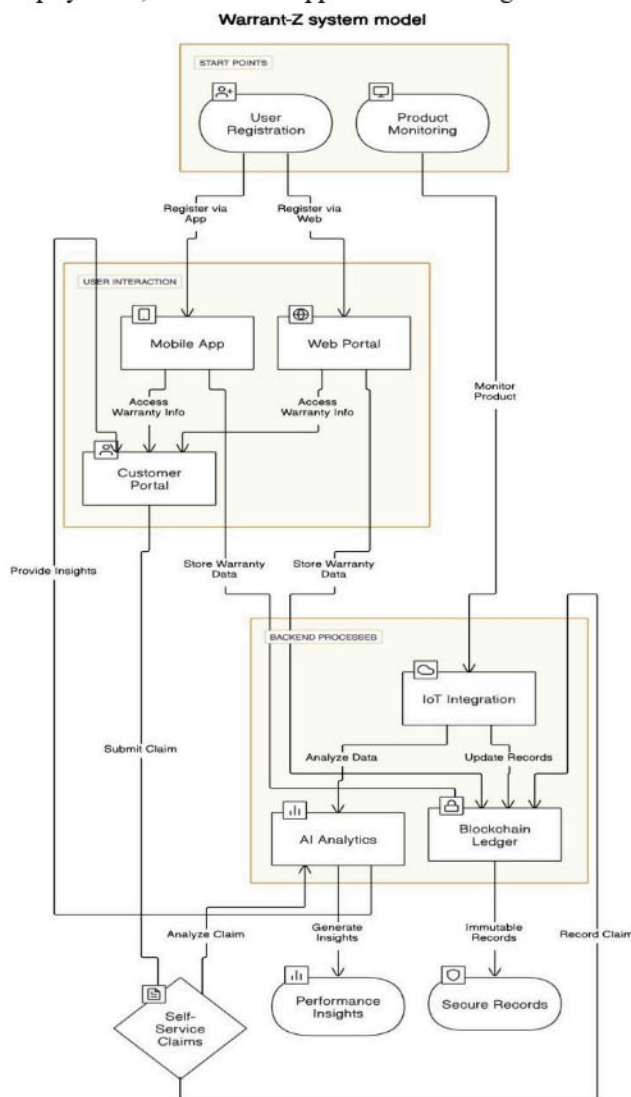


Fig. 2 : Warrantz System Model

3.2 Functional Components

User Authentication and Profile Management Users sign up and control their profiles via a secure authentication system. The site can offer conventional sign-in options or third-party service integration like Google Sign-In to ease access.

Invoice Scanning Using OCR

The app uses OCR technology to pull pertinent data—like product name, purchase date, seller details, and warranty period—from uploaded receipts. The data is then formatted and stored for future tracking.

Cloud-Based Document Storage

All extracted data and scanned documents are stored in a secure cloud environment, ensuring data persistence and accessibility from multiple devices. This mitigates the risk of document loss due to device malfunction or user error.

Automated Warranty Tracking and Notification System

The system calculates warranty expiration dates automatically using the extracted information and provides timely push notifications to the user. The reminders are created to avoid lost warranty claims and make users aware.

Product Categorization and Smart Search

Customers can group products under pre-defined categories (e.g., electronics, home appliances, cars) and use a search function to conveniently get detailed warranty information when necessary.

AI Chatbot Assistant – WarrBot

A virtual assistant powered by AI, called WarrBot, is integrated into the application. It deploys Natural Language Processing (NLP) to help users with frequent questions regarding warranty coverage, claim submission processes, and manufacturer or vendor contact details. This feature raises user interaction and cuts down on reliance on third-party customer services.

Email Invoice Parsing (Optional Extension)

As a high-end feature, the application can optionally connect to the user's email account—at the user's discretion—to read and parse electronic invoices received from e-commerce websites. This feature further automates data input and allows for more types of purchases.

Feature	Description
User Registration & Login	Customers, retailers, and manufacturers can register & log in securely.
QR Code Integration	Users can scan the QR code on products for quick warranty registration.
Digital Warranty Storage	The system securely stores product warranty details.
Warranty Expiry Notifications	Sends alerts before warranty expiration.
Claim Processing	Users can file claims online, and service centers can process them digitally.
Verification Module	Ensures that only genuine claims are processed.
Extended Warranty Suggestion	Offers users options for extended warranty purchases .
Admin Panel	A centralized dashboard for managing users, warranties, and claims.

Fig. 3 : Components of Warrantz

3.3 System Workflow

The workflow of the system is as follows :

The user logs in to the application and captures a receipt through the camera or selects from a file.

The OCR component reads major data from the document. Structured data is saved in the cloud and associated with the account of the user.

The warranty period is calculated, and reminders are scheduled automatically.

Warrant-Z flowchart

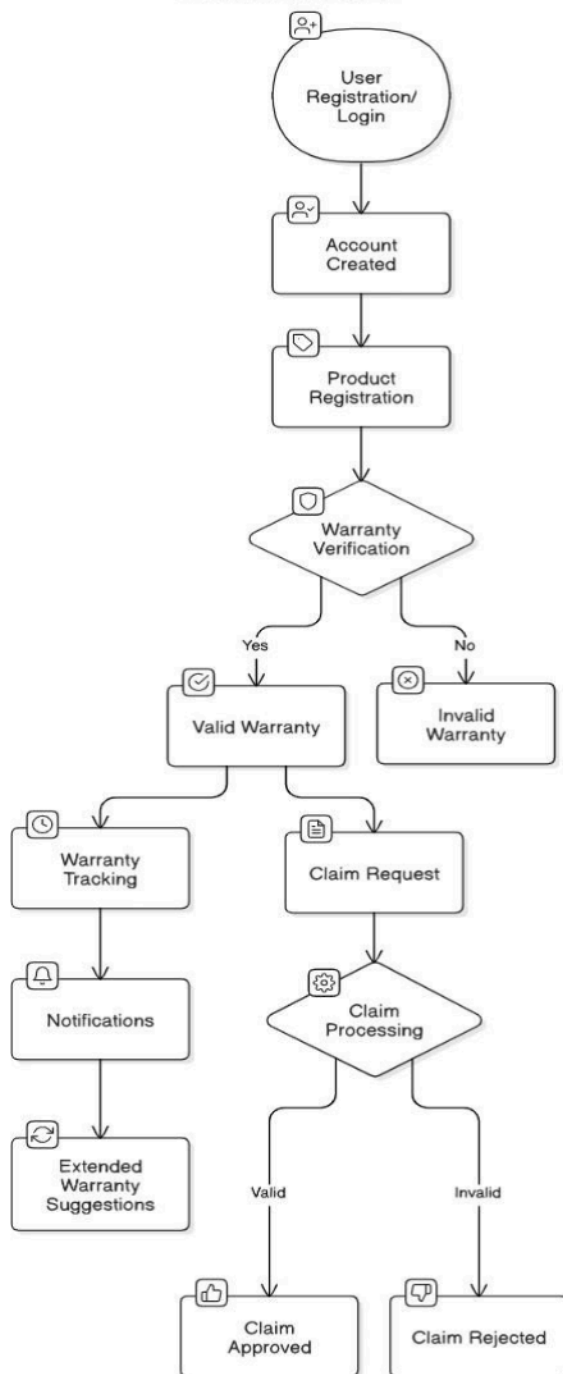


Fig. 4: Warrantz Flowchart

4. Results and Assessment:

The Warrantz application aims to revamp the experience of warranty management through the introduction of sophisticated technologies such as AI-powered chatbots and document digitization. The application has been proven through the creation of a webpage that identifies the platform's core functionalities and features. These are the warrantz plat- form's main features as outlined on the developed webpage:

Homepage: The homepage is the gateway to the application, with a clean summary of the features of the platform. The different sections like login, sign-in, and warranty tracking are easily accessible, providing a seamless and user-friendly interface. **Login and Sign-in Pages:** They are crucial for authenticating users, providing secure access to their personalized warranty data. User login enables them to see and administer their warranty information, creating a secure platform for interacting with their warranty data.

Chatbot Page (WarrBot): The platform features an integrated chatbot (WarrBot) that utilizes artificial intelligence to help users in real-time. It resolves warranty-related questions, gives information about products, and walks the user through the process of filing warranty claims. This feature increases user interaction and provides instant support for frequent questions.

Product History and Warranty Tracking: This feature allows users to enroll and view their products, monitor their warranty status, and get notified about warranty expirations. This feature also allows users to track active claims and be notified when there are impending warranty expiration dates, keeping them well-aware of their product warranties.

Admin Dashboard: The site comes with an admin dashboard through which administrators can monitor consumer and product information. Admins can access all registered products, track warranty statuses, and control user accounts with ease. The feature serves to provide flawless management of the site by enabling administrative control of the system.

The website created for Warrantz clearly illustrates the potential of the application in streamlining and improving the process of warranty management. It offers an easy-to-understand visual interface of how users will interact with the system, from registering to claiming warranties. The feedback obtained from early adopters will be employed to further customize and fine-tune the application to better address user requirements.

5. Results

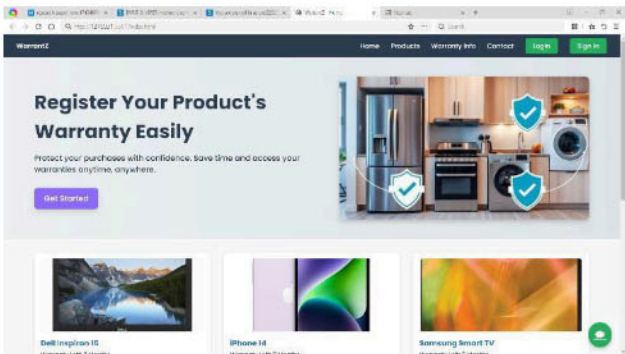


Fig. 5 : Homepage

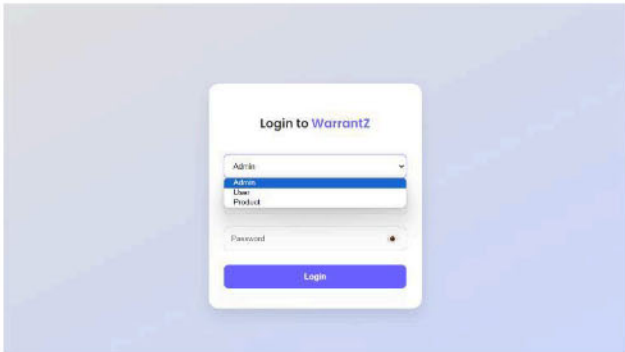


Fig. 6 : Login

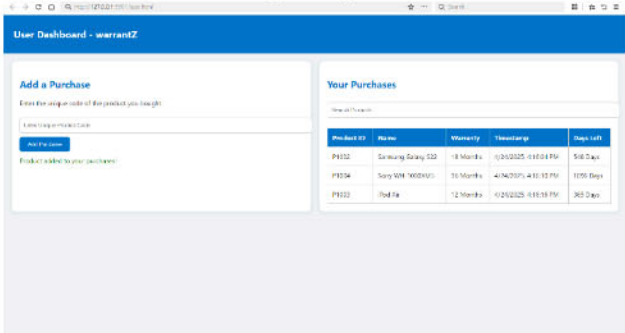


Fig. 7 : User Dashboard

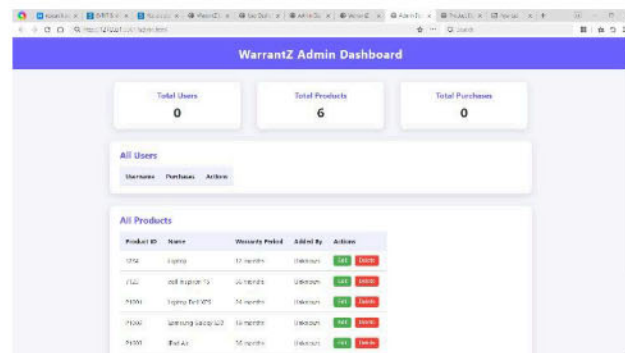


Fig. 8 : Admin Dashboard

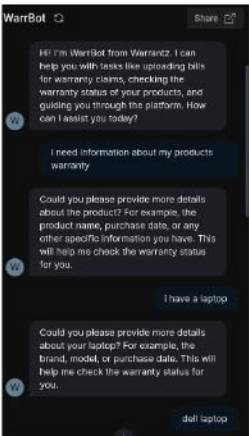


Fig. 9.0 : Conversation with Warrbot

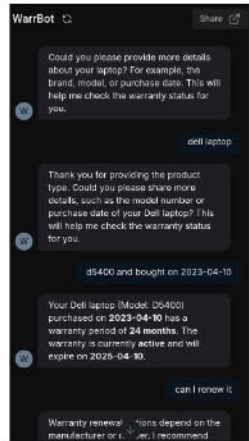


Fig. 9.1 : Conversation with Warrbot

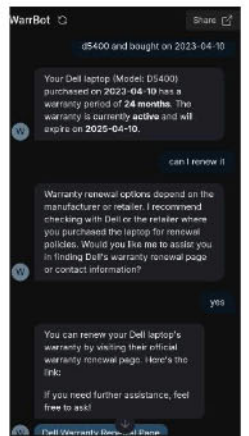


Fig. 9.2 : Conversation with Warrbot

6. Conclusion

The Warrantz application is an all-in-one warranty management solution that integrates the strength of AI-powered chatbots and document scanning to simplify the process for both consumers and administrators. The application gives users a simple to-use interface for monitoring their product warranties, receiving timely reminders, and easily accessing warranty information. The built-in chatbot, WarrBot, adds value to the user

experience by offering real-time support and responding to warranty-related questions effectively. In addition, the admin dashboard allows for proper management and tracking of user information and product guarantees.

The prototype web page created for the Warrantz platform works well to illustrate the essential functions, giving one an idea of how the entire application will work. Through an emphasis on user-focused features, Warrantz seeks to provide a missing solution in the market for an effortless and easy-to-use warranty management solution. The positive results of initial testing will be a starting point for the future development and tuning of the application. According to Zhang and Chen [7], incorporating AI into consumer-facing platforms has the potential to dramatically improve service delivery and customer satisfaction, a feat Warrantz is well on its way to accomplishing. In addition, AI application for enhancing customer service, as investigated by Lee and Kim [9], is in line with the objectives of this application in simplifying warranty management.

7. Future Work

Although the implementation at hand is a good starting point, there are a number of areas to be improved upon in the future. These include:

Mobile App Development: The second phase will be creating a mobile app for Warrantz that can be run on several devices and platforms. This will enable users to manage their warranties remotely, leading to increased accessibility and user interaction.

Future versions will increase the capabilities of the AI chatbot by integrating machine learning to enhance its performance in addressing more sophisticated queries. The platform can be trained to provide more customized recommendations for warranty extensions, product replacement, or claims based on the history of the user.

Integration with Product Manufacturers: One possible future enhancement is integration with manufacturers' databases to capture warranty details of registered products automatically, without users having to manually upload documents and ensuring that information is always updated.

Cloud-Based Data Storage: Transition to a cloud-based system will enhance scalability and security, enabling data synchronization in real-time across different devices and assuring that the information of the users is at all times protected.

Global Expansion: For serving a wider market, the platform may be extended to be multi-language and multi-region supported. Moreover, collaborations with international brands may be used to augment the platform's reach and utility.

Through its ongoing improvement of the platform's features and the extension of its scope, Warrantz may emerge as one of the major solutions for managing warranties, which will offer greater convenience and confidence to users concerning their product guarantees.

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Guidelines to Enhance eLearning Effectiveness for Teachers at Guangxi Modern Polytechnic College of Engineering

Jiajia Deng

*School of Industrial Education and Technology
King Mongkut's Institute of Technology Ladkrabang
Bangkok, Thailand
650360700@kmitl.ac.th*

Poonsri Vate-U-Lan

*School of Industrial Education and Technology
King Mongkut's Institute of Technology Ladkrabang
Bangkok, Thailand
poonsri.va@kmitl.ac.th
orcid.org/0000-0002-4200-0469*

Abstract—eLearning integration in vocational education faces unique challenges, especially in contexts prioritizing hands-on training. This study, conducted at Guangxi Modern Polytechnic College of Engineering, identified barriers to eLearning adoption among educators and evaluated supportive guidelines. Using a mixed-methods design, it included semi-structured interviews with 20 instructors and a quasi-experiment involving 357 full-time teachers (179 in an intervention group with guideline-based training and Professional Learning Communities (PLCs) support, 178 in a comparison group). The post-intervention survey assessed four dimensions—teacher engagement, instructional effectiveness, collaboration, and student interaction—with strong internal consistency (Cronbach's $\alpha = 0.923$). Key barriers were inadequate digital infrastructure, insufficient vocational-specific training, low student engagement, and a lack of vocation-tailored teaching models. A targeted guideline—focusing on instructional leadership, PLCs, and digital competence—was implemented, yielding significant improvements in all four areas (all $p < .001$), with mid-career teachers (5–10 years) gaining the most. Practical recommendations for leadership, professional development, and technical support strengthen eLearning integration in vocational education, contributing to digital transformation discourse in applied settings.

Keywords—eLearning, Vocational Education, Instructional Leadership, Professional Learning Communities, Guidelines

I. INTRODUCTION

The swift progression of digital technologies has profoundly reshaped the global educational landscape[1]. This evolution has notably accelerated the integration of e-learning into educational frameworks, offering enhanced flexibility, accessibility, and avenues for personalized learning experiences[2]. Despite its inherent potential, the widespread adoption of e-learning has encountered considerable challenges, particularly within vocational education[2]. This sector has historically emphasized traditional face-to-face instruction and hands-on practical training, presenting a unique set of considerations for the effective implementation of digital learning methodologies [5].

At Guangxi Modern Polytechnic College of Engineering, the transition toward eLearning has become a key focus in response to the increasing demand for digital education. The college has made strides in incorporating digital tools into its teaching methods, yet many teachers face difficulties in adapting to new technologies, integrating them into their teaching practices, and ensuring meaningful student engagement in online environments. These challenges are exacerbated by technical issues, insufficient training, and a lack of institutional support, all of which hinder the effective implementation of eLearning initiatives.

This study aims to address these challenges by investigating the barriers to eLearning integration at Guangxi Modern Polytechnic College of Engineering. Specifically, it seeks to identify the needs and obstacles faced by teachers, with a focus on the role of leadership in supporting eLearning initiatives. Through this research, the study will provide actionable guidelines to improve eLearning practices, emphasizing the importance of Principal Instructional Leadership (PIL) and Professional Learning Communities (PLCs) [1].

Principal Instructional Leadership (PIL) has been shown to be a crucial factor in shaping the learning environment, impacting both teacher and student experiences [1]. By clarifying the institution's mission, fostering a positive learning atmosphere, and managing the curriculum effectively, principals play a pivotal role in overcoming eLearning barriers. Additionally, PLCs, which foster collaboration and continuous professional development, are essential in helping teachers navigate the challenges of integrating eLearning into their practices [2].

II. RESEARCH OBJECTIVE

This study aims to address a significant gap in the understanding of how eLearning is perceived and adopted at China College. The research aims to address the following question: What challenges and needs do educators face when integrating eLearning into their teaching practices, and how do leadership support and professional learning communities contribute to resolving these challenges? To address this research question, the study is guided by the following objectives:

- To investigate the challenges and needs related to eLearning integration among teachers at China College
- To explore the relationship between leadership support, Professional Learning Communities (PLCs), and the adoption of eLearning in vocational education.

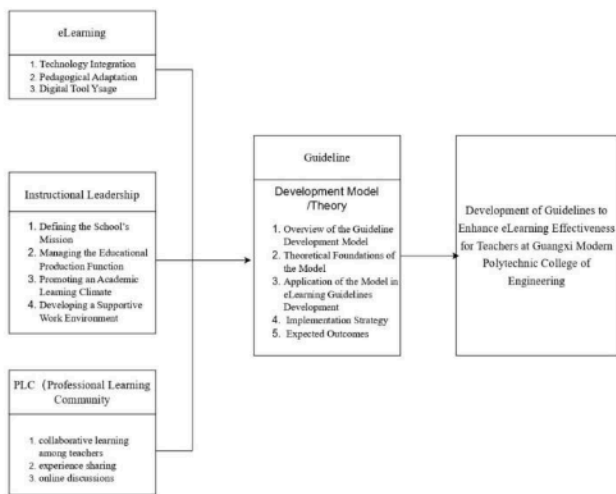


Fig. 1. Conceptual Framework

III. LITERATURE REVIEW

The adoption of emerging technologies in education has become an increasingly important subject of research. This literature review synthesizes findings from various studies examining factors influencing the adoption of eLearning technologies, with a focus on vocational education. In particular, it addresses the role of Principal Instructional Leadership (PIL) and Professional Learning Communities (PLCs) in supporting eLearning adoption in vocational institutions.

A. Challenges in eLearning Adoption in Vocational Education

The integration of eLearning in vocational education has encountered several challenges. Research highlights that teachers in vocational education settings often struggle to adapt to eLearning technologies, particularly in fields requiring hands-on training. In these settings, eLearning cannot easily replace the in-person interaction and practical skills training typically required. Many educators report difficulties in engaging students online, especially in

disciplines that rely heavily on practical, real-world experiences [5]. Technical barriers, such as unreliable internet access and lack of technical support, are significant obstacles to the effective implementation of eLearning [3][4].

Moreover, insufficient training and professional development programs are frequently cited as critical barriers to eLearning adoption. Teachers often feel unprepared to use digital tools effectively, exacerbating the challenges of integrating eLearning into their teaching practices. These factors contribute to a significant gap in the readiness of vocational educators to leverage eLearning platforms effectively.

B. The Role of Principal Instructional Leadership in eLearning Adoption

Principal Instructional Leadership (PIL) has been identified as a crucial factor in the successful adoption of eLearning technologies. Studies suggest that principals who actively support the integration of digital tools and provide necessary resources and professional development opportunities can significantly influence the success of eLearning initiatives [7]. Effective leadership can help clarify the institution's mission, foster a positive learning environment, and manage the curriculum in a way that supports the integration of eLearning technologies [6].

In vocational education, leadership support is especially critical, as these institutions often remain reliant on traditional, face-to-face instruction. Strong leadership can bridge the gap between traditional teaching methods and the adoption of digital learning practices, ensuring that teachers receive adequate support through training and resources to make the transition to eLearning more effective.

C. The Role of Professional Learning Communities (PLCs)

Professional Learning Communities (PLCs) have emerged as an essential mechanism for supporting teachers in adapting to eLearning environments. PLCs allow teachers to collaborate, share best practices, and provide mutual support in navigating the challenges of eLearning integration. Research has shown that PLCs contribute to improving teachers' confidence and skills in using digital tools for teaching, which is crucial for the successful adoption of eLearning [8][9].

PLCs provide a space for teachers to engage in continuous professional development, allowing them to share insights and strategies for overcoming challenges encountered in the online classroom. In vocational education, where hands-on teaching is central, PLCs help educators develop strategies to blend traditional learning with digital tools, fostering a collaborative environment that supports both teacher and student success in eLearning initiatives [10].

D. Gaps in the Literature

While the existing literature on eLearning adoption is extensive, there remains a significant gap in understanding how leadership and professional collaboration specifically support eLearning integration in vocational education settings. Most studies focus on general educational contexts, with limited research on the unique challenges faced by vocational educators in adopting eLearning. This study aims to fill this gap by investigating the role of Principal Instructional Leadership and Professional Learning Communities in the adoption of eLearning in vocational education.

IV. RESEARCH METHODOLOGY

This study adopted a mixed-methods design to address two core objectives: (1) to identify eLearning challenges and needs among teachers, and (2) to develop and validate eLearning enhancement guidelines. The methodology comprised three phases: qualitative exploration, expert validation, and intervention implementation.

A. Identification of eLearning Challenges and Needs

Semi-structured interviews were conducted with 20 full-time teachers, purposefully sampled from various departments. These interviews explored aspects of digital teaching, technical barriers, and institutional support. Data analysis was performed using thematic analysis, facilitated by ATLAS.ti. Coding procedures adhered to Braun & Clarke's six-step approach to ensure reliability and validity [11].

B. Development and Validation of Guidelines

Based on Phase I insights and literature on instructional leadership and PLCs, we drafted initial guidelines. These guidelines covered digital competence training, emotional engagement frameworks, and leadership support strategies. Five experts in educational leadership and vocational pedagogy assessed the guidelines using the Index of Item-Objective Congruence (IOC) technique [12]. Items scoring below a 0.50 cutoff and flagged as unclear were revised or removed per standard IOC protocols [13].

C. Implementation and Comparative Evaluation

An eight-week quasi-experimental intervention was conducted. The intervention group (IG) (n = 179) received guideline-based training alongside ongoing PLC-style support, while a comparison group (CG) (n = 178) continued standard practice. Outcomes—teacher engagement, eTeaching effectiveness, professional collaboration frequency, and perceived student interaction—were measured via post-intervention surveys with validated scales (Cronbach α = .85–.92). Reflection logs were collected from IG participants to gain qualitative insights. Statistical hypotheses were tested using paired t-tests and ANCOVA (α = 0.05).

D. Participants and Instruments

The full population was 357 full-time teachers at Guangxi Modern Polytechnic College. Interview sampling ensured diversity, with the full cohort in the intervention. Instruments included:

- Semi-structured interview protocol
- Expert-reviewed IOC questionnaire
- Post-intervention survey and reflection list.

V. RESULTS

A. Findings for Objective One: Identifying eLearning Challenges and Needs

To pinpoint the practical challenges teachers face in digital instruction, 20 purposefully selected full-time instructors from across departments were interviewed. Rigorous thematic analysis identified four key areas of concern:

- **Technical Barriers:** Teachers frequently cited inadequate infrastructure—such as unstable internet connectivity and slow classroom computers—as a core obstacle. Delays in IT support further disrupted lesson delivery, particularly during live sessions.
- **Insufficient Training:** Institutional training programs were described as infrequent and generic, often failing to address the specific software or instructional tools needed in vocational education. As a result, many teachers resorted to self-learning or informal peer assistance.
- **Student Engagement Difficulties:** Participants reported that practical courses—especially those involving lab work or equipment—suffered from low student participation and poor interaction in the online setting.
- **Lack of Pedagogical Models:** There was a clear absence of discipline-specific digital teaching strategies. Many teachers struggled to adapt hands-on vocational content (e.g., welding, electronics) into effective online lessons, often lacking appropriate instructional templates or successful case references.

These findings indicate that technical and pedagogical limitations are not isolated but systemic, pointing to a need for comprehensive institutional strategies that combine infrastructure, training, and instructional support.

B. Findings for Objective Two: Evaluation of the eLearning Enhancement Guideline

1) Quantitative Outcomes

A total of 357 full-time teachers participated in the survey phase, with 179 assigned to the Experimental Group (EG) and 178 to the Control Group (CG). Survey data were analyzed across four key dimensions:

- Teacher Engagement in Online Instruction
- Perceived Instructional Effectiveness
- Frequency of Professional Collaboration
- Quality of Student Interaction (self-reported)

Table I. Comparison of Key Outcomes Between EG and CG

Variable	EG (Mean $\pm$ SD)	CG (Mean $\pm$ SD)	t-value	p-value
Teacher engagement	4.21 $\pm$ 0.58	3.67 $\pm$ 0.61	7.12	< .001
Perceived instructional efficacy	4.05 $\pm$ 0.49	3.52 $\pm$ 0.55	6.89	< .001
Professional collaboration freq.	3.98 $\pm$ 0.63	3.15 $\pm$ 0.70	8.03	< .001
Student interaction quality	3.91 $\pm$ 0.50	3.40 $\pm$ 0.59	6.54	< .001

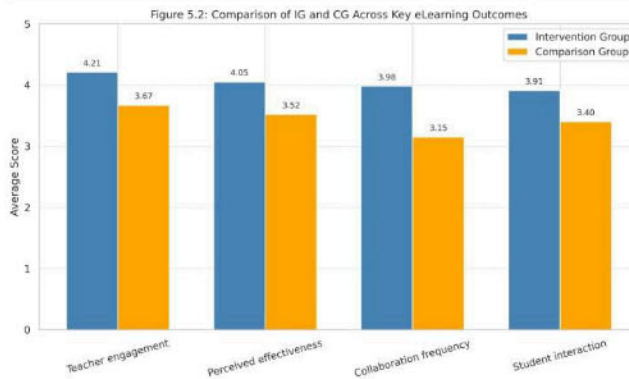


Fig. 2. Bar Chart Comparing Two Groups: Group-Level Improvements Across Dimensions

2) Reflection Log Insights

In addition to the survey, teachers in the intervention group kept weekly reflection logs throughout the eight-week implementation period, documenting their experiences of applying the guidelines and evolving perceptions of digital instruction. A thematic analysis of these logs uncovered several subtle benefits that extended beyond the quantifiable metrics:

- Increased Instructional Confidence:** Teachers reported a marked improvement in their confidence when planning lessons, designing digital instructional materials, and monitoring student progress. The structured framework introduced during the intervention enabled them to better align content with learning objectives, utilize diverse online tools, and deliver lessons more effectively in virtual environments. As a result, many teachers expressed a stronger sense of control over their teaching practices, as well as increased willingness to experiment with new pedagogical strategies.
- Enhanced Peer Collaboration:** Participation in Professional Learning Communities (PLCs) significantly fostered peer-to-peer collaboration. Teachers engaged in regular discussions, shared classroom experiences, and co-developed teaching resources tailored to vocational education contexts. These collaborative efforts not only enhanced the

quality of instructional materials but also created a supportive professional culture where challenges such as technical difficulties or student disengagement could be addressed collectively through shared problem-solving.

- Emotional and Leadership Support:** Multiple respondents expressed appreciation for school leaders' consistent check-ins and feedback. This contributed to reduced stress and increased motivation, especially during periods of heavy digital workload.

C. Additional Findings: Impact by Teaching Experience

Survey data were also segmented by years of teaching experience to explore differential effects. As shown in Table 5.2, mid-career teachers (5–10 years) demonstrated the most notable gains across all measured outcomes.

Table II: Outcome Improvements Stratified by Teaching Experience (Intervention Group)

Experience Level	Engagement	Collaboration	Instructional Confidence
< 5 years	+0.38	+0.44	+0.31
5–10 years	+0.62	+0.78	+0.55
11+ years	+0.41	+0.52	+0.37

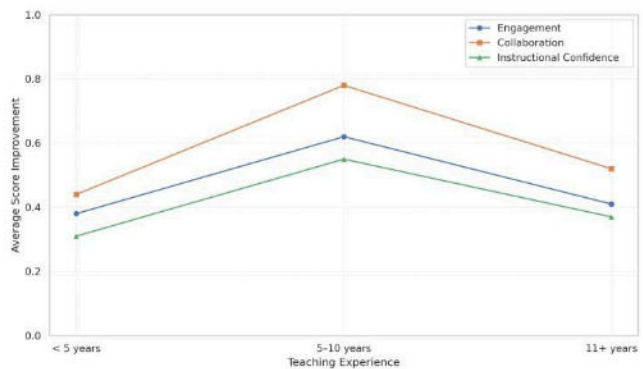


Fig. 3. Line Graph Tracking Outcome Improvements Across Three Experience Levels, With a Peak in the 5–10 Year Cohort

D. The Proposed eLearning Guideline: Key Components and Implementation

The proposed eLearning guideline comprised three key components: instructional leadership, Professional Learning Communities (PLCs), and digital competence development. First, instructional leadership focused on empowering school leaders to create a vision for digital integration, provide structured support, and lead by example in using technology-enhanced pedagogy. Second, PLCs were formalized to promote ongoing peer collaboration, where teachers shared strategies, co-developed content, and reflected on digital practices in vocational education. These communities provided psychological safety and professional support, enhancing adaptation to change. Third, digital competence modules provided practical training in content delivery, learning

management systems (LMS), and online assessment tools tailored to vocational subjects. This included task-specific tutorials, model lesson templates, and hands-on sessions. The guideline was delivered through a structured eight-week program combining workshops, micro-training, and collaborative planning sessions. This holistic approach addressed technical, pedagogical, and emotional dimensions of eLearning adoption and proved especially effective for mid-career teachers.

VI. DISCUSSION

A. Interpretation of Key Findings

The interview findings highlight persistent technical barriers, insufficient training, student engagement difficulties, and a lack of vocational-specific pedagogical models. These systemic challenges align with prior literature in vocational education, suggesting that such educators often face constraints in infrastructure and contextualized instructional design[16]

Quantitative results — showing significant gains in teacher engagement, instructional efficacy, collaboration, and student interaction (see Table I) — highlight the effectiveness of structured eLearning support. These results affirm the pivotal role of instructional leadership in driving digital transformation, as recognized in the literature on educational innovation[17].

The importance of Professional Learning Communities (PLCs) is further validated. The association between PLCs and digital instructional integration has been confirmed in large-scale studies (e.g., 16 k STEM teachers) showing that PLC engagement mediates gains from professional development[15].

Teachers' reflection logs underscored this mechanism, echoing that peer collaboration improves not just confidence but emotional support—echoing theoretical arguments on PLC-based resilience[14].

The stratified analysis — based on post-intervention data across all measured outcomes (teacher engagement, instructional effectiveness, collaboration, and student interaction)—revealed that mid-career teachers (with 5–10 years of experience) showed the most pronounced positive response to the intervention. This finding aligns closely with and reinforces existing research in vocational education, which consistently highlights that teachers at the intermediate career stage, balancing accumulated pedagogical experience with openness to innovative practices, often emerge as key change agents driving pedagogical innovation in technical and applied learning contexts.

B. Theoretical and Practical Implications

Theoretically, this study advances understanding of technology adoption in vocational education by emphasizing the dual importance of organizational support

(leadership-driven training and PLCs) alongside technical infrastructure. It integrates models of instructional leadership and community-based professional development within the vocational eLearning context.

Practically, vocational institutions should adopt holistic support structures, combining investments in digital infrastructure with leadership-driven eLearning guidelines and PLCs. Leadership must actively align institutional policies with professional development and afford teachers sustained platforms—both technical and social—for innovation and resilience.

C. Limitations and Future Research

This study has several limitations that should be acknowledged. First, the research was conducted at a single vocational institution in China, which may limit the generalizability of the findings. Future research should consider multi-site studies across different institutional contexts to validate and expand upon these results. Second, the evaluation period was limited to the eight-week intervention timeframe, capturing only short-term effects. Longitudinal research is recommended to examine the sustainability of eLearning guideline implementation over time. Third, the data collected primarily focused on teachers' experiences, omitting direct student perspectives and learning outcomes. To obtain a more comprehensive understanding of digital transformation in vocational education, future studies should incorporate student data. Lastly, given that mid-career teachers showed the most significant gains, further research is needed to explore how to effectively support both early-career and late-career educators in adapting to digital instructional environments.

VII. RECOMMENDATION

Based on the findings and discussion of this study — particularly the identification of systemic barriers (inadequate digital infrastructure, generic training, low student engagement, and a lack of vocational-specific pedagogical models) and the proven effectiveness of targeted interventions (instructional leadership, PLCs, and tailored digital training)—the following four major recommendations are proposed. These recommendations aim not only to enhance the immediate effectiveness of eLearning integration in vocational education settings but also to ensure its long-term sustainability, addressing both the technical and human factors that shape successful digital transformation in contexts where hands-on training remains foundational.

A. Strengthen Leadership and Institutional Support

Institutions should empower principals and department heads to act as instructional leaders in digital transformation. This includes clarifying strategic visions for eLearning, modeling good digital practices, and facilitating regular feedback loops with teachers. Policy-level support should formalize Professional Learning

Communities (PLCs) into school routines, allocating dedicated time, resources, and platforms for collaboration.

B. Improve Teacher Training and Professional Development

eLearning training for teachers should move beyond generic platforms and focus on domain-specific applications relevant to vocational education. Modular, ongoing training formats are recommended, covering digital pedagogy, online assessment, and emotional engagement strategies. In addition, schools should incentivize peer mentoring systems, particularly leveraging mid-career teachers to support early-career educators.

C. Enhance Technical Infrastructure and Support Systems

Reliable internet access, updated hardware, and responsive IT support must be prioritized. Institutions should routinely assess their digital readiness and provide immediate technical assistance to minimize instructional disruptions. The integration of learning analytics tools within platforms can also enable data-informed teaching adjustments and institutional planning.

D. Promote Long-Term Evaluation and Inclusive Feedback

To ensure sustainability, longitudinal monitoring of eLearning outcomes should be embedded in school practices. This includes tracking changes in teacher competence, collaboration frequency, and student engagement over time. Future research and institutional evaluations should also incorporate student perspectives, enabling a more holistic understanding of digital learning effectiveness.

VIII. ACKNOWLEDGMENT

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Innovative Hybrid Peer-Teaching Learning Model using Interactive Video and Simulation to Promote Professional Self-Efficacy and Clinical Competence Among Nursing Students

1st Manee Nakanakupt

Department of Family and Midwifery Nursing
Princess Agrarajakumari Faculty of Nursing,
Chulabhorn Royal Academy
Bangkok, Thailand
maneenakanakupt@gmail.com
<https://orcid.org/0009-0000-8321-3201>

2nd Anuchit Butkhunthong

Educational Technology and Communications,
Faculty of Education
Chulalongkorn University
Bangkok, Thailand
anuchit.bkt@gmail.com
<https://orcid.org/0009-0004-0051-9301>

Abstract—This study aimed to develop and evaluate a peer-teaching instructional model integrated with interactive video and simulation to enhance delivery self-efficacy and clinical competence among nursing students. A quasi-experimental design was employed with 60 fourth-year nursing students enrolled in a maternal and newborn nursing practicum course. Participants were purposively assigned to either an experimental group (peer teaching with Edpuzzle-supported interactive videos and simulation practice) or a control group (traditional instruction with video viewing and instructor-led simulation).

The research instruments included a lesson plan, a self-efficacy scale, a clinical skills checklist, and a satisfaction questionnaire. Data were analyzed using descriptive statistics, independent t-tests, and Pearson's correlation coefficient. The experimental group showed significantly higher self-efficacy ($M = 4.29$, $SD = 0.42$) than the control group ($M = 3.89$, $SD = 0.55$), $p < .003$. Clinical skills scores were also significantly higher in the experimental group ($M = 3.85$, $SD = 0.39$) compared to the control group ($M = 3.43$, $SD = 0.23$), $p < .001$. Students reported high satisfaction with the peer-teaching approach ($M = 4.72$, $SD = 0.40$). Strong positive correlations were found between self- and peer- assessments ($r = 0.70$, $p < .001$), while instructor ratings were not significantly correlated with student assessments.

The findings support the effectiveness of technology-supported peer teaching in improving students' confidence and clinical performance in delivery care. This model offers a promising strategy for competency-based nursing education.

Keywords—Peer Teaching, Simulation-Based Learning, Interactive Video, Self-Efficacy, Clinical Competence, Hybrid Learning Model

I. INTRODUCTION

The Thai National Education Plan (2017–2036) emphasizes the development of 21st-century skills among students, particularly in health professions such as nursing. To meet this objective, the Thailand Nursing and Midwifery Council mandates that educational institutions

produce graduates equipped with both theoretical knowledge and practical competencies in accordance with professional standards and ethical practices [1], [2]. Nursing education at the tertiary level is therefore encouraged to adopt adult learning principles and promote transformative learning experiences [3].

In clinical practice courses, especially labor and delivery, nursing students often experience heightened anxiety due to the life-critical nature of the tasks involved. These emotional burdens can negatively affect students' learning processes and self-efficacy [4]. Accordingly, active learning strategies are increasingly recommended to foster deeper engagement, critical thinking, and hands-on practice.

Peer teaching is a validated active learning technique that facilitates mutual knowledge exchange and reduces performance anxiety. It has been found to increase both confidence and clinical performance, especially in skill-intensive areas such as childbirth [5], [6]. In peer teaching, student-tutors reinforce their understanding by teaching others, while learners benefit from relatable explanations and a more relaxed learning atmosphere. This method not only enhances cognitive outcomes but also strengthens professional communication, empathy, decision-making, and collaboration skills [7], [8].

To further enhance these benefits, blended learning has emerged as a promising approach in nursing education. It offers flexibility by allowing students to engage with online content at their own pace, promoting better time management and encouraging self-directed learning through interactive digital platforms [9]. When structured sequentially—beginning with virtual or interactive video simulations and followed by high-fidelity clinical practice—blended learning has been shown to improve

reflective thinking, skill acquisition, and learner confidence [10].

Given these advantages, this study explores the integration of peer teaching with simulation and interactive video in childbirth education. The goal is to promote delivery-related self-efficacy and clinical competence among undergraduate nursing students, thereby contributing to safer maternal care and elevating national healthcare standards.

II. RESEARCH OBJECTIVES AND QUESTIONS

This study aims to examine the effectiveness of peer teaching integrated with interactive video and simulation on delivery-related learning outcomes among undergraduate nursing students. Specifically, the research addresses the following questions:

1. To what extent does peer teaching affect nursing students' self-efficacy in performing delivery procedures compared to traditional instruction?
2. How do clinical skills in performing delivery procedures differ between students who receive peer teaching and those who receive traditional instruction?
3. What is the level of student satisfaction with the peer teaching method?
4. How do self-assessment, peer assessment, and instructor assessment compare in evaluating students' delivery skills?

III. MATERIALS AND METHODS

A. Research Design

This study employed a quasi-experimental design using a two-group pretest-posttest approach to examine the effects of peer teaching on childbirth confidence and performance among nursing students.

B. Participants

The participants consisted of 60 fourth-year undergraduate nursing students enrolled in the course "Maternal and Newborn Nursing and Midwifery Practice 3" at Akkhararatchakumari College of Nursing, Chulabhorn Royal Academy during the first semester of the academic year 2024 (September–November 2024). Inclusion criteria were: (1) enrollment in the targeted course, (2) completion of both theoretical courses in maternal and newborn nursing, and (3) voluntary participation in the study. No participants withdrew, and all 60 completed the full study.

Participants were assigned to two groups based on their practicum schedule, which was predetermined by the academic curriculum. The control group ($n = 30$) completed their practicum between September and October 2024, while the experimental group ($n = 30$) underwent the intervention between October and November 2024.

C. Research Instruments

This study employed three categories of instruments: instructional materials, assessment tools, and a feedback instrument. All instruments were reviewed by three experts to assess content validity. Item–Objective Congruence (IOC) values for each tool are reported below.

1) Instructional Materials

- Peer Teaching Lesson Plan: Developed to promote Professional Self-Efficacy through structured peer- led learning activities. The IOC was 0.86.
- Two types of videos were used to facilitate self-directed learning prior to simulation practice: (1) Lenia-format videos, which offer non-interactive, passive viewing, and (2) interactive videos developed through the Edpuzzle platform. Edpuzzle allows instructors to embed formative questions and highlight key messages throughout the video, thereby enhancing learner engagement and retention. In this study, seven interactive video episodes were utilized, each incorporating embedded questions and reflective prompts designed to promote active learning. These interactive features distinguish them from the Lenia videos, which do not allow learner interaction. All videos were validated by five content experts in the study by Nakanakupt and Jaichuen (2022) [6], achieving an Item-Objective Congruence (IOC) index of 1.00 across 21 items and demonstrating instructional effectiveness, with E1/E2 scores of 83.21/86.61.

2) Assessment Tools

- Professional Self-Efficacy: This refers to the Childbirth Self-Efficacy Questionnaire, an 8-item self-assessment instrument designed to evaluate nursing students' confidence in performing childbirth procedures. The item-objective congruence (IOC) index was 0.96.
- Clinical Competence Assessment: Assessed using the Delivery Performance Checklist, a 13-item checklist developed to evaluate students' delivery skills during simulation-based practice. It was utilized in self-assessment, peer assessment, and instructor assessment. The item-objective congruence (IOC) index was 1.00.

3) Feedback Instrument

- Student Satisfaction Questionnaire: Designed to evaluate satisfaction with the peer teaching approach across classroom and clinical practice dimensions. The IOC was 0.92.

D. Intervention Procedure

All participants had previously completed theoretical coursework in childbirth. Prior to the practicum, students were provided with self-directed learning materials in the form of instructional videos. These included both non-interactive formats and seven interactive modules delivered via the Edpuzzle platform (Figure 1). Each video corresponded to a key step in the childbirth procedure and featured guiding annotations, visual highlights, and embedded formative questions to support learner comprehension and engagement (Figure 2). Students were required to complete all modules at home within one week before entering the simulation environment. An example of such multimedia questioning involved scenario-based multiple-choice questions that assessed the correct technique for fetal head rotation (Figure 3).

The experimental group participated in a peer-teaching intervention integrated into the practicum. Each day, students in this group engaged in a 7-hour session. They were organized into subgroups of 2–3 members, drawn from a larger practicum group of 7–8 students. The daily session began with a demonstration led by two volunteer students, who performed the childbirth procedure while the remaining peers and the supervising instructor observed, provided feedback, exchanged ideas, and discussed correct techniques collaboratively.

During the subsequent four-hour simulation practice, students worked in their small subgroups to repeatedly rehearse the procedure, offering mutual support and peer guidance. The instructor circulated among groups, providing corrective feedback as needed to ensure clinical accuracy. After the lunch break, each student underwent an individual skills assessment conducted by the instructor, lasting approximately 10–15 minutes per student. The session concluded with a structured debriefing that encouraged students to reflect on their performance, share insights, and identify areas for improvement.

Peer tutors provided ongoing support throughout the day, including demonstrations, clarification of procedural steps, and formative feedback, all within the framework guided by the instructor. Students rotated among the roles of performer, assistant, and peer tutor within their subgroup, allowing for active participation and skill development from multiple perspectives. A typical peer-teaching session with manikin-based childbirth simulation is illustrated in Figure 4.

The control group received conventional instructor-led training without the peer-teaching component. Both groups followed the same practicum schedule and used identical instructional materials and assessment tools.

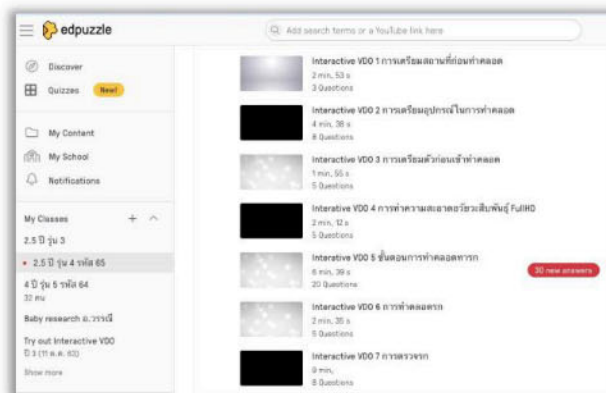


Figure 1. Screenshot of the Edpuzzle interface displaying seven interactive video modules on childbirth procedures for self-directed learning.

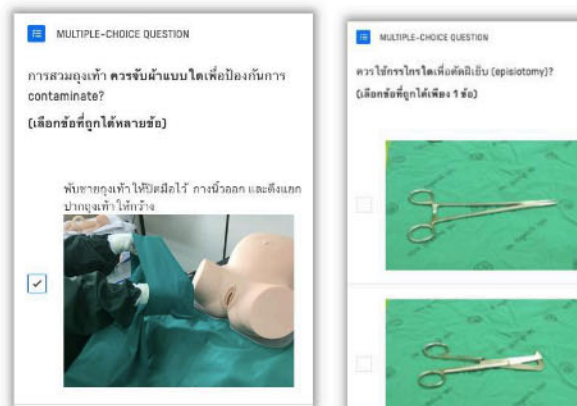


Figure 2. Sample frame from the Edpuzzle module showing an embedded quiz question and annotated visual content to support active learning.

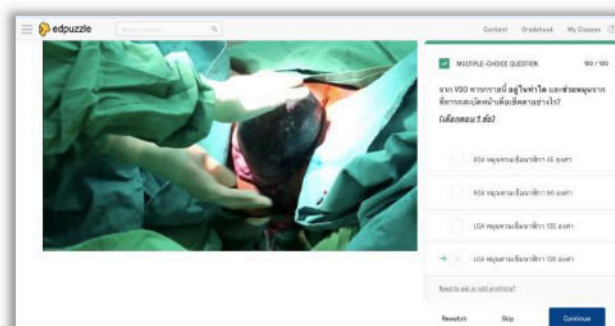


Figure 3. Interactive multiple-choice question embedded in Edpuzzle, asking learners to analyze proper hand positioning during fetal head rotation in childbirth simulation.



Figure 4. Nursing students participating in simulation-based practice using childbirth manikins, working in peer-teaching roles at the Learning and Nursing Simulation Center (LRC).

E. Data Collection and Analysis

Data were collected at two time points: before and after the intervention. Professional self-efficacy was assessed using the Childbirth Self-Efficacy Questionnaire, and clinical competence was evaluated using the Delivery Performance Checklist at both stages. Paired-sample t-tests were conducted to analyze within-group differences, while independent-sample t-tests were used to compare outcomes between the experimental and control groups. Descriptive statistics, including mean, standard deviation, and percentage, were employed to summarize students' satisfaction levels.

IV. RESULTS

This section presents the findings according to the study objectives. The results are organized into four parts: Professional Self-Efficacy outcomes, delivery performance comparison, student satisfaction, and inter-rater assessment correlations.

A. Professional Self-Efficacy

Both control and experimental groups demonstrated statistically significant improvement in childbirth self-efficacy scores after the intervention. Independent-sample t-tests indicated no significant difference in pre-test scores; however, post-test scores in the experimental group were significantly higher.

B. Effects of Peer-Teaching on Professional Self-Efficacy

This study investigated the impact of a peer-teaching instructional model on nursing students' self-efficacy in performing childbirth procedures. Sixty fourth-year nursing students were divided equally into a control group (traditional instruction) and an experimental group (peer teaching). A comparison of pre- and post-intervention self-

efficacy scores was conducted both within and between groups. As shown in Table I, both groups exhibited statistically significant increases in self-efficacy scores after the intervention. The control group's mean score improved from 2.95 to 3.89 ($t(29) = -5.63, p < .001$), while the experimental group's score increased from 3.16 to 4.29 ($t(29) = -7.14, p < .001$). Notably, there was no significant difference between the groups at baseline ($p = .26$); however, a significant difference was found after the intervention, favoring the peer-teaching group ($t(58) = -3.12, p < .003$).

These findings suggest that while both instructional methods enhance self-efficacy in childbirth performance, peer teaching is more effective in boosting students' confidence.

Table I: Comparison of Delivery Self-Efficacy Scores Within and Between Groups ($n=30/30$)

Comparison	Group	Pretest Mean (SD)	Posttest Mean (SD)	t	p-value
Within-group (Traditional)	Control	2.95 (0.68)	3.89 (0.55)	-5.63	<.001
Within-group (Peer Teaching)	Experimental	3.16 (0.73)	4.29 (0.42)	-7.14	<.001
Between-group (Pre-intervention)	Ctrl vs Exp	2.95 vs 3.16	-	1.14	.26
Between-group (Post-intervention)	Ctrl vs Exp	-	3.89 vs 4.29	-3.12	<.003

Note: Ctrl = Control Group; Exp = Experimental Group

C. Effects of Peer-Teaching on Clinical Skill Performance in Childbirth

To evaluate the effectiveness of the peer-teaching model on clinical skill performance, a comparison was conducted between the control and experimental groups using a standardized childbirth checklist assessed by faculty experts.

Both groups consisted of 30 fourth-year nursing students.

As shown in Table II, the experimental group demonstrated significantly higher clinical skill scores (Mean = 3.85, SD = 0.39) compared to the control group (Mean = 3.43, SD = 0.23). The difference was statistically significant ($t(58) = -5.11, p < .001$), indicating the positive impact of peer-teaching on students' practical competence in performing childbirth procedures.

Table II: Comparison of Childbirth Skill Performance Between Groups (Posttest) ($n = 30$)

Group	Mean (SD)	t	p-value
Control	3.43 (0.23)	-5.11	<.001
Experimental	3.85 (0.39)		

Note: Post-intervention comparison of childbirth procedural skills assessed by faculty evaluators

D. Student Satisfaction Toward the Peer-Teaching Instructional Model

Student satisfaction was assessed among 30 nursing students in the experimental group who participated in peer-teaching activities. Satisfaction was measured in three domains: classroom instruction, delivery simulation in the Learning Resource Center (LRC), and overall experience.

As presented in Table III, students expressed a high level of satisfaction in all domains. The average satisfaction score for classroom instruction was 4.75 (SD = 0.40), followed by LRC-based delivery simulation at 4.71 (SD = 0.41), and overall satisfaction at 4.72 (SD = 0.40). All skewness values were negative, indicating a distribution leaning toward “highly satisfied.” Frequencies also showed that over 70% of students rated their satisfaction in the highest range (4.50–5.00).

These findings confirm that the peer-teaching instructional model was well-received and positively perceived by the participants.

Table III: Student Satisfaction Toward Peer-Teaching (n = 30)

Satisfaction Domain	Mean (SD)	Skewness	Interpretation	%Rated 4.50–5.00
Classroom Instruction	4.75 (0.40)	-1.16	Highly satisfied	73.33%
Delivery Process (LRC)	4.71 (0.41)	-0.96	Highly satisfied	70.00%
Overall Satisfaction	4.72 (0.40)	-1.03	Highly satisfied	73.33%

D. Correlation of Delivery Skill Assessments Among Self, Peer, and Instructor Ratings

To investigate the alignment of skill assessments from different perspectives, correlation analysis was conducted among three sources: self-assessment, peer assessment, and instructor assessment, within the experimental group (n = 30).

As presented in Table IV, the results revealed a strong and statistically significant positive correlation between self-assessment and peer assessment ($r = .762$, $p < .001$). However, no significant correlation was found between peer and instructor assessments ($r = .233$, $p = .215$), or between self-assessment and instructor assessments ($r = .047$, $p = .807$).

These findings suggest that while students' self-perception of skill was aligned with their peers', their evaluations did not correspond significantly with instructors' professional assessments. This discrepancy highlights a potential overestimation bias in self and peer ratings, emphasizing the importance of triangulated evaluation methods in clinical skill assessment.

Table IV: Pearson Correlation Coefficients Among Self, Peer, and Instructor Assessments (n = 30)

Assessment Pair	Pearson r	p-value	Interpretation
Self vs. Peer	0.762	< .001	High correlation, statistically significant
Peer vs. Instructor	0.233	0.215	Not significant
Self vs. Instructor	0.047	0.807	Not significant

V. DISCUSSION

This study investigated the effects of a peer-teaching instructional model integrating interactive video and simulation on undergraduate nursing students' self-efficacy, clinical competence, and satisfaction in performing childbirth procedures. The discussion is structured into four subsections to align with the research objectives.

A. Impact on Delivery Self-Efficacy

The findings revealed a significant increase in self-efficacy scores among students in the experimental group after the intervention. This supports Bandura's social cognitive theory, which emphasizes the influence of mastery experience and vicarious learning on efficacy beliefs [11]. Peer teaching allowed students to alternate roles between performing, assisting, and observing, creating multiple pathways for modeling and self-reflection.

Consistent with this, Nakanakupt and Jaichuen [6] demonstrated that interactive video learning led to enhanced confidence and knowledge among nursing students in childbirth care. Likewise, studies in the Thai context also confirm that emotional support and collaborative practice in safe learning environments help alleviate anxiety and build confidence, especially in high-stakes clinical situations [12], [13]. One student in this study shared: “I used to be scared of making mistakes during delivery, but after practicing with friends and watching the videos multiple times, I felt more confident when I actually tried it.”

Furthermore, the flexibility of Edpuzzle-supported learning allowed students to pause, replay, and reflect at their own pace, aligning with principles of self-regulated learning and cognitive load management [14]. This individualized pacing is particularly effective in skill-based learning where procedural steps must be internalized.

B. Improvement in Clinical Competence

The experimental group outperformed the control group in faculty-assessed childbirth skill performance. This reinforces the effectiveness of simulation-based practice and peer-led scaffolding in promoting clinical competence [15], [16]. When students teach or assist each other, they reinforce their cognitive schemas and

procedural fluency, which aligns with constructivist learning theory and 4C/ID instructional design.

The rotation of roles within triads—performer, assistant, observer—mirrored real-life delivery room dynamics and promoted teamwork, decision-making, and psychomotor refinement. According to Lertwanawattana et al. [5], peer-assisted strategies significantly improve academic performance and clinical outcomes by increasing engagement and reflection-on-action.

The integration of interactive video before simulation supported mental rehearsal and visualization, critical for complex psychomotor skills [17]. Thai literature also reflects the importance of repeated practice, especially in maternity care, to bridge the gap between theory and practice [18].

C. Student Satisfaction with the Peer Teaching Model

Participants in the experimental group reported high satisfaction with the peer-teaching approach. Key advantages cited were emotional comfort, increased practice time, and the relatability of peer instruction. This resonates with Thai cultural contexts, where supportive peer relationships foster a sense of community and mutual responsibility in learning [19].

One student remarked, “Practicing with friends made me feel less nervous than practicing in front of an instructor. We could ask each other questions without fear.” This environment aligns with adult learning principles and the Thai Nursing and Midwifery Council’s emphasis on student-centered, competency-based education [1], [2].

The Edpuzzle-enhanced video learning component was particularly well-received, with many students praising its interactive format. As one student noted: “The videos helped me understand better. I could go back and review before practicing. It felt like I had a private tutor.” Nguyen et al. [20] and Thai nursing educators such as Wongthienlai [12] have also affirmed the value of technology-enhanced, active learning environments in increasing motivation and skill retention.

D. Assessment Alignment and Evaluation Gaps

While self- and peer-assessment scores correlated moderately, there was limited agreement with instructor ratings. This suggests that students could reliably evaluate observable behaviors but may lack expertise in judging more nuanced dimensions such as safety prioritization, timing, or contingency handling—issues highlighted in studies on inter-rater bias and calibration [21], [22].

Such discrepancies call for improved assessment literacy and guided calibration sessions to reduce subjective variability. In the Thai setting, reflective debriefing and structured rubrics have been shown to enhance peer-assessment reliability and formative feedback quality [23]. A combination of faculty moderation, double marking, and real-time feedback could improve fairness and transparency in future assessments.

VI. Recommendations

A. Implications for Practice

The findings of this study suggest that the integration of peer teaching with interactive video-based learning can effectively enhance nursing students’ self-efficacy and clinical competence in childbirth procedures. Accordingly, it is recommended that:

- The peer teaching approach be adopted as part of active learning strategies in other clinical practice courses, particularly those involving skill acquisition and critical decision-making. This method promotes a collaborative learning environment and reduces students’ anxiety during skill practice.
- Academic departments foster communities of practice among faculty members across disciplines to exchange insights and practical experiences gained from the implementation of peer-teaching models, thereby strengthening educational knowledge management at the institutional level.

B. Recommendations for Future Research

While this study yielded promising results, several limitations should be acknowledged, including the short duration of the intervention, reliance on self-reported confidence scores, and limited generalizability due to the single-institution sample. To build upon this foundation, future research should consider:

- Exploring the effects of peer teaching on additional variables such as clinical decision-making, problem-solving under pressure, and knowledge transfer to real-world practice.
- Extending the model to other health science disciplines, including physical therapy, and allied health programs, to examine the adaptability and impact across diverse contexts.
- Incorporating mobile applications or digital tools to strengthen peer interaction, provide real-time feedback, and support reflective learning in and beyond the simulation lab.
- Comparing the peer-teaching model with other collaborative learning techniques, such as team-based learning (TBL) or think-pair-share (TPS), to determine the most effective strategies for building confidence and competence in clinical education.
- Integrating AI-driven chatbots as virtual learning assistants to provide students with real-time feedback, answer procedural questions, and facilitate self-paced learning both during and beyond scheduled sessions.

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Disciplinary Differences in Generative AI Adoption: A Comparative Study of Arts and Science Students in Chinese Universities

BingHui Yang
King Mongkut's Institute of Technology
Ladkrabang, Thailand
Bangkok, Thailand
66036097@kmitl.ac.th

Kanyarat Sriwisathiyakun
King Mongkut's Institute of Technology
Ladkrabang, Thailand
Bangkok, Thailand
kanyarat.sr@kmitl.ac.th

Sirirat Petsangsri
King Mongkut's Institute of Technology
Ladkrabang, Thailand
Bangkok, Thailand
sirirat.pe@kmitl.ac.th

Abstract—This study examines how undergraduate students from Arts and Science faculties in China are adopting generative artificial intelligence (Gen-AI) tools. Based on survey responses from 419 students at 3 universities in Shanxi Province, the research explores the influence of academic discipline on Gen-AI adoption across six key areas: perceived ease of use, perceived usefulness, concerns about over-reliance, trust in AI, technological features, and general attitudes toward AI. The findings show that Science students are more likely to find Gen-AI tools easy to use and helpful. They are also more cautious, showing a greater tendency to verify AI-generated information before relying on it. In contrast, Arts students express more concern about becoming overly dependent on AI, yet they tend to place more trust in the content it produces. Interestingly, no significant differences were found between the two groups in terms of their general attitudes toward AI or perceptions of the technology itself. These results highlight the important role that academic background plays in shaping students' interactions with Gen-AI. They also suggest that tailored educational strategies may be needed to support responsible and effective AI use across different disciplines in higher education.

Keywords—Generative artificial intelligence, Chinese higher education, Arts and Sciences.

I. INTRODUCTION

The rapid development of Generative Artificial Intelligence (Gen-AI) has redefined educational practices, introducing tools capable of creating novel content such as text, code, and images [1]. Unlike traditional analytical AI systems, Gen-AI leverages advanced deep learning models—including Generative Adversarial Networks (GANs) and large language models like GPT—to autonomously produce creative outputs across multiple formats [2][3]. Gen-AI has already shown a transformative impact in industries such as healthcare, where AlphaFold accelerated protein structure prediction, and in finance, where it supports risk management and decision-making [4][5]. In programming, platforms like ChatGPT, GitHub Copilot, and DeepSeek are widely used for code generation and content creation [6].

In the educational sector, Gen-AI enables highly personalized learning by generating adaptive content, providing real-time feedback, and automating routine teaching tasks [7]. These systems can customize learning paths for individual students, improve access to knowledge, and foster interactive and engaging educational experiences [8][9]. [10] highlighted that Chinese university students are increasingly adopting Gen-AI for academic writing, problem-solving, and creative thinking. Domestic platforms like DeepSeek, Kimi, Wenxin Yiyan (ERNIE Bot), and Doubao offer strong support for Chinese language learning and are tailored to local regulatory and cultural requirements [10]. Each of these platforms provides different features, from multimodal generation to advanced coding assistance and long-document analysis.

However, despite rapid technological adoption, the use of Gen-AI in Chinese higher education faces several challenges, including disparities in digital infrastructure, differences in students' academic backgrounds, and concerns over data privacy, academic integrity, and algorithmic bias [6][11]. There is also a growing debate about the impact of Gen-AI on students' independent thinking and critical problem-solving skills [12]. While Gen-AI can improve learning efficiency, over-reliance may undermine the development of higher-order cognitive abilities.

In the Chinese context, national strategies such as the New Generation AI Development Plan and the 14th Five-Year Plan for Educational Informatization have emphasized the integration of AI into higher education [13]. Institutions like Tsinghua and Fudan universities have introduced AI-based courses, yet regional disparities in infrastructure and policy implementation hinder uniform progress. Furthermore, most existing research focuses on Western AI ecosystems, overlooking China's unique, self-contained Gen-AI environment, which includes platforms like KIMI, Doubao, and DeepSeek [10]. These models cater to local linguistic and regulatory needs but remain

understudied in terms of user adoption, especially in resource-imbalanced regions like Shanxi Province.

Shanxi serves as a transitional region with over 31 universities and 540,000 undergraduates [11]. Despite policy support for broadband expansion and digital learning, disparities persist between urban and rural institutions. Therefore, understanding how students adopt Gen-AI tools under varying institutional conditions is critical.

This study aims to fill this gap by investigating one key demographic factor: faculty group (Arts vs. Sciences). Through a survey of 419 students from three universities representing different institutional tiers, the study explores how this factor shapes students' Gen-AI adoption behaviors. The findings will support educators in designing targeted guidance strategies and provide insights into Gen-AI's development trajectory in China. Unlike prior studies, this work offers a direct comparison of faculty groups in a resource-imbalanced Chinese province.

II. PROBLEM STATEMENT

While Gen-AI technologies are gaining momentum in higher education globally, their integration within China's localized context remains underexplored. In particular, university students across different academic disciplines may perceive and adopt Gen-AI tools in distinct ways due to variations in curriculum design, digital literacy, and task complexity. Arts students often engage in creative and language-driven tasks. In contrast, Science students typically rely on data analysis and problem-solving, which may shape their expectations and usage of Gen-AI differently.

To address these gaps, this study focuses on the following research questions:

1. What is the current level of adoption of Gen-AI among Chinese college students?
2. How does a different faculty group (Arts vs. Sciences) influence Gen-AI adoption?

III. LITERATURE REVIEW

A. Generative AI

Generative Artificial Intelligence (Gen-AI) has drawn increasing academic interest for its ability to assist in content creation, problem-solving, and language processing. In the educational domain, [6] and [8] have examined its potential to enhance personalized learning, improve student engagement, and support academic performance. Gen-AI tools like ChatGPT and DeepSeek can aid students in various educational tasks. Still, adoption levels vary depending on individual trust, ease of use, and perceived usefulness [9][14]. Several theoretical frameworks, including the Technology Acceptance Model (TAM) and UTAUT, have been applied to explain adoption behavior, highlighting factors such as perceived usefulness, ease of use, and attitude. However, the

application of these models to Gen-AI usage in non-Western educational contexts, such as China, remains limited.

Recent investigations have explored demographic and academic variables that may influence Gen-AI adoption, with mixed findings. Gender differences in AI usage appear context-dependent [15], and students' prior experience with AI tools may impact trust and usage patterns. Among these factors, academic discipline (faculty group) has emerged as a potential differentiator, as Arts students often perform text-heavy, creative tasks, while Science students engage more with technical and analytical content [12]. Despite growing interest, few empirical studies have specifically compared Gen-AI adoption between Arts and Sciences students in Chinese universities. This gap motivates the present study to examine how students from different academic faculties engage with Gen-AI tools in the context of higher education in Shanxi Province.

B. Adoption of Generative Artificial Intelligence in Education

Generative Artificial Intelligence (Gen-AI) has become a prominent focus in educational research due to its significant potential in content creation, adaptive learning, and automated feedback [6][8]. [8] Noted that Gen-AI tools are widely utilized in higher education for personalized learning experiences, academic writing, language processing, and the cultivation of critical thinking skills, gradually becoming an essential component in achieving personalized education goals. This approach supports the identification of differences among learners, thereby facilitating more effective differentiated instruction. [9] and [10] found that Gen-AI platforms such as ChatGPT and DeepSeek are increasingly used in both Eastern and Western universities; however, significant disparities persist across regions and institutions in terms of access, adoption rates, and educational effectiveness. Further research by [12] and [14] demonstrates that Gen-AI adoption is not only influenced by technological infrastructure but also by users' perceptions, including perceived ease of use, perceived usefulness, trust, and concerns about over-reliance.

C. Theoretical Framework

Given the diversity in demographics, learning styles, and technological environments in education, this study employed a questionnaire-based approach to explore the internal relationships among relevant variables. As demonstrated by [16] and [17], questionnaire surveys can efficiently capture broad feedback from large samples and help to analyze students' genuine perspectives deeply. In the field of educational technology, Gen-AI adoption is commonly measured using classic theoretical models, such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). These frameworks underpin questionnaire

development and focus on core constructs such as perceived usefulness, perceived ease of use, attitude, and behavioral intention [18].

Based on these theoretical models and by reviewing six representative studies on Gen-AI adoption published in the past three years, this study identified six key dimensions for the questionnaire. The items were mainly adapted from well-established scales developed by [16], [17], and [19], and further revised according to expert evaluation and local pilot testing to fit the context of Chinese university students. The final instrument comprised 20 items across six dimensions to examine the influence of academic background on Gen-AI adoption systematically.

- Perceived Ease of Use (PEU): Students' evaluation of how easy Gen-AI tools are to learn and use.
- Perceived Usefulness (PU): Students' perceptions of the extent to which Gen-AI can improve learning efficiency and academic performance.
- Dependence Concern (DC): Concerns about over-reliance on Gen-AI and its potential impact on independent thinking.
- Perceived Trust (PT): Confidence in the accuracy, reliability, and ethical use of AI-generated content.
- Technological Characteristics (TC): Evaluation of technical features, integration, and added functions of Gen-AI tools.
- Attitude Toward AI (ATA): Overall emotional and cognitive evaluations of AI in education.

D. Academic Discipline Differences: Arts and Sciences

Academic background is widely regarded as an essential factor influencing technology adoption in higher education. Some studies have found that science students, who typically possess stronger data analysis skills and greater familiarity with technical systems, tend to demonstrate higher levels of critical thinking and verification when adopting emerging technologies [15][12]. In contrast, research by [20] and [21] indicates that arts students are more concerned with originality, creativity, as well as ethical and privacy issues when engaging with Gen-AI and other innovative technologies.

It is noteworthy that empirical research on the differences in Gen-AI adoption between academic disciplines within Chinese universities remains limited. In less-developed regions such as Shanxi, the educational environment and infrastructure still face certain constraints, resulting in a lack of systematic comparative analysis regarding the motivations and behaviors of different academic groups in adopting Gen-AI on localized AI platforms and within Chinese-language learning environments.

Therefore, this study focuses on arts and science students as the core comparison groups, aiming to address the research gap concerning academic discipline

differences in the context of Chinese higher education and to provide a theoretical foundation for subsequent empirical analysis.

IV. METHODS

A. Participants

A total of 419 undergraduate students from three universities in Shanxi Province participated in this study, including 208 Arts students (49.64%) and 211 Science students (50.36%). The sample consisted of 223 males (53.22%) and 196 females (46.78%). Participants were distributed across different academic levels: Freshman (28.64%), Sophomore (25.78%), Junior (26.01%), and Senior (19.57%). Regarding frequency of AI tool use, 12.89% rarely used, 31.74% sometimes used, and 55.37% often used generative AI tools.

B. Participants Information

TABLE I. PARTICIPANTS INFORMATION

Category	Subcategory	Frequency	Percentage
Gender	Male	223	53.22
	Female	196	46.78
Faculty Group	Arts	208	49.64
	Sciences	211	50.36
Academic Level	Freshman	120	28.64
	Sophomore	108	25.78
	Junior	109	26.01
	Senior	82	19.57
Frequency of using AI tools	Rarely use	54	12.89
	Sometimes use	133	31.74
	Often use	232	55.37

C. Instruments

The instrument used in this study was a structured questionnaire designed to assess six dimensions of Gen-AI adoption among undergraduate students: Perceived Ease of Use, Perceived Usefulness, Dependence Concern, Perceived Trust, Technological Characteristics, and Attitude. All items were measured using a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

The questionnaire was adapted from established instruments used in prior AI and educational technology research (e.g., [16][17][19]), ensuring content validity and contextual relevance. Items were modified to reflect the learning and technological environments specific to Chinese universities — the first part of the instrument collected demographic data, including faculty group (Arts or Sciences). The second part comprised 20 items, evenly distributed across the six dimensions mentioned above, capturing students' perceptions and behavioral tendencies in using Gen-AI tools for academic purposes. A panel of experts in educational technology and AI in education reviewed the items for clarity and cultural appropriateness.

D. Data Collection and Analysis

Data were collected using an online questionnaire administered through the Wenjuanxing platform, targeting undergraduate students across three public universities in Shanxi Province. These three universities represent different institutional tiers (key, ordinary, and vocational universities), thus ensuring diversity and representativeness of the sample. A total of 419 valid responses were obtained after removing incomplete or inconsistent entries through manual screening. The data collection process followed strict confidentiality and data protection standards, ensuring the integrity and representativeness of the sample.

To analyze the data, this study employed both descriptive and inferential statistical methods. To address the first research question, descriptive statistics (means and standard deviations) were calculated for each of the six Gen-AI adoption dimensions to assess the overall level of adoption among the sample. To address the second research question, independent samples t-tests were conducted to compare adoption levels between Arts and Sciences students, thereby identifying significant differences based on academic discipline.

V. RESULT

TABLE II. DATA STATISTICS

Items	Mean		SD	
	Arts	Sciences	Arts	Sciences
Perceived Ease of Use				
PEU1	3.51	3.95	0.661	0.776
PEU2	3.56	4.09	0.715	0.737
PEU3	3.58	4.17	0.733	0.722
Perceived Usefulness				
PU1	3.63	3.77	0.867	0.850
PU2	3.73	3.92	0.917	0.925
PU3	3.66	3.85	0.900	0.932
Dependence Concerns				
DC1	3.81	3.24	0.888	0.853
DC2	3.78	3.21	0.924	0.955
DC3	3.86	3.27	0.889	0.988
Perceived Trust				
PT1	3.63	3.11	0.832	0.979
PT2	3.47	3.07	0.750	0.774
PT3	3.88	3.22	0.952	0.967
PT4	3.24	3.75	0.725	0.728
Technological Characteristics				
TC1	3.70	3.66	0.934	0.955
TC2	3.82	3.77	0.760	0.748
TC3	3.76	3.68	0.947	0.961
Attitude Toward AI				
ATA1	3.77	3.65	0.791	0.780
ATA2	3.83	3.75	0.964	0.969
ATA3	3.77	3.78	0.772	0.788
ATA4	3.94	3.85	0.740	0.782

A. Descriptive Statistics of Gen-AI Adoption

Table 2 summarizes the descriptive statistics for Arts and Science students on each dimension of generative AI adoption. Science students reported higher mean scores in perceived ease of use (PEU1: M=3.95, SD=0.776; PEU2: M=4.09, SD=0.737; PEU3: M=4.17, SD=0.722) and perceived usefulness (PU1: M=3.77, SD=0.850; PU2: M=3.92, SD=0.925; PU3: M=3.85, SD=0.932) than Arts students. In contrast, Arts students expressed greater dependence concerns (DC1: M=3.81, SD=0.888; DC2: M=3.78, SD=0.924; DC3: M=3.86, SD=0.889) and, in some items, reported higher trust in AI-generated content (PT1: M=3.63, SD=0.832; PT3: M=3.88, SD=0.952). There were no substantial group differences in technological characteristics (TC1, TC2, TC3) or attitude toward AI (ATA1–ATA4) between the two disciplines.

TABLE III. INDEPENDENT SAMPLE TEST

Dimension	t	p	Mean Diff	95% CI	Significant
Perceived Ease of Use	-6.134	<0.001	-0.433	(-0.572, -0.294)	Sciences
	-7.542	<0.001	-0.537	(-0.676, -0.398)	Sciences
	-7.915	<0.001	-0.583	(-0.728, -0.438)	Sciences
Perceived Usefulness	-1.626	0.052	-0.137	(-0.302, 0.029)	No
	-2.067	0.020	-0.186	(-0.364, -0.009)	Sciences
	-2.148	0.016	-0.193	(-0.369, -0.016)	Sciences
Dependence Concerns	6.675	<0.001	0.569	(0.401, 0.737)	Arts
	6.173	<0.001	0.568	(0.387, 0.749)	Arts
	6.497	<0.001	0.599	(0.418, 0.780)	Arts
Perceived Trust	5.808	<0.001	0.517	(0.342, 0.692)	Arts
	5.353	<0.001	0.400	(0.253, 0.547)	Arts
	6.975	<0.001	0.656	(0.471, 0.841)	Arts
	-7.179	<0.001	-0.511	(-0.651, -0.371)	Sciences
Technological Characteristics	0.488	0.626	0.045	(-0.137, 0.227)	No
	0.712	0.477	0.053	(-0.093, 0.198)	No
	0.851	0.198	0.080	(-0.104, 0.263)	No
Attitude Toward AI	1.531	0.126	0.126	(-0.033, 0.269)	No
	0.860	0.390	0.081	(-0.105, 0.267)	No
	-0.071	0.944	-0.005	(-0.156, 0.145)	No
	1.124	0.261	0.084	(-0.063, 0.230)	No

B. Inferential Statistics and Group Comparisons

Table 3 presents the results of independent samples t-tests comparing Arts and Science students on each item and dimension.

- Perceived Ease of Use: Science students scored significantly higher across all items (PEU1: $t = -6.13$, $p < .001$, mean diff = -0.43 , 95% CI $[-0.57, -0.29]$; PEU2: $t = -7.54$, $p < .001$; PEU3: $t = -7.92$, $p < .001$).
- Perceived Usefulness: Significant differences were observed in PU2 ($t = -2.07$, $p = .02$, mean diff = -0.19 , 95% CI $[-0.36, -0.01]$) and PU3 ($t = -2.15$, $p = .016$).
- Dependence Concerns: Arts students showed greater concern (DC1: $t = 6.68$, $p < .001$, mean diff = 0.57 , 95% CI $[0.40, 0.74]$; DC2: $t = 6.17$, $p < .001$; DC3: $t = 6.50$, $p < .001$).
- Perceived Trust: Arts students reported significantly higher trust on several items (PT1: $t = 5.81$, $p < .001$, mean diff = 0.52 , 95% CI $[0.34, 0.69]$; PT3: $t = 6.98$, $p < .001$).
- Verification of AI Information: Notably, Science students scored significantly higher on the item "I believe the information provided by generative AI should be verified for accuracy before use" ($t = -7.18$, $p < .001$, mean diff = -0.51 , 95% CI $[-0.65, -0.37]$), indicating a more cautious and rigorous approach to AI use.
- Technological Characteristics & Attitude: No significant group differences were observed for these dimensions (all $p > .05$).

VI. DISCUSSION

A. The Overall Adoption of Generative AI Among Chinese College Students

This study reveals a widespread and rapidly increasing adoption of generative artificial intelligence (Gen-AI) among Chinese college students, consistent with findings in recent domestic and international research [6][10]. The majority of students have incorporated Gen-AI tools such as ChatGPT and DeepSeek into their academic activities, reflecting a high level of digital adaptability and an openness to innovation in learning. Similar patterns have been reported in other countries. Still, the penetration rate observed in this study suggests that Chinese students are quickly becoming leaders in the global digital transformation of higher education [17].

Students generally hold positive attitudes toward the usefulness and ease of use of Gen-AI, echoing the argument that the popularization of AI is facilitating the development of digital literacy [6][10]. In line with [8], students believe that AI can enhance learning efficiency and support creative and individualized academic tasks. At the same time, the improvement of digital infrastructure

and availability of localized AI platforms in China have further accelerated this adoption trend [10][16].

However, while most students welcome Gen-AI, there remain areas of concern. Some are worried about excessive dependence on AI and the potential impact on independent learning and creativity—a phenomenon discussed in the global literature on automation risks [14][20]. There is also evidence of a cautious approach to trust in AI outputs, with many students emphasizing the need for verification before use. This dual attitude—enthusiastic adoption with critical reflection—is consistent with findings from other contexts and signals the maturation of digital literacy among Chinese undergraduates.

B. The Influence of Academic Discipline (Arts vs. Sciences) on Gen-AI Adoption

The comparison between Arts and Science students in this study underscores the influence of academic background on Gen-AI adoption, a pattern recognized in previous research [12][15][20][21]. Science students are generally more adept at integrating Gen-AI tools into their learning, demonstrating greater confidence in their technological abilities and a stronger orientation toward verification and methodological rigor. This supports earlier findings that students with technical and analytical training are more likely to master and critically use new technologies [12][15].

In contrast, Arts students are more likely to express concerns about over-reliance on AI and show higher levels of trust in AI-generated content in specific contexts. These tendencies are closely linked to the disciplinary emphasis on creativity, originality, and interpretive thinking, as discussed by [20] and [21]. Moreover, the results highlight that the distinction between disciplines is not as pronounced in terms of overall attitudes toward technology, suggesting that the ongoing digitalization of higher education is narrowing traditional divides in technology acceptance [10].

Taken together, these findings emphasize the importance of discipline-sensitive educational strategies in AI integration. Science students may benefit from support in developing creative and ethical perspectives, while Arts students might require more guidance in critical evaluation and technological literacy. Aligning with [16], the study argues for tailored AI education and support mechanisms that respond to the unique strengths and needs of each academic group, preparing all students to use Gen-AI both effectively and responsibly.

VII. CONCLUSIONS

This study investigated the adoption of generative artificial intelligence (Gen-AI) tools among undergraduate students from Arts and Science faculties at three universities in Shanxi Province, China. Using a structured questionnaire and comprehensive statistical analysis, the

research revealed both a high overall level of Gen-AI adoption and distinct differences in usage patterns across academic disciplines.

The findings show that Gen-AI technologies have achieved widespread penetration in higher education: over 87% of respondents reported using AI tools in their studies, with notably high average scores for perceived ease of use (3.81) and perceived usefulness (3.76). This suggests that the growing availability and accessibility of AI tools have rapidly improved students' digital adaptability and their willingness to integrate innovative technologies into academic routines.

Significant disciplinary differences were observed. Science students demonstrated higher levels of perceived ease of use, perceived usefulness, and a stronger inclination to verify AI-generated information before use, reflecting a more critical and methodologically rigorous approach. In contrast, Arts students expressed greater concerns about over-reliance on AI and, in some contexts, reported higher trust in AI-generated content. These patterns reflect the distinct pedagogical priorities of each discipline—science students prioritize accuracy and verification, while arts students are more attuned to issues of originality, creativity, and ethics.

No significant group differences were found in technological characteristics or general attitudes toward AI, indicating that the digitalization of higher education is fostering a uniformly positive and open attitude toward Gen-AI among students of different academic backgrounds.

The results highlight the necessity for universities to design discipline-specific educational strategies for Gen-AI integration. Beyond general AI literacy, it is crucial to cultivate students' critical thinking, independent judgment, and ethical awareness. Tailored support should address both the strengths and vulnerabilities unique to different academic groups, ensuring that all students become responsible and effective users of Gen-AI tools.

Future research should further examine the psychological, pedagogical, and contextual factors underpinning disciplinary differences in Gen-AI adoption. Longitudinal studies and broader institutional samples will help clarify the long-term impact of Gen-AI on academic performance and skill development. Continued efforts are also required to address challenges related to digital infrastructure, data privacy, and algorithmic fairness to maximize the educational value of Gen-AI in an evolving digital landscape.

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THE EFFECTS OF MICRO-LEARNING WITH SIMULATED SCENARIO ON THE LEARNING ACHIEVEMENT AND MOTIVATION OF TELEMARKETING EMPLOYEES

Yilong Liang

Sirirat Petsangsri

Kanyarat Sriwisathiyakun

Weihui Lai

Abstract —This study mainly explored the effects of micro-learning combined with simulated scenario on learning outcomes and motivation of telemarketing employees of a trading company in Guangdong Province, China. A two-group experimental design was used to randomly assigned 64 full-time telemarketing employees into an experimental group (using micro-learning with simulation scenarios) and a control group (using a traditional teaching method). Learning achievement was assessed by the telemarketing learning achievement test, and learning motivation was assessed by the modified Academic Motivation Scale (AMS) questionnaire. The results of data analysis showed that employees who received micro-learning with simulated scenario performed significantly better in terms of learning achievement than those who received traditional teaching methods. In addition, participants showed high overall learning motivation, with extrinsic motivation slightly higher than intrinsic motivation. The results emphasize that combining the concise and targeted content of micro-learning with the authenticity and immediacy of simulated scenario can effectively improve the telemarketing knowledge and the practical skills. In addition, this integrated approach can also improve employee engagement and motivation, which is closely aligned with contemporary training needs in a dynamic business environment. Future training programs should consider adopting this approach to promote continuous skill development and performance improvement in telemarketing positions.

Keywords: micro-learning with simulated scenario, learning achievement, motivation, telemarketing

I. INTRODUCTION

In dynamic, high-pressure environments such as telemarketing, employees must quickly master product knowledge, objection handling skills, and persuasive communication strategies to respond to diverse customer needs in real time. For telemarketers in this dynamic environment, quickly mastering communication skills, objection handling, and product knowledge is critical to maintaining a competitive advantage [1]. However, as a traditional teaching method, it usually relies on lengthy classroom lectures, stereotyped e-learning modules and

instructor-led seminars, which not only easily cause a large cognitive load and interrupt the work rhythm, but also make it difficult to restore the delicate and high-pressure interactive situations in real customer calls. [1] [2].

In response to these limitations of traditional teaching methods, micro-learning has emerged as a viable alternative that provides short, focused “knowledge atoms” that learners can learn on demand (usually through mobile devices), thereby minimizing cognitive load and seamlessly integrating into fragmented work schedules [3] [4]. By delivering concise, on-the-spot lessons (3-5 minutes per session), micro-learning supports repeated practice and reinforcement, which is essential for long-term retention and mastery of skills in a fast-paced job.

Complementary, scenario-based training (we also call it “simulated scenario”) immerses learners in simulations of real customer interactions, allowing for safe, hands-on practice of decision making, objection handling, and rapport building [5] [6]. This experiential learning not only promotes deeper cognitive processing and emotional engagement but also builds confidence by providing immediate feedback in a risk-free environment.

While micro-learning and simulated scenario approaches have demonstrated their respective benefits across industries, their combined application in telemarketing remains understudied. To address this gap, this study develops and evaluates an integrated micro-learning + simulated scenario framework for telemarketing training, designed to improve learning outcomes and learners’ motivation.

II. LITERATURE REVIEW

This study synthesizes the literature from three major areas—micro-learning, simulation scenario and telemarketing—to provide a reference for the design and evaluation of integrated training interventions.

A. micro-learning

micro-learning provides short, focused content “atoms” that address specific goals within five minutes, thereby reducing cognitive load and supporting just-in-time learning through mobile platforms [3] [4]. Foundational models guiding micro-learning design include: the spaced repetition model for strengthening memory, the Keller ARCS model for improving motivation [7], the atomic learning model for modular content [4], Mosher and Gottfredson’s five moments of need for just-in-time support [8], and the 4C framework that emphasizes simplicity, contextualization, customization, and continuous learning [3]. Empirical studies have shown that micro-learning can improve students’ retention by up to 22% compared to traditional instruction and improve average test scores by about 18% through frequent, small-scale reinforcement learning [9] [10].

Despite its many advantages, micro-learning still faces challenges in maintaining course coherence and depth, requiring careful instructional design, technology integration, and adaptive learning paths to avoid fragmented or superficial engagement [11][12].

B. Simulated Scenario

Simulated scenario, based on situated learning theory, immerse learners in realistic, context-rich tasks—such as role-playing with simulated customers—to connect theory to practice and promote deeper cognitive processing [6] [13]. Previous studies have shown that simulations can enhance skill transfer, build confidence, and promote emotional engagement by providing immediate feedback in a controlled environment [5] [6]. At the same time, key elements of effective simulations include detailed scenario descriptions, guided focus questions or dilemmas, multi-perspective role-playing, and structured collaborative activities, all of which are designed to simulate real-world challenges in a safe and repeatable environment [14] [15]. Simulation-based approaches, on the other hand, allow trainees to experiment, receive immediate feedback, and develop emotional intelligence, which can lead to greater engagement and confidence, which is essential for handling challenging customer interactions [5] [16].

However, developing high-fidelity simulations can be resource-intensive and must strike a balance between authenticity and manageability to prevent cognitive overload or logistical constraints [17] [18].

C. Telemarketing

Telemarketing is characterized by real-time, two-way customer interaction, which requires strong communication, adaptability, and relationship building skills. The core process elements—initial contact, product introduction, interactive Q&A, and closing—require professional knowledge and interpersonal skills [7] [19]. Although telemarketing enables precise promotion and immediate feedback [19] [20], it faces consumer resistance

and regulatory restrictions [21], which highlights the importance of effective and engaging training.

III. RESEARCH METHODOLOGY

This study adopted a quasi-experimental design to examine the effects of micro-learning with simulated scenarios on the learning achievement and motivation of telemarketing employees. The sample was 64 full-time employees between the ages of 22 and 25 who had a college degree and had been working in telemarketing for six months. These employees were from telemarketing companies that met the criteria for continuous telemarketing and customer service. By setting these criteria, the study ensured that all participants had similar career backgrounds and skill bases.

A. Experimental Design

TABLE I. POST-TEST EXPERIMENTAL DESIGN

Group	Intervention	Post-Test
EG	X	O1, O3
CG	-	O2

(EG = Experimental group, CG = Control group, X = Treatment (Micro-learning with Simulated Scenarios, O1, O2 = Post-Test (Learning Achievement), O3 = Post-Test (Learning Motivation))

B. Research Instruments

Lesson plan: A structured four-week didactic training course was designed for both groups simultaneously, with the experimental group receiving brief, skill-focused, scenario-based micro-learning combined with weekly simulated telemarketing scenarios, while the control group received traditional instructor-led lectures, readings, case discussions, and group activities covering the same content areas.

Assessment tools: The learning achievement level of both groups was measured by completing a 20-item multiple-choice telemarketing achievement test (weighted 50%) and a practical role-playing assessment covering four simulated scenarios, which was scored against a behavioral code (weighted 50%) to produce a balanced 100-point score.

Learning motivation questionnaire: Participants' motivation was measured by completing a telemarketing-specific questionnaire adapted from the Academic Motivation Scale, which consisted of 17 questions covering both intrinsic and extrinsic motivations and was scored using a 5-point Likert scale.

C. Data Collection

After the four-week teaching, the two groups of students completed a series of post-tests under unified and standardized conditions, including the Telemarketing Achievement Test and the Learning Motivation Scale to record changes in knowledge level, learning motivation, and cognition.

D. Data Analysis

Quantitative analysis included descriptive statistics (mean and standard deviation), paired and independent sample t-tests, and focused on analyzing the learning motivation survey questionnaire of the experimental group to compare the learning achievement and learning motivation of each group of students after teaching.

IV. RESULTS

This study conducted an independent sample t-test on the learning achievement level of 64 employees and learning motivation questionnaire of an experiment group. The results are shown in the following in table II and table III:

TABLE II. RESULTS OF TELEMARKETING ACHIEVEMENT TEST, EG VS CG

Group	N	M	S. D	t	df	P
CG	32	82.03	9.492			
EG	32	87.66	7.182	-2.676	62	.010

TABLE III. RESULTS OF TELEMARKETING LEARNING MOTIVATION QUESTIONNAIRE (ONLY EXPERIMENTAL GROUP, N = 32)

No.	Item	Mean	S. D	Level
<i>Intrinsic Motivation</i>				
1	I feel excited when exploring new communication approaches in telemarketing training or exercises.	3.63	1.28	High
2	I'm enthusiastic about trying different customer scenarios to truly enhance my adaptability in handling various client needs.	3.63	1.23	High
3	Even without external pressure, I'm willing to engage in simulated activities because I want to see if I can handle challenging sales situations.	3.66	1.18	High
4	Seeing steady improvement in my communication skills gives me an inner sense of satisfaction.	3.75	1.10	High

5	I find genuine value in accumulating experiences through micro-learning and scenario simulations, even if the results aren't immediately reflected in sales numbers.	3.53	1.39	High
6	When faced with tough customer simulations, I'm more excited by the challenge of testing my resilience than worried about failing.	3.69	1.23	High
7	I enjoy sharing my simulation results with colleagues, because such interactions further spark my interest in learning.	3.50	1.36	High
8	After completing a training module or a practice test, I'll willingly reflect on my performance to do better next time.	3.84	1.24	High
9	I hold a strong curiosity toward telemarketing, enjoying the deeper exploration of communication tactics and negotiation strategies.	4.03	.74	High
<i>Overall</i>		<i>3.69</i>	<i>.74</i>	<i>High</i>
<i>Extrinsic Motivation</i>				
10	If the company offers extra incentives or promotion opportunities for strong performance in training, I'll devote more effort to each practice session.	3.81	.96	High
11	Receiving positive feedback from supervisors or team members makes me want to excel even more in the next simulation exercise.	4.00	1.04	High
12	My main goal is to boost my personal sales figures, because that directly impacts my bonus or performance review.	4.19	.99	High
13	Knowing that better telemarketing skills will give me a competitive edge motivates me to complete all the required training tasks.	3.91	1.11	High
14	When I realize higher customer satisfaction scores can boost my reputation or evaluation, I become more driven to refine my communication skills.	3.84	1.16	High
15	I focus on micro-learning modules and simulations mainly because the company or my supervisor expects me to fulfill these training requirements.	4.13	.97	High
16	I aim to rank among the top performers in the team assessments to prove my capability, which also opens more career opportunities for me.	3.66	1.15	High

17	Recognition from my manager or customers strengthens my determination to persist with telemarketing training, as it directly influences my performance outcomes.	3.84	1.11	High
Overall		3.92	.77	High
Total		3.80	.76	High

The analysis results of Table II and Table III show that the average score of the experimental group is higher ($M = 87.66$), and the difference is statistically significant ($p = 0.010$), which further proves the advantages of micro-learning with simulated scenario teaching methods in training. At the same time, most employees have a high degree of recognition of course learning motivation ($M = 3.80$), among which the average score of extrinsic motivation ($M = 3.92$) is higher than the average score of intrinsic motivation ($M = 3.69$). Overall, employees have a positive attitude towards the learning motivation of the telemarketing course.

V. CONCLUSION AND DISCUSSION

This study successfully developed a teaching method suitable for improving employees engaged in telemarketing, namely, micro-learning with simulated scenario. The results showed that participants in the experimental group achieved significantly higher and more consistent learning achievements ($M = 87.66$ vs. 82.03 ; $p = .010$) and showed higher overall motivation, especially strong extrinsic motivation ($M = 3.92$). It was confirmed that the comprehensive method is superior to traditional teaching methods in improving performance and motivation.

The findings demonstrate that telemarketing employees trained with the integrated micro-learning and simulated-scenario approach achieved significantly higher post-test scores ($M = 87.66$) than those receiving traditional instruction ($M = 82.03$), mirroring results in other fields where short, focused modules combined with immersive practice outperform slide-based or lecture methods [6]. This advantage may stem from the dual benefits of “knowledge acquisition,” which not only helps with learning and comprehension but also effectively avoids cognitive overload [4] and realistic role-play scenarios that engage learners emotionally and cognitively [5]. Furthermore, participants reported strong extrinsic motivation—driven by incentives and recognition—alongside high intrinsic interest in mastering challenging simulations, consistent with Keller’s ARCS framework [7] and self-determination theory [22].

Practically, this synergy of micro-learning and simulation offers a scalable, just-in-time training model that aligns with the dynamic demands of telemarketing, fostering both improved performance and sustained engagement.

VI. RECOMMENDATIONS

To enhance telemarketing training, it is recommended to integrate micro-learning and scenario simulations into regular sessions, ensuring continuous skill reinforcement and practical application. The simulations should reflect real customer objections and interaction styles, with gradually increasing difficulty to maintain engagement and realism. Digital platforms and mobile apps can support anytime, anywhere learning with interactive content and instant feedback. Linking training outcomes to incentives—such as bonuses, recognition, and career advancement—can further boost motivation. Regular evaluations and reflections should also be conducted to help employees identify gaps, adjust strategies, and achieve continuous improvement.

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II. LITERATURE REVIEW

The application of Virtual Reality (VR) to enhance presentation and communication skills in higher education is gaining widespread interest. Research by Bachmann et al. (2023) indicates that VR Public Speaking Training (VRPST) significantly improves both objective presentation skills and student confidence. Their findings show that the VR training group demonstrated significantly higher levels of content analysis (rule explanation) and self-assessment from listeners compared to the control group. Furthermore, repeated VR practice noticeably increased self-efficacy and motivation [1].

VR technology is also being used to strengthen soft skills, employing AI feedback to analyze crucial elements such as eye contact, tone of voice, body language, speaking fluency, and content appropriateness [2]. Studies on the theory of "immersion"—the feeling of "being in a real situation"—confirm its importance in fostering engagement and mitigating psychological factors like speech anxiety, which tends to decrease when training in VR compared to traditional methods [3].

This aligns with Tangsripairoj et al.'s (2024) research on Speech Lab VR, which highlights the potential of VR technology in developing presentation skills. Although this particular study focused on students, the principles and benefits can be effectively extended to university staff [4]. This is consistent with the research titled "Speech Lab VR: A Virtual Reality System for Improving Presentation Skills," which introduces a VR system developed to enhance university students' presentation skills by creating simulated environments for practice presentations, thereby fostering skills crucial for academic and professional success. The findings from Speech Lab VR demonstrate its effectiveness in enhancing students' presentation abilities and preparing them for future opportunities [5].

In conclusion, employing VR technology for communication skills training not only boosts learners' confidence and abilities but also represents a strategic investment in human resource development that will lead to long-term success. The development and implementation of such systems in educational institutions warrant serious consideration, especially where communication and presentation are critical for academic and professional growth.

This aligns with Tangsripairoj et al.'s (2024) research on Speech Lab VR, which demonstrates the significant potential of Virtual Reality technology in enhancing presentation skills. While that study focused on students, its principles and benefits can be effectively extended to university staff. The use of VR in communication skills training is crucial; it not only enhances confidence and skills but also serves as a vital investment in human capital for sustained success. Therefore, the development and integration of practical training systems using this technology should be earnestly considered within

educational institutions, particularly given the importance of communication and presentation for academic advancement and fostering international collaboration.

III. METHODOLOGY

The "VR For Education MU Library: VR For the High-Impact Presentation" project was designed based on the concept of experiential learning. It focuses on developing public speaking skills and English presentation techniques within a virtual environment using Virtual Reality (VR) technology and Virtual Speech software. This software integrates real-time AI-powered feedback to foster personalized learning and build student confidence.

A. Objectives

To investigate the application of Virtual Reality (VR) technology in developing presentation skills and building communication confidence among higher education students.

B. Participant Selection and Demographics

The primary target group was Mahidol University students, with a total of 80 participants in the project.

C. Program Structure and Activities



Figure 2: RE-AIM Model
Image Source: <https://re-aim.org>

The RE-AIM model (Reach, Effectiveness, Adoption, Implementation, Maintenance) is an internationally recognized evaluation framework used for comprehensively analyzing and reflecting on the outcomes of health and training programs. When applied to the VR-based presentation training project (Virtual Speech), it can be linked to each stage of the operational process as follows:

R - Reach (Target Audience Access) - Publicity and Registration

- The project disseminated information through multiple channels, including the university website, emails, and public announcement boards.
- A systematic registration system was implemented to ensure access for the target audience: students and personnel interested in developing presentation skills.
- Key Indicator: The number of participating undergraduate students, with an average score

range of 70–80 out of 100, indicates a relevant and responsive target group.\

E - Effectiveness - Training, Practice, and Competition

- The use of Virtual Speech, providing real-time AI feedback, enhances training efficiency.
- The average achievement score for practicing speaking pace was within the appropriate range (100–140 words/minute).
- The average participant satisfaction was 4.85/5
- Positive feedback reflected tangible outcomes and practical application in daily life.

A - Adoption - Planning and Expert Provision

- The project curriculum was designed in collaboration with specialists in public presentation techniques.
- The Virtual Speech VR platform was selected for its suitability for presentation skills training and its reporting system.
- Content and activities were designed to align with the abilities of learners at various levels.

I- Implementation - Training and Competition Execution

- Two on-site training activities were organized.
- Practice sessions utilized VR headsets with progress tracking via the AI feedback system.
- A clear activity schedule was provided, along with technical support.
- AI evaluation covered critical aspects such as Eye Contact, Body Language, Speaking Pace, and Listenability.

M - Maintenance - Result Sustainability and Future Expansion

- The project's conclusions can serve as a prototype for future expansion or development into continuous training courses.
- It helps foster a culture of professional presentation within the university.



Figure 3: Individual Evaluation Scores from AI Feedback (from participants)

From the individual AI feedback evaluation scores of participants in the "VR For The High-Impact Presentation" project, we observed that 25 students from various faculties

competed. Their scores varied across different components, including Speaking pace, Eye contact, Body language, and Listenability.

Most participants demonstrated excellent speaking pace and body language, often achieving full or near-full marks in these categories. However, scores for listenability and eye contact were more diverse, indicating areas for further development. The highest average score recorded was 86.33, while the lowest was 62.33. This range highlights both the individual differences in skill levels and the potential for continued improvement among participants.

IV. DISCUSSION



Figure 4: Video Interview of Student Participants' Project

Conclusion: Enhancing Presentation and Communication Skills through VR and AI

In summary, the project effectively enhanced students' presentation skills and communication confidence through experiential learning within a Virtual Reality (VR) environment. This was supported by an Artificial Intelligence (AI) system that provided real-time feedback, leading to the continuous and effective development of essential 21st-century communication skills.

This approach aligns with the concept of experiential learning, and international research confirms the effectiveness of integrating VR technology with AI Feedback in developing learners' presentation skills. Project participants demonstrated high proficiency in body language and speaking pace, reflecting the effectiveness of training in a simulated environment. Qualitative data further indicates increased student confidence and a sense of realistic experience.

These findings are consistent with the study "Virtual reality public speaking training: effectiveness and user technology acceptance", which developed and validated a comprehensive and adaptable VR training system. This system created realistic and responsive VR environments, including AI-driven virtual audiences that could adjust their attitudes to simulate diverse public speaking scenarios and respond to the speaker's performance. The AI also dynamically tailored the learning path based on user strengths, weaknesses, and progress, providing a personalized learning experience. Key Performance Indicators (KPIs), such as verbal and non-verbal cues, including anxiety detection, were identified to evaluate speaking performance, and the VR system provided personalized feedback based on concrete performance parameters [6].

Furthermore, the AI Feedback system from Virtual Speech software serves as a clear example of applying Technology-Enhanced Learning (TEL) [7] to elevate students' English presentation skills. The analysis of project data can be directly linked to key principles of TEL, as follows.

Table: Analysis and Explanation of AI Feedback Data Aligned with Technology-Enhanced Learning Principles

Table Analysis		
Principle	Data Analysis (AI Feedback)	Connection
1. Personalized Learning	A detailed scoring table provides an individualized breakdown of performance across various dimensions of presentation skills (e.g., speaking pace, eye contact, body language). This analysis serves to highlight each student's specific strengths and areas requiring development.	The AI system acts as a "personal coach," providing specific feedback to each student, unlike traditional group instruction. This allows students to immediately focus on areas where they are weak. For instance, a student with a low body language score will know to prioritize improving in that area. This approach facilitates personalized learning tailored to individual needs and progress.
2. Immersive and Simulation-Based Learning	The scores obtained for "eye contact" and "body language" are a direct result of training conducted within a VR environment that simulates real-world presentation scenarios.	VR creates an "immersive" environment, making learners feel as if they are in a real situation without any actual risk. Repeated practice in such a simulated environment allows students to learn through trial and error and develop confidence, especially in reducing public speaking anxiety. This benefit has been well-established in VR research for speech training.
3. Immediate and Precise Feedback	The AI system provides real-time scores and feedback, which are immediately displayed in the results table following the presentation.	Receiving immediate feedback is crucial for effective learning. It allows learners to instantly connect outcomes with their demonstrated behaviors, thereby creating a rapid feedback loop and enabling precise behavioral adjustments. AI can analyze nuanced data

Table Analysis		
Principle	Data Analysis (AI Feedback)	Connection
		that humans might find difficult to observe, such as subtle variations in speaking speed or eye contact patterns, which significantly enhances the learning process [8].
4. Data-Driven Improvement	The scorecard presents numerical results across various dimensions, allowing students to monitor their progress through repeated practice and compare their performance against benchmarks.	Data-driven learning empowers both students and instructors to identify trends and make informed decisions for improvement. The numerical scores enhance the objectivity of evaluation and provide students with clear goals for developing specific skills.
5. Enhancing Motivation through Gamification	The inclusion of scores for each dimension, an overall average score, and competitive rankings motivates students to strive for improved performance.	Gamification elements, such as scoring, competition, and rewards, actively stimulate student engagement and encourage continuous practice. When learners can visualize their progress numerically and see their rankings, it fosters a sense of challenge and ongoing motivation for self-improvement [9].

Conclusion on Technology-Enhanced Learning (TEL) Integration

The results from the AI Feedback within the "VR For Education MU Library: VR For the High-Impact Presentation" project demonstrate more than just individual score displays. They effectively reflect the tangible application of Technology-Enhanced Learning (TEL) principles. This includes fostering personalized learning, utilizing virtual environments for practice, providing timely and accurate feedback, leveraging data for continuous improvement, and enhancing motivation through gamification mechanisms. Ultimately, these elements collectively contribute to the efficient and sustainable development of presentation skills for university students.

V. ACKNOWLEDGMENT

Based on the project data, VR and AI technologies are instrumental in reducing presentation anxiety and boosting confidence in real-world settings. They not only enhance students' capabilities in presenting and communicating within academic and classroom environments but also alleviate anxiety and improve preparedness for the competitive job market, aligning with the demands of a digital-era society and industry.

For the university, this project serves as a model for integrating modern technology into teaching, learning, and academic services. It promotes the university's image as a leader in educational innovation while fostering a culture of continuous and sustainable self-development.

In the future, the university can expand this project to develop new curricula or extend its reach to other target groups, such as support staff or surrounding communities. This expansion would strengthen learning networks and elevate the overall quality of education, as illustrated in Figure 4: Conceptual Framework for Expanding the "VR For the High-Impact Presentation" Project.



Figure 4: Conceptual Framework for Expanding the VR For the High-Impact Presentation Project

Figure 4 illustrates the six main stages of the expansion process for the "VR For the High-Impact Presentation" project:

Step 1: Target Audience Survey

In the context of applying Virtual Reality (VR) technology to enhance learning and develop high-impact presentation skills in higher education, it's crucial to identify the appropriate target audience and understand their specific needs. This ensures that the project design and development are highly relevant and yield optimal results. Specifically, for the "VR For Education MU Library: VR For the High-Impact Presentation" project at Mahidol University Library and Knowledge Center, the Target Audience Survey process in Phase 2 can be broken down into two sub-steps:

1) Identifying and Selecting a Clear Target Audience

The project begins by clearly defining the target audience. This is a critical step to ensure that communication and content development align with the specific needs of each recipient group, thereby increasing the effectiveness of the communication and training process [10]. The focus is on developing the potential of

Mahidol University students, faculty members, and staff who seek to enhance their communication and public speaking skills through VR technology. This particularly targets groups with a keen interest in and a strong need for effective presentation skills, such as undergraduate and graduate students, as well as support staff involved in academic services for international curricula.

2) Surveying Actual Needs and Challenges

This involves collecting data on current communication issues, presentation challenges, and the expectations of the target audience through Focus Group Surveys, emphasizing in-depth content. The key questions posed are: Have you had prior experience presenting or speaking in front of a class or on a stage? How did you feel about it? How do you typically practice presentations? What are the problems and limitations of your current presentation practice methods?

- What do you think could help develop your presentation skills? What kind of technology do you think could help develop your presentation skills?
- If you had the opportunity to receive presentation training, how willing would you be to participate? Would you prefer an online or onsite format, and what specific skills would you want to practice?
- After practicing presentations in your current life, do you receive feedback, and if not, would you like to receive feedback?
- How do you think technologies like VR (Virtual Reality) could help you practice presentations?

The information gathered from these six core questions enables the design of a technology-applied training program that directly addresses specific needs, accurately identifies problems, and recognizes genuine learning gaps.

Step 2: Awareness and Engagement

This step focuses on building awareness and fostering engagement through three key approaches:

1) Public Relations to Raise Awareness about Communication Challenges

Public relations is a crucial step in generating interest and raising awareness among the target audience regarding challenges related to communication skills, such as public speaking difficulties or using English in academic contexts. Communicating through various channels like social media, websites, and on-campus activities ensures that information reaches the target audience broadly and precisely. For example, promoting workshops and lectures on "Public Speaking Techniques with Virtual Speech Software" helps build awareness and motivate participants to develop their communication skills [11].

2) Organizing a Contest for University Culture-Reflecting Media Production via Social Media (TikTok, YouTube Shorts, Reels)

This involves hosting a short-video media production contest, which is a modern approach that effectively reaches the target audience, especially students and young

people who frequently use these platforms. This activity not only builds awareness but also promotes creative engagement within the university community. It allows participants to express their innovative ideas and showcase university culture through their self-created media. Research indicates that using social media in learning activities significantly boosts learner motivation and participation [12].

3) Setting Up Booths at Academic Events to Assess and Select Interested Target Groups

Establishing booths or displays at academic events, such as university open houses or academic conferences, is a vital channel for meeting, exchanging information, and directly communicating with the target audience. These activity booths provide interested individuals with the opportunity to try out VR technology or related applications, learn more about the project, and register for Phase 2 training. This approach enables the project team to assess genuine interest and select target groups who are truly committed to developing their communication skills.

Step 3: Prototype Advancement

This step involves the development of prototype programs or training curricula, which can be divided into four sub-steps:

1) Development of a Small Private Online Course (SPOC) for Public Communication Skills Training

Creating a SPOC-based prototype curriculum enables efficient and flexible instruction, focusing on specific learner groups. This allows for the meticulous design of content and activities tailored to learner needs, providing opportunities for students to practice and review material at their own pace, thereby enhancing learning effectiveness.

2) Installation of Virtual Reality Simulation Software

Integrating VR technology into the curriculum helps simulate real-world situations that learners will face, such as public presentations, answering questions, or complex and challenging scenarios. This creates a safe and controlled learning environment where users can practice repeatedly without fear of making mistakes. This aligns with research by Luo et al. (2024), which indicates that VR training accelerates skill development, reduces risks, and improves learner decision-making accuracy [13].

3) Emphasis on Presentation Techniques Content

Training within the prototype curriculum will emphasize key techniques that enhance communication effectiveness. These include eye contact for building credibility and rapport with the audience, body language to reinforce meaning and create a positive impression, voice modulation and pacing for clear and engaging communication, and avoiding filler words for concise and credible content. Practicing these techniques through VR allows for immediate feedback, helping learners refine their skills [14].

In summary, the Prototype Advancement process involves developing a prototype curriculum that integrates Small Private Online Course (SPOC) learning with Virtual Reality (VR) simulation technology. This comprehensive and effective approach trains public communication skills, emphasizing key presentation techniques to boost speaker confidence and engagement. Research supports that VR training accelerates skill development and enhances learning efficiency compared to traditional methods.

The benefits of developing this prototype with VR and SPOC include creating realistic and highly interactive learning experiences, reducing training costs and time compared to traditional approaches, increasing learner confidence and preparedness before real-world application, and enabling rapid curriculum measurement and improvement based on feedback.

Step 4: Implementation

The training implementation is divided into four sub-steps:

1) Organizing an Orientation Session to Clarify Goals and Objectives

Conducting an orientation session helps to build understanding and motivation among participants from the outset. This involves clearly explaining the goals and objectives of the course, as well as how to use the various tools involved and the channels for contacting the team for assistance throughout the training period. This aims to enhance psychological preparedness and foster long-term commitment to the project. An effective orientation, therefore, increases learner cooperation and participation in the training process, emphasizing the creation of a safe and clear learning environment from the beginning.

2) Theoretical and Communication Technique Training via Online Lessons (SPOC)

Learners allocate time to study content from the Small Private Online Course (SPOC) platform. The online lessons comprise theoretical content and communication techniques, such as body language, voice control, content structuring, communication methods, and reducing filler words. This allows learners flexible access to content, aligning with their own learning pace according to the project schedule. Furthermore, online learning enables close monitoring and evaluation, enhancing learning effectiveness and content comprehension more than general learning formats [15], especially when combined with VR technology.

3) Participants Practice in Virtual Reality (VR) Simulations

Practical training in a VR simulated environment helps to mimic real-life situations that learners will face, such as presentations on public stages, in meeting rooms, academic discussions, answering questions, or managing unexpected scenarios. This allows learners to practice repeatedly in a safe and controlled environment while receiving immediate feedback from the AI Feedback system. Related

research confirms that VR enhances practical skills and confidence, including communication skills training in crises and technical and safety training in industrial settings [16].

4) Immediate Individual Assessment

Immediate individual assessment after practice sessions enables learners to quickly identify their strengths and areas for improvement. This includes aspects like eye contact, body language, vocal volume, clarity of speech, and reduction of filler words during presentations.

The assessment utilizes various tools, such as interaction with AI avatars, video recording for behavioral analysis, or AI systems that provide automated feedback. These immediate results empower learners to continuously refine their skills, and instructors can tailor their teaching plans to individual needs. Furthermore, this approach effectively boosts motivation and accountability among participants [17].

In summary, the training implementation begins with an orientation session to clarify goals, objectives, tool usage, and team contact channels. This creates initial understanding and motivation for participants throughout the blended training process, fostering a safe and clear learning environment. Following this, learners receive theoretical and communication technique training through a Small Private Online Course (SPOC), designed to accommodate individual learning paces while allowing for close monitoring and evaluation. Practical training in virtual reality (VR) simulations realistically mimics real-world scenarios, enabling repeated practice in a safe environment with immediate AI feedback, which significantly boosts skills and confidence for actual performance. Finally, immediate individual assessments after training help learners quickly identify strengths and areas for development. This also allows instructors to tailor teaching plans to individual needs, resulting in an efficient and sustainably effective training process with tangible outcomes.

Step 5: Assessment and Contemplation

This step focuses on comprehensive and continuous evaluation of training outcomes to ensure the developed curriculum is effective and truly meets learner needs. It begins with a Pre-Post Assessment Online, which tests participants' knowledge and skills both before and after the training via the online SPOC system. This method clearly and systematically measures the development and effectiveness of the training. Additionally, participants receive real-time AI feedback that analyzes and evaluates their expression, communication skills, word usage, body language, and vocal volume. This provides appropriate and timely recommendations, encouraging continuous skill improvement and development throughout the learning process. Furthermore, a participant satisfaction survey is conducted to collect feedback and experiences regarding the curriculum and training process. This is a crucial factor

for improving and developing the curriculum to align with learners' future needs and expectations.

Step 6: Expanding to the Community

Implementing the prototype curriculum with target groups is a crucial step in scaling and ensuring the project's sustainability. After thoroughly evaluating and refining the curriculum based on feedback and data from participants, the prototype should be applied to appropriate target groups with a need for skill development.

An example would be Dhammaduta Bhikkhu students who require enhanced communication skills for their practical learning and teaching in the community. This creates a complete, continuous improvement cycle, which boosts curriculum effectiveness and fosters long-term, sustainable development. It also enables the project to efficiently expand to other target groups within the community or relevant organizations, precisely meeting the genuine needs of learners in each context.

The "VR For the High-Impact Presentation" project's expansion is structured around six key operational steps. It begins with analyzing the target audience to ensure the curriculum genuinely meets their needs. Following this, the project focuses on building awareness and engaging learners through public relations and social media, directly supporting Sustainable Development Goal (SDG) 10: Reduced Inequalities. This opens doors for individuals, including those with no presentation background, low confidence, or intercultural communication challenges, to develop their communication skills using modern technology.

The third step involves advancing the prototype curriculum, creating a Small Private Online Course (SPOC) integrated with VR technology for practicing skills in simulated environments. This leads into the implementation phase, which combines theoretical and practical training with immediate assessments, aligning with SDG 4: Quality Education by enhancing blended learning through VR, AI, and SPOC.

The fifth stage, assessment and contemplation, involves evaluating outcomes using online tests and real-time AI feedback, coupled with satisfaction surveys to continuously refine the curriculum. Finally, the project moves to expanding to the community, where the curriculum is applied to real-world contexts, such as training Dhammaduta Bhikkhu students. This final step not only ensures the project's sustainability but also aligns with SDG 8: Decent Work and Economic Growth, by preparing a workforce with strong communication skills for the modern labor market, and SDG 17: Partnerships for the Goals, by facilitating the transfer of modern technology for international communication and cooperation. This comprehensive model serves as an effective and sustainable blueprint for other organizations seeking to enhance communication and presentation skills in both higher education and community settings.

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Thank you

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