

Enhancing academic performance of business students using generative AI: An interactive-constructive-active-passive (ICAP) self-determination perspective

Ziyi Gao^a, Jun-Hwa Cheah^{b,*}, Xin-Jean Lim^c, Xi Luo^d

^a School of Overseas Education, Yunnan University of Finance and Economics, Kunming, Yunnan, China

^b Norwich Business School, University of East Anglia, Earlham Rd, Norwich, NR4 7TJ, United Kingdom

^c School of Business and Economics, Universiti Putra Malaysia, Serdang, Malaysia

^d Sunway Business School, Sunway University, Sunway City, Selangor, Malaysia

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ABSTRACT

Generative artificial intelligence (GAI) tools, such as ChatGPT, have emerged as valuable assets in higher education. Despite their potential benefits in academic support, questions persist about the concrete advantages of integrating this technology into learning processes and its impact on academic outcomes. This research addresses this gap by investigating the influence of technology integration on academic performance, employing the Interactive-Constructive-Active-Passive (ICAP) framework and self-determination theory. The empirical findings from Chinese business students using *Wenjuanxing* platform reveal a positive impact of technology integration on business students' motivation, encompassing their learning desires, self-efficacy, and future beliefs, ultimately leading to enhanced academic performance. Notably, while epistemic curiosity augments the effects of technology integration on learning desires and future beliefs, its influence on self-efficacy is not significant. This suggests that curiosity alone might not be enough to alter deeply ingrained beliefs about one's capabilities. In conclusion, this study underscores the academic significance of these findings and their practical implications for educators and business students in optimizing ChatGPT's potential for academic success.

1. Introduction

The advent of ChatGPT, developed by OpenAI, has brought about a revolution in higher education, showcasing its remarkable capabilities such as generating human-like dialogues, brainstorming ideas, composing essays, and even assisting in coding tasks (Ali et al., 2024; Ameen et al., 2024; Lian et al., 2024; Strzelecki, 2023). Despite concerns about its potential impact on academic integrity, the demonstrated potential of ChatGPT should not be overlooked. Its educational content enhances student engagement and interaction, making it a valuable addition to instructional learning methodologies (Ivanov & Soliman, 2023; Kasneci et al., 2023). With the ability to correct wrong answers and remember previous user interactions, ChatGPT's ongoing dialogues with students refine its performance, thereby deepening their learning experiences. This positions ChatGPT as a prime tool for nurturing students' analytical and writing prowess, aiding them in realizing their academic ambitions (Rejeb et al., 2024; Strzelecki, 2023). For educators and

* Corresponding author.

E-mail addresses: lawrencegaozy@gmail.com, gaozy@ynu.edu.cn (Z. Gao), jackycheahjh@gmail.com, J.Cheah@uea.ac.uk (J.-H. Cheah), lim.xinjean@yahoo.com (X.-J. Lim), clorislx79656@gmail.com (X. Luo).

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university students alike, ChatGPT establishes a transformative relationship with knowledge.

As the utilization of generative artificial intelligence (GAI) learning tools, such as ChatGPT, becomes increasingly prominent in higher education, ongoing discussions persist regarding their impact on learning activities and academic outcomes (Ali et al., 2024; Duong et al., 2023; Ratten & Jones, 2023). While some technologies may demonstrate limited efficacy or even impede academic performance (Bryant et al., 2020), observations by McNeil (2016) indicate that only half of educators perceive technology integration as somewhat beneficial. This incomplete understanding may present challenges in how students engage with ChatGPT-assisted learning, with insufficient input of prompts potentially resulting in misleading or incomplete feedback (Choi et al., 2023). Misuse or misconceptions regarding effective prompts could lead to confusion, diminishing interest in utilizing the technology for learning purposes. Over-reliance or blind trust in ChatGPT may disconnect students from their course content, undermining independent thinking and self-efficacy, which contradicts the intended purpose of technology in education. Concerns also arise regarding the impact of ChatGPT on students' social skills, particularly in interactions with peers and educators, as inadequate human interaction skills could negatively influence students' perceptions of their future prospects. For business students, the integration of technology aims to equip them with the capacity to blend theoretical knowledge with practical skills and align educational practices with industry requirements (Pitic & Irimiaş, 2023). This approach seeks to enhance educational practices, fostering students' ability to envision a more promising future. Therefore, a deeper study is needed to comprehensively understand the consequences of using ChatGPT on business students' academic performance.

The academic discourse on ChatGPT in higher education is promising but still in its early stages, with limited empirical studies on its consequences (Farrokhnia et al., 2023; Lim et al., 2023; Skavronskaya et al., 2023). While there is research on motivation and technological attributes (Antonietti et al., 2023; Consoli et al., 2023), there is lack of focus on observable learning activities. The essence of students' learning activities lies in how technology is employed, rather than what is employed (Backfisch et al., 2021; Chien et al., 2016; Wekerle et al., 2022). In response to this gap, the current research constructs a model to comprehend the impact of ChatGPT on the academic performance of business students. To provide academia and practitioners with deeper insights, the study leverages the interactive-constructive-active-passive (ICAP) framework (Chi et al., 2018; Chi & Wylie, 2014) and self-determination theory (Deci & Ryan, 2000; Ryan & Deci, 2020). The ICAP framework suggests that digital technology integration can be assessed through observable learning activities. Self-determination theory aids in understanding factors influencing intrinsic and autonomous extrinsic motivations, ultimately impacting performance outcomes. Considering the link between student engagement and motivation, overt learning behaviors are regarded as determinants influencing students' motivational elements and academic performance.

This study also explores the moderating effect of epistemic curiosity, emphasizing the pursuit of new knowledge and information (Lee et al., 2022). While the desire for learning focuses on seeking specific, unfamiliar information, epistemic curiosity highlights an individual's emotional thirst for in-depth knowledge (Fisher & King, 2010; Junça-Silva & Silva, 2021; Lee et al., 2022). Epistemic curiosity positively motivates business students to explore, concentrate, and persevere in learning tasks (Cheng, 2023; Hwang, 2023). The research suggests that business students with this characteristic are more likely to bridge informational gaps in ChatGPT-integrated educational scenarios, fueling their motivational elements during learning activities. The study addresses gaps with three objectives:

- i. To explore the impact of technology integration in learning activities on business students' motivational elements (i.e., desire for learning, self-efficacy, and beliefs about the future).
- ii. To examine the mediating role of business students' motivational elements (i.e., desire for learning, self-efficacy, and beliefs about the future) in enhancing academic performance.
- iii. To investigate the moderating effect of epistemic curiosity in altering business students' motivational elements (i.e., desire for learning, self-efficacy, and beliefs about the future).

This paper follows a structured approach. It commences with an overview of the theoretical foundation, centering on two key theories: the ICAP framework and the self-determination theory. This is succeeded by a focused literature review, culminating in the formulation of hypotheses that delineate the proposed relationships. The subsequent section details the methodology, followed by a discussion of the findings, encompassing both practical and theoretical implications. Both limitations and suggestions for future research are included at the last section.

2. Theoretical background

The effectiveness of integrating technology into learning processes is determined more by its ability to cognitively motivate and engage students than by the nature or frequency of the technology itself (Chien et al., 2016; Wekerle et al., 2022). While previous studies acknowledged the importance of incorporating technology into educational settings (Fütterer et al., 2022; Petko et al., 2017), they often overemphasized the attributes of the technology, neglecting the process of integration into learning activities and its functional role (Antonietti et al., 2023). Models like the technology acceptance model (TAM) and the unified theory of acceptance and use technology (UTAUT) have been dominant in technology-based educational research, focusing primarily on the attributes of the technology (Dwivedi et al., 2020; Scherer et al., 2019). However, the current research shifts the focus to business students' learning activities, emphasizing the integration of technology rather than the technology itself.

This research utilizes the ICAP framework (Chi et al., 2018; Chi & Wylie, 2014) to scrutinize diverse student perceptions concerning the integration of ChatGPT in learning activities. It also integrates the self-determination theory (Deci & Ryan, 2000; Ryan & Deci, 2020) to explore how this tech-driven educational method affects students' desire for learning, self-efficacy, beliefs about the future,

and ultimately, their academic performance. This synthesis of theories is consistent with Backfisch et al. (2021), who suggest that understanding the value of technology in education requires an examination of how it alters learning tasks and improves outcomes through cognitive and emotional constructs. Specifically, this approach examines the learning tasks of business students using ChatGPT, focusing on their observable learning behaviors as outlined in the ICAP framework. Furthermore, the self-determination theory provides insights into how the features of ChatGPT may positively influence the overall academic success of business students through emotional and motivational factors.

2.1. The interactive-constructive-active-passive (ICAP) framework

Chi (2009) introduced the ICAP framework, later refined by her and her colleagues in subsequent years (Chi et al., 2018; Chi & Wylie, 2014). The framework classifies modes of student engagement in learning processes based on observable behaviors, categorizing them into Interactive (I), Constructive (C), Active (A), and Passive (P). Passive learners absorb information, active learners apply pre-existing knowledge, constructive learners focus on personal knowledge growth, and interactive learners collaborate with others. Interactive learning tends to yield the most favorable outcomes, following the sequence $I \rightarrow C \rightarrow A \rightarrow P$. The ICAP framework emphasizes actions rather than the emotional and motivational facets of engagement (Antonietti et al., 2023) and is adaptable across diverse learning sectors.

In essence, the ICAP framework evaluates engagement through tangible learning actions, such as note-taking or summarizing, as highlighted by Chi and Wylie (2014). ChatGPT complements these activities, aiding in information retrieval, in-depth concept exploration, and orderly explanations. Effective technology integration aligns with educational goals (Wekerle et al., 2022), and through the ICAP lens, this study assesses ChatGPT's contribution to education by identifying observable learning behaviors supported by the technology. The ICAP framework appears well-suited to investigate how business students integrate ChatGPT into their learning activities. It is important to note that the ICAP model has been primarily used from the perspective of teachers, often in qualitative studies, with limited quantitative use, especially in technology-integrated educational contexts (Consoli et al., 2023; Wekerle et al., 2022). To address this gap, Antonietti et al. (2023) adapted the ICAP framework for technological settings, introducing the ICAP-Technology Scale to enhance the measurability of ChatGPT's integration into learning activities.

2.2. Self-determination theory

The self-determination theory offers a comprehensive framework to understand intrinsic and autonomous extrinsic motivations, impacting performance outcomes (Deci & Ryan, 2000; Ryan & Deci, 2020). Intrinsic motivation involves actions pursued for personal interest and enjoyment, driven by a voluntary desire for satisfaction. Extrinsic motivation is behavior driven by external factors, defined by its association with personal autonomy. Even under external pressures, individuals may engage in an activity with choice and willingness as long as they recognize its value. This theory emphasizes intrinsic and autonomous extrinsic motivations, where people engage in activities for inherent gratification, increasing the likelihood of positive outcomes (Agonács et al., 2020).

Self-determined behaviors reflect a positive cognitive state observed across various cultural and situational landscapes, especially when individuals find these endeavors meaningful (Gaggioli et al., 2017). Ryan and Deci (2020) highlight that self-directed actions are influenced by a mix of intrinsic and extrinsic motivators which align with individuals' autonomy and competence needs. In line with this, this study emphasizes autonomy and competence needs to elucidate intrinsic and autonomous extrinsic motivations effectively. Autonomy is tied to the individual's inherent need to control actions and goals, indicating a sense of personal agency (Ryan & Deci, 2020; Vansteenkiste et al., 2020). This is exemplified by the desire for learning, where students voluntarily and eagerly engage in the learning process (Agonács et al., 2020; Fisher & King, 2010). Competence involves achieving expertise and effectiveness, aligning with self-efficacy in using ChatGPT for learning (Ryan & Deci, 2020; Vansteenkiste et al., 2020). When students lack confidence in mastering technology integration, achieving favorable academic outcomes becomes challenging (Mendoza et al., 2023). Anderman and Gray (2015) emphasize that fulfilling students' competence needs should align with their desire for the future. Hence, this study includes "beliefs about the future" to explore how ChatGPT use could offer a competitive advantage for future pursuits.

3. Hypotheses development

3.1. Technology integration in learning activities and motivational elements

In alignment with the ICAP framework, the concept of technology integration in learning activities involves four engagement modes: interactive, constructive, active, and passive (Chi et al., 2018; Chi & Wylie, 2014). Expanding upon the definition of each engagement mode, the practical examples of ChatGPT's integration within the ICAP model are as follows:

Interactive (I) activities: These involve collaborative generation of educational content through dialogue between two or more learners, referencing and responding to each other's statements. Business students engage directly with ChatGPT, participating in dynamic discussions. For instance, learners can sharpen negotiation and communication skills through business role-plays with ChatGPT, fostering critical analysis and creative problem-solving.

Constructive (C) activities. This category involves developing new understanding beyond the original learning content. Business students actively build upon their knowledge, using ChatGPT to devise custom business plans, explore speculative market situations, and investigate complex business theories. For example, learners can draft bespoke business roadmaps under ChatGPT's guidance, integrating elements like market dynamics, competitive analysis, and expansion potentials.

Active (A) activities: These enable students to assimilate new information with their pre-existing knowledge and frameworks, tackling challenges with ChatGPT's insights. Students engage in decision-making exercises, unravelling business dilemmas and making informed choices grounded in empirical evidence.

Passive (P) activities: In these activities, students consume knowledge dispensed by ChatGPT, such as decoding complex financial data or familiarizing themselves with fundamental business terminology. These sessions offer clear explanations and concise overviews, deepening students' grasp of sophisticated business concepts.

The construct of "desire for learning" signifies a general motivation to acquire new knowledge or skills through a diverse range of learning activities, encompassing both formal and informal approaches (Agonács et al., 2020; Fisher & King, 2010; Grande et al., 2022). Wekerle et al. (2022) posit that the effectiveness of technology integration lies in its ability to intellectually stimulate students during learning tasks. The primary task is to leverage technology, such as ChatGPT, to ignite the thirst for knowledge among business students. Contemporary digital tools, including ChatGPT, have demonstrated the potential to enhance specific cognitive engagements. For instance, Fütterer et al. (2022) found that the use of tablet computers positively influences students' immediate cognitive participation. Wekerle et al. (2022) observed heightened willingness among students to engage in learning activities with the integration of technology. This study proposes that students will experience a strong desire for learning when they are able to integrate technology into their learning activities. Therefore, the following hypothesis is established:

H1a. Technology integration in learning activities (i.e., using ChatGPT) has a positive influence on desire for learning.

Self-efficacy, denoting a student's conviction in their aptitude and proficiency to proficiently execute designated tasks and attain desired outcomes, constitutes a pivotal construct in educational psychology (Hazzam & Wilkins, 2023). Within the sphere of higher education, self-efficacy assumes a paramount role, particularly given the recurrent instances wherein students confront challenges autonomously. The adept navigation of such challenges not only represents opportunities for cognitive maturation (Han & Geng, 2023) but also underscores the centrality of self-efficacy in the academic journey.

In the specific context of business education, the seamless integration of ChatGPT into learning activities or the adept resolution of intricate problems assumes a critical role in fostering a profound sense of mastery and capability among students. The mastery experiences derived from successfully leveraging ChatGPT contribute substantively to the cultivation of self-efficacy beliefs. This newfound confidence, rooted in efficacious encounters with technology, augments students' readiness and determination to confront and excel in tasks enriched by technological augmentation (Kang & Park, 2023; Liong et al., 2023). Therefore, the present study posits that:

H1b. Technology integration in learning activities (i.e., using ChatGPT) has a positive influence on self-efficacy.

Beliefs about the future encompass the internalized sense of optimism, hope, and long-term vision that students hold regarding their future goals, options, and choices (Kim & Jang, 2015). These beliefs, whether rooted in educational aspirations or career objectives, exert a profound influence on students' trajectories and actions, functioning as a catalyst propelling them toward the pursuit of their passions (Davies & Ercolani, 2021; Salusky & Tull, 2021). Within the scope of this research, the integration of ChatGPT into learning activities is perceived as a transformative force, augmenting business students' digital proficiency and equipping them for a technology-centric workforce. Immersive engagement with technology-enhanced learning is anticipated to instill a sense of possessing a competitive edge in future job markets, thereby fostering a positive outlook on their professional trajectories. This optimistic perspective, grounded in the enhancement of digital skills, has the potential to amplify students' trust in forthcoming prospects, enabling them to envision themselves as adaptable entities in an ever-evolving technological environment (Liong et al., 2023; Salusky & Tull, 2021). Building upon this rationale, the following hypothesis is formulated:

H1c. Technology integration in learning activities (i.e., using ChatGPT) has a positive influence on beliefs about the future.

3.2. *Desire for learning and self-efficacy*

A robust desire for learning denotes an inherent motivation to acquire new knowledge and engage in academic pursuits (Agonács et al., 2020; Fisher & King, 2010; Grande et al., 2022). This motivation typically emanates from the conviction that the learning process will yield positive outcomes such as acquiring new insights, personal development, or enhancing abilities. The observation of these favorable outcomes serves to reinforce individuals' confidence in their learning capabilities, contributing to an augmented sense of self-efficacy. Moreover, a strong desire for learning fosters resilience, motivating individuals to persist in the face of obstacles or setbacks (Kim & Jang, 2015; Wu et al., 2023). As business students attain milestones, unravel complex concepts, or overcome challenges through their dedicated pursuit of knowledge, they accumulate a series of successful experiences that further enhance their self-efficacy. Therefore, the formulated hypothesis posits:

H2. When students' learning is seamlessly integrated with technology (i.e., using ChatGPT), desire for learning has a positive influence on self-efficacy.

3.3. *Beliefs about the future and self-efficacy*

Believing in a promising future can serve as a motivating force for individuals to establish ambitious goals, meticulously plan their endeavors, and invest effort with persistence to achieve them (Salusky & Tull, 2021). This optimistic perspective on the future not only provides a foundation for resilience but also acts as a guiding force during challenging times. As articulated earlier, overcoming

obstacles contributes to a student's growing confidence in their abilities, thereby reinforcing their self-efficacy (Liong et al., 2023). Consequently, the hypothesis is posited as:

H3. When students' learning is seamlessly integrated with technology (i.e., using ChatGPT), beliefs about the future has a positive influence on self-efficacy.

3.4. Motivational elements and academic performance

Motivations, whether stemming from intrinsic or autonomous extrinsic factors, are widely acknowledged as predictors of positive learning outcomes (Baek & Kim, 2023; Huang et al., 2023; Mendoza et al., 2023). When business students demonstrate proactive interest in their learning, they exhibit a tendency to invest dedicated time and effort into their studies. This innate desire for learning propels them to actively engage in classes, concentrate with greater diligence, delve deeply into readings, and extend their exploration beyond the prescribed curriculum (Grande et al., 2022). Consequently, these motivated learners typically acquire a more profound understanding of concepts, retain knowledge for an extended duration, and demonstrate excellence in both assignments and examinations (Agonács et al., 2020). Thus, this study posits the following prediction:

H4a. When students' learning is seamlessly integrated with technology (i.e., using ChatGPT), desire for learning has a positive influence on academic performance.

When students possess a robust sense of self-efficacy, they approach their studies with confidence and a positive perspective (Zakariya et al., 2022). Those possessing high self-efficacy are prone to setting ambitious academic goals and maintaining resilience in the face of challenges. Rather than perceiving setbacks as failures, they interpret them as opportunities for learning and personal development (Han & Geng, 2023). This heightened sense of self-efficacy facilitates efficient time management, empowering business students to organize their schedules effectively. Essentially, students who believe in their potential are inclined to opt for more challenging courses, potentially enhancing their overall academic performance (Hazzam & Wilkins, 2023). Accordingly, it is hypothesized that:

H4b. When students' learning is seamlessly integrated with technology (i.e., using ChatGPT), self-efficacy has a positive influence on academic performance.

Positive beliefs about the future cultivate a growth-oriented mindset (Kim & Jang, 2015). When business students hold the belief that their academic pursuits lead to promising opportunities and future successes, they are more inclined to engage in proactive learning actions such as seeking additional resources or participating in extracurricular activities. This dedication, rooted in the anticipation of long-term benefits, fosters consistent effort, deep engagement, and a commitment to continuous improvement, all of which collectively contribute to enhance academic performances (Liong et al., 2023; Salusky & Tull, 2021). Therefore, the hypothesis is formulated that:

H4c. When students' learning is seamlessly integrated with technology (i.e., using ChatGPT), beliefs about the future has a positive influence on academic performance.

3.5. The mediating role of motivational elements

The self-determination theory outlines a three-step process to comprehend self-determined behaviors: drivers of motivation, the motivational elements, and the outcomes stemming from those motivations (Deci & Ryan, 2000; Ryan & Deci, 2020). In this study, it is predicted that implementing ChatGPT in learning activities can influence business students' level of engagement and motivation, subsequently affecting their academic outcomes. ChatGPT, by offering tailored explanations (passive), responding to inquiries (active), and enabling enriched learning experiences (constructive and interactive), can amplify business students' interest and involvement in their studies. A motivated student typically exhibits a higher inclination to exert additional effort, delve into active learning, persevere against hurdles, and pursue in-depth comprehension (Han & Geng, 2023). Such behaviors can foster improved study habits, better retention of information, and ultimately, superior academic achievement (Hazzam & Wilkins, 2023; Salusky & Tull, 2021). Drawing on the self-determination theory, the following hypotheses are postulated:

H5a. The influence of technology integration in learning (i.e., using ChatGPT) on academic performance is mediated by desire for learning.

H5b. The influence of technology integration in learning (i.e., using ChatGPT) on academic performance is mediated by self-efficacy.

H5c. The influence of technology integration in learning (i.e., using ChatGPT) on academic performance is mediated by beliefs about the future.

3.6. The moderating role of epistemic curiosity

Epistemic curiosity refers to individuals' inherent emotional need to acquire knowledge and solve intellectual challenges, aiming to bridge the disparity between expected and actual understanding (Lee et al., 2022). This curiosity consists of two aspects: one is characterized by a joyful enthusiasm to explore (interest type), while the other stems from an urge to mitigate uncertainty (deprivation

type). Although they have distinct emphases, both are rooted in a fundamental craving for knowledge with an objective to fill knowledge voids (Cheng, 2023; Zedelius et al., 2022). Hence, having epistemic curiosity can bolster positive learning motivation among business students.

This research hypothesized that epistemic curiosity would moderate the relationships between technology integration in learning activities and motivational elements (i.e., desire for learning, self-efficacy, and beliefs about the future). First, epistemic curiosity can influence how business students perceive the relevance and value of technology integration. Those with pronounced epistemic curiosity might view technology as a personalized instrument that aligns with their learning preferences and affect, enabling in-depth explorations (Cheng, 2023; Junça-Silva & Silva, 2021). Such a bespoke learning approach can amplify motivation in diverse learning contexts (Huang et al., 2023).

Specifically, the natural inquisitiveness of business students leads them to delve deeper into ChatGPT's range of functions and potential uses. This immersive exploration could reveal novel and appealing learning styles, potentially amplifying their desire for learning (Gherghel et al., 2023; Molinillo et al., 2018). Moreover, this enhanced engagement, fueled by epistemic curiosity, augments the likelihood of fruitful tech experiences (Hwang, 2023). Such achievements can elevate their perceived competence (Ulfert-Blank & Schmidt, 2022). Furthermore, the intensified participation enables business students to recognize ChatGPT's efficacy as a learning tool, which is effective in preparing for future challenges. Based on the above reasonings, the following hypotheses are proposed:

H6a. The positive influence of technology integration in learning (i.e., using ChatGPT) on desire for learning is stronger when epistemic curiosity is high.

H6b. The positive influence of technology integration in learning (i.e., using ChatGPT) on self-efficacy is stronger when epistemic curiosity is high.

H6c. The positive influence of technology integration in learning (i.e., using ChatGPT) on beliefs about the future is stronger when epistemic curiosity is high.

Based on the abovementioned, the focus is on four distinct forms of overt student engagement (interactive, constructive, active, and passive) in technology-integrated learning activities. The objective is to discern students' motivational levels. Learning behaviors that are observable serve as a reflection of the students' internal attitudes. Students with lower motivation tend not to participate in interactive or constructive activities, whereas more motivated students are less inclined to be passive. Similarly, it is anticipated that students with higher motivation (characterized by a greater desire for learning, stronger self-efficacy, and more robust beliefs in the future) will show enhanced academic performance, while those with lower motivation are expected to have comparatively lower academic achievements. Motivational elements are believed to act as a connector between students' learning behaviors and their academic performance, serving to both mirror and internalize these behaviors, which then impact their overall academic outcomes. Finally, epistemic curiosity is anticipated to enhance the expression of students' internal attitudes, driven by their innate emotional inclination to seek knowledge and tackle intellectual challenges.

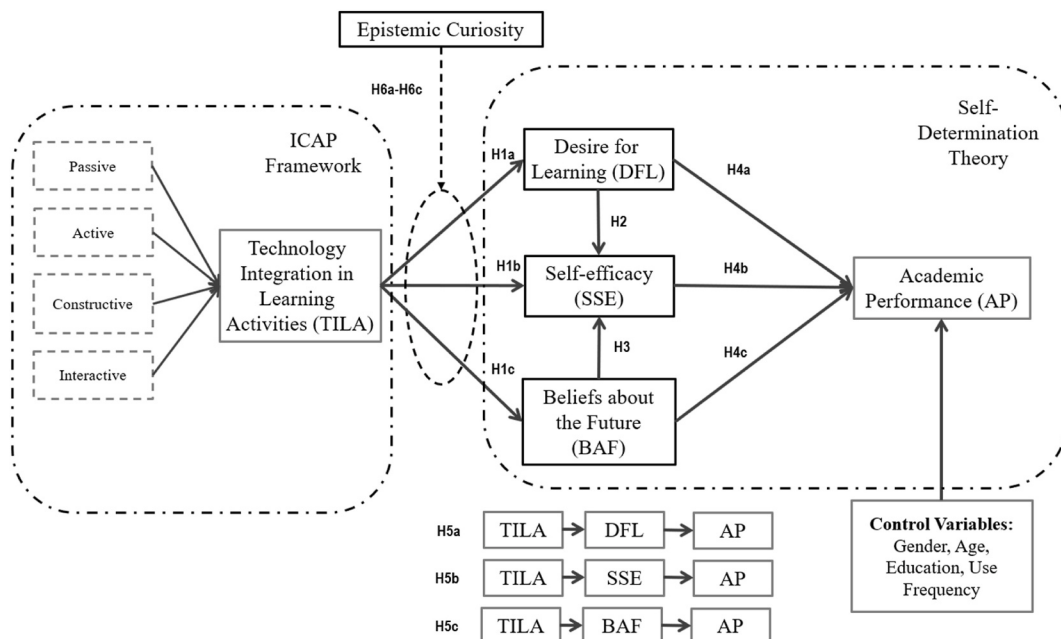


Fig. 1. Research model. Note: Dashed line box represents sub-dimensions of Technology Integration in Learning Activities.

3.7. Control variables

Several related prior research studies have indicated that demographic factors may impact individuals' learning outcomes and academic performance. For instance, females with fewer gender-biased beliefs tend to demonstrate a stronger inclination towards mastering information and communication technologies (Liong et al., 2023). University students in earlier academic years tend to exhibit greater emotional engagement in-class sessions, while their seniors allocate more time for self-directed study (Gherghel et al., 2023). When comparing college and high school students, the former places a higher premium on emotional gratification as a measure of their contentment with learning activities (Wu et al., 2023). Moreover, regular technology users show increased enthusiasm towards educational tasks (Grande et al., 2022). To mitigate potential distortions arising from these variables, this research incorporated four control factors, namely gender, age, education level, and technology use frequency. The research model is shown in Fig. 1.

4. Methodology

4.1. Data collection and sampling

The research employed purposive sampling for data collection, specifically targeting Chinese international students pursuing their degrees in the field of business-related studies at both private and public institutions in Malaysia. To ensure sufficient familiarity with the survey questions, this study exclusively focused on students who had utilized ChatGPT (i.e., ChatGPT 3.5) as a learning aid. The choice to focus on ChatGPT 3.5 instead of ChatGPT 4.0 was influenced by its cost-free availability, leading status in the AI domain, and its significant presence in the market across web and mobile platforms (Lim et al., 2023; Luo et al., 2023; Statista, 2023a).

Kuala Lumpur, the capital city, was selected as the sampling location for this study due to its status as Malaysia's most advanced city, attracting a significant portion of the 39,000 Chinese international students enrolled in Malaysia in 2022 (Statista, 2023b). This choice was made with the expectation that international students from China would provide unique insights and learning experiences when integrated with ChatGPT, given the potential for broader adoption of similar AI tools in China. The study sample was surveyed by distributing questionnaires via the *Wenjuanxing* platform, which is similar to Qualtrics, from June to August 2023. At the beginning of the questionnaire, a prominent notice is displayed, highlighting the limitations of using ChatGPT 3.5, including issues like hallucinations/accuracy, biases, and the currency of information. This is to ensure that students are aware that the knowledge they receive from ChatGPT might not always be accurate. Out of the 381 responses collected, 376 were deemed valid for data analysis after addressing issues related to straight-lining answers. Based on the guidelines of Hair et al. (2022), a sample size of 376 is adequate, significantly surpassing the estimation of 129 responses from the prior analysis with G*power 3.1 (involving 4 predictors, a 0.15 effect size, and 95 % power) (Faul et al., 2009).

4.2. Measures

The research employed established measures tailored to this study's context. The measurement scale incorporated two higher-order constructs (HOCs): technology integration in learning activities, encompassing interactive, constructive, active, and passive dimensions as outlined by Antonietti et al. (2023), as well as epistemic curiosity (Lee et al., 2022), including interest type and deprivation type. The desire for learning was assessed using the scale developed by Fisher and King (2010), self-efficacy was gauged with Hazzam and Wilkins's (2023) scale, and beliefs about the future were adapted from Kim and Jang (2015). Items related to academic performance were evaluated based on Islam's (2013) scale.

Before the actual data collection, the questionnaire underwent a pre-test with ten experts reviewing it for clarity and relevance. Based on their feedback, slight modifications were made. A pilot survey involving 60 Chinese international students who use ChatGPT was carried out before the main survey. The reliability and validity outcomes for the constructs were found to be acceptable, with composite reliability and loading exceeding 0.70, and average variance extracted surpassing 0.50, allowing for the initiation of the primary data gathering process.

4.3. Data analysis

This study employed the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach due to its predictive capabilities and proficiency in optimizing explained variance (Cheah, Magno, & Cassia, 2023; Wang, Cheah, et al., 2023), providing meaningful insights in the context of higher education (Barrett et al., 2021; Lee et al., 2022). The technique's capability to handle complex models, including higher-order constructs, mediation, and moderation, ensured dependable analytical outcomes (Becker et al., 2023; Sarstedt et al., 2019, 2020). The evaluations of both the measurement and structural models were performed using SmartPLS 4 (Cheah, Kersten, et al., 2023; Ringle et al., 2023).

5. Results

5.1. Profile of respondents

The majority of respondents were male (56.4 %), aged between 21 and 25 years old (39.6 %), held a bachelor's degree (76.9 %), and had a use frequency of ChatGPT about once a day (41.5 %). In addition, the primary reason for them to utilize ChatGPT is for

creative writing and storytelling, with 87.2 % of users reporting this. This is followed by transforming learning materials into quizzes (83.2 %), providing step-by-step explanations (71.5 %), practicing languages (69.9 %), delving into concepts (61.2 %), summarizing texts (56.4 %), brainstorming ideas (54.3 %), and note-taking (24.2 %) (see [Table 1](#)).

5.2. Common method bias (CMB)

Before collecting the data, measures were taken to reduce the Common Method Bias (CMB) by offering explicit instructions and using both five-point and seven-point Likert scales for exogenous and endogenous variables, respectively ([Podsakoff et al., 2012](#)). In the phase of post-data collection, the study used both the full collinearity method ([Kock & Lynn, 2012](#)) and Harman's single-factor approach to address concerns related to CMB. The full collinearity method's results demonstrated that the variance inflation factors (VIFs) for all constructs were below 3, with values between 1.190 and 1.363 ([Table 2](#)) ([Kock & Lynn, 2012](#)). Meanwhile, Harman's single-factor method indicated that only 32.53 % (less than 40 %) of the variance was accounted for by the primary factor ([Aguirre-Urreta & Hu, 2019](#)). These tests validated that CMB was not an issue in the study.

5.3. Reflective measurement model

Based on [Table 2](#), the reliability of the constructs was deemed satisfactory, as the composite reliability (CR) scores exceeded the recommended 0.70 threshold ([Hair & Sarstedt, 2019](#)). The data also confirmed convergent validity, with outer loadings surpassing 0.70 and the average variance extracted (AVE) values being above 0.50 ([Bagozzi et al., 1991](#); [Bagozzi & Yi, 1988](#); [Fornell & Larcker, 1981](#)). Discriminant validity was validated by the heterotrait-monotrait (HTMT) ratio, where all results were beneath the suggested 0.85 threshold as shown in [Table 3](#) ([Hair et al., 2022](#); [Henseler et al., 2015](#)).

5.4. Higher-order constructs (HOCs)

The HOCs were evaluated using a disjoint two-stage ([Becker et al., 2023](#); [Sarstedt et al., 2019](#)). The path coefficients of the technology integration in learning activities ($\beta = 0.789$) and epistemic curiosity ($\beta = 0.831$) demonstrated satisfactory convergent validity ([Cheah et al., 2018](#)). Each of the sub-dimensions had strong outer weights (above 0.30) and was statistically significant ($p < 0.01$), underscoring their significance in shaping the HOCs. In addition, there were no multicollinearity issues, with VIF values remaining under 3 ([Hair et al., 2022](#)). Hence, it can be concluded that it is reasonable to conceptualize technology integration in learning activities with four sub-dimensions (i.e., interactive, constructive, active, and passive) and epistemic curiosity with two sub-dimensions (i.e., interest type curiosity and deprivation type curiosity) (see [Table 4](#)).

Table 1
Respondent profile.

Characteristic	Item	Frequency (n = 387)	Percent (%)
Gender	Male	212	56.4
	Female	164	43.6
Age	20 years old and below	51	13.6
	21–25 years old	149	39.6
	26–30 years old	105	27.9
	31–35 years old	60	16
	36 years old and above	11	2.9
Education	Undergraduate degree (B.Sc., B.A. etc.)	289	76.9
	Master's degree (M.Sc., M.A., MBA etc.)	73	19.4
	Doctoral Degree (PhD, DBA etc.)	14	3.7
Frequency	Never use	6	1.6
	Less than once a week	11	2.9
	About once a week	36	9.6
	Several times a week	106	28.2
	About once a day	156	41.5
Purpose ^a	Several times a day	61	16.2
	Information gathering	201	53.5
	Language Practice	263	69.9
	Concept Exploration	230	61.2
	Brainstorm Ideas	204	54.3
	Step-by-step Explanation	269	71.5
	Turn the Learning Materials into Quizzes	313	83.2
	Summarization of Texts	212	56.4
	Note-taking	91	24.2
	Creative Writing and Storytelling	328	87.2

^a Note: Respondents can select all the purposes that apply to them in their usage of ChatGPT.

Table 2

Results of reliability, convergent validity, and full collinearity.

Construct	Item	Measurement Items	Outer Loading	CR	AVE
Technology Integration in Learning Activities		I can use ChatGPT			
<i>Interactive</i> (FC = 1.190)	INT1	To develop new knowledge together with others.	0.898	0.863	0.779
	INT2	To discuss different points of view with others.	0.891		
	INT3	To work on complex problems.	0.860		
<i>Constructive</i> (FC = 1.246)	CON1	To acquire new knowledge individually.	0.914	0.878	0.803
	CON2	To develop individual solutions for complex problems.	0.888		
	CON3	To become individually creative and produce something new.	0.886		
<i>Active</i> (FC = 1.266)	ACT1	To write down and record the knowledge imparted.	0.885	0.867	0.789
	ACT2	To actively repeat and practice the knowledge imparted.	0.885		
	ACT3	To solve simple tasks with the knowledge imparted.	0.895		
<i>Passive</i> (FC = 1.217)	PAS1	To inform about learning objectives and content.	0.896	0.849	0.762
	PAS2	To demonstrate learning content vividly.	0.855		
	PAS3	To explain learning content in a comprehensible way.	0.868		
Desire for learning (FC = 1.232)	DFL1	I want to learn new information.	0.853	0.948	0.702
	DFL2	I enjoy learning new information.	0.832		
	DFL3	I have a need to learn.	0.845		
	DFL4	I enjoy a challenge.	0.819		
	DFL5	I do not enjoy studying.	0.836		
	(R)				
	DFL6	I critically evaluate new ideas.	0.829		
	DFL7	I learn from my mistakes.	0.845		
	DFL8	I need to know why.	0.839		
Self-efficacy (FC = 1.258)	DFL9	When presented with a problem I cannot resolve, I will ask for assistance.	0.845	0.949	0.864
	SSE1	I usually receive excellent grades in classes.	0.933		
	SSE2	I usually understand the most complex material in classes.	0.921		
	SSE3	I do an excellent job on assignments and tests in classes.	0.931		
	SSE4	Considering the difficulty of courses, the lecturer, and my skills, I do well in classes.	0.933		
Beliefs about the future (FC = 1.363)	BAF1	I have the confidence I need to solve future problems.	0.844	0.900	0.710
	BAF2	I have confidence that I will be a useful person when I grow up.	0.839		
	BAF3	I do expect to get what I want.	0.852		
	BAF4	I can see that my future is pleasant.	0.836		
	BAF5	It is possible for me to be satisfied in the future.	0.840		
Epistemic Curiosity					
<i>Interest type curiosity</i> (FC = 1.308)	ITC1	I enjoy exploring new ideas.	0.924	0.952	0.860
	ITC2	I enjoy learning about subjects that are unfamiliar to me.	0.925		
	ITC3	I find it fascinating to learn new information.	0.919		
	ITC4	I enjoy learning something new and, to find out more about it.	0.940		
<i>Deprivation type curiosity</i> (FC = 1.310)	DTC1	I spend hours on a problem because I cannot rest without an answer.	0.909	0.937	0.835
	DTC2	Conceptual problems keep me awake thinking about solutions.	0.898		
	DTC3	I feel frustrated if I cannot figure out problems, so I work even harder.	0.921		
	DTC4	I work like a fiend at problems that I feel must be solved.	0.928		
Academic performance (FC = 1.261)	AP1	I anticipate good grades in such courses where ChatGPT is used heavily.	0.963	0.918	0.919
	AP2	I anticipate better grades in such courses where some of the in-class activities are replaced by ChatGPT-based activities.	0.954		

Note: FC = Full Collinearity; CR = Composite Reliability; AVE = Average Variance Extracted; (R) = Reverse-coded.

Table 3

Discriminant validity result using the Heterotrait-Monotrait (HTMT) ratio of correlations.

No	Construct	1	2	3	4	5	6	7	8	9	10
1	Academic Performance										
2	Active	0.287									
3	Belief about Future	0.364	0.359								
4	Constructive	0.353	0.417	0.415							
5	Deprivation Type Curiosity	0.345	0.400	0.310	0.360						
6	Desire for Learning	0.342	0.448	0.415	0.503	0.418					
7	Interactive	0.259	0.319	0.306	0.322	0.274	0.372				
8	Interest Type Curiosity	0.279	0.344	0.410	0.322	0.373	0.389	0.314			
9	Passive	0.375	0.230	0.315	0.339	0.355	0.428	0.244	0.270		
10	Student Self-efficacy	0.266	0.316	0.348	0.276	0.329	0.350	0.291	0.238	0.221	

5.5. Heterogeneity with control variables

As shown in Table 5, all the control variables (i.e., gender, age, education level, and use frequency, on academic performance) yielded non-significant results ($p > 0.05$), indicating negligible observed heterogeneity in this study.

5.6. Structural model

Multicollinearity was not a concern in the current research, as evidenced by the inner VIFs, which varied between 1.200 and 1.961 (Hair et al., 2022). To test the proposed hypotheses, the bootstrapping technique with 10,000 sub-samples was employed, with the results outlined in Table 5 (Becker et al., 2023). Specifically, desire for learning (H1a: $\beta = 0.358$; $p < 0.001$), self-efficacy (H1b: $\beta = 0.116$; $p < 0.05$), and beliefs about the future (H1c: $\beta = 0.268$; $p < 0.001$) were predicted by technology integration in learning activities. Surprisingly, desire for learning (H2: $\beta = 0.051$; $p = 0.219$) showed an insignificant relationship with self-efficacy, while a positive relationship was found for beliefs about the future (H3: $\beta = 0.120$; $p < 0.05$). Furthermore, desire for learning (H4a: $\beta = 0.194$; $p < 0.001$), self-efficacy (H4b: $\beta = 0.126$; $p < 0.05$), and beliefs about the future (H4c: $\beta = 0.228$; $p < 0.001$) had significant positive relationships with academic performance. For the mediation effect, desire for learning (H5a: $\beta = 0.069$; $p < 0.01$) (H5a) and beliefs about the future (H5c: $\beta = 0.061$; $p < 0.01$) significantly mediated the impacts of technology integration in learning activities on academic performance, while student self-efficacy (H5b: $\beta = 0.015$; $p = 0.228$) failed to show a mediation effect.

The moderation analysis illustrated that the interaction effects of epistemic curiosity $\times$ technology integration in learning activities significantly impacted desire for learning (H6a: $\beta = 0.327$; $p < 0.001$) and beliefs about the future (H6c: $\beta = 0.207$; $p < 0.001$) (Table 5). Stronger links between technology integration in learning activities and desire for learning as well as beliefs about the future were observed with higher levels of epistemic curiosity (Figs. 2 and 3). On the other hand, the interaction effect of epistemic curiosity $\times$ technology integration in learning activities on student self-efficacy (H6b: $\beta = 0.232$; $p < 0.001$) was not considered valid results based on the simple slope analysis.

The variable of technology integration in learning activities accounted for 44.7 %, 21.8 %, and 27.5 % of the variance in desire for learning, self-efficacy, and beliefs about the future respectively, while desire for learning, student self-efficacy, and beliefs about the future explained 17.8 % of the variance in academic performance. The $Q^2_{predict}$ values for desire for learning (0.404), student self-efficacy (0.168), beliefs about the future (0.249), and academic performance (0.147) were greater than zero, indicating the predictive relevance of the model (Chin et al., 2020; Shmueli et al., 2019). In addition, the findings from PLSpredict indicate a medium predictive power for academic performances (refer to Table 6).

6. Discussion and implications

6.1. Discussion of results

By integrating the ICAP framework and self-determination theory, the findings of this research highlight that the infusion of technology into learning activities significantly shapes motivational elements among business students. Notably, there is a positive impact on their desire for learning, self-efficacy, and beliefs about the future (H1a, H1b, and H1c were supported). Examination reveals that business students exhibit heightened motivation in AI-enhanced learning environments, particularly those emphasizing interactive and constructive learning methodologies (Antonietti et al., 2023; Bao et al., 2023; Wekerle et al., 2022). Specifically, the integration of ChatGPT into learning activities emerges as a key driver, elevating learning motivation while dismantling barriers that could impede academic success (Gherghel et al., 2023; Huang et al., 2023). Leveraging ChatGPT's capacity to personalize learning explanations, it functions as a continuous study companion, alleviating frustrations and establishing consistent study patterns (Kasneci et al., 2023; Lim et al., 2023). These adaptive and supportive learning contexts consistently enhance business students' interests and desire for learning, providing an optimal environment for grasping complex concepts (Kent et al., 2023).

Moreover, this research delves into the intricate relationships among various motivational elements, revealing unexpected patterns. Specifically, the connection between the desire for learning and self-efficacy yielded insignificance (H2 was not supported), while beliefs about the future exhibited marginal significance (H3 was supported). Notably, the impact of ChatGPT in stimulating

Table 4
Assessment of higher-order constructs.

Higher Order Construct	Lower Order Construct	Convergent Validity	Outer VIF	Outer Weights	t-value	p-value	Confidence Interval
Technology integration in learning activities	Interactive	0.789	1.144	0.435	10.735**	0.000	(0.358,0.516)
	Constructive		1.261	0.345	7.845**	0.000	(0.256,0.429)
	Active		1.205	0.393	9.072**	0.000	(0.307,0.477)
	Passive		1.122	0.308	7.478**	0.000	(0.227,0.389)
Epistemic curiosity	Interest type curiosity	0.831	1.141	0.613	15.257**	0.000	(0.530,0.690)
	Deprivation type curiosity		1.141	0.604	15.395**	0.000	(0.524,0.678)

Note: ** $p < 0.001$, VIF = Variance Inflation Factor.

Table 5
Results of structural model.

Path Relationship	Std. Beta	Std. Error	t-value	p-value	CI	VIF	f ²	R ²	Q ² _predict
H1a: TILA - > DFL	0.358	0.048	7.483	0.000**	(0.287,0.442)	1.646	0.141(S)	0.447	0.404
H1b: TILA - > SSE	0.116	0.065	1.775	0.038*	(0.012,0.226)	1.961	0.009(T)	0.218	0.168
H1c: TILA - > BAF	0.268	0.056	4.773	0.000**	(0.181,0.363)	1.646	0.060(S)	0.275	0.249
H2: DFL - > SSE	0.051	0.066	0.776	0.219	(-0.052,0.162)	1.815	0.002(T)		
H3: BAF - > SSE	0.120	0.061	1.975	0.024*	(0.020,0.221)	1.383	0.013(T)		
H4a: DFL - > AP	0.194	0.055	3.546	0.000**	(0.103,0.282)	1.277	0.036(S)	0.178	0.147
H4b: SSE - > AP	0.126	0.057	2.217	0.013*	(-0.030,-0.217)	1.200	0.016(T)		
H4c: BAF - > AP	0.228	0.052	4.346	0.000**	(0.143,0.315)	1.258	0.050(S)		
H5a: TILA - > DFL - > AP	0.069	0.023	3.056	0.002**	(0.029,0.118)				
H5b: TILA - > SSE - > AP	0.015	0.012	1.204	0.228	(-0.001,0.044)				
H5c: TILA - > BAF - > AP	0.061	0.020	2.992	0.003**	(0.027,0.107)				
H6a: Epistemic Curiosity x TILA - > DFL	0.327	0.048	6.805	0.000**	(0.224,0.414)				
H6b: Epistemic Curiosity x TILA - > SSE	0.232	0.058	3.971	0.000**	(0.112,0.342)				
H6c: Epistemic Curiosity x TILA - > BAF	0.207	0.053	3.882	0.000**	(0.097,0.305)				
Control variables									
Gender - > AP	-0.172	0.098	1.767	0.077	(-0.357,0.025)				
Age - > AP	0.021	0.046	0.447	0.655	(-0.069,0.113)				
Education - > AP	0.091	0.047	1.955	0.051	(-0.001,0.182)				
Discipline - > AP	0.031	0.096	0.322	0.747	(-0.158,0.216)				
Use Frequency - > AP	0.033	0.054	0.614	0.539	(-0.072,0.136)				

Note: *p < 0.05; **p < 0.01; TILA = technology integration in learning activities; DFL = desire for Learning; SSE = student self-efficacy; BAF = belief about the future; AP = academic performance; CI = confidence interval; effect size: S = small; M = medium; L = large.

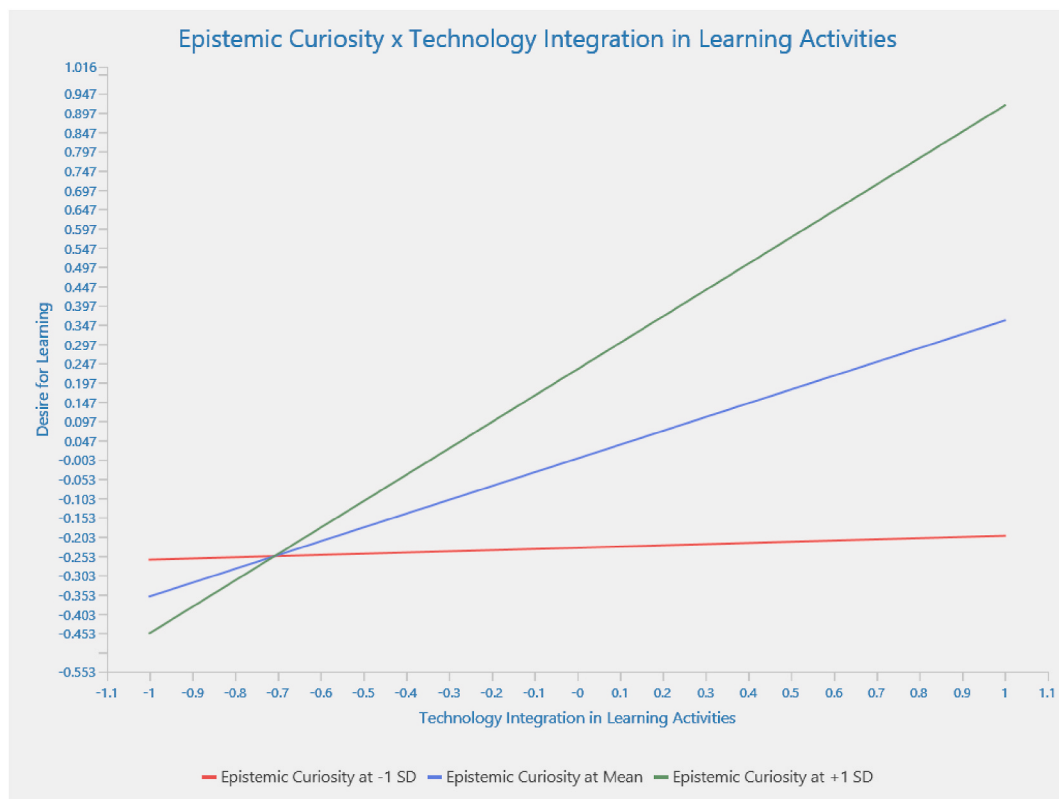


Fig. 2. Epistemic curiosity*technology integration in learning activities on desire for learning.

business students' interest in learning introduces an intriguing nuance, as its efficacy may inadvertently trigger "imposter syndrome" in learners. This phenomenon manifests when students attribute their achievements to the AI tool rather than recognizing their own efforts (Breeze, 2018). Contrary to this, a robust belief in a promising future emerges as a potent driver, compelling business students to refine essential skills. This, in turn, enhances their confidence and self-efficacy in academic pursuits (Davies & Ercolani, 2021; Salusky & Tull, 2021). While ChatGPT plays a pivotal role in motivation, it is crucial to navigate potential challenges associated with the

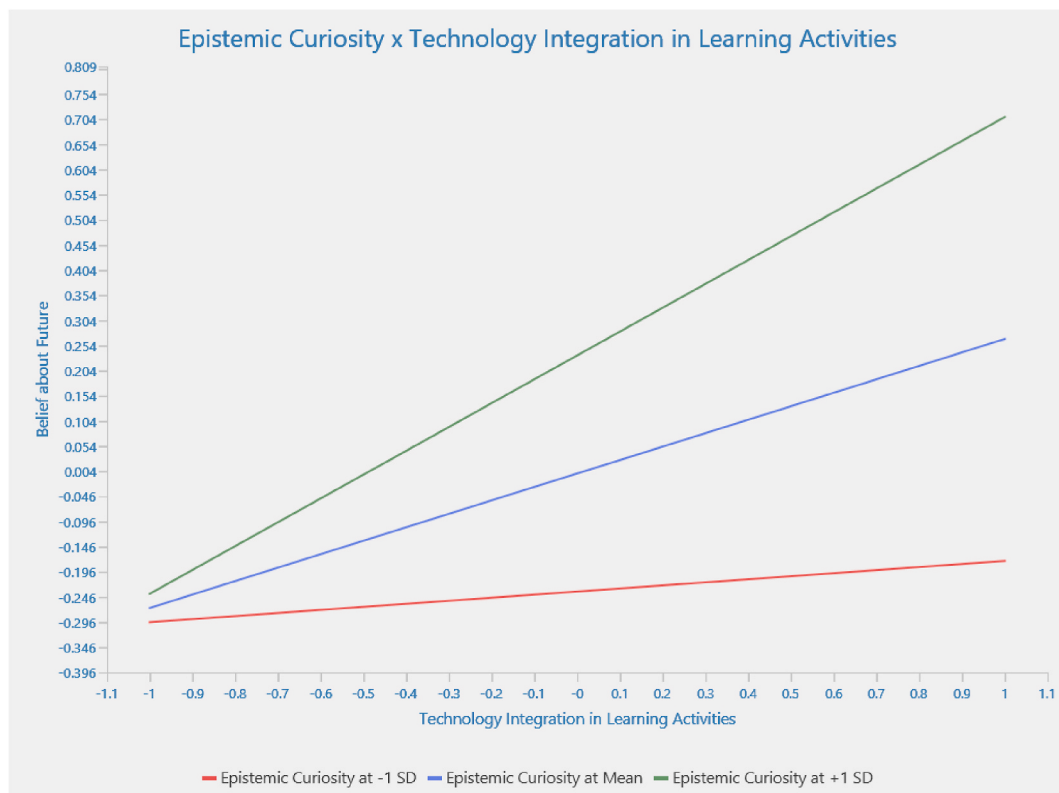


Fig. 3. Epistemic curiosity*technology integration in learning activities on belief about the future.

Table 6

Assessment of PLS predict.

Item	$Q^2_{predict}$	PLS		LM		PLS-LM		Predictive Power
		RMSE	MAE	RMSE	MAE	RMSE	MAE	
AP1	0.138	1.559	1.258	1.538	1.251	0.021	0.007	Medium
AP2	0.132	1.560	1.276	1.551	1.285	0.009	-0.009	

Note: AP = academic performance.

perceived source of achievement.

Grounded in the self-determination theory, self-determined behaviors manifest when individuals perceive certain activities as advantageous opportunities (Gaggioli et al., 2017). Business students immersed in AI-integrated educational experiences tend to exhibit elevated perceptions of motivation, encompassing the desire for learning, self-efficacy, and beliefs about the future, which correlate with enhanced academic achievements (H4a, H4b, and H4c were supported). These findings underscore the positive impacts of various motivational elements on intentional behaviors, specifically academic performance, aligning closely with previous research (Huang et al., 2023; Wu et al., 2023). A heightened desire for learning typically stimulates deeper comprehension, improved retention, and practical application of information (Agonács et al., 2020; Grande et al., 2022; Kim & Jang, 2015). Business students driven by passion are naturally inclined to invest greater effort, a commitment that often translates to higher academic marks.

Furthermore, high self-efficacy is associated with superior academic achievement, refined problem-solving skills, and increased resilience against challenges (Han & Geng, 2023; Hazzam & Wilkins, 2023). Business students with a positive outlook on their future aspirations tend to set higher goals, strategize more effectively, and dedicate themselves more profoundly to their academic journey (Liong et al., 2023; Salusky & Tull, 2021). This forward-looking mindset acts as a powerful motivator, propelling business students to attain the necessary qualifications and expertise for their prospective professional goals.

Also, the self-determination theory posits that intrinsic and autonomous extrinsic motivations act as intermediaries for ChatGPT-integrated learning activities and self-determined behaviors (Deci & Ryan, 2000; Ryan & Deci, 2020). In alignment with this theory, this study reveals that motivational elements of business students, such as the desire for learning and beliefs about the future, play mediating roles in the relationship between technology integration in learning activities and academic performances (H5a and H5c were supported). This finding echo results from Wu et al. (2023), suggesting that business students, upon immersion in

ChatGPT-enhanced learning environments, cultivate specific motivations that subsequently shape their academic behaviors and outcomes. Intriguingly, the mediating role of student self-efficacy was found to be non-significant (H5b was not supported), deviating from conventional findings (Han & Geng, 2023). As mentioned earlier, the emergence of “imposter syndrome” might impede the development of student self-efficacy, potentially attributed to ChatGPT’s prowess as an external factor rather than recognized internally, hindering its role as a connective factor between technology integration and academic success.

This study further explores the moderating effect of epistemic curiosity in reinforcing positive relationships between technology integration in learning activities and business students’ motivational elements (i.e., desire for learning and beliefs about the future) (H6a and H6c were supported). Business students with strong epistemic curiosity perceive technology as an asset that enhances their learning, subsequently expanding their future prospects. In these instances, technology acts as a catalyst, facilitating the satisfaction of their inquisitiveness and elevating both their passion for learning and optimism about the future (Hwang, 2023; Lee et al., 2022; Liong et al., 2023). However, epistemic curiosity did not appear to influence the positive relationship between technology integration in learning activities and students’ self-efficacy (H6b was not supported), as indicated by the results of the simple slope test. One possible explanation for this unexpected finding is the rapid feedback provided by ChatGPT to inquiries. While this swift response aids accelerated learning, it may deprive business students of the typical learning progression involving grappling with challenges, delving deeper, and finally attaining comprehension—a process that typically elevates self-efficacy (Kasneji et al., 2023; Lim et al., 2023). In essence, whether a business student is inherently curious or not, the journey of obtaining answers, crucial for self-efficacy development, is expedited. Thus, the moderating effect of this curiosity becomes less evident. This lack of significance indicates that simply being curious might not suffice to alter long-established views about one’s capabilities. As explained by Bandura’s (2001), self-efficacy is a deeply rooted belief system that is often resistant to alteration through indirect interventions. Therefore, the effect of technology integration in learning activities on students’ self-efficacy is not easily swayed by external factors and is challenging to extend to other aspects.

6.2. Theoretical implications

This research examines the relevance of the ICAP framework (Chi et al., 2018; Chi & Wylie, 2014) within ChatGPT-integrated learning, shedding light on the process of integrating technology into tangible learning activities. In particular, the study takes a quantitative approach, uniquely focusing on the experiences of business students, in contrast to the predominantly qualitative emphasis on teachers’ perspectives in the existing literature (Consoli et al., 2023; Wekerle et al., 2022). Employing the self-determination theory (Deci & Ryan, 2000; Ryan & Deci, 2020), this research evaluates how the integration of technology in learning activities influences business students’ motivational elements (i.e., desire for learning, self-efficacy, and beliefs about the future), subsequently impacting their academic outcomes. Through this holistic approach, the study provides deeper insights into factors influencing business students’ technology integration in observable learning activities, motivational elements, and academic achievements.

Moreover, this study contributes to the literature by expanding understandings of the mediating role of motivational elements (i.e., desire for learning and beliefs about the future) in shaping business students’ academic performances. While prior studies predominantly focused on emotional factors as direct precursors to academic achievements (Antonietti et al., 2023; Wekerle et al., 2022), this research delves deeper into the mediating roles these emotional or motivational elements play between tech-integrated learning and academic results. A notable revelation is the unexpected insignificance of self-efficacy as an intermediary, diverging from patterns observed in previous studies (Han & Geng, 2023). This raises intriguing questions about the potential influence of the “imposter syndrome,” where business students might attribute their successes predominantly to ChatGPT, potentially diminishing their own capabilities and efforts (Breeze, 2018). Such insights prompt essential considerations regarding ChatGPT’s exact role in AI-enhanced educational settings, especially when compared to previous technology implementations where the technology served as an adjunct, ensuring the student remained the primary beneficiary (Huang et al., 2023; Wang, Liu, et al., 2023). These findings underscore the urgent need for future studies to adopt a broader perspective, moving beyond merely examining direct correlations to recognizing the intricate mediating roles of motivational elements.

Lastly, the current study confirms the potential contingent effect of epistemic curiosity on some of students’ motivational elements (i.e., desire for learning and beliefs about the future) when integrating ChatGPT into business students’ learning activities. The observation of an insignificant moderating effect on students’ self-efficacy underscores the importance of a more in-depth investigation into business students’ unique encounters and personal narratives within ChatGPT-integrated learning contexts.

6.3. Practical implications

The findings of this study can provide significant implications to three major parties, including students, educators and academic institutions.

(i) For business students:

Business students are strongly advised to employ a diverse range of engagement methods when utilizing ChatGPT as a learning aid. This involves transitioning from passive information absorption, such as seeking definitions or explanations, to more active forms of interaction. Examples include posing thought-provoking questions, constructively summarizing complex topics, and initiating interactive discussions. This multifaceted approach not only enriches the learning experience but also nurtures critical thinking skills and a

deeper understanding of the subject matter. While ChatGPT serves as a powerful tool for learning and knowledge acquisition, business students should exercise discernment in deciding when to rely on it and when to independently challenge their understanding. Achieving the right balance between using AI-driven assistance and independently grappling with academic challenges is paramount for holistic skill development.

Moreover, it is crucial for business students to recognize that motivational elements, although often correlated with academic success, are not always interdependent. A student may demonstrate enthusiasm for learning but maintain a pessimistic outlook regarding their future prospects, or vice versa. Understanding the nuanced relationships between various motivational elements empowers business students to identify their individual needs and preferences. This, in turn, enables them to seek the right tools or assistance, ensuring that their academic progression is attributed not solely to external aids but also to the cultivation of their internal capabilities. In essence, the effective utilization of ChatGPT as a learning tool extends beyond harnessing its capabilities. It involves developing a holistic and self-aware approach to learning that encompasses motivation, critical thinking, and the judicious use of external resources.

(ii) For educators:

The integration of technology undoubtedly forms a promising foundation for modern education, but its true impact is realized when it becomes a catalyst for enhancing essential motivational elements in business students. In this dynamic landscape, educators shoulder the critical responsibility of crafting customized tools and strategies designed to identify and leverage the distinct motivational profiles of each student. By doing so, educators can offer individualized educational support that not only addresses academic needs but also nurtures and sustains intrinsic motivation to learn among business students.

In the current era where the role of epistemic curiosity is increasingly acknowledged, educators must confront the challenge of discerning varying degrees of curiosity exhibited by business students in their interactions with ChatGPT and other AI-driven learning tools. This necessitates the incorporation of assessment tools within ChatGPT interfaces and similar platforms, enabling educators to accurately gauge and measure student curiosity levels. Armed with this information, educators can fine-tune the depth and scope of AI-student dialogues, tailoring the learning experience to match each student's individual curiosity and inquiry preferences.

However, as educators embrace the potential of ChatGPT and similar technologies, measured reliance is vital. Striking a delicate balance is crucial. While AI-driven tools like ChatGPT can undoubtedly enhance learning outcomes, they should complement rather than replace traditional teaching methods. The integration of ChatGPT with other enriching learning modalities, such as in-class discussions, problem-solving activities, collaborative projects, and hands-on experiments, remains paramount. This holistic approach not only promotes analytical thought but also fosters collaborative efforts, critical thinking, and the development of essential skills beyond information retrieval. It is imperative to note that the future of education lies in the hands of educators who can leverage technology to unlock the full potential of their business students while maintaining a holistic and balanced approach to teaching and learning.

(iii) For academic institutions (e.g., universities):

Institutions of higher learning should not view technology integration as a mere add-on; rather, it should be considered a fundamental element that, when seamlessly aligned with business students' motivational factors, has the potential to significantly enhance academic outcomes. It is imperative for institutions to champion teaching methods that not only incorporate technology but also cater to the emotional and mental well-being of business students. By establishing and maintaining robust feedback channels, academic institutions can systematically evaluate the impact of ChatGPT and similar technologies on business students' motivation. Equipped with valuable insights from these assessments, institutions can strategically optimize the integration of ChatGPT into their curricula. The objective should extend beyond treating ChatGPT solely as a sophisticated tool for information retrieval; it should encompass maximizing its capacity to ignite students' intrinsic desire for learning and nurturing a hopeful outlook on their academic journey. Both of these elements are foundational pillars of academic excellence and overall student development.

Similar to other stakeholders, academic institutions should advocate for a balanced approach where technology serves as an enhancement rather than a replacement for traditional teaching practices. This involves leveraging technology to create engaging and interactive learning experiences while preserving essential human aspects of education, such as mentorship, guidance, and the cultivation of critical thinking skills. By embracing this holistic approach, institutions can ensure that technology, like ChatGPT, contributes meaningfully to the holistic development and success of their students.

7. Conclusion and future research directions

In today's swiftly evolving educational landscape, leveraging AI, specifically ChatGPT, is indispensable for business students aspiring to enrich their learning experiences and attain academic excellence (Kasneci et al., 2023; Lim et al., 2023). This research amalgamates the principles of the ICAP framework with the self-determination theory, delineating a comprehensive progression of learning activities with ChatGPT. It delves into observable learning behaviors, student motivation, and eventual learning outcomes, thereby extending the applicability of both theories. To optimize the advantages of technology integration in learning, it is crucial to underscore four distinct learning modalities: interactive, constructive, active, and passive. When deployed effectively, technology can ignite a business student's passion for learning, enhance their confidence, and amplify their future aspirations—elements critical for academic success. Additionally, this research underscores that epistemic curiosity can enhance the benefits of positive tech-integrated

learning experiences, particularly in nurturing a business student's desire for learning and future aspirations.

However, this study is not without its limitations, pointing towards areas that warrant further exploration. Firstly, the research employs a cross-sectional design. While the presented framework implies a sequential and causal relationship, a more thorough investigation of these relationships is essential, necessitating the use of longitudinal or experimental designs. Additionally, the intricate dynamics between various motivational elements call for deeper scrutiny. This prompts questions about whether educators should perceive these motivational elements as distinct pillars or as part of an integrated spectrum (Ryan & Deci, 2020). Moreover, the non-significant results regarding students' self-efficacy, both in mediating and moderating effects, suggest potential challenges related to "imposter syndrome" when interacting with ChatGPT. The readily available answers from ChatGPT may hinder confidence-building processes and self-efficacy development (Wang, Liu, et al., 2023). Future studies could explore the theory of behavioral control, delving into the non-significant effect and comparing covert behavioral controls like self-efficacy with more overt ones, such as the affordability of premium versions of GAI (e.g., ChatGPT 4.0) or other GAI platforms (e.g., Google Bard, Gemini). In-depth scrutiny into the dynamics of self-efficacy within ChatGPT-integrated learning environments holds promise for maximizing its benefits for learners. Lastly, a notable limitation of our investigation into the incorporation of Generative AI, specifically ChatGPT, in educational activities, is the reliance on the veracity of the generated content and students' capacity for critical evaluation. While the construct of epistemic curiosity in the current framework provides an initial understanding, it may not fully encompass the breadth of cognitive and metacognitive processes involved. Future inquiries could benefit from integrating more nuanced constructs such as cognitive flexibility and information literacy to offer a comprehensive understanding of how learners interact with and evaluate AI-generated content, thereby providing deeper insights into the pedagogical implications of Generative AI in educational settings.

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CRediT authorship contribution statement

Ziyi Gao: Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Jun-Hwa Cheah:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Xin-Jean Lim:** Writing – review & editing, Validation, Conceptualization. **Xi Luo:** Writing – review & editing, Validation.

Declaration of competing interest

The authors declare no conflicts of interest in the current study.

Data availability

Data will be made available on request.

References

- Agonács, N., Matos, J. F., Bartalesi-Graf, D., & O'Steen, D. N. (2020). Are you ready? Self-Determined learning readiness of language MOOC learners. *Education and Information Technologies*, 25(2), 1161–1179. <https://doi.org/10.1007/s10639-019-10017-1>
- Aguiire-Urreta, M. I., & Hu, J. (2019). Detecting common method bias: Performance of the Harman's single-factor test. *Data Base for Advances in Information Systems*, 50(2), 45–70. <https://doi.org/10.1145/3330472.3330477>
- Ali, O., Murray, P. A., Momin, M., Dwivedi, Y. K., & Malik, T. (2024). The effects of artificial intelligence applications in educational settings: Challenges and strategies. *Technological Forecasting and Social Change*, 199. <https://doi.org/10.1016/j.techfore.2023.123076>
- Ameen, N., Tarba, S., Cheah, J. H., Xia, S., & Sharma, G. D. (2024). Coupling artificial intelligence capability and strategic agility for enhanced product and service creativity. *British Journal of Management*. <https://doi.org/10.1111/1467-8551.12797>. Advanced online publication.
- Anderman, E. M., & Gray, D. L. (2015). Motivation, learning, and instruction. In *International encyclopedia of the social & behavioral sciences* (2nd ed., pp. 928–935). Elsevier Inc. <https://doi.org/10.1016/B978-0-08-097086-8.26041-8>.
- Antonietti, C., Schmitz, M. L., Consoli, T., Cattaneo, A., Gonon, P., & Petko, D. (2023). Development and validation of the ICAP Technology Scale to measure how teachers integrate technology into learning activities. *Computers and Education*, 192, Article 104648. <https://doi.org/10.1016/j.compedu.2022.104648>
- Backfisch, I., Lachner, A., Stürmer, K., & Scheiter, K. (2021). Variability of teachers' technology integration in the classroom: A matter of utility. *Computers and Education*, 166. <https://doi.org/10.1016/j.compedu.2021.104159>
- Baek, T. H., & Kim, M. (2023). Is ChatGPT scary good? How user motivations affect creepiness and trust in generative artificial intelligence. *Telematics and Informatics*, 83, Article 102030. <https://doi.org/10.1016/j.tele.2023.102030>
- Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, 16(1), 74–94. <https://doi.org/10.1007/BF02723327>
- Bagozzi, R. P., Yi, Y., & Phillips, L. W. (1991). Assessing construct validity in organizational research. *Administrative Science Quarterly*, 36(3), 421–458. <https://doi.org/10.2307/2393203>
- Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, 52, 1–26. <https://doi.org/10.1146/annurev.psych.52.1.1>
- Bao, D. Q., Phong, N. D., & Tho, N. D. (2023). Co-creation in higher education and quality of college life: The roles of students' co-creation effort, interactions, and mindfulness. *International Journal of Management in Education*, 21(3), Article 100862. <https://doi.org/10.1016/j.ijme.2023.100862>
- Barrett, A. J., Pack, A., & Quaid, E. D. (2021). Understanding learners' acceptance of high-immersion virtual reality systems: Insights from confirmatory and exploratory PLS-SEM analyses. *Computers and Education*, 169, Article 104214. <https://doi.org/10.1016/j.compedu.2021.104214>
- Becker, J. M., Cheah, J. H., Gholamzade, R., Ringle, C. M., & Sarstedt, M. (2023). PLS-SEM's most wanted guidance. *International Journal of Contemporary Hospitality Management*, 35(1), 321–346. <https://doi.org/10.1108/IJCHM-04-2022-0474>

- Breeze, M. (2018). Imposter syndrome as a public feeling. In Y. Taylor, & K. Lahad (Eds.), *Feeling academic in the neoliberal university* (pp. 191–219). Springer International Publishing. https://doi.org/10.1007/978-3-319-64224-6_9.
- Bryant, J., Child, F., Dorn, E., & Hall, S. (2020). *New global data reveal education technology's impact on learning*. Retrieved 20 August 2023 from: <https://www.mckinsey.com/industries/education/our-insights/new-global-data-reveal-education-technologys-impact-on-learning>.
- Cheah, J. H., Kersten, W., Ringle, C. M., & Wallenburg, C. (2023). Guest editorial: Predictive modeling in logistics and supply chain management research using partial least squares structural equation modeling. *International Journal of Physical Distribution & Logistics Management*, 53(7/8), 709–717. <https://doi.org/10.1108/IJPDLM-08-2023-552>
- Cheah, J. H., Magno, F., & Cassia, F. (2023). Reviewing the SmartPLS 4 software: The latest features and enhancements. *Journal of Marketing Analytics*. <https://doi.org/10.1057/s41270-023-00266-y>
- Cheah, J. H., Sarstedt, M., Ringle, C. M., Ramayah, T., & Ting, H. (2018). Convergent validity assessment of formatively measured constructs in PLS-SEM: On using single-item versus multi-item measures in redundancy analyses. *International Journal of Contemporary Hospitality Management*, 30(11), 3192–3210. <https://doi.org/10.1108/IJCHM-10-2017-0649>
- Cheng, K. H. (2023). An epistemic curiosity-evoking model for immersive virtual reality narrative reading: User experience and the interaction among epistemic curiosity, transportation, and attitudinal learning. *Computers and Education*, 201, Article 104814. <https://doi.org/10.1016/j.compedu.2023.104814>
- Chi, M. T. H. (2009). Active-constructive-interactive: A conceptual framework for differentiating learning activities. *Topics in Cognitive Science*, 1(1), 73–105. <https://doi.org/10.1111/j.1756-8765.2008.01005.x>
- Chi, M. T. H., Adams, J., Bogusch, E. B., Bruchok, C., Kang, S., Lancaster, M., Levy, R., Li, N., McEldeen, K. L., Stump, G. S., Wylie, R., Xu, D., & Yaghmourian, D. L. (2018). Translating the ICAP theory of cognitive engagement into practice. *Cognitive Science*, 42(6), 1777–1832. <https://doi.org/10.1111/cogs.12626>
- Chi, M. T. H., & Wylie, R. (2014). The ICAP framework: Linking cognitive engagement to active learning outcomes. *Educational Psychologist*, 49(4), 219–243. <https://doi.org/10.1080/00461520.2014.965823>
- Chien, Y. T., Chang, Y. H., & Chang, C. Y. (2016). Do we click in the right way? A meta-analytic review of clicker-integrated instruction. *Educational Research Review*, 17, 1–18. <https://doi.org/10.1016/j.edurev.2015.10.003>
- Chin, W., Cheah, J. H., Liu, Y., Ting, H., Lim, X. J., & Cham, T. H. (2020). Demystifying the role of causal-predictive modeling using partial least squares structural equation modeling in information systems research. *Industrial Management and Data Systems*, 120(12), 2161–2209. <https://doi.org/10.1108/IMDS-10-2019-0529>
- Choi, E. P. H., Lee, J. J., Ho, M. H., Kwok, J. Y. Y., & Lok, K. Y. W. (2023). Chatting or cheating? The impacts of ChatGPT and other artificial intelligence language models on nurse education. *Nurse Education Today*, 125. <https://doi.org/10.1016/j.nedt.2023.105796>, 105796–105796.
- Consoli, T., Désiron, J., & Cattaneo, A. (2023). What is “technology integration” and how is it measured in K-12 education? A systematic review of survey instruments from 2010 to 2021. *Computers and Education*, 197, Article 104742. <https://doi.org/10.1016/j.compedu.2023.104742>
- Davies, P., & Ercolani, M. G. (2021). Gender, motivation and labour market beliefs in higher education choices. *Higher Education*, 82(1), 127–144. <https://doi.org/10.1007/s10734-020-00625-z>
- Deci, E. L., & Ryan, R. M. (2000). The “what” and “why” of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01
- Duong, C. D., Vu, T. N., & Ngo, T. V. N. (2023). Applying a modified technology acceptance model to explain higher education students' usage of ChatGPT: A serial multiple mediation model with knowledge sharing as a moderator. *International Journal of Management in Education*, 21(3). <https://doi.org/10.1016/j.ijme.2023.100883>
- Dwivedi, Y. K., Rana, N. P., Tamilmanni, K., & Raman, R. (2020). A meta-analysis based modified unified theory of acceptance and use of technology (meta-UTAUT): A review of emerging literature. *Current Opinion in Psychology*, 36, 13–18. <https://doi.org/10.1016/j.copsyc.2020.03.008>
- Fütterer, T., Scheiter, K., Cheng, X., & Stürmer, K. (2022). Quality beats frequency? Investigating students' effort in learning when introducing technology in classrooms. *Contemporary Educational Psychology*, 69, Article 102042. <https://doi.org/10.1016/j.cedpsych.2022.102042>
- Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2023). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education & Teaching International*, 1–15. <https://doi.org/10.1080/14703297.2023.2195846>
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, 41(4), 1149–1160. <https://doi.org/10.3758/BRM.41.4.1149>
- Fisher, M. J., & King, J. (2010). The self-directed learning readiness scale for nursing education revisited: A confirmatory factor analysis. *Nurse Education Today*, 30(1), 44–48. <https://doi.org/10.1016/j.nedt.2009.05.020>
- Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of Marketing Research*, 18(3), 382. <https://doi.org/10.2307/3150980>
- Gaggioli, A., Riva, G., Peters, D., & Calvo, R. A. (2017). Positive technology, computing, and design: Shaping a future in which technology promotes psychological well-being. In *Emotions and affect in human factors and human-computer interaction* (pp. 477–502). <https://doi.org/10.1016/B978-0-12-801851-4.00018-5>
- Gherghel, C., Yasuda, S., & Kita, Y. (2023). Interaction during online classes fosters engagement with learning and self-directed study both in the first and second years of the COVID-19 pandemic. *Computers and Education*, 200, Article 104795. <https://doi.org/10.1016/j.compedu.2023.104795>
- Grande, R. A. N., Berdida, D. J. E., Cruz, J. P., Cometa-Manalo, R. J., Balace, A. B., & Ramirez, S. H. (2022). Academic motivation and self-directed learning readiness of nursing students during the COVID-19 pandemic in three countries: A cross-sectional study. *Nursing Forum*, 57(3), 382–392. <https://doi.org/10.1111/nurf.12698>
- Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2022). *A primer on partial Least Squares structural equation modeling (PLS-SEM)* (3rd ed.). Sage Publications. <https://doi.org/10.1007/978-3-030-80519-7>
- Hair, J. F., & Sarstedt, M. (2019). Factors versus composites: Guidelines for choosing the right structural equation modeling method. *Project Management Journal*, 50(6), 619–624. <https://doi.org/10.1177/8756972819882132>
- Han, J., & Geng, X. (2023). University students' approaches to online learning technologies: The roles of perceived support, affect/emotion and self-efficacy in technology-enhanced learning. *Computers and Education*, 194, Article 104695. <https://doi.org/10.1016/j.compedu.2022.104695>
- Hazzam, J., & Wilkins, S. (2023). The influences of lecturer charismatic leadership and technology use on student online engagement, learning performance, and satisfaction. *Computers and Education*, 200, Article 104809. <https://doi.org/10.1016/j.compedu.2023.104809>
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115–135. <https://doi.org/10.1007/s11747-014-0403-8>
- Huang, A. Y. Q., Lu, O. H. T., & Yang, S. J. H. (2023). Effects of artificial Intelligence-Enabled personalized recommendations on learners' learning engagement, motivation, and outcomes in a flipped classroom. *Computers and Education*, 194, Article 104684. <https://doi.org/10.1016/j.compedu.2022.104684>
- Hwang, Y. (2023). When makers meet the metaverse: Effects of creating NFT metaverse exhibition in maker education. *Computers and Education*, 194, Article 104693. <https://doi.org/10.1016/j.compedu.2022.104693>
- Islam, A. K. M. N. (2013). Investigating e-learning system usage outcomes in the university context. *Computers and Education*, 69, 387–399. <https://doi.org/10.1016/j.compedu.2013.07.037>
- Ivanov, S., & Soliman, M. (2023). Game of algorithms: ChatGPT implications for the future of tourism education and research. *Journal of Tourism Futures*, 9(2), 214–221. <https://doi.org/10.1108/JTF-02-2023-0038>
- Junça-Silva, A., & Silva, D. (2021). Curiosity did not kill the cat: It made it stronger and happy, but only if the cat was not “dark.”. *Acta Psychologica*, 221, Article 13444. <https://doi.org/10.1016/j.actpsy.2021.103444>
- Kang, D., & Park, M. J. (2023). Learner innovativeness, course interaction, and the use of a new educational technology system after the COVID-19 pandemic. *International Journal of Management in Education*, 21(3), Article 100824. <https://doi.org/10.1016/j.ijme.2023.100824>
- Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., ... Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, 103, Article 102274. <https://doi.org/10.1016/j.lindif.2023.102274>

- Kent, J., Tilton, J., Lewis, M., & Pipes, J. (2023). Client-based student consulting: Insights for course design and delivery. *International Journal of Management in Education*, 21(3), Article 100854. <https://doi.org/10.1016/j.ijme.2023.100854>
- Kim, H. J., & Jang, H. Y. (2015). Factors influencing students' beliefs about the future in the context of tablet-based interactive classrooms. *Computers and Education*, 89, 1–15. <https://doi.org/10.1016/j.compedu.2015.08.014>
- Kock, N., & Lynn, G. S. (2012). Latent collinearity and misleading results in variance-based SEM: An illustration and recommendations. *Journal of the Association for Information Systems*, 13(7), 546–580. <https://doi.org/10.17705/1jais.00302>
- Lee, S. W. Y., Hsu, Y. T., & Cheng, K. H. (2022). Do curious students learn more science in an immersive virtual reality environment? Exploring the impact of advance organizers and epistemic curiosity. *Computers and Education*, 182, Article 104456. <https://doi.org/10.1016/j.compedu.2022.104456>
- Lian, Y., Tang, H., Xiang, M., & Dong, X. (2024). Public attitudes and sentiments toward ChatGPT in China: A text mining analysis based on social media. *Technology in Society*, 76. <https://doi.org/10.1016/j.techsoc.2023.102442>
- Lim, W. M., Gunasekara, A., Pallant, J. L., Pallant, J. I., & Pechenkina, E. (2023). Generative AI and the future of education: Ragnarök or reformation? A paradoxical perspective from management educators. *International Journal of Management in Education*, 21(2), Article 100790. <https://doi.org/10.1016/j.ijme.2023.100790>
- Liong, M., Yeung, D. Y., Cheng, G. H. L., & Cheung, R. Y. H. (2023). Profiles of ICT identity and their associations with female high school students' intention to study and work in ICT: A mixed-methods approach. *Computers and Education*, 195, Article 104722. <https://doi.org/10.1016/j.compedu.2022.104722>
- Luo, W., He, H., Liu, J., Berson, I. R., Berson, M. J., Zhou, Y., & Li, H. (2023). Aladdin's genie or Pandora's box for early childhood education? Experts chat on the roles, challenges, and developments of ChatGPT. *Early Education and Development*, 1–18. <https://doi.org/10.1080/10409289.2023.2214181>
- McNeil, E. (2016). *Teachers like technology in the classroom, but few think it's well integrated*. Retrieved 15 July 2023 from: <https://www.edweek.org/teaching-learning/teachers-like-technology-in-the-classroom-but-few-think-it-s-well-integrated/2016/05>.
- Mendoza, N. B., Yan, Z., & King, R. B. (2023). Supporting students' intrinsic motivation for online learning tasks: The effect of need-supportive task instructions on motivation, self-assessment, and task performance. *Computers and Education*, 193, Article 104663. <https://doi.org/10.1016/j.compedu.2022.104663>
- Molinillo, S., Aguilar-Illescas, R., Anaya-Sánchez, R., & Vallespín-Arán, M. (2018). Exploring the impacts of interactions, social presence and emotional engagement on active collaborative learning in a social web-based environment. *Computers and Education*, 123, 41–52. <https://doi.org/10.1016/j.compedu.2018.04.012>
- Petko, D., Cantieni, A., & Prasse, D. (2017). Perceived quality of educational technology matters: A secondary analysis of students ICT use, ICT-related attitudes, and PISA 2012 test scores. *Journal of Educational Computing Research*, 54(8), 1070–1091. <https://doi.org/10.1177/0735633116649373>
- Pitic, D., & Irimias, T. (2023). Enhancing students' engagement through a business simulation game: A qualitative study within a higher education management course. *International Journal of Management in Education*, 21(3), Article 100839. <https://doi.org/10.1016/j.ijme.2023.100839>
- Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of method bias in social science research and recommendations on how to control it. *Annual Review of Psychology*, 63, 539–569. <https://doi.org/10.1146/annurev-psych-120710-100452>
- Ratten, V., & Jones, P. (2023). Generative artificial intelligence (ChatGPT): Implications for management educators. *International Journal of Management in Education*, 21(3), Article 100857. <https://doi.org/10.1016/j.ijme.2023.100857>
- Rejeb, A., Rejeb, K., Appolloni, A., Treiblmaier, H., & Iranmanesh, M. (2024). Exploring the impact of ChatGPT on education: A web mining and machine learning approach. *International Journal of Management in Education*, 22(1). <https://doi.org/10.1016/j.ijme.2024.100932>
- Ringle, C. M., Wende, S., & Becker, J.-M. (2023). *SmartPLS 4. Boenningstedt: SmartPLS*. Retrieved 10 August 2023 from: <https://www.smartpls.com>.
- Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, 61, Article 101861. <https://doi.org/10.1016/j.cedpsych.2020.101860>
- Salusky, I., & Tull, M. (2021). Making it to the finish line: Educational resilience among Dominican women of Haitian descent. *Race, Ethnicity and Education*, 1–19. <https://doi.org/10.1080/13613324.2021.1924131>
- Sarstedt, M., Hair, J. F., Cheah, J. H., Becker, J. M., & Ringle, C. M. (2019). How to specify, estimate, and validate higher-order constructs in PLS-SEM. *Australasian Marketing Journal*, 27(3), 197–211. <https://doi.org/10.1016/j.ausmj.2019.05.003>
- Sarstedt, M., Hair, J. F., Nitzl, C., Ringle, C. M., & Howard, M. C. (2020). Beyond a tandem analysis of SEM and PROCESS: Use of PLS-SEM for mediation analyses. *International Journal of Market Research*, 62(3), 288–299. <https://doi.org/10.1177/1470785320915686>
- Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers and Education*, 128, 13–35. <https://doi.org/10.1016/j.compedu.2018.09.009>
- Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J. H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: Guidelines for using PLSpredict. *European Journal of Marketing*, 53(11), 2322–2347.
- Skavronskaya, L., Hadinejad, A., & Cotterell, D. (2023). Reversing the threat of artificial intelligence to opportunity: A discussion of ChatGPT in tourism education. *Journal of Teaching in Travel & Tourism*, 23(2), 253–258. <https://doi.org/10.1080/15313220.2023.2196658>
- Statista. (2023a). *Number of ChatGPT daily app downloads worldwide as of May 22, 2023*. Retrieved 10 July 2023 from: <https://www.statista.com/statistics/1386342/chat-gpt-app-downloads/>.
- Statista. (2023b). *Number of international students studying in higher education institutes in Malaysia in 2022, by country of origin*. Retrieved 10 July 2023 from <https://www.statista.com/statistics/866731/international-students-in-malaysia-by-country-of-origin/>.
- Strzelecki, A. (2023). To use or not to use ChatGPT in higher education? A study of students' acceptance and use of technology. *Interactive Learning Environments*, 1–14. <https://doi.org/10.1080/10494820.2023.2209881>
- Ulfert-Blank, A. S., & Schmidt, I. (2022). Assessing digital self-efficacy: Review and scale development. *Computers and Education*, 191, Article 104626. <https://doi.org/10.1016/j.compedu.2022.104626>
- Vansteenkiste, M., Ryan, R. M., & Soenens, B. (2020). Basic psychological need theory: Advancements, critical themes, and future directions. *Motivation and Emotion*, 44, 1–31. <https://doi.org/10.1007/s11031-019-09818-1>
- Wang, S., Cheah, J. H., Wong, C. Y., & Ramayah, T. (2023). Progress in partial least squares structural equation modeling use in logistics and supply chain management in the last decade: A structured literature review. *International Journal of Physical Distribution & Logistics Management*. <https://doi.org/10.1108/IJPDLM-06-2023-0200>
- Wang, X., Liu, Q., Pang, H., Tan, S. C., Lei, J., Wallace, M. P., & Li, L. (2023). What matters in AI-supported learning: A study of human-AI interactions in language learning using cluster analysis and epistemic network analysis. *Computers and Education*, 194, Article 104703. <https://doi.org/10.1016/j.compedu.2022.104703>
- Wekerle, C., Daumiller, M., & Kollar, I. (2022). Using digital technology to promote higher education learning: The importance of different learning activities and their relations to learning outcomes. *Journal of Research on Technology in Education*, 54(1), 1–17. <https://doi.org/10.1080/15391523.2020.1799455>
- Wu, Y., Xu, X., Xue, J., & Hu, P. (2023). A cross-group comparison study of the effect of interaction on satisfaction in online learning: The parallel mediating role of academic emotions and self-regulated learning. *Computers and Education*, 199, Article 104776. <https://doi.org/10.1016/j.compedu.2023.104776>
- Zakariya, Y. F., Nilsen, H. K., Goodchild, S., & Bjørkestøl, K. (2022). Self-efficacy and approaches to learning mathematics among engineering students: Empirical evidence for potential causal relations. *International Journal of Mathematical Education in Science & Technology*, 53(4), 827–841. <https://doi.org/10.1080/0020739X.2020.1783006>
- Zedelius, C. M., Gross, M. E., & Schooler, J. W. (2022). Inquisitive but not discerning: Deprivation curiosity is associated with excessive openness to inaccurate information. *Journal of Research in Personality*, 98, Article 104227. <https://doi.org/10.1016/j.jrp.2022.104227>

Ziyi Gao, Ph. D., is currently a lecturer at the School of Overseas Education, Yunnan University of Finance and Economics. His research interests include consumer behavior, technology marketing, online marketing, and quantitative research. His papers are published in the *Journal of Vacation Marketing* and the *Journal of Marketing Advances and Practices*. He can be reached via lawrencegaozy@gmail.com.

Jun-Hwa Cheah (Jacky) is an Associate Professor at Norwich Business School, the University of East Anglia. His areas of interest include consumer behaviour, quantitative research, and methodological issues. His publications appear in journals such as the *British Journal of Management*, *Journal of Business Research*, *European*

Journal of Marketing, Psychology and Marketing, Technological Forecasting and Social Change, Internet Research, Tourism Management, Journal of Travel Research, International Journal of Contemporary Hospitality Management, etc. He has also received several research awards (i.e., Emerald Young Researcher Award 2021). He can be contacted at jackycheahjh@gmail.com

Xin-Jean Lim working as a senior lecturer in Universiti Kebangsaan Malaysia (UKM). She earned her doctorate degree from Universiti Putra Malaysia. Her research interests include consumer behaviour, social media marketing, online marketing, and customer relationship management. Her papers have been published in Technological Forecasting and Social Change, Journal of Retailing and Consumer Services, Industrial Management and Data Systems, Marketing Intelligence and Planning, Young Consumers and Asia Pacific Journal of Marketing and Logistics, etc.

Xi Luo (Cloris) is a lecturer in the Department of Marketing Strategy & Innovation, Sunway Business School at Sunway University in Malaysia. Her research interests focused on generative AI, e-commerce, online marketing, and consumer behavior. Before Joining Sunway University, Cloris has worked in Academy for Global Development at Beijing Normal University, where she conducted research in the areas of social policy and environmental sustainability. Her academic achievements include publications in reputable journals such as Science, Journal of Retailing and Consumer Services, Journal of Computer Information Systems, and Journal of Marketing Advances and Practices, as well as the Social Governance Review. She can be reached via clorislx79656@gmail.com