How Technology Promotes Educational Change:
Studies of Virtual Learning Environment in Higher Education

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy

By

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Declaration

I hereby declare that this Thesis represents my original research work which has been done after registration for the degree of Doctor of Philosophy at the University of Liverpool, under the supervision of Dr Xiaojun Zhang, Dr Maria Limniou and Prof. Youmin Xi. This Thesis has not been submitted by me for the award of any other degree of any other University or Institute. Part of the Thesis has been published or is under review for publication. Appendix 2 lists the detailed declaration of rights, permission, and authorship. Following is a general overview of the published work and submitted work.

Studies in chapters two, four, five, six and eight of this Thesis have been accepted and published in five peer-reviewed international journals:

1. Chapter two: Li, N., Zhang, X., & Limniou, M. (2021). A country's national culture affects virtual learning environment adoption in higher education: A systematic review (2001–2020). *Interactive Learning Environments*, 1-19. https://doi.org/10.1080/10494820.2021.1967408.

2. Chapter four: Li, N., Zhang, X., Limniou, M., & Xi, Y. (2022). Meaning-making in virtual learning environment enabled educational innovations: A 13-year longitudinal case study. Interactive Learning Environments. https://doi.org/10.1080/10494820.2022.2081582.

3. Chapter five: Li, N., Wang, Q., Liu, J., & Marsick, V. (2021). Improving interdisciplinary online course design through action learning: A Chinese case study. *Action Learning: Research and Practice*, *19*(1), 49-64. https://doi.org/10.1080/14767333.2021.2002681.

4. Chapter six: Li, N., Lim, E. G., Leach, M., Zhang, X., & Song, P. (2022). Role of perceived self-efficacy in automated project allocation: Measuring university students' perceptions of justice in interdisciplinary project-based learning. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2022.107381.

5. Chapter eight: Li, N., Huijser, H., Xi, Y., Limniou, M., Zhang, X., & Kek, M. Y. C. A. (2022). Disrupting the disruption: A digital learning HeXie ecology model. *Education Sciences*, *12*(63). https://doi.org/https://doi.org/10.3390/educsci12020063.

Additionally, two news articles introducing the studies in chapter two and chapter five have been published for better research engagement:

1. Chapter two: Li, N., Zhang, X., & Limniou, M. (2021). How does national culture affect the adoption of learning technology? Retrieved April 8, 2022, from https://www.timeshighereducation.com/campus/how-does-national-culture-affect-adoption-learning-technology.

2. Chapter five: Li, N., Wang, Q., Liu, J, & Marsick, V. (2022). Using action learning to improve interdisciplinary online teaching. Retrieved April 8th, 2022, from https://www.timeshighereducation.com/campus/using-action-learning-improve-interdisciplinary-online-teaching.

The preliminary research results of the studies in chapters four, five, six, and seven have been presented or accepted to be presented at five international academic conferences:

1. Chapter four: Li, N., Zhang, X., & Limniou, M. (2021, April 8-12). Technology-mediated educational institutionalisation: A case study. American Educational Research Association Annual Meeting 2021, Online.

2. Chapter four: Li, N., Zhang, X., & Limniou, M. (2021, September 13-16). The dynamic balance of technology adoption and educational transition: A case study in higher education. British Educational Research Association Conference 2021, Online.

3. Chapter five: Li, N., & Wang, Q. (2021, August 26). What to do when hard data does not work? — The “Art” of problem solving. Art of Management and Organisation in The Pandemic 2021 Conference, Online.

4. Chapter six: Li, N., Lim, E. G., Leach, M., Zhang, X., & Song, P. (2022, June 15-17). Using Moodle for fair and effective project-based learning: A case study in China. The Learning Ideas Conference 2022, Online.

5. Chapter seven: Li, N., Purwanto, E., Zhang, X., Cao, F., Wong, K. H., & Chen, X. (2022, January 21-23). Moodle-based interactive hybrid learning in computer science education: Insights from structural equation modelling. The 2022 3rd International Conference on Education, Knowledge, and Information Management, Online.

The manuscript of the study in chapter seven is under review by the journal Interactive Learning Environments:

Chapter seven: Li, N., Purwanto, E., Zhang, X., Cao, F., Wong, K. H., & Chen, X. (under review). Understanding the perceived pedagogical value of JazzQuiz in interactive hybrid learning among university students: A technology acceptance analysis. *Interactive Learning Environments.*

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Abstract

Virtual Learning Environments (VLEs), as the critical educational technology, have the potential to enable new learning opportunities (e.g., personalized adaptive learning and seamless mobile learning) and promote educational innovations for sustainable educational change in Higher Education (HE). While the research on VLEs and technology-enhanced learning in HE has been promising, the adoption of VLEs and the diffusion of educational innovations are not as widespread as expected, and the mechanism is unclear. Additionally, most the Higher Education Institutions (HEIs) have, until the recent COVID-19 disruption, been somewhat cautious about the potential educational reform. Whether the emergency educational transition is temporary or sustainable remains an open question. This research programme investigates how technology promotes educational change through six sub-studies of VLEs in HE. Five studies have been published as journal papers, while one is under review. Firstly, a systematic literature review was conducted to analyse the recent studies of VLE adoption from 2001 to 2020. Two-factor categories - institutional and individual were synthesized from 290 factors identified from findings of 145 studies across 42 countries and regions. Consequently, knowledge gaps of the institutional and individual factors and mechanisms were further investigated by conducting five studies from multiple perspectives.

Specifically, four empirical studies examined three key aspects (institutional normative facilitating, institutional cognitive-cultural influence, and individual cognitions) of the VLE adoption and educational innovation institutionalisation in a Sino-British international university in China. The four studies employed various

research methods (qualitative, quantitative, and mixed) to investigate technology promoted educational changes in different institutional stages at the individual and organisational levels. Finally, a conceptual study was conducted to reconceptualise the digital learning ecology model based on the existing literature and empirical findings at an institutional field level, a social arena in which individuals and organizations share a common meaning system (Scott, 2004). The main results revealed that VLEs could promote sustainable educational change through the technology-human interactions that are directed by the two-dimensional meaning-making process: collective cognitive consensus (i.e., national culture and learning community) and individual cognitive divergence (i.e., perceived pedagogical value, perceived self-efficacy, and perceptions of justice).

This research programme contributes to the literature on Education, Information Technology, Psychology and Sociology by extending people's understanding of the existing theories and models (e.g., Unified Theory of Acceptance and Use of Technology, Institutionalisation Model, Social Learning Theory, Organizational Justice Theory and Equity Theory, HeXie Education Model) through the theory development and reconceptualisation. This research programme provides theoretical and practical implications to address the grand challenges in HE (i.e., success in technology adoption, widespread innovations, and sustainable educational change). The research findings suggested that educational policy makers and practitioners should include teachers and students as the co-creators of the future digital learning ecosystem, provide continuous teacher professional development in technological and pedagogical skills and knowledge, and develop student competence in self-directed learning and digital resilience.

Educators, learners, and researchers should utilise the findings and supporting methods to develop innovative learning and teaching approaches. Future research is needed to test the theoretical models in other educational contexts (e.g., K12 and vocational) and geographies with larger samples to enhance global development.

Chapter 1 Introduction

The global disruption caused by COVID-19 has forced stakeholders to rethink the current problems of the education system and presented a silver lining of revolutionary change in Higher Education (HE) (Green et al., 2020; Greener, 2020; Whitelock et al., 2021). One of the overarching grand challenges is how to "use educational technology as the mechanism for institutional development as well as for enhancing learning" and break the "deadlock" of the educational system that is "very difficult to change because they are bound together in an interlocking set of curricula, standards and examining processes" (Sharples, 2016, p. 63). Recent trends have led to a proliferation of studies that investigate technology-enhanced blended or hybrid learning using the web-based interactive learning platform Virtual Learning Environments (VLEs), alternatively called Learning Management Systems (LMSs) (Barari et al., 2020; Chen et al., 2020).

Over the years, many Higher Education Institutions (HEIs) in different countries, such as the UK (Efiloğlu Kurt & Tingöy, 2017; Limniou & Smith, 2010) and China (Teo et al., 2019; van Raaij & Schepers, 2008), have implemented VLEs (e.g., Moodle, Blackboard and Canvas). Because VLEs can provide new learning opportunities that blend the face-to-face classroom instructions and the online virtual learning activities (e.g., online quizzes and discussion forums) to enhance students' experience and satisfaction (Ghazal et al., 2018). However, VLEs' adoption and diffusion are not smooth, and the educational innovations enabled by VLEs are not as widespread as expected (Green & Chewning, 2020), promoting revolutionary change in HE (Garcia-Huidobro et al., 2017). Numerous efforts have been made to investigate the technological functionality design, development, and implementation, while the mechanism of how technology promotes educational change remains an open question (Flavin, 2020). This thesis argues that the investigations of VLE adoption are critical premises to address the grand challenge of education change. However, despite the many existing studies investigating the factors and processes influencing VLE adoption by key stakeholders (e.g., teachers and students), the findings from different HEIs in different countries are sometimes inconsistent or even contradictory (Li, Zhang, et al., 2021). The standardisation and theorisation of this research area are still in their infancy stage.

In China, the Ministry of Education (MoE) has implemented several supporting policies to promote student-centred and digital educational change in the past decades (Huang & Teo, 2019; Yang et al., 2021; Zhang & Xi, 2021). The rapidly increased number of students and teachers(Ministry of Education of the People's Republic of China, 2020) has added extra challenges for Chinese universities to achieve the expected educational reform, such as successful technology adoption (Huang, Sánchez-Prieto, et al., 2020; F. Huang, T. Teo, et al., 2021) and enhanced learning and teaching experiences through educational transitions from the traditional “old teaching norm” (e.g., teacher-centred face-to-face class as the only teaching approach, low-tech instructions) (Chan et al., 2021, p. 169) to the expected student-centred agile (Varga-Atkins, Sharpe, et al., 2021) and sustainable digital learning ecosystem (Li, Huijser, et al., 2022). The growing demand for understanding the mechanism of technology promoted an educational change in China has emerged to accelerate the development of the Chinese higher education system and thus, presented a promising research hotspot.

This thesis explores solutions to address the grand challenge of promoting sustainable educational change using VLE related educational technology through six sub-studies (studies 1, 2, 3, 4, 6 have been published, and study 5 is under review by Interactive Learning Environments). The central research question in this thesis asks how VLE could promote sustainable educational change in HE.

The overall structure of this thesis takes the form of nine chapters, including this introductory chapter (Figure 1.1).

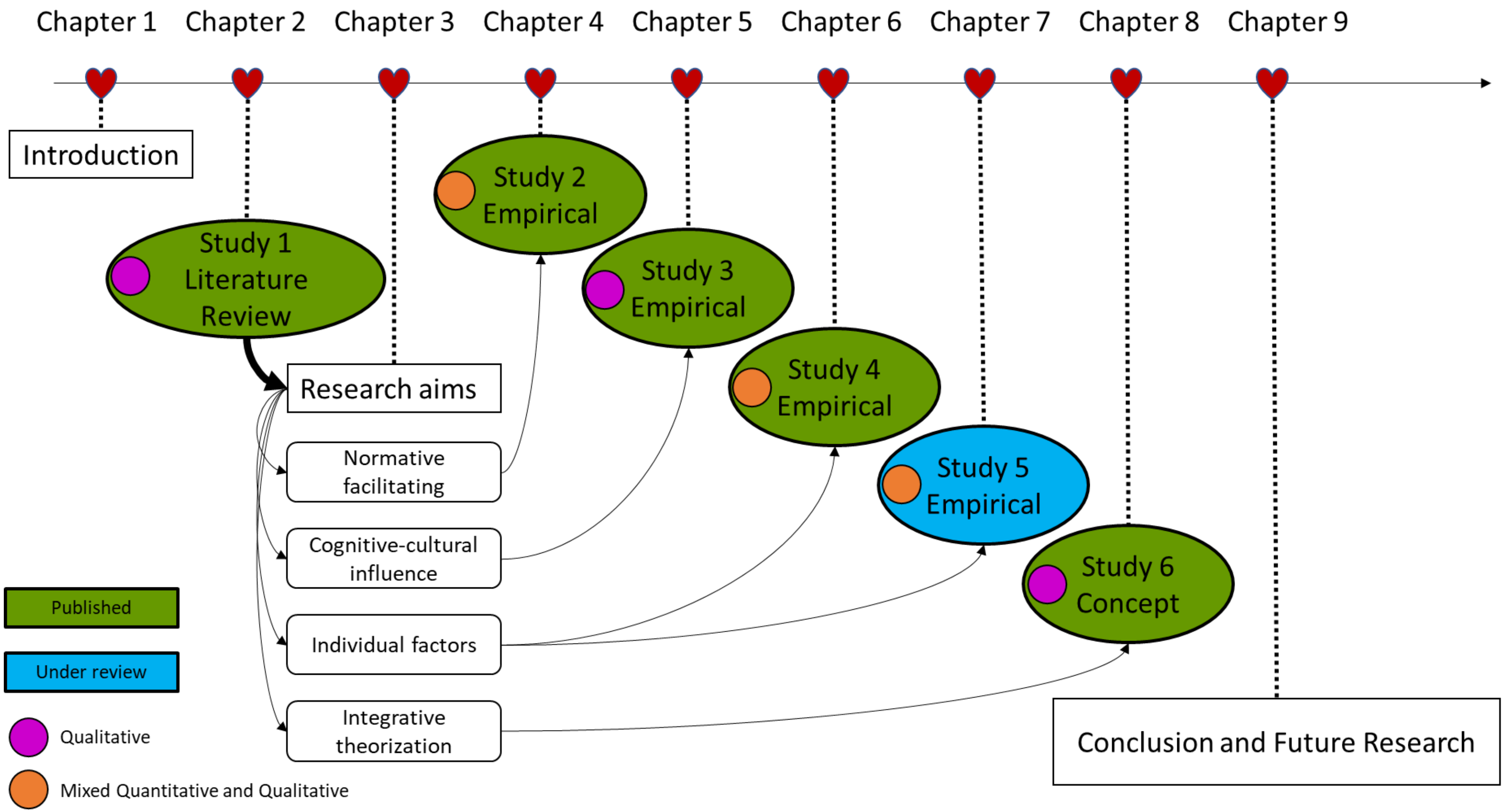


Figure 1.1 Thesis Structure Overview.

Chapter two begins by laying out the theoretical dimensions of the research through a systematic literature review on VLE’s adoption in HE between 2001 and 2020. The third chapter elaborates on the four research aims linked to the four research gaps identified by the literature review (Table 1.1).

Table 1.1 Overview of Research Aims, Research Gaps, Studies, and Chapters

Research Aims	Research Gaps	Study	Chapter
1. Investigating institutional normative facilitating process.	Existing theories have limitations in explaining the normative facilitating mechanism of VLE-enabled educational innovation institutionalisation in HE.	Study 2	Chapter 4
2. Evaluating cognitive-cultural influence.	Inadequate empirical research about VLE-based online teaching that is influenced by Chinese culture.	Study 3	Chapter 5
3. Examining individual cognition.	Renewed research trends on individual factors that affect VLE adoption and online learning during pandemics.	Studies 4, 5	Chapters 6, 7
4. Developing a new model.	Emerging needs for a reconceptualisation of the digital learning ecology for future HE.	Study 6	Chapter 8

In this thesis, chapters four to eight report five studies. Specifically, chapter four introduces a meaning-making theoretical model (developed through a 13-year longitudinal case study of a university), which attempts to explain the mechanism of the VLE enabled educational innovation institutionalisation process. Chapter five connects to chapter four by examining the VLE enabled online teaching effectiveness at the meaning-making stage of the educational change in a novice situation during the initial COVID disruption. More importantly, the study in chapter five addresses the second research gap by using action learning to critically reflect on the cognitive-cultural influence on university teacher professional development for effective use of VLE in interdisciplinary online teaching. Chapter six connects to chapter four, focusing on the VLE enabled educational change at the meaning-making stage and examining the impact of university students' self-efficacy and perceptions of justice in using VLE for effective project-based learning. Chapter seven also connects to chapter four through a focused study at the meaning-making stage that investigates university students' perceived pedagogical value of using the VLE for interactive hybrid learning. Chapter eight connects to all the other chapters and expands the frame to consider the reconceptualisation of the digital learning ecology for future education. Finally, chapter nine draws upon the entire thesis, summarises the conclusion and implications by tying up the various theoretical and empirical strands to address the central question about how VLE-based learning technology could promote sustainable educational change in HE. Moreover, chapter nine critiques the findings for further development and discusses the value of the future research would bring to the novel components of this thesis.

Table 1.2 presents the overview of the detailed research questions of six studies in this thesis. According to the Vitae Researcher Development Framework, this thesis employed various research methods (Table 1.3) to examine the research questions in-depth. Specifically, study 1 applied the systematic review method (Alexander, 2020; Moher et al., 2009) to analyse the literature of the past two decades on VLE adoption in HE. Study 2 used grounded theory (Charmaz, 2014) in a mixed-method longitudinal case study (Yin, 2018), including the mixed quantitative descriptive statistics and qualitative grounded analysis of archival documents and interview responses.

Study 2 examined the 13 years process of the technology promoted educational changes from an institutionalisation perspective. Based on study 2's findings of the meaning-making stage as the threshold stage of institutionalisation, study 3 used content analysis (Miles et al., 2014) in a qualitative case study to explore the effectiveness of the VLE enabled online teaching at the meaning-making stage from teachers' perspectives. Studies 4 and 5 focused on the investigations at the meaning-making stage from students' perspectives. Both studies mixed the quantitative methods (i.e., collecting data via survey and analysing the data through exploratory factor analysis, confirmatory factor analysis, structural equation modelling) and qualitative methods (i.e., collecting data via interview, open survey questions and focus group and analysing the data through content analysis and case study) (Johnson, 2004; Tashakkori & Teddlie, 2010). Study 6 used the theory development method (Jaakkola, 2020) to reconceptualise a digital learning ecology model.

Table 1.2 Research Questions Overview

No.	Research Question
Study 1	1.1 What are the factors that may influence VLE adoption across different countries? 1.2 Does the country's national culture affect VLE adoption and, if so, how?
Study 2	2.1 What is the threshold stage of the institutionalisation process of VLE enabled educational innovations? 2.2 How do the innovations become institutionalised in the threshold stage?
Study 3	3 How to improve the effectiveness of VLE-based online interdisciplinary teaching through action learning?
Study 4	4.1 What aspects of project allocation justice are measured by the PSPJS? 4.2 How reliable are the scores produced by the PSPJS as measured by correlation? 4.3 How valid are the constructs measured by the PSPJS? 4.4 What are the relationships of the constructs measured by the PSPJS in automated project allocation, and why?
Study 5	5.1 What are the relationships between students' perceived pedagogical value (PPV), acceptance of JazzQuiz, and academic performance? 5.2 How and why does students' perceived pedagogical value (PPV) influence their acceptance of JazzQuiz and their academic performance?
Study 6	6 How could future universities gain digital resilience to disrupt the disruption?

Table 1.3 Research Methods Overview

No.	Study Type	Research Method	Data source	Data type	Data period	Data analysis
1	C	Literature review	S	Q	2001-2020	Grounded theory
2	E	Interview, observation	P	M	2007-2020	Statistical analysis; Grounded theory
3	E	Case study	P	Q	2020	Content analysis
4	E	Survey, focus group	P	M	2020-2021	Statistical analysis; Exploratory structural equation modelling; Content analysis
5	E	Survey, interview	P	M	2021	Statistical analysis; Confirmatory structural equation modelling; Content analysis
6	C	Theory develop	S	Q	N/A	Content analysis

Note. C = Concept; E = Empirical; S = Secondary data; P = Primary data; Q = Qualitative; M = mixed qualitative and quantitative.

The four empirical studies (2,3,4,5) focused on the selected case Xi'an Jiaotong-Liverpool University (XJTLU). It is a Sino-British international university joint between a high-ranking Chinese public university (Xi'an Jiaotong University) and a world-famous British university (University of Liverpool). As an English medium instruction (EMI) university, XJTLU implemented a Moodle-based VLE as the centralized learning and teaching platform to support blended learning approaches at the very beginning of its establishment in 2006. Over the 15 years, the VLE has played an essential role in university learning and teaching practices. All the online learning and teaching behaviours were tracked and recorded in the VLE's database. As an educational developer working at XJTLU, I have observed educational changes since 2012. I witnessed resistance to new integrations of the VLE and observed success in using the VLE to promote practical educational innovations and improve learning and teaching effectiveness.

The insider role has provided great opportunities for me to obtain ethical approval, access the university's internal documentary and the VLE dataset, and organise interviews and surveys with key informants. The multiple data sources and various research methods were designed to reduce the potential bias from my insider role, increase the representativeness of the data and widen the trustworthiness and triangulation (Yin, 2018). As Figure 1.2 and Table 1.4 show, study 2 collected archival documents and VLE logs recorded from 2006 to 2019. Moreover, study 2 followed the grounded theory strategy and interviewed 51 university staff members from 2019 to 2021 until the theoretical saturation (Bryant & Charmaz, 2019). Study 3 collected archival documents, VLE logs about 11 lecturers' online team teaching and reflection notes from two lecturers. All the data was restored at the beginning of 2020 during the initial COVID disruption. Next, study 4 collected survey data from 763 students and interview data with ten students from 2020 to 2021 in a focus group discussion. Study 5 surveyed 246 students and interviewed 14 students within the year 2021.

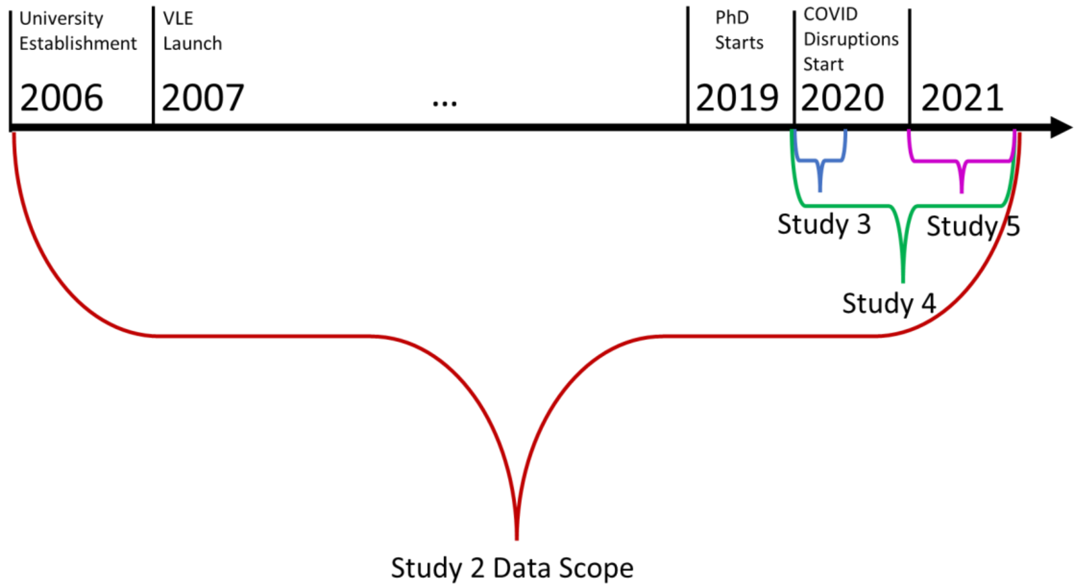


Figure 1.2 The Chronological Data Scope of Four Empirical Studies

Table 1.4 Empirical Studies Participants Overview

Empirical Study	Role	Sample Size
Study 2	Teacher	Interview (N = 51)
Study 3	Teacher	Teaching materials (N = 11)
Study 4	Student	Survey (N = 763), Focus group (N = 10)
Study 5	Student	Survey (N = 246), Interview (N = 14)

Based on the above four empirical studies, the final study (study 6) integrated the theoretical insights and the rich empirical findings into a new conceptual model for agile digital learning ecology. This thesis contributes to the literature on Education, Information Technology, Psychology and Sociology with valuable theoretical and practical implications through two conceptual studies and four empirical studies. The conceptual studies contribute to the literature at the institutional field level (Scott, 2014) by synthesising the phenomenon and insights from the cultural and ecological perspectives. The empirical studies unfold the mechanisms of the technology promoted educational changes at the individual and organizational level (Scott, 2014). Throughout this thesis, the term VLE will refer to the web-based interactive e-learning platform and the integrated digital tools (e.g., quiz, forum, and project allocation). Appendix 1 shows all the abbreviations used for important terms throughout in this study. Appendix 2 provides the details of the rights, permissions, and authorship of the published studies.

As discussed above, I was motivated by my work experiences and the literature to investigate the mechanism of technology-enabled educational change and seek solutions that could promote a broader scope of success in the educational transition within XJTLU and beyond. Before proceeding with the empirical research, it is important to have a systematic understanding of the literature in the field first. Therefore, I conducted a systematic literature review on VLE adoption in HE to develop the research framework for the PhD research programme. The chapter that follows (chapter 2) moves on to introduce the synthesis and evaluation of 145 existing empirical studies about VLE adoption in different universities across 42 countries and regions that were published between 2001 and 2020.

Chapter 2 Literature Review

Section 2.1 Problem Statement

As higher education increasingly integrates new technologies in enhancing learning and teaching, many novel digital tools have come to provide student-centred, active, and collaborative education (Martin et al., 2020; Williams et al., 2020). Virtual learning environments (VLEs) or learning management systems, such as Blackboard, Canvas, and Moodle, have been designed to bridge pedagogical recommendations in active learning through the use of numerous digital tools (e.g., interactive quizzes and discussion forums) that support online and hybrid learning (Borup et al., 2020; Farooq & Benade, 2019; Limniou & Smith, 2010). In this study, VLEs are defined as the web-based online interactive e-learning environment which aims to support effective learning and teaching (Barari et al., 2020; Brown, 2010). About two decades ago, Britain and Liber (1999) forecasted that VLEs would become one of the key technology innovations in technology-enhanced learning because of the possibility of allowing a resource-based, student-centred approach and alleviating teachers of extra administrative burdens. Since then, various universities in diverse countries have implemented VLEs (Ashrafi et al., 2020; Henritius et al., 2019; Limniou et al., 2016). In the COVID-19 pandemic, there are many usages of VLEs with the expectation to cope with challenges and barriers caused by the global crisis (Greener, 2020; Raza et al., 2020; Rook & McManus, 2020). However, the massive investments made by universities to implement VLEs are in sharp contrast with the low satisfaction and ineffective actual usage in higher education (Green & Chewning, 2020; Habib et al., 2014; Limniou et al., 2015; Singh

& Hardaker, 2013). The disappointment caused by these situations has brought severe management problems for university managers. They are encountering difficulties in making requisite plans and strategies for their organisations to increase VLE adoption and for teachers and students to better use the technology to enhance learning and teaching.

Many scholars investigated the factors that influenced VLE adoption and provided valuable implications for managers within specific cultural backgrounds (e.g. Chan et al., 2019; Jackson & Fearon, 2014; Martins & Kellermanns, 2004; Park et al., 2007). However, the rapid internationalisation of higher education has brought more challenges for university managers to integrate the technology for a diverse body of teachers and students holding different cultural values (F. Huang, J. C. Sánchez-Prieto, et al., 2021). Moreover, although various factors have been identified that impact teachers' and students' intention to use VLEs (Eraslan Yalcin & Kutlu, 2019), the findings of different studies are sometimes inconsistent or even contradictory especially between different countries. For example, "perceived ease of use" substantially affected Greek students' intention to use the VLE, but this was not the case for Mexican students (Terzis et al., 2013), who might be influenced by the country's different national cultural values of masculinity. In South Korea, Han and Shin (2016) found that, based on a sample size of 1608 participants, gender is a significant predictor of a student's intention to use the system. In their study, male students were 24% more likely to use the mobile VLE than female students. However, Agbatogun (2013) demonstrated that gender has the most negligible influence on a faculty member's intention to use the system in the UK. The fragmented findings fail to understand the mechanism influencing technology adoption in different countries comprehensively. “Some reasons for the divergent findings may lie in the cultural specificity of the factors hypothesised to explain technology acceptance and adoption…” (Scherer & Teo, 2019, p. 2387).

This systematic literature review was driven by the lack of integration and consistency in studies on VLE adoption and the potential role that the country’s national culture plays in higher education. To examine the various factors and to have an integrative view of the VLE adoption process, we looked into the categorisation of factors in the existing literature. Keller (2009) categorised factors into two main groups (organisational and individual), whereas Park (2009) labelled them as personal, social, and organisational. El-Masri and Tarhini (2017) extended the classifications to include behavioural, individual, social, organisational, and cultural dimensions of masculinity, power distance, individualism, and uncertainty. Two studies (Eraslan Yalcin & Kutlu, 2019; Park et al., 2012) maintained the top individual, social, and organisational elements categories. Widyasar et al. (2019) included the technical component and the organisational and cultural aspects in their classification. The extant classification of the individual or personal related factors is too broad to be analysed in depth. Moreover, the non-individual related factors are classified differently with less coherence, which is ambiguous for researchers to understand the underlying mechanisms better. Therefore, it is crucial to identify the factor characteristics and classifications for further investigation.

Specifically, this study aims to conduct a systematic review through the following two questions:

(1) What are the factors that may influence VLE adoption across different countries?

(2) Does the country's national culture affect VLE adoption and, if so, how?

Section 2.2 Virtual Learning Environments

Over decades ago, the leading educational scholars explored the virtual worlds for learning (Whitelock & Holland, 1992) and emphasized the importance of Virtual Learning Environments' (VLEs) design and structure in affecting human perceptions of presence for virtual learning (Jelfs & Whitelock, 2000; Whitelock et al., 2000). Piccoli et al. (2001) highlighted the feature of communications in supporting individualized learning through a web-based VLE that provides interactive learning opportunities. Littleton and Whitelock (2004) provided practical guidance to create "common knowledge" and construct understanding in a VLE. VLE is also known as a Learning Management Systems (LMS) (Nichols, 2003), emphasising its course management and administration role. Browne et al. (2006) demonstrated that VLEs have become popular in higher education over the years, but the technology-enhanced pedagogical practices have not been as widespread as expected. Practitioners and educators made outstanding contributions to the TEL policy (Huang & Teo, 2020) implementation staircase through standardized practices like institutional VLE template development (Varga-Atkins, 2016). However, Barari et al. (2020) identified the problem of insufficient pedagogical standards for getting the best out of VLEs. Despite the rapid development of information and communication technologies that have accelerated VLEs' technological design, the above problems remain unsolved (Hamutoglu et al., 2020). Many researchers started investigating the mechanism and factors that affect the VLEs' diffusion and adoption.

Section 2.3 Technology Adoption

Scholars have developed many theoretical models focusing on factors that affect technology adoption to explain the diffusion of specific technologies and related applications in organizations (Mortenson, 2016; Straub, 2009). Figure 2.1 shows the chronology of the theoretical models developed for technology adoption studies over the years. Table 2.1 elaborates on these theoretical models with descriptions and references. One of the most commonly applied frameworks to study the uptake of new technology is the Technology Acceptance Model (TAM), introduced by Davis (1986). This framework has originated in the psychological theory of reasoned action (TRA), elaborated by Ajzen and Fishbein (1980), in which behaviour results from the formation of specific intentions to behave. Further, the theory of planned behaviour (TPB) (Ajzen, 1985) links one's beliefs and conduct with the use of technology. Although TAM was extended in later studies (Viswanath Venkatesh & Hillol Bala, 2008; Venkatesh & Davis, 2000; Venkatesh et al., 2003), the original theory has evolved to become a primary framework for understanding predictors of human behaviour toward the potential acceptance or rejection of technology (Marangunić & Granić, 2014).

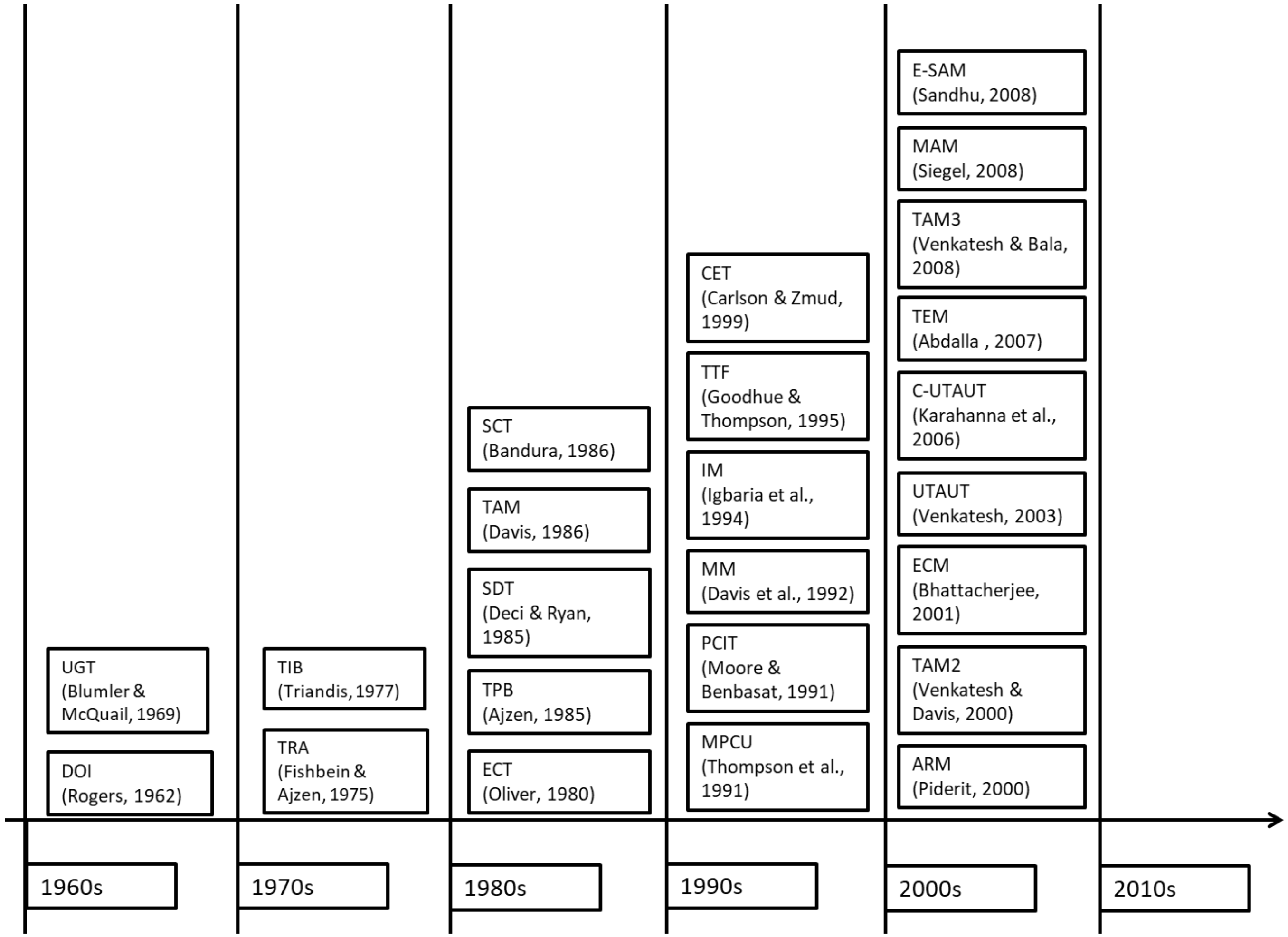


Figure 2.1 Overview of Theoretical Models for Technology Adoption Studies

Table 2.1 Theoretical Models Description

No.	Year	Theory Models	Full Name
1	1962	DOI	Diffusion of Innovation theory (Rogers, 2003)
2	1969	UGT	Uses and Gratification Theory (Blumler, 1979)
3	1975	TRA	Theory of Reasoned Action (Fishbein & Ajzen, 1975)
4	1977	TIB	Theory of Interpersonal Behaviour (Triandis, 1977)
5	1980	ECT	Expectation–Confirmation Theory (Oliver, 1980)
6	1985	TPB	Theory of Planned Behaviour (Ajzen, 1985)
7	1985	SDT	Self-Determination Theory (Deci & Ryan, 1985)
8	1986	TAM	Technology Acceptance Model (Davis, 1986)
9	1986	SCT	Social Cognitive Theory (Bandura, 1986a)
10	1991	MPCU	Model of PC Utilisation (Thompson et al., 1991)
11	1991	PCIT	Perceived Characteristics of Innovating Theory (Moore & Benbasat, 1991)
12	1992	MM	Motivational Model (Davis et al., 1992)
13	1994	IM	Igbaria's Model (Igbaria et al., 1994)
14	1995	TTF	Task-Technology Fit (Goodhue & Thompson, 1995)
15	1999	CET	Channel Expansion Theory (Carlson & Zmud, 1999)
16	2000	TAM2	Extension of Technology Acceptance Model (Venkatesh & Davis, 2000)
17	2000	ARM	Academic Resistance Models (Piderit, 2000)
18	2001	ECM	Expectation-Confirmation Model (Bhattacherjee, 2001)
19	2003	UTAUT	Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)
20	2006	C-UTAUT	Compatibility UTAUT (Karahanna et al., 2006)
21	2007	TEM	Technology Effectiveness Model (Abdalla, 2007)
22	2008	TAM3	Technology Acceptance Model 3 (V Venkatesh & H Bala, 2008)
23	2008	MAM	The Motivation and Acceptance Model (Siegel, 2008)
24	2008	E-SAM	E-Services Acceptance Model (Sandhu, 2008)

Technology adoption research in the education context has become an attractive trend with the rapid development of technology-enhanced learning globally (Al-Emran et al., 2018; Bower, 2017). TAM has been broadly used to investigate teachers' and students’ adoption of learning technologies (Scherer et al., 2019; Weerasinghe & Hindagolla, 2017). Researchers reviewed the technology acceptance research in the learning and teaching context and suggested a promising research direction that focuses on “identifying additional external factors that could further explain acceptance and usage "of various learning technologies” (Granic´ & Marangunic´, 2019, p. 2573). Studies found different factors that might influence teachers' and students’ intention to use VLE, such as individual perceptions of the technology usefulness (Ameen et al., 2019; Sánchez-Mena et al., 2019), motivation (El-Masri & Tarhini, 2017; Geng et al., 2019), and cultural influence (Nistor et al., 2014; Terzis et al., 2013).

Section 2.4 Cultural Dimensions

Culture may interfere with an individual’s perceptions, motivations, and interactions with others in the daily social routines (Mittelmeier et al., 2018). National culture is implicated in organisational technology adoption failures with cultural resistance (Leidner & Kayworth, 2006). The core of national culture is a cultural value, which could affect an individual’s behaviours (Gudykunst, 1997). Specifically, in higher education, the various factors identified to explain teachers’ and students’ intentions to use VLEs may depend on the cultural values (F. Huang, T. Teo, J. C. Sánchez-Prieto, et al., 2019) that they live by. Accordingly, culture might be an essential underlying mechanism that explains the divergent findings in the VLE adoption process. Scholars have looked at culture as a profoundly complex notion (Baptista & Oliveira, 2015) from diverse angles, such as national, organisational, educational, and technological cultures; intercultural communication; and Confucianism (Brown et al., 1989; Hall, 1989; Hofstede, 1980; Phillips et al., 1994; Triandis, 1982). In this study, the researchers adhere to Hofstede's definition of culture as the "collective properties" and "common mental programming" ascribed to the citizens of certain countries and regions (Hofstede et al., 2010, p. 36). Culture has been examined from the broad perspective of the country's national culture.

To address the assumption that a country's national culture might play an essential hidden role in affecting the VLE adoption process, the researchers adopted Hofstede's six cultural values in the systematic review of the extant studies on VLE adoption. Hofstede's (1980) earlier work identified four cultural dimensions: (1) power distance (the extent to which a culture's less powerful members accept the unequal distribution of power within their society); (2) masculinity-femininity (the distribution of emotional roles between genders); (3) uncertainty avoidance (intolerance to unstructured, unknown, or unusual situations faced by a society's members); and (4) individualism-collectivism (the extent to which people in society value the importance of collective interests). Two other facets, (5) long- and short-term orientation (the extent to which people value the importance of the future, present, and past) and (6) indulgence-restraint (a society's permissibility regarding basic needs and the desire to enjoy life), were included in later studies (Hofstede, 2001; Hofstede et al., 2010; Hofstede & McCrae, 2004).

Each of the above dimensions has a quantified national culture score to present the relative positions of countries and regions: the Power Distance Index

(PDI) Values, the Masculinity Index (MAS) Values, the Uncertainty Avoidance Index (UAI) Values, the Individualism Index (IDV) Values, the Long-Term Orientation Index (LTO) Values, and the Indulgence Versus Restraint (IVR) Index Values (Hofstede et al., 2010). These index values have been applied in different empirical studies to investigate VLE adoption separately, but they have not yet been systematically mapped with various empirical findings in a holistic view.

Although Hofstede's notion of having a national culture is criticised with the objection that cultural diversity may vary between countries and regions (Mosakowski et al., 2013; Ono, 2010; Williamson, 2002), the empirical studies that support this objection are limited (Vaate et al., 2020). Hofstede's cultural dimensions have gained wider acceptance and provided theoretical grounds for exploring technology acceptance in higher education (Khan, 2017). Although Hofstede's studies on cultural values were challenged in the business context and measurement limitations, individually espoused cultural values could help researchers better understand people's beliefs and intentions to adopt VLEs in higher education (Teo & Huang, 2019). Hofstede's cultural index values were criticised due to the data gathering process that only involved participants from well-educated, mid-, or upper-level employees of IBM from around the world (Piller, 2011). However, the non-representative issue might not affect the research on VLE adoption in the higher education context because stakeholders in this research area are either already well-educated or currently receiving higher education.

Section 2.5 Materials and Methods

This section elaborates on the detailed article selection procedures adopted from Alexander's (2020) guidance in this systematic review, which include three main steps: identification, screening, and eligibility. Following that, the researchers summarise the descriptive characteristics of the included articles. Figure 2.2 visualises the inclusion process flow. In reporting this review, the researchers followed the 27-item checklist of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009).

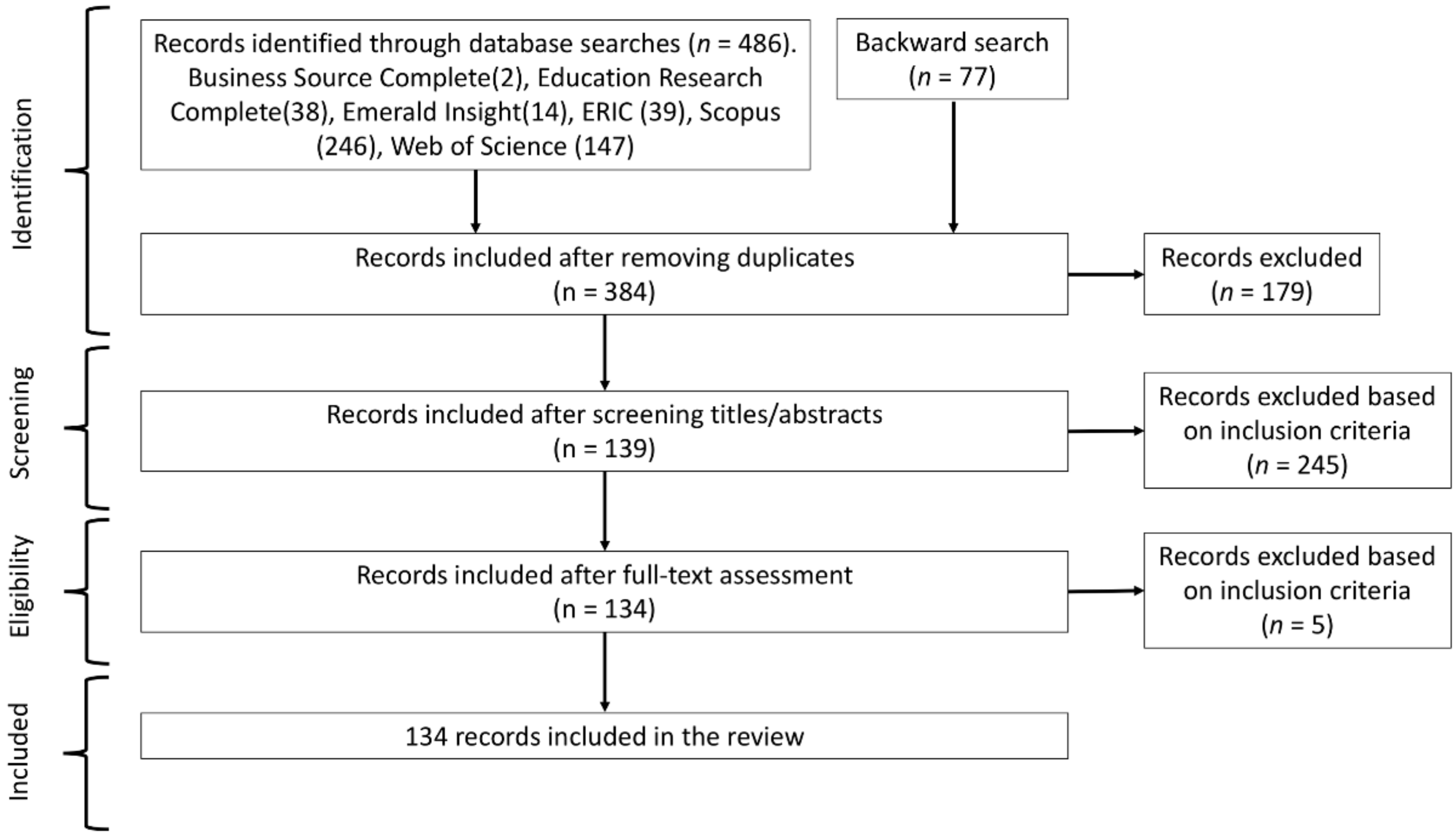


Figure 2.2 Article Inclusion Procedure Flow Chart of the Systematic Review.

Section 2.5.1 The Identification Procedure

The research team started the identification procedure with a systematic search in the following databases: Business Source Complete, Education Research Complete, Emerald Insight, ERIC, Scopus, and Web of Science. To ensure the inclusiveness of the keyword search, the researchers consulted the prevailing literature about VLEs' definitions and names. Piccoli et al. (2001) defined the concept of VLE and added the dimension of communication to the individualised learning experience. Various terms and definitions of VLE platforms have been used over the years by different researchers and countries. For example, Nichols (2003) defined VLE with Learning Management Systems (LMS) as a set of digital e-learning tools available through an open and shared administrative interface. Yueh and Hsu (2008) discussed VLE with the names "Course Management System" and "Learning Content Management System." Based on the above definitions, the researchers included three components of keywords in the Boolean operator's search: (1) Virtual Learning Environment or Learning Management System or Course Management System or Learning Content Management System, (2) acceptance or adoption, and (3) higher education or university or college. Appendix 3 displays the detailed search strings for each database. This study completed the last search on the 1st of January 2021 and retrieved 486 records from the database search. To check the cited references of the eligible articles, the researchers conducted a backward search and found another 77 records. By removing the duplicates of the overall 563 records, the researchers kept 384 unique records for further screening.

Section 2.5.2 The Screening Procedure

In the second stage, the researchers screened the 384 selected articles' titles and abstracts by applying the inclusion criteria (see Appendix 4 for full details): (1) being an article from a peer-reviewed academic journal with an abstract preview in English; (2) being empirical research, that is, a study that relies on direct experience or observation rather than existing or second-hand information (Powner, 2015); (3) reporting on the factors that influence the adoption of VLEs within the higher education context; and (4) indicating the country or region information where the study was conducted. The researchers remarked and included the articles that were difficult to assess through the title and abstract screening and, thus, saved them for full-text screening in the next stage. Consequently, this stage resulted in 139 relevant articles.

Section 2.5.3 The Eligibility Procedure

The researchers started the final eligibility assessment by downloading the full-text PDF file. They imported all the downloaded files into the NVIVO 12 software to help them further analyse the text. Appendix 5 contains the detailed coding scheme of this procedure, including the general publication characteristics (e.g., authors, year of publication) and specific context (e.g., education level, target group, and the study's country nation). Articles that did not meet the inclusion criteria were excluded from the dataset. Consequently, the researchers selected 134 articles as the final eligible publications for this review. They recorded the factors that significantly influenced VLE adoption in each study and tagged them with a positive or negative relationship. If available, the researchers noted the effect size and different variables (e.g., dependent variables, independent variables, moderate variables, mediating variables, and control variables) in the coding scheme.

Section 2.5.4 Article Characteristics

Overall, the researchers analysed 134 peer-reviewed academic journal articles (Appendix 6) published by 46 international journals (average JCR impact factor = 2.8) in the last 19 years. The majority of the articles were published in the recent five years. These articles comprised 145 studies carried out in 42 different countries and regions, which applied quantitative, qualitative, and mixed methods, and sample sizes ranged from 22 to 17,000 participants. The age of the participants ranged from 17 to 59. The majority of the participants were university students and teachers; only five studies involved managers and administrators as participants. Fifteen out of the 145 studies reported participants' gender percentages. The most commonly applied frameworks to study the adoption of VLEs are the Technology Acceptance Model (TAM) (Davis, 1986) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). Venkatesh et al. (2003) developed the UTAUT model, which combined eight-core theories and models (including TAM), by conducting a meta-analysis of the existing empirical studies on technology acceptance.

Section 2.5.5 Data Analysis

This study applied qualitative data analysis to infer contextual understanding for the classification of factors through constructivist grounded (Charmaz, 2014) content coding. The inductive data analysis provided broader cultural connections between the country/region and the VLE adoption factors. Culture is hypothesised as an explanatory factor to address the research questions.

Factors of VLE Adoption.

In response to the first research question, the researchers identified 290 significant factors that were hypothesised to explain VLE adoption in the 145 reviewed studies. These factors were examined in different countries and regions and were named differently. The researchers followed the constructivist grounded theory (Charmaz, 2014) and conducted data coding in three stages: initial coding, focused coding, and theoretical coding (Bryant & Charmaz, 2019). In the initial coding stage, the researchers scrutinised the meaning of each factor in the specific context of the reviewed study and produced valuable abstractions. As a result of comparing the initial codes and synthesising the data segments in focused coding, the researchers categorised the various factors into five themes: characteristics, cognition, digital capability, cognitive influence, and normative facilitating. The researchers generated the five themes at two theoretical levels in the final stage: individual and institutional. Five unique factor category names were defined, namely, Individual Characteristics (ICH), Individual Cognition (IC), Individual Digital Capability (IDC), Institutional Cognitive-Cultural Influence (ICI), and Institutional Normative Facilitating (INF). Figure 2.3 presents the data analysis structure and the representative quotations.

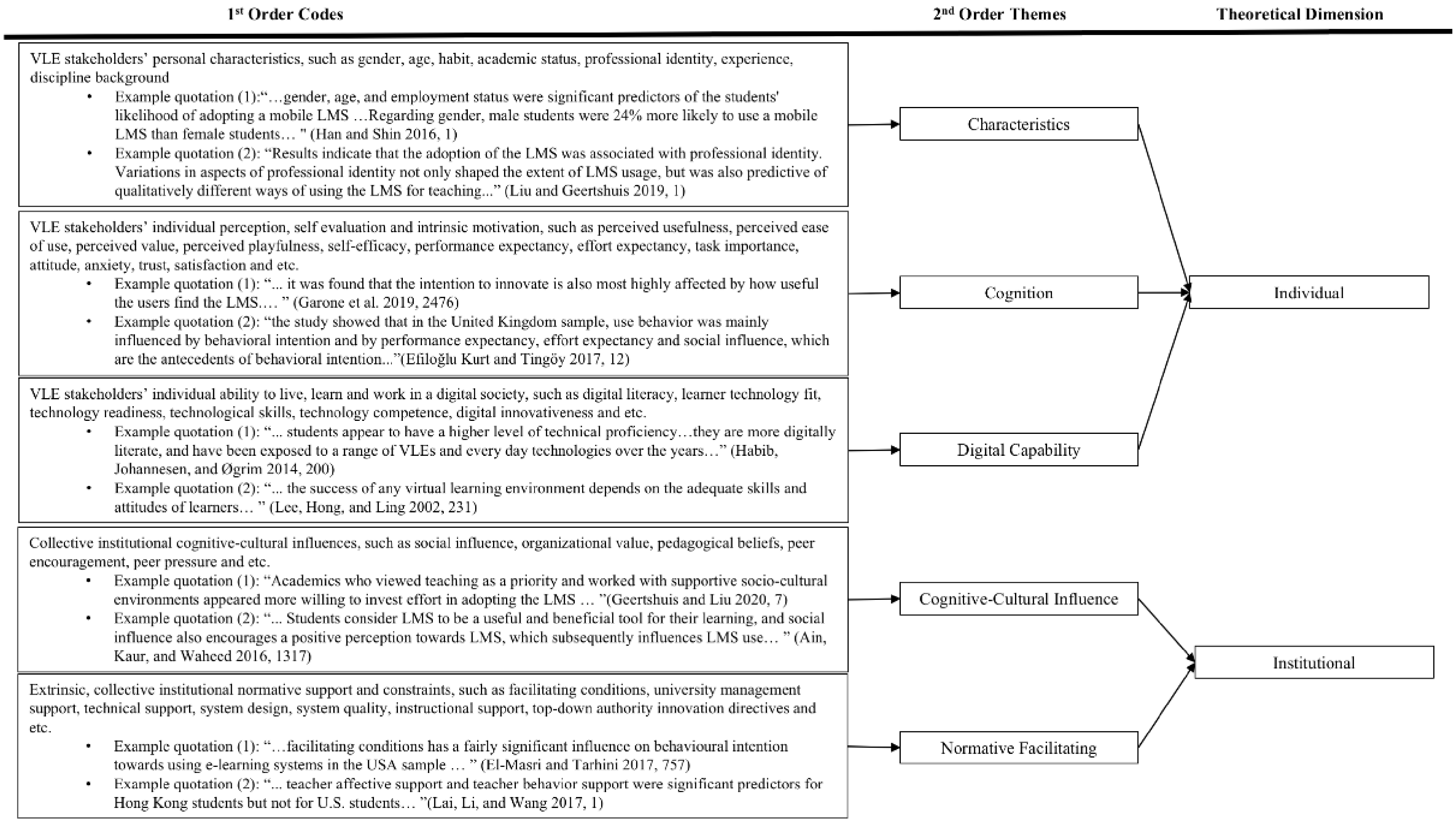


Figure 2.3 Factors Categorisation Structure.

The Relationship Between Factors and Culture.

To investigate the relationship between factors that were hypothesised to explain VLE adoption in different studies and the country's national culture, this study linked each study's country nation with Hofstede's six national cultural dimension index values (PDI, IDV, MAS, UAI, LTO, and IVR) (Hofstede et al., 2010). The research team grouped the studies by the same country/region in the next stage. The descriptive data of each country/region's study number and factor number and the relevant national cultural dimension index values were recorded in a table for further analysis (see Appendix 7 for details). To explore the connections between the country's national culture and the different factors that affect VLE adoption, the research team compared the differences between the factors that influence users' intention to use the VLE between studies in the same country/region. The national cultural dimension index values of each country/region were remarked with the following tags: high (value equals or exceeds 50) and low (value is less than 50). Studies from countries/regions with a high value of the six national cultural dimensions were examined separately from those with low value. Thus, the intersection and divergence of the fragmented empirical findings were analysed vertically and horizontally. This data analysis process provided in-depth understanding by combining factor categorisation and the cultural impact on VLE adoption into a conceptual research framework.

Section 2.6 Results

This section first interprets the factor categorisation results and then illustrates the relationship between factors and the country's national culture.

Section 2.6.1 Factors that May Influence VLE Adoption

In the reviewed studies, the empirical findings describe VLE adoption as a complex process influenced not only by individual characteristics like intrinsic perceptions, endogenous identity, and personal ability but also by institutional features such as extrinsic conditions, exogenous rules, and collective cognition. This study categorised factors that may influence VLE adoption at two levels: individual and institutional, through grounded data coding based on the identified core constructs.

Individual Factor Characteristics: Individual Characteristics (ICH).

This theme relates to how personal and demographic characteristics, such as gender, age, habit, academic status, professional identity, experience, and discipline background, influence the use of VLEs in learning and teaching. For instance, Han and Shin (2016) found that gender significantly predicted South Korean students' intention to adopt a mobile VLE; female students were less likely to use a mobile VLE than male students. El-Masri and Tarhini (2017) found that students are more likely to use the VLE when its use becomes a habit. Their study identified habit as the most potent predictor of Qatari students' intention to use the VLE system and the second most critical predictor among American students. Age, gender, and experience, as moderators in the UTAUT model (Venkatesh et al., 2003), were the most critical determinants in two studies from China (Hwang & Francesco, 2010; Zhai et al., 2017). Academic status influenced junior and senior academic staff regarding the adoption of VLEs in the UK (Agbatogun, 2013), while teachers' work style was an influencing factor in Norway (Habib et al., 2014).

Individual Factor Characteristics: Individual Cognition (IC).

Many studies revealed the importance of personal perceptions, self-evaluation, and intrinsic motivation (Ibrahim & Nat, 2019) in affecting users' behavioural intentions toward VLE usage. This theme includes perceived usefulness, ease of use, value, playfulness, self-efficacy, performance expectancy, effort expectancy, task importance, attitude, anxiety, trust, and satisfaction. For instance, perceived usefulness is a core variable in the TAM framework (Davis, 1986), describing how an individual believes that using a particular system will enhance his/her performance. Researchers across various countries found that teachers and students were more willing to use VLEs if they believed VLEs would improve their learning and teaching performance (e.g., Ameen et al., 2019; Duygu Fındık-Coşkunçay, 2017; Eraslan Yalcin & Kutlu, 2019; Garone et al., 2019; Terzis et al., 2013).

Individual Factor Characteristics: Individual Digital Capability (IDC).

The third individual theme is related to people's ability to live, learn, and work in a digital society, such as digital literacy, learner technology fit, technology readiness, technological skills, technical competence, and digital innovativeness. Varga-Atkins (2020) emphasized the disciplinary divergence of students' digital capability and digital signature capabilities. According to Habib et al. (2014), students' level of digital literacy was essential in their educational experiences via VLEs. Asian students considered VLEs technological artefacts that they needed to master, whereas European and North American students appeared to have a higher level of technical proficiency in using the same VLE. Lee et al. (2002) found that the success of VLE adoption depends on students' adequate skills in Malaysia. In

Norway, researchers also found that "... students appear to have a higher level of technical proficiency…they are more digitally literate and have been exposed to a range of VLEs and everyday technologies over the years…" (Habib et al., 2014, p. 200).

The non-individual factors are beyond personal control and influence people's behavioural intention via organisational arrangements or societal rules (El-Masri & Tarhini, 2017; Eraslan Yalcin & Kutlu, 2019; Park, 2009; Park et al., 2012; Widyasar et al., 2019). From the institutional perspective, the various non-individual factor characteristics can be generalised to different types of institutions. According to Scott, "a cultural-cognitive conception of institutions stresses the central role played by the socially mediated construction of a common framework of meanings… A normative conception stresses a deeper, moral base for assessing legitimacy" (Scott, 2014, pp. 70-74). We developed two themes of the factors with institutional characteristics by adopting Scott's classification of the institutions: cognitive-cultural and normative institutions.

Institutional Factor Characteristics: Institutional Cognitive-Cultural Influence (ICI).

Different from the individual factors, institutional factors focus on collective elements. This theme represents extrinsic cognitive-cultural influences, such as social influence, organisational value, pedagogical beliefs, peer encouragement, and peer pressure. Researchers revealed that "students consider VLE to be a useful and beneficial tool for their learning, and social influence also encourages a positive perception towards VLE, which subsequently influences VLE use…" (Ain et al., 2016,

p. 1317). In New Zealand, Geertshuis and Liu (2020) found that teachers are more willing to adopt VLEs when working in a supportive socio-cultural environment.

Institutional Factor Characteristics: Institutional Normative Facilitating (INF).

This theme includes factors that represent extrinsic normative support and constraints, such as facilitating conditions, university management support, technical support, system design, system quality, instructional support, and top-down authority innovation directives. Students and teachers were found to be more willing to use VLEs based on shared learning and teaching principles, in addition to the influence of university norms (e.g., Ameen et al., 2019; Chen et al., 2009; Duygu Fındık-Coşkunçay, 2017; Eraslan Yalcin & Kutlu, 2019; F. Huang, T. Teo, & M. Zhou, 2019; Park, 2009; Park et al., 2012; Teo et al., 2019). Lai et al. (2017) argued that students in Hong Kong rely on teachers' affective support and behaviour support, which became significant predictors of students' intention to use the VLE. In addition, students' intention to use VLEs was influenced by the benefit of use, for example, improved quality and increased productivity of learning (Ameen et al., 2019; Li et al., 2012; Pham et al., 2019; Teo et al., 2019; Wang et al., 2012; Widyasar et al., 2019; Zhai et al., 2017).

Section 2.6.2 Relationships Between Factors and the Country's National Culture

The inductive data analysis unveiled four pairs of relationships between factors' characteristics and the country's national cultural values, which helped construct the conceptual research framework shown in Figure 2.4.

Firstly, the Power Distance cultural value affected VLE adoption by connecting with the Institutional Cognitive-Cultural Influence (ICI) factors. Specifically, VLE users from countries or regions with higher-level power distance cultures are more likely to be influenced by extrinsic pressures, shared logic of action, or common beliefs. For instance, students in Malaysia (PDI = 104) were influenced by several ICI factors, such as classmate attitude, subjective norms, and social influence (e.g. Ain et al., 2016; Ghazal et al., 2018; Lee et al., 2002; Yusop, 2015). On the other hand, students in Ireland (PDI = 1), Algeria (PDI = 1), and Vietnam (PDI = 1) were not affected by ICI factors (e.g. Harrati et al., 2017; Neville et al., 2005; Pham et al., 2019).

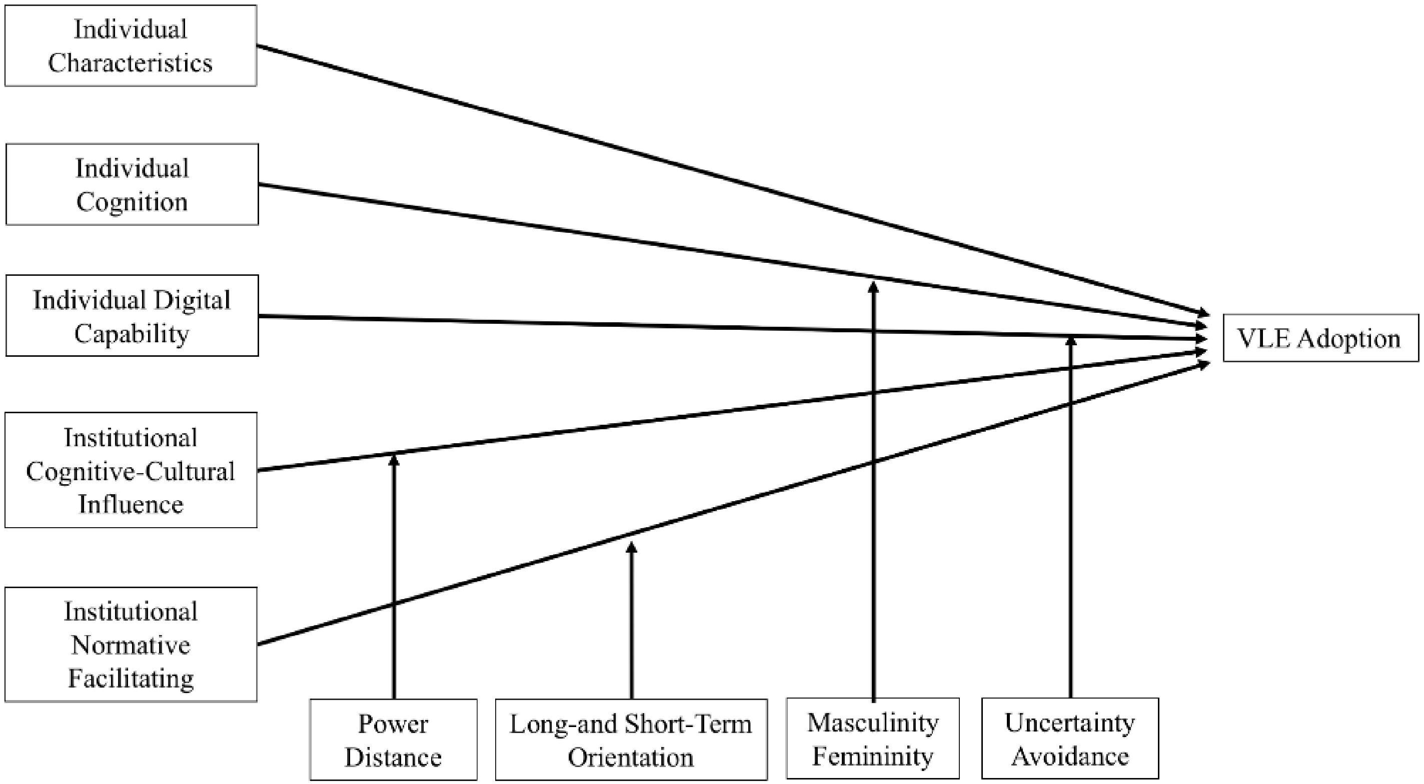


Figure 2.4 Conceptual Research Framework.

Secondly, the Long-Term Orientation cultural value might constrain the development of the institutional norms or facilitating conditions to support VLE use, and thus, it affects users' intention to use the VLE. This finding revealed that VLE users from countries or regions with lower-level long-term orientation cultures are influenced more significantly by contextual and situational factors. Studies in Australia (LTO = 21) found that teachers' and students' use of university VLEs is affected mainly by the Institutional Normative Facilitating (INF) factors like the quality control of online teaching, assessment procedure, learning task design, administrative workload, technical affordance, and university technical support (Weaver, 2008; Zanjani et al., 2016). In the higher-level culture, studies in South Korea (LTO = 100) did not find INF factors significant VLE use predictors (e.g. Antee, 2020; Lim et al., 2020; Shin & Kang, 2015).

Thirdly, the masculinity cultural value influences VLE adoption by connecting with the Individual Cognition (IC) factors. This result showed that teachers and students from countries or regions with lower-level masculinity cultures are more affected by endogenous perceptions, emotions, and intrinsic motivations. For instance, academic staff in countries with low-level masculinity culture, Sweden (MAS = 5) and Norway (MAS = 8), were found to be significantly influenced by the IC factor: effort expectancy (Keller, 2009). Another study found that Swedish students' VLE usage was affected mainly by IC factors like perceived ease of use, usefulness, and attitude toward technology (Saroia & Gao, 2018). Regarding countries or regions with higher-level masculinity culture, IC factors were not significant factors that influenced British (MAS = 66) users' intention to use VLEs (e.g. Agbatogun, 2013; Jackson & Fearon, 2014; Martin & Treves, 2007).

Finally, the uncertainty avoidance cultural value might impact people's perception of developing their digital capability in terms of VLE adoption. In other words, VLE users' intention to use the technology from countries and regions with lower-level uncertainty avoidance may be influenced by an individual's ability to live, work, and learn in a digital society. For example, Malaysian (UAI = 36) students' VLE use was significantly influenced by the Individual Digital Capability (IDC) factor: adequate digital skills (Lee et al., 2002). Chinese (UAI = 30) students' intentions to use VLEs were affected by another IDC factor: individual digital competence (Su & Chen, 2020). In terms of higher-level uncertainty avoidance culture, IDC factors were not significant factors. El-Masri and Tarhini (2017) discussed the issues of security and trust (IC factors) that dominated students' decisions to adopt VLEs in the US (UAI = 46). High uncertainty avoidance might decrease users' intention to use VLEs in Germany (UAI = 65) and Romania (UAI = 90) due to the belief that more effort is required to adopt unknown technology (Nistor et al., 2014).

Section 2.7 Discussion

This study systematically reviewed 145 studies (from 134 journal publications) in the past 19 years to present an overview of the impact of a country's national culture on VLE adoption in a higher education setting. To provide an in-depth understanding of the topic, the researchers applied qualitative content analysis to the data collected from a scientific search to address the research questions. The main findings were interpreted in a conceptual research framework (Figure 2.4) from two main perspectives: (1) the categorisation of factors that may influence VLE adoption and (2) the impact of the country's national culture on VLE adoption. The proposed framework extends the UTAUT model (Venkatesh et al.,

2003) by generalising the core UTAUT factors along with other essential factors into five specific themes at the individual and institutional levels and introducing four constructs to unfold the relationship between the factors and the country's national culture in the process of VLE adoption.

Section 2.7.1 Factor Categorisation

The five themes of factors at the individual and institutional levels were based on the 145 empirical studies' research findings, and the researchers integrated the key concepts from the institutional theory in theorising the categorisation. The individual-level category consists of three themes (characteristics, cognition, and digital capability) that have discussed a person-centred approach (Garone et al., 2019). The main category is consistent with the reviewed studies' definitions of personal (Park, 2009) and individual factors (El-Masri & Tarhini, 2017; Eraslan Yalcin & Kutlu, 2019; Keller, 2009; Park et al., 2012). The non-individual factors, such as the social norms, organisational facilitating, and intangible rules (e.g. Raza et al., 2020; Widyasar et al., 2019), which provided stability and meaning to the use of VLEs, were generalised as institutions from the institutional perspective (Scott, 2014). This study discovered a new theoretical opportunity for studies on technology adoption by integrating the institutional theory to address the research gap and cross the disciplinary boundaries of information technology studies, educational studies, and management studies.

Section 2.7.2 The Impact of the Country's National Culture

This study unveiled the hidden impact of the four cultural dimensions between the factors and behavioural intentions toward using VLEs. The key findings extended the UTAUT model (Venkatesh et al., 2003) by introducing the new situational constructs and explaining the mechanisms that cause divergent VLE adoption processes in different countries and regions.

Power distance culture affects VLE adoption

In high-level power distance cultures, people with less power tend to follow and listen to more powerful members of the society (Hofstede, 2001). Specifically, teachers are more potent than students in countries or regions with higher-level power distance cultures. Therefore, students are more likely to follow teachers' guidance in using VLEs (Ameen et al., 2019; El-Masri & Tarhini, 2017; Lai et al., 2017). For teachers, if their line managers or the organisational institutions encourage them to use VLEs, they are more likely to take the advice (Jackson, 2011; Keller, 2009). However, these influences from a more powerful hierarchy might negatively affect students' and teachers' intention to use VLEs in a country or region with lower-level power distance culture (Ngampornchai & Adams, 2016; Terzis et al., 2013). The above explains how the power distance culture influences the strength of the relationship between the institutional cognitive-cultural impact and people's behavioural intentions toward VLE adoption. As Brockner and the team asserted, "the tendency for people to respond less favourably to relatively low levels of voice depends on the extent to which they consider voice to be legitimate, that is, sanctioned by cultural norms" (Brockner et al., 2001, p. 301). This mechanism unveiled the multilevel connections between the individual behaviours, organisational cognitive-cultural institutions, and societal power distance culture in the VLE adoption process.

Long- and short-term orientation culture affects VLE adoption

In a culture that is long-term oriented, people respect traditions and value thrift, perseverance, steadiness, and stability (Hofstede et al., 2010). Thus, it is more challenging for universities to break the “law book” of the traditional teacher-centred education mode, not to say establishing new rules and creating new facilitating conditions to embrace new technology (VLE) that is linked to the student-centred learning design (Lai et al., 2017). On the contrary, teachers and students in a short-term oriented culture have more opportunities to get support from the institutional frameworks and guidelines, making their lives easier in learning and trying VLEs (Nistor et al., 2014). Therefore, if a study in a long-term orientation culture did not find any institutional normative facilitating factors that significantly influence people’s intention to use VLEs, we should reflect on the institutionalisation situation (Huang & Teo, 2019) rather than doubting the value of the facilitating support. If the required support for adopting VLEs is insufficient to have an impact, how could researchers further investigate the association in VLE adoption? Theoretically, the long- and short-term orientation culture as a new construct in the VLE adoption process opens a new avenue of inquiry into the relationship between normative institutions and individuals’ behaviours.

Masculinity-femininity culture affects VLE adoption

In cultures that value masculinity more than femininity, men are more assertive, whereas women are more modest and caring (Hofstede, 2001). In modern society, biological sex no longer can represent the emotional role that an individual plays. In other words, men can have feminine features, while women can carry masculine characteristics. In an educational setting, students and teachers in a high femininity culture tend to follow their personal feelings and perceptions before deciding whether to use VLEs (El-Masri & Tarhini, 2017; Nistor et al., 2014). The aforementioned explains how the masculinity-femininity culture influences the impact of individual cognition on people's behavioural intentions toward the use of VLEs. This study advances the theory by stepping back and examining how the pieces fit together among the extant sporadic and fragmented studies on various individual cognitive factors in the VLE adoption process.

Uncertainty avoidance culture affects VLE adoption

People in a high uncertainty avoidance culture have a lower degree of tolerance toward uncertainty and ambiguity (Hofstede, 2001). For example, in a university in a country or region with high uncertainty avoidance, teachers and students more easily feel threatened by ambiguous and unknown issues when using any new technology (Terzis et al., 2013) and might be less willing to develop their digital capability over time. By contrast, in countries and regions with a lower level of uncertainty avoidance culture, people are more open to gaining new digital skills, and the whole society values individual digital capability (Lai et al., 2017; Ngampornchai & Adams, 2016). When reflecting on the factors affecting their intentions to use VLEs, there will be more focus on the impact of individual digital capability. Thus, the association between individual digital capability factors and users' intention to use VLEs depends on the level of uncertainty avoidance. At the micro-level, it is an individual's responsibility to develop their digital capability to better embrace VLEs. However, at the meso-level, the uncertainty avoidance culture creates an environment in which teachers and students have less trust in using VLEs (Dorobat et al., 2019; Jackson, 2011). If the university can create an encouraging environment for people to motivate themselves to learn new technologies, VLE adoption will be more effective. This study contributed to the extant literature by extending our understanding of the VLE adoption process from the micro-strategy of the individual digital capability development to the meso-strategy of organisational learning environment development.

Section 2.7.3 Strengths and Limitations

This study positions itself in the relatively new field of research on VLEs and technology acceptance. Most of the reviewed articles in this area were published in 2019 (e.g. Chan et al., 2019; Liu & Geertshuis, 2019), which illustrates the topic's novelty. The first article about VLE adoption in higher education was published in 2001 (Piccoli et al., 2001), although the concept of VLE was in its infancy at that time, which emphasises the long-standing awareness of the importance of the topic. The impact of a country's national culture on VLE adoption has been investigated in a few empirical studies (e.g. Hwang & Francesco, 2010; Keller, 2009; Nistor et al., 2014; Terzis et al., 2013), but it has not yet been systematically mapped. The research findings connect cultural dimensions with the VLE adoption factors from a holistic perspective. The conceptual research framework could serve as a starting point for scholars to plan for future research on VLE adoption in higher education, such as cultural theories and their epistemological companions within different disciplines, the classification of factors, and measurements (to look for differences or associations) regarding the connection between culture and VLE adoption.

Regarding the limitations, the extant technology acceptance theories and models used by studies on VLE adoption, such as the TAM (Davis, 1986) and the UTAUT (Venkatesh et al., 2003), were developed based on prevailing empirical studies that were primarily conducted in western contexts, which might have a cultural bias (Lee, 2016; McCoy et al., 2005). The second limitation concerns the country or region identification. This study assessed a country's national culture based on the geographical location of the universities studied. However, whether the immigrant or non-local participants are influenced by the local cultural values of their original cultural values remains unknown. In terms of the methodology, to address the research question of how the country's national culture affects VLE adoption, this study applied the inductive reasoning method to organise logical thinking and generalise the relationships between the VLE adoption factors and the country's national culture through qualitative analysis and observation. Future studies could further test the proposed research framework by using quantitative methods with a bigger sample size.

Section 2.8 Future Research and Implications

This systematic literature review demonstrates that the complexity of explaining the contradictory findings of extant studies lies in the overlooked hidden role of a country's national culture. Theoretically, this review has shown a more coherent picture of the characteristics of factors and processes of VLE adoption. Regarding the divergent patterns discussed in this study, the principal results imply that integrating the institutional theories, technology acceptance theories, and national culture theories is essential to understanding better the complexity of the relationship between a country's national culture and VLE adoption. Pragmatically, this study provides implications that could help educators, practitioners, policymakers, and managers to leverage the educational digital transition and enhance the development of the interactive learning environment in response to the COVID-19 pandemic challenges under diverse cultural contexts.

Further research is needed in three main directions: (1) more empirical case studies with mixed methods to investigate factors that may influence VLE adoption in different countries and regions; (2) more testing and validation of the proposed conceptual research framework and further investigation to the cultural value as the explanatory variable; (3) using the cultural-historical activity theory (O'Brien et al., 2012) for more innovative visual research.

Section 2.8.1 Future Research on Factors that may Influence VLE Adoption

The individual-level factors (individual characteristics, individual cognition, and individual digital capability) have drawn much attention in most the western countries and regions over the past 19 years (2001 to 2020) (e.g. Agbatogun, 2013; Hwang & Francesco, 2010; Khechine et al., 2020; Zanjani et al., 2016). More studies on VLE adoption in the eastern context (Huang et al., 2017) are needed to avoid potential cultural bias. The number of factors regarding individual perspectives is significantly higher than institutional ones. The above might relate to the student-centred pedagogical design of VLEs, which encourages self-regulated active learning rather than centrally constrained learning. However, the review results demonstrate the diversity of learner identities, cognition, and capabilities (e.g. Daspit & D'Souza, 2012; Habib et al., 2014; Robinson, 2016), which need further facilitating level support in a different socio-cultural environment. Future research could further probe the link between the attributes of individual cognition and the pedagogical perspectives of VLE adoption.

The findings of this study demonstrate that the pedagogical perspective of VLE adoption gained attention very early in 2001 (Piccoli et al., 2001), and this factor was investigated extensively (Arbaugh & Benbunan-Fich, 2006; Arevalillo-Herráez et al., 2011; Li et al., 2012; Oh & Park, 2009; Piccoli et al., 2001; Shana, 2009; Teo, 2010). The pedagogical factors belong to the institutional cognitive-cultural influence theme. They are directly related to the educational context reflecting the instructional design, delivery process, and interactions between teachers and students. However, a few questions were not addressed clearly throughout the extant empirical studies. For example, it is not clear how the pedagogical value of VLEs is transformed to support specific learning and teaching approaches. Future research could explore more the connection between VLE adoption and the pedagogical value of VLEs, as Farooq and Benade (2019) also suggested in their review.

Section 2.8.2 Future Research on the Conceptual Research Framework Testing and Validation

The proposed conceptual research framework is developed throughout the systematic analysis of the extant empirical studies that frame VLE adoption in higher education. Future testing and validation could take into consideration the following four aspects.

Methods. The studies included in this systematic literature review mainly applied a quantitative model test (e.g. Eraslan Yalcin & Kutlu, 2019; Garone et al., 2019; Herrador-Alcaide et al., 2019; F. Huang, T. Teo, & M. Zhou, 2019), which provides valuable information about the validation of the existing theories and models' applicability in different countries and regions. However, this field also applies qualitative, grounded, longitudinal, and process case study designs.

Participants. Many studies included in this review argue that their research aims to provide implications for policymakers, universities, and the management of technologies (e.g. Ameen et al., 2019; Park, 2009), but researchers have not investigated managers' perceptions in much detail. Marangunić and Granić (2014) found the same situation in their review of studies on technology acceptance. Increasing the involvement of other stakeholders, such as managers and admin staff members, could provide new insights from different perspectives.

Contexts. The reviewed studies were primarily conducted in local public universities or colleges (e.g. Dorobat et al., 2019; Juárez Santiago et al., 2020). Future research could include other business models of Higher Education Institutions (HEIs), such as international, transnational, and open universities.

Cultural Dimensions. This study has investigated Hofstede's national culture and discussed the impacts of four cultural dimensions through four themes of factors. Future research could explore the impact of the other two cultural dimensions. Moreover, culture is also an essential construct in improving academic leadership (Xi et al., 2015). Researchers could investigate managers' perceptions of VLE adoption by connecting GLOBE's culture and leadership dimensions (House et al., 2004). More specifically, there are five main streams that future studies could consider: (1) organizations (House et al., 2004; Triandis, 1982; Trompenaars & Hampden-Turner, 1988); (2) learning (Brown et al., 1989; Charlesworth, 2008; Davis & Fill, 2007; Kretschmann, 2008; Lai, 2011; Lim, 2004; Parrish & Linder-VanBerschot, 2010; Wong, 2004); (3) communication (Hall, 1989; Ono, 2010); (4) technology

(Jackson & Philip, 2010; Leidner & Kayworth, 2006; Nistor et al., 2014; Phillips et al., 1994; Srite & Karahanna, 2006; Straub et al., 1997; Taksa & Flomenbaum, 2009; Venkatesh & Zhang, 2010); and (5) Confucianism (Bond, 1996; Chang et al., 2001).

This review extended our understanding of the various factors that may influence VLE adoption with greater generalizability. Moreover, the researchers explored the possibility of intangible mechanisms that may interfere with the relationship between the factors and VLE adoption. Remarkably, this review highlighted the critical role of a country's national culture in interpreting better the underlying reasons for the differences in the research findings on VLE adoption. Finally, the main findings provide valuable insights for university managers to identify the underlying contradictions and develop multi-pronged strategies for their diverse VLE user groups to adopt the technology in their universities effectively.

Section 2.9 Addendum

Chapter 2 is a published paper. According to the university policy, no amendments can be made. Therefore, this section includes the newly developed content to respond to examiners' feedback.

(1) The "low satisfaction and ineffective actual usage" on page 35 refers to several different situations, such as the limited use of discussion boards of the VLE even among experienced online education teachers, the increasing dissatisfaction towards the VLE-centric model of higher education (Green & Chewning, 2020), the scepticism and reluctance to use VLE for online text publishing (Habib et al., 2014), low usage of interpersonal technologies (e.g., chat tools, wikis and blogs) (Limniou

et al., 2015) and complaints about the extra time for learning the technology (Singh & Hardaker, 2013).

(2) This chapter focused on the most commonly used models (TAM, TRA, TPB and UTAUT) in the educational context. The literature review of the other models and theories (see Table 2.1), which have made significant contributions in different contexts, provided a holistic understanding of the theoretical development of technology acceptance over the years.

(3) The paragraph on page 45 about the rationale for using Hofstede's cultural dimensions was revised for a better logic flow:

Hofstede's cultural dimensions have gained a wide acceptance and provided theoretical grounds for exploring technology acceptance in higher education (Khan, 2017). Although Hofstede's notion of having a national culture is criticised with the objection that cultural diversity may vary between countries and regions (Mosakowski et al., 2013; Ono, 2010; Williamson, 2002), the empirical studies that support this objection are limited (Vaate et al., 2020). Some studies challenged Hofstede's work on cultural values because it was originally conducted in a business context, with the data gathering process only involving participants from well-educated, mid-, or upper-level employees of IBM from around the world (Piller, 2011). This study argues that the non-representative issue might not affect the research on VLE adoption in the higher education because stakeholders in this research area are either already well-educated or currently receiving higher education. Additionally, researchers found empirical evidence that Hofstede's cultural dimensions influenced university teachers' adoption of information communication technologies in Chinese and Spanish universities (F. Huang, J. C.

Sánchez-Prieto, et al., 2021). Consequently, this study used Hofstede's cultural dimensions for further exploration.

(4) Factors like perceived ease of use, effort expectancy, and self-efficacy of using technology have been categorized into the individual cognition theme. Because they were defined to measure an individual's intrinsic motivation and mental action or process of acquiring understanding through thought, experience, and senses. Although they are highly relevant to developing individual digital competence, they cannot be used to measure an individual's capability directly. Therefore, they were not categorized into the individual digital capability theme.

(5) This study examined the potential influences of six cultural dimensions on VLE adoption with a qualitative approach, but only revealed the influences of four cultural dimensions. The data I have collected from the 145 reviewed studies did not provide sufficient qualitative evidence to indicate the influences of the other two cultural dimensions (individualism-collectivism and indulgence-restraint) on the various factors that affect VLE adoption in different countries. Therefore, I have proposed to further explore the other two cultural dimensions in future research with a different dataset or different research method.

Following this chapter, the next chapter (chapter 3) introduces the research aims developed based on the four research gaps identified by the literature review of this chapter and discusses the connections between study 1 and the other five studies.

Chapter 3 Research Aims

The systematic literature view in chapter two identified several lines of enquiry for further development. Responding to the calls from prior researchers (e.g., Bower, 2017; Garcia-Huidobro et al., 2017; Salmon, 2019; Sharples, 2016), this research programme aims to strengthen our understanding of the underlying mechanism of the institutional and individual influence on technology-facilitated educational change. Furthermore, this research programme focuses on the factors and processes that influence the VLE adoptions and innovation diffusions among university teachers and students as the premise for long-term educational transition. As aforementioned in Table 1.4 of chapter one, the research questions aligned to the relevant aims to foster a deeper understanding and investigate a network of normative facilitating, cognitive-culture, individual cognition, and theorisation central to VLE adoption and educational change in HE. Specifically, the main research aims are as follows.

First, study 2 in chapter four aims to investigate the mechanism of the institutionalisation of VLE-enabled educational innovation and develop a new theoretical framework grounding on the 13 years' longitudinal empirical data of a Chinese international university (XJTLU). Because previous studies have reported the critical role of institutional normative facilitating (e.g., procedure, policy, and support) in influencing VLE adoption and diffusion, particularly in China (e.g., Huang & Teo, 2020; Huang & Wu, 2017; Lai et al., 2017), but existing theories have limitations to address the research gap.

Second, during the rapid educational transition forced by the COVID-19 disruption, worldwide learner dissatisfaction has increased the concerns about teachers’ technological and pedagogical skills and knowledge for effective online education (Baber, 2020; Fawns et al., 2020; Watermeyer et al., 2020). Therefore, study 3 in chapter five evaluates the VLE-enabled emergency remote teaching (Hodges et al., 2020). More importantly, study 3 seeks a practical teacher professional development approach to support technology-enhanced online learning and teaching by applying action learning in a Confucian culture context in China, where the topic is rarely examined.

Third, to contribute to the emerging literature on individual factors that might influence students’ intention to use the technology (Granic´ & Marangunic´, 2019), study 4 in chapter six aims to develop a validated and reliable measurement scale to examine students' perceived self-efficacy and perceptions of justice in the VLE-enabled automated project-based learning (PBL). Furthermore, study 4 investigates the relationships between the individual cognitions (self-efficacy and perceived justice) and seeks practical solutions to support students’ use of the technology for fair and efficient learning.

Fourth, study 5 in chapter seven aims to address the research gap concerning the overlooked student perceived pedagogical value of VLE in HE (Farooq & Benade, 2019; Li, Zhang, et al., 2021). Specifically, study 5 aims to assess the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) in a Chinese context and explore the mechanism of how students’ perceived pedagogical value of VLE influences their intention and actual usage of the VLE-based in-class quiz for interactive hybrid learning. Finally, drawing on the findings of the prior studies, study 6 in chapter eight aims to reconceptualise the digital learning ecology model in respond to the societal needs of an increasingly adaptive higher education system (Cunha et al., 2020; Huijser et al., 2019).

The following chapters 4-8 introduce five studies that tied to the four research gaps with different research aims.

Chapter 4 Meaning-Making in Virtual Learning Environment Enabled Educational Innovations: A 13-Year Longitudinal Case Study

Section 4.1 Problem Statement

Although the virtual learning environments (VLEs) or learning management systems have been designed as integrative, communicative, and interactive learning environments to advocate new learning opportunities for online or hybrid learning, the educational innovations enabled by VLEs are not widespread as expected (Ashrafi et al., 2020; Flavin, 2020). Despite its negative impacts, the COVID-19 has accelerated the development of online education and provided opportunities for critical reflection on current educational practice (Green et al., 2020). However, people are missing the "old teaching norm" (i.e., face-to-face or any other instructional approaches that dominated higher education in the past), and resistance to changes exists (Chan et al., 2021, p. 169). It is still an open question if either or both the external disruption (e.g., COVID-19 and emerging technologies) or the internal cognitive evolution plays a critical role in promoting long-term transformative change in higher education (HE).

Institutional theory "has proven generative for research and insightful for practice" (Marsan et al., 2020, p. 5) to study the means through which human actors accept innovation and achieve stability and legitimacy in patterns of collective action (Greenwood et al., 2017). Many educational scholars started to adopt institutional theory and emphasized the importance of institutionalising educational innovations across the university (e.g., J. Huang et al., 2021; Nworie, 2015). Therefore, we use Tolbert and Zucker's (1996) three-stage model to study the institutionalisation process of VLE enabled innovations in HE. The term innovation in this study is defined as a new or changed educational practice or idea enabled by VLE capabilities.

Specifically, we explore the threshold stage and how VLE enabled innovations can achieve institutionalisation by completing this threshold stage. We apply quantitative and qualitative methods to examine the institutionalisation trajectories of 19 VLE enabled innovations in an international university's 13 years of development. Our analysis finds that the threshold stage is from innovation initiation to habitualisation. Habitualisation may not be achieved if teachers fail to "create a meaning" of innovations, leading to incomplete institutionalisation. Meaning-making, therefore, plays a critical role in the threshold stage through two parallel dimensions: individual cognitive divergence (Colyvas, 2007) and collective cognitive consensus (Combe & Carrington, 2015).

This study highlights the value of integrating the sociological concept of meaning-making in an extended institutional theoretical model to specify the cognitive mechanism of institutionalising the VLE enabled innovations in HE. Further, we stress the importance of individual and collective cognitive filters (Combe & Carrington, 2015) to understand better how teachers create meaning from the VLE enabled innovations and habitualised standards (Colyvas, 2007) learning and teaching practices emerge in the institutionalisation process. We discuss the research significance and practical implications of the COVID-19 pandemic.

Section 4.2 Literature Review

Section 4.2.1 VLE Enabled Innovations and Educational Transformation

Rogers defined innovation as "an idea, practice, or object perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 49). Prior scholars studied different drivers of innovations and included technology as one of the key drivers (Scott, 2014; Van de Ven & Hargrave, 2004). Universities are expected to provide new learning opportunities and promote educational innovations to reshape learning and teaching practices by integrating technologies (Pelletier et al., 2021). VLEs, as one of the universal educational technologies, are designed with critical pedagogical value (e.g., constructivism and connectivism) and technological functionalities (e.g., instant feedback, paperless multimedia submission and group discussion) to enable new learning opportunities in an interactive and communicative online or hybrid learning environments (Barari et al., 2020; Browne et al., 2006). We defined VLE enabled innovation as a new or changed educational practice or idea enabled by VLE capabilities.

However, the material benefits of VLE enabled innovations for the institutional structure are "not readily calculable" (Tolbert & Zucker, 1996: 186), which increases the complexity of us understanding its mechanism (Sinclair & Aho, 2018). Studies found that many innovations "result in fads or temporary novelties, while others may endure for many years while receiving little attention" (Natividad et al., 2018, p. 85). "It is surprising that higher education has not been transformed by technology, as many other goods and services have been" (Flavin, 2020, p. 145). Further, the extant educational literature shows little evidence of wide-scale educational transformation with digital technologies (Blundell et al., 2020).

Technology acceptance models (Davis, 1986; Venkatesh et al., 2003) and innovation diffusion theory (Rogers, 2003) provided a valuable theoretical framework for emerging studies on VLE adoption and diffusion, while the institutional theory provides a processual perspective that considers the collective cultural influence and individual rationales to seek innovation institutionalisation (Li, Zhang, et al., 2021).

Further, institutional theory has made excellent contributions in stressing the "unreflective, routine, and taken-for-granted nature of most human action" (Raviola & Norbäck, 2013, p. 1173). Scott stated that some innovations "procced successfully" to "set the stage for objectification" while some "prove to be unsatisfactory and are dropped" (Scott, 2014, p. 148). Tolbert and Zucker highlighted the contribution of institutions in solving the "recurring problems" (Tolbert & Zucker, 1996, p. 180) in the form of the "reciprocal typification of habitualized actions by types of actors" (Berger & Luckmann, 1967, p. 54). Institutions aim to provide stability and meaning to social life (Scott, 2014), influence human behaviour and outcomes (such as policies, strategies, and cognition), and "provide opportunities for intentional institutional change, as well as unleash processes of unintentional changes" (Greif, 2006, p. 380).

The process of institutionalisation makes the connections between institutions and actions in the institutional change. The leading scholar in the institutional analysis of organizations, Selznick claimed that—

Institutionalisation is a process. It is something that happens to an organisation over time, reflecting the organization's own distinctive history, the people who have been in it, the groups it *embodies and the vested interests they have created, and the way it has adapted to its environment… In what is perhaps its most significant meaning, "to institutionalise" is to infuse with value beyond the technical requirements of the task at hand (Selznick, 1957, pp. 16-17).*

Extant institutional studies have significantly contributed to explaining how existing institutions influence the organizational structure, the functioning of organizations, organizational populations, and organizational fields (Fuenfschilling & Truffer, 2014; Hinings & Tolbert, 2008). With the maturation of institutional theory over the years, there is an increasing demand to explore "how institutions arise and achieve stability, legitimacy, and adherents" (Scott, 2014, p. 113). There are various mechanisms of the institutionalisation process, such as those based on returns (Greif, 2006; North, 1990), commitment (DiMaggio & Powell, 1991; Selznick, 1992), argument (Green et al., 2009), emergence (Colyvas & Maroulis, 2015), Semiotic (Y. Li, 2017), verbal text (Meyer et al., 2017) and objectification (Berger & Luckmann, 1967; Greenwood et al., 2017).

Berger and Luckmann (1967) defined institutionalisation as a process occurring over time that could create rules, norms, and shared knowledge and belief systems with increasing objectification. Their discussion on institutionalisation inspired other institutional theorists to investigate the process further, leading to multistage models (Greenwood et al., 2017).

Section 4.2.2 The Sequential Multistage Institutionalisation Model

In their three-stage sequential multistage model, Tolbert and Zucker (1996) expanded the objectification-based institutionalisation process (Berger &

Luckmann, 1967). The three stages are habitualisation, objectification, and sedimentation.

Habitualisation. From an educational perspective, habitual actions require considerable repetition with a learning task (Sargent, 2015). The habitualisation process develops patterned behaviours and generates "new structural arrangements" (such as policies, procedures, and offices) to solve "a specific organizational problem or set of problems" (Tolbert & Zucker, 1996, pp. 181-182). From a sociological perspective, habitualisation is a voluntary process based on the "psychological gain" appreciated by all stakeholders with reciprocity (Berger & Luckmann, 1966, p. 74). Berger and Luckmann proposed that—

> *All human activity is subject to habitualisation. Any action that is repeated frequently becomes cast into a pattern, which can then be reproduced with an economy of effort and which, ipso facto, is apprehended by its performer as that pattern. Habitualisation further implies that the action in question may be performed again in the future in the same manner and with the same economical effort (Berger & Luckmann, 1967, pp. 70-71).*

In the organizational context, the process of habitualisation develops patterned behaviours. It generates "new structural arrangements" (such as policies, procedures and offices) to solve "a specific organizational problem or set of problems" (Tolbert & Zucker, 1996, pp. 181-182). Compared with other stages, the habitualisation stage has a high "structure failure rate" and high "variance in implementation" with no involvement of the "theorisation activity" (Tolbert &

Zucker, 1996, p. 185). Van de Ven and Hargrave (2004) interpreted habitualisation as how other actors try to innovate. Habitualized actions were considered the key to understanding the connection between the individual behaviours at the micro-level and the organizational institutions at the macro-level (Reay et al., 2013).

Objectification. Through the objectification process that produces tangible and intangible objects (Barman et al., 2016), an organisation develops a certain "degree of social consensus among organizational decision-makers concerning the value of a structure" (Tolbert & Zucker, 1996, p. 182). Van de Ven and Hargrave interpreted objectification as the process by which new structural elements move toward "a more permanent and widespread status" (Van de Ven & Hargrave, 2004, p. 276). From a phenomenological perspective, first-order objectification generates and stabilizes "particular meanings beyond their specific context," while second-order objectification makes "objectively available and subjectively plausible the first-order objectification that has been institutionalized" (Y. Li, 2017, p. 535). Vaujany et al. (2019) highlighted that objectification constitutes theorisation (framing the new ideas into conceptual models) and rhetorical strategies (adapting new ideas for broader adoption) as the two core activities.

Sedimentation. Sedimentation contributes to achieving full institutionalisation (Van de Ven & Hargrave, 2004) by completing the spread of the new arrangements and structures across generations of innovation adopters (Rogers, 2003) within as well as between organizations over time (Tolbert & Zucker, 1996). Berger and Kellner defined the institution as "a sedimentation of meanings or, to vary the image, a crystallisation of meanings in objective form" (Berger & Kellner, 1981, p. 31). Jarzabkowski et al. (2009) considered sedimentation a form of institutional logic in institutional pluralism studies. In the review of the semiotic theory of institutionalisation, “[s]edimentation is widespread of patterned behaviours and meanings and their perpetuation and solidification. The sedimentation stage gives the institution the quality of exteriority and taken-for-grantedness” (Y. Li, 2017, p. 532).

The three-stage institutionalisation model has been used in many studies (e.g., Marsan et al., 2020; Wei, 2021), but few educational studies so far. To address this research gap, we adopted the theoretical model to explore the institutionalisation process in the HE context, where organizations have a looser structure and higher autonomy (Hsu et al., 2018). Another research gap is about the threshold stage that determines the success of institutionalisation. Studies found that innovations faded or stopped progressing at different institutionalisation stages. For instance, Wei (2021) found that the habitualisation stage is unstable and, thus, has a higher failure rate for the institutionalisation of the innovation. Haack et al. (2021) argued that the objectification stage is the gatekeeper for full institutionalisation. To date, which stage is the threshold remains controversial.

Section 4.2.3 Research Questions

Our study investigated two research questions: what is the threshold stage of the institutionalisation process of VLE enabled innovations, and how do the innovations become institutionalised in the threshold stage?

Section 4.3 Methodology

Qualitative case study research is commonly acceptable for addressing this type of research, which could generate rich data from cultural and historical contexts (Creswell, 2012; Miles & Huberman, 1994). The rationale for conducting a single case study was to have a deeper understanding of the complex existence of a phenomenon, build situation-specific knowledge to detail the context and process, seek new theoretical relationships concerning the research questions and develop generalisations beyond the case itself (Dyer et al., 1991; Merriam, 1998; Siggelkow, 2007; Yin, 2018). This longitudinal case study examined the institutionalisation process at an international university (from here on, "University") for the richness and openness of its technological innovation projects from 2006 to 2019. The University has integrated 65 digital technologies on the Moodle-based VLE, enabling various educational innovations. We collected quantitative and qualitative data, including 13 years of digital panel data, about 1248 pages of archive documents, and over 100 hours of semi-structured interviews with 51 participants. Following the constructivist grounded theory (Bryant & Charmaz, 2019), we built a theoretical structure based on the original detailed data with high accuracy and integrated the theoretical concepts from substantive theory to a more general level (Gioia et al., 2013). This study received the University ethics approval, and we followed the case study protocol to conduct fieldwork for data collection, analysis, and study reports (Yin, 2018).

Section 4.3.1 Data Collection

Digital Panel Data.

We identified VLE enabled innovations, tracked their changes, and determined the institutionalisation stage to explore the first research question. Specifically, we collected 13 years of digital panel data from the Moodle databases (about three terabytes of auto-recorded user logs). These data included vital information, like the number of formal courses taught per academic year, the type of digital technologies integrated, and the actual use (Appendix 8). We cleaned the raw data by eliminating erroneous or irrelevant information and scrubbed the data of digital technologies with shallow usage (i.e., no actual user attempts). The user logs reflected teachers' actual behaviours with the digital technologies, such as online activity creation time, time spent on VLE, and user attempts. These data helped triangulate the interview responses regarding technology usage in the innovation institutionalisation process.

Archival Documents.

To better understand the documented history of VLE enabled innovations, such as decision-making processes and policy implementation, we collected 1248 pages of 475 archival documents published between 2006 and 2019 (Appendix 9). For instance, the document "2017 Policy on student attendance and engagement" reported that all course leaders "should decide on the most appropriate way to record attendance" using VLE-based online attendance technology. All collected documents were imported into NVivo version 12 for content analysis and data coding.

Interviews.

While the digital panel data and the archival documents showed "photos" of the University's history, the interview informants played a critical role in narrating the vivid stories behind the static "snapshots." Applying the purposeful sampling strategy (Guest et al., 2006), we interviewed four staff members from different countries. They had worked at the University from 2006 to 2019 in different roles. Then, we adopted the snowballing technique (Aguinis & Solarino, 2019) to select referrals recommended by prior informants for further investigation. In line with the grounded strategy, we asked semi-structured open questions such as, “what learning technology did you use in the past years, and how was your experience?” (See Table 4.1 for the complete list of interview questions). The number of interviews continued until the data reached saturation (Bryant & Charmaz, 2019). Finally, we recorded over 100 hours of in-depth interviews with 51 informants. They were representatives of the population of interest who had core leadership and academic roles, with a mixed international cultural background (including American, Australian, British, Canadian, Chinese, French, German, Greek, Indian, Italian, Malaysian, Mexican, Nepalese and Philippines), were diverse in gender and educational background, and had served for seven years in the University on average (Table 4.2). We used the auto transcription technology with a manual audit. The non-English transcriptions were manually translated into English before data analysis.

Table 4.1 Interview Questions

No.	Interview Questions
1	Would you please talk about your understanding of learning and teaching?
2	What is your opinion about the role of a teacher in learning and teaching?
3	To what extent do you think technology is helpful for your teaching approach?
4	What learning technology did you use in the past years, and how was your experience?
5	What factors will affect your intention to use technology in your teaching practice?
6	How does/can the Institution support the technology influence learning and teaching?
7	Would you please describe any changes to learning and teaching that you have experienced or observed in the past years?
8	To what extent and in what ways did this/these change (s) influence your teaching approach?
9	Has technology influenced these changes, and are they linked to pedagogy, and if yes, how?
10	Any other comments?

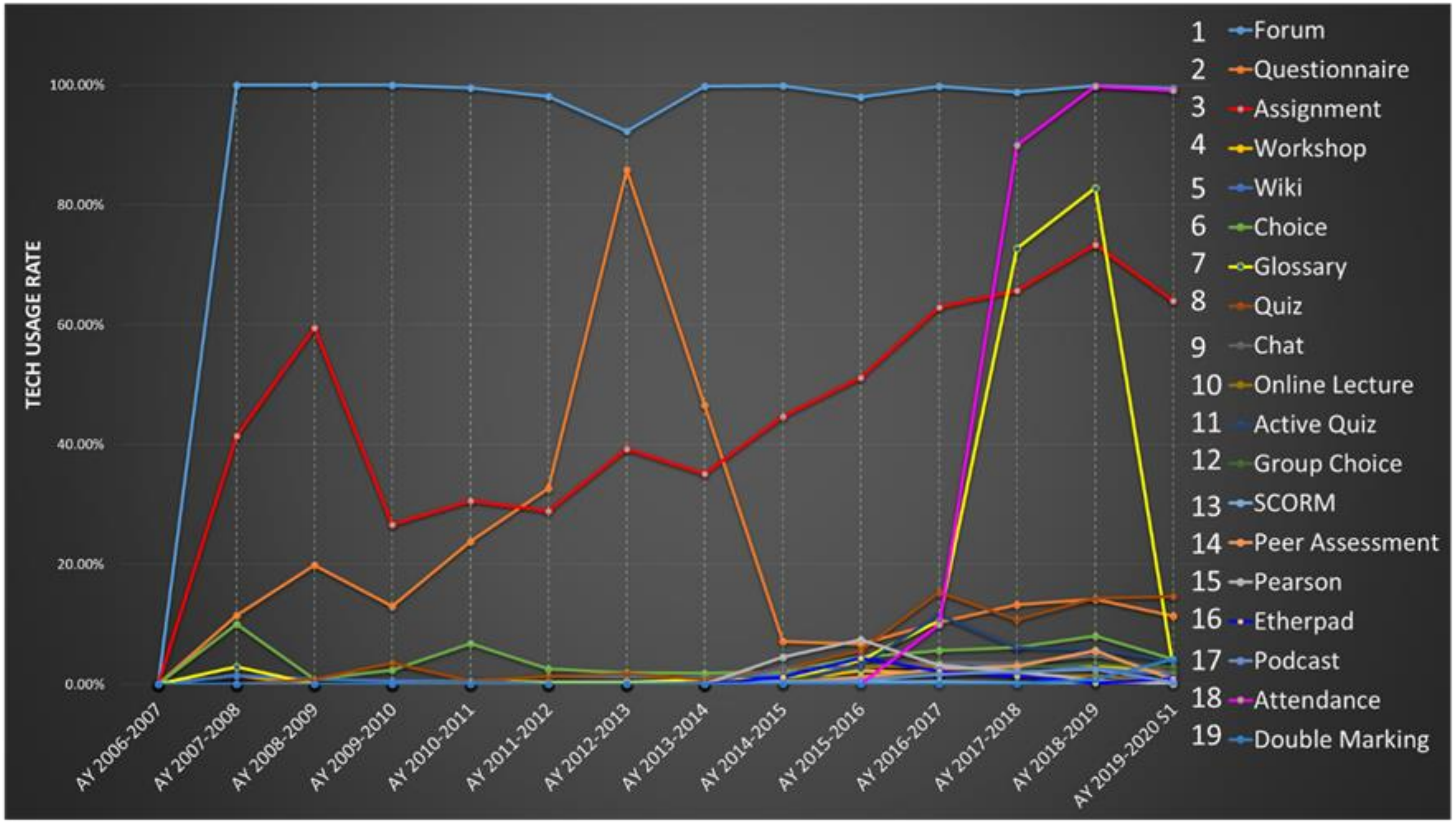
Table 4.2 Overview of Interview Participant Information

Participant ID	Gender	Nationality	Interview Date	Onboard	Discipline
INT 1	M	Chinese	20191202	2010	Education
INT 2	M	Chinese	20191211	2011	Registry
INT 3	M	Chinese	20191211	2008	Management
INT 4	F	Australian	20191212	2013	Urban Planning
INT 5	M	British	20191213	2012	Linguistics
INT 6	F	Chinese	20191213	2010	Registry
INT 7	F	Chinese	20191216	2013	English Language
INT 8	M	American	20191217	2015	Education
INT 9	F	American	20191223	2014	Academic Service
INT 10	M	Chinese	20191223	2007	Computer Science
INT 11	F	Chinese	20191223	2012	English Language
INT 12	F	Chinese	20191227	2006	Registry
INT 13	M	British	20191224	2006	Applied Linguistics
INT 14	F	Chinese	20191224	2008	Chinese Language
INT 15	M	Chinese	20191230	2006	Mathematics
INT 16	M	Malaysian	20200108	2013	Civil Engineering
INT 17	F	Canadian	20200108	2013	English Language
INT 18	M	British	20200110	2014	Educational Technology
INT 19	M	Chinese	20200114	2009	Information Technology
INT 20	M	British	20200115	2014	Electrical and Electronic Engineering
INT 21	M	Australian	20200116	2014	China Studies
INT 22	F	Chinese	20200812	2011	Registry
INT 23	F	Chinese	20200813	2013	Accounting
INT 24	M	Chinese	20200813	2016	Education
INT 25	F	Chinese	20200817	2012	Academic Quality Assurance
INT 26	M	Malaysian	20200915	2013	Applied Linguistics
INT 27	M	Greek	20200924	2011	Civil Engineering
INT 28	M	Chinese	20200925	2010	Physics
INT 29	M	Italian	20201130	2017	Architecture
INT 30	M	Chinese	20201130	2012	Mathematics
INT 31	F	Chinese	20201201	2012	Architecture
INT 32	M	Italian	20201201	2013	Strategic Management and Organisations
INT 33	M	American	20201202	2019	Education
INT 34	M	British	20201202	2014	International Relationship
INT 35	M	Mexican	20201203	2014	Computer Science

INT 36	F	Indian	20201204	2017	Film and TV Arts
INT 37	M	British	20201204	2019	Film and TV Arts
INT 38	F	British	20201207	2013	English Language
INT 39	M	Malaysian	20201207	2007	Computer Science
INT 40	M	British	20201208	2020	Linguistics
INT 41	M	Nepalese	20201208	2011	Economics
INT 42	M	Chinese	20201208	2006	Linguistics
INT 43	F	American	20201209	2012	Intelligent Operations and Marketing
INT 44	M	French	20201209	2013	Chemistry
INT 45	M	Italian	20201210	2016	Architecture
INT 46	F	German	20201210	2017	Architecture
INT 47	M	German	20201210	2017	Biological Sciences
INT 48	M	British	20200104	2013	Strategic Management and Organisations
INT 49	M	Philippines	20210115	2013	Public Health
INT 50	F	Chinese	20210122	2018	Education Psychology
INT 51	M	British	20211113	2019	Education

Section 4.3.2 Data Analysis

The data collected were analysed in three steps. First, we conducted descriptive quantitative data analysis to “triangulate” the data and “paint the most comprehensive picture” for decision-making (Duesbery & Twyman, 2020, p. 94). The University implemented 65 digital technologies over the 13 years, the majority of them were excluded according to the following sampling criteria: 1) the tool should have been implemented and made available for all teachers and students at some point between 2006 and 2019, and 2) the tool should have been used by teachers and students in a formal credit course. Figure 4.1 illustrates the 19 selected digital technologies. To compare the technology adoption in an academic year with that in other years, we calculated the technology usage rate by dividing the total number of all credit-bearing courses by the number of credit-bearing courses using technology per academic year. For example, in the academic year 2018–2019, there were 985 credit-bearing courses, and 723 courses used the digital assignment tool. Therefore, the usage rate for the assignment tool in that academic year was 73%.



Note:
AY = Academic Year; S1= Semester One (from September 2019 to January 2020)
Technology usage rate (for each academic period) = (number of courses that used the technology/total number of courses) × 100%
Technology ordered by the time that the digital tool was implemented at the University

Figure 4.1 Technology Usage Rate Chart (2006–2019).

In the second step, we identified and labelled the institutionalisation stage of each innovation. Specifically, we utilised the ethnographic notes from the documentary content analysis and interviews. In chronological order, we reconstructed vital historical events in innovation with the following information: innovation name, the digital technology used in the innovation, time, institutionalisation stage, and empirical evidence. Figure 4.2 shows our definitions and references of the institutionalisation stages used for data coding. For instance, we quantified “patterned behaviours” (Berger & Luckmann, 1967) for when over 50% of credit courses had used the technology in learning and teaching practice.

	Innovation	Habitualization	Objectification	Sedimentation
Definitions	a new or changed educational practice or idea enabled by VLE capabilities	An unforced process with patterned behaviors (i.e., technology usage rate is over 50%). New structural arrangements (including organizational or departmental guidelines, framework, policy, or office) are generated at the completion of this stage.	A process follows the habitualization stage, with increased adoption of patterned behaviors, and frames the new structural arrangements into the conceptual models (i.e., organizational strategy) for broader adoption.	The process follows the objectification stage and involves the spread of patterned behaviors and the new structural arrangements across generations (i.e., academic years) of technology users within the organization.
References	Flavin, 2020 Rogers, 2003	Scott, 2014 Tolbert & Zucker, 1996 Berger & Luckmann, 1967	Scott, 2014 Tolbert & Zucker, 1996 Berger & Luckmann, 1967	Scott, 2014 Tolbert & Zucker, 1996 Berger & Luckmann, 1967

Figure 4.2 Definitions of the Institutionalisation Stages.

In the final step, we divided the 19 innovations into two groups—complete and incomplete institutionalisation. We considered the institutionalisation stage, where most innovations failed to cross the threshold stage. By applying a three-phase grounded coding process (Figure 4.3), we aimed to understand the mechanism for generalising the critical theoretical concept from empirical data (Bryant & Charmaz, 2019). We reviewed incidents in the identified threshold stage in the initial phase and started with open coding. As the analysis progressed, the coding moved "from comparing incident to incident to comparing incidents with properties of categories" (Bryant & Charmaz, 2019, p. 5) among the complete and incomplete innovations. The complete innovations crossed the threshold stage (thus entering the habitualisation stage) when both of the following conditions were met: 1) over 50% usage; 2) a new policy and/or new structure. The incomplete innovations, however, were abandoned or neglected without clear institutional changes.

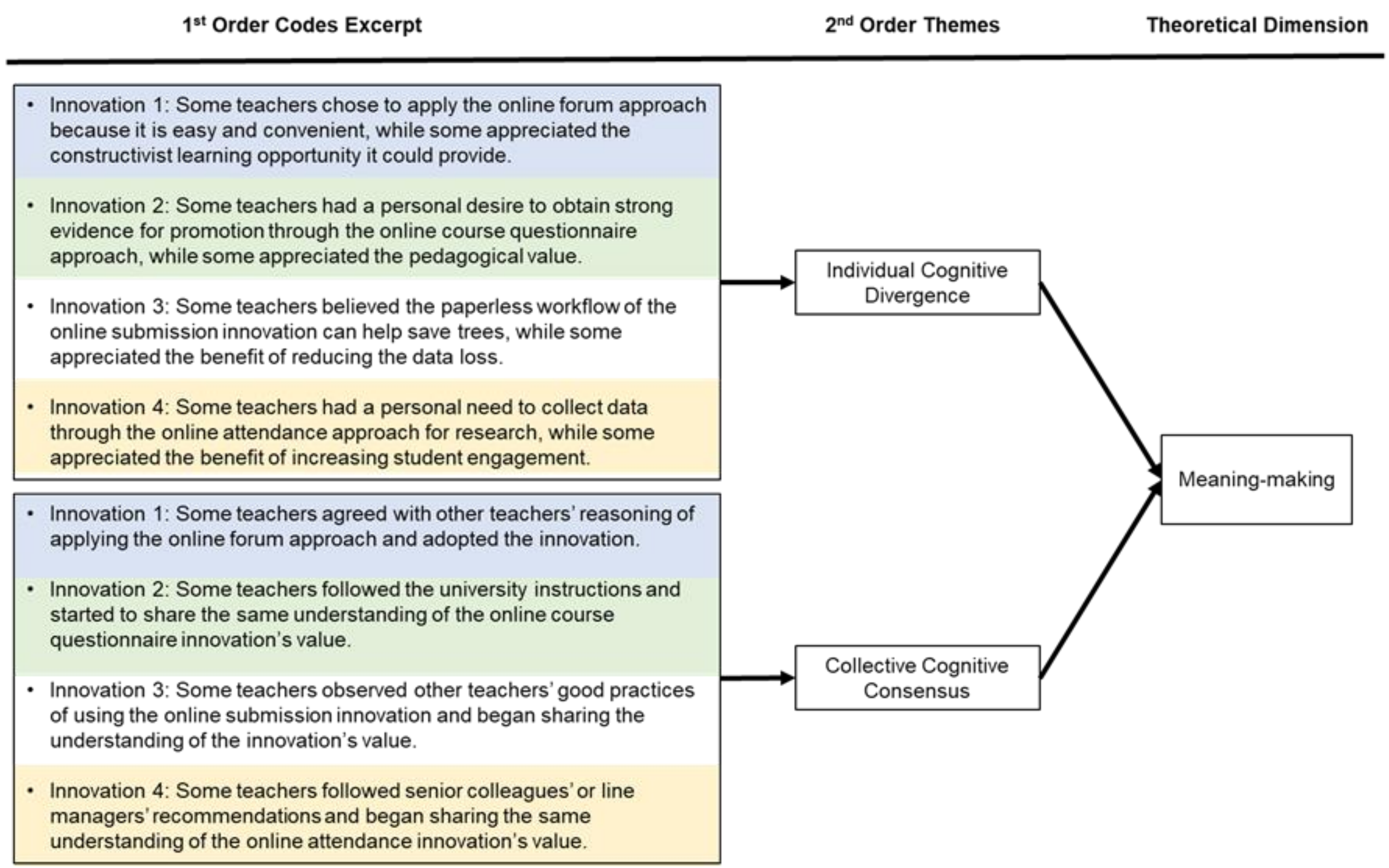


Figure 4.3 Data Analysis Structure.

To discover the “underlying uniformities in the original set of categories or their properties” (Glaser & Strauss, 1967, p. 110), we went back and forth between the theoretical literature and the grounded data regarding various reasons for teachers to adopt these innovations at the early initiation stage. Then we reconsidered the connections and underlying logic among the individual teachers and groups of teachers. Ultimately, we moved two second-level themes—individual cognitive divergence and collective cognitive consensus—to a higher-level concept: meaning-making.

Section 4.4 Results

Section 4.4.1 The Threshold Stage of The Institutionalisation Process of VLE Enabled Innovations

Complete Institutionalisation.

Four innovations completed institutionalisation (Figure 4.4). Innovation 1 was enabled by the newly implemented VLE-based online forum in 2007. Instead of sending emails conventionally, the vice president for academic affairs modelled the new approach of using an online forum to communicate with staff and students. From the VLE logs, we observed a 100% usage rate of the online forum across the University in the first academic year, 2007–2008. According to our definition, having a 50% or higher usage rate is one of the two conditions to achieve habitualisation. The second condition was reached in the academic year 2014–2015. A new office was formed with the new function to better support the institutional technology-enhanced learning (TEL) and launched the TEL framework in 2016. For instance, the TEL framework reported: “effectively moderated discussion forums can provide a way to enrich formal and informal conversations within a subject via providing greater opportunities for open exchanges of ideas and views."

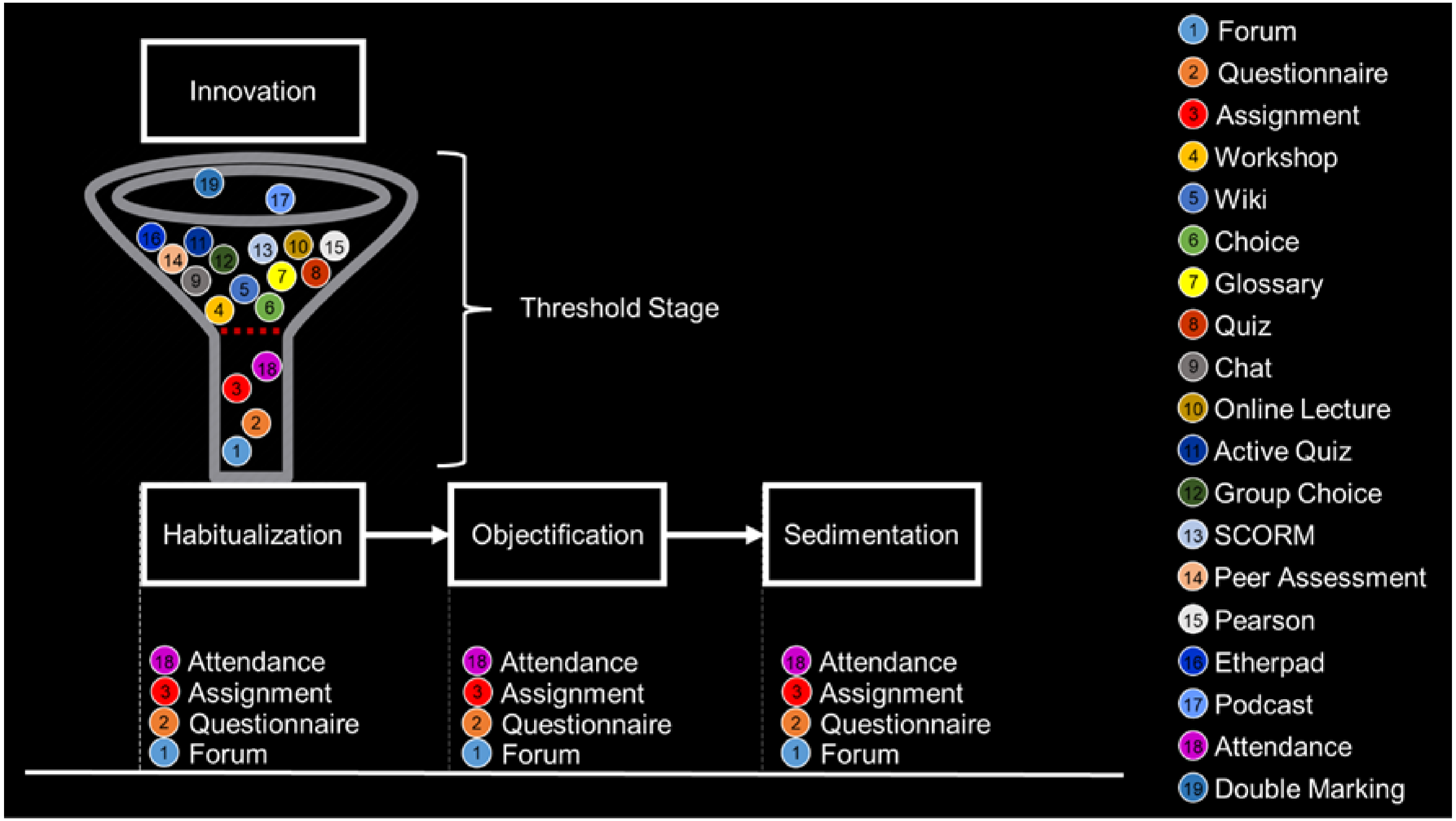


Figure 4.4 Overview of VLE Enabled Innovations at Each Institutionalisation Stage.

Innovation 2 (questionnaire) and 3 (assignment) were also inspired by the VLE-based digital technologies in 2007. The habitualisation process for Innovation 3 was just like Innovation 1 but slightly different for Innovation 2. The Innovation 2 usage rate kept increasing to 86% and dropped in 2013-2014. The University switched online questionnaires to another system that year. According to the archival documents and interviews, the approaches continued in the new system for all credit-bearing courses implementing the institutional guideline. Therefore, Innovation 2 achieved habitualisation. Innovation 18 (attendance) was implemented simultaneously with a university policy on attendance and student engagement in 2017. Resistances existed, but the usage rate kept between 90% to 99% since its initiation. It was a top-down approach initially but habitualised by the whole university over time.

The processes of objectification and sedimentation for the four innovations were quite similar. The habitualised behaviours were further standardized to seek institutional objectification, implementing the University's five-year academic strategy (2018–2023) more stable (Miles et al., 1987). Their high usage rates (over 50%) lasted for the remaining years, which evidenced the sedimentation of innovation across generations of teachers and students.

Incomplete Institutionalisation.

The remaining 15 innovations failed to complete the transition from initiation to habitualisation. For example, Innovation 7 used VLE-based online glossary technology to replace the paper-based glossary. Although the online glossary has been included in a VLE course template for all credit-bearing courses (which created a fake peak in Figure 4.1), the actual student attempts to use this technology for learning were minimal (usage rate 1%–11%) and never reached the "patterned behaviour" condition of habitualisation. The University then removed the tool from the course template, and the innovation faded over time. The other 14 innovations faded at the threshold stage with lower usage rates.

Section 4.4.2 Meaning-Making Through Individual Cognitive Divergence and Collective Cognitive Consensus.

Based on the above findings for the first research question, we further investigated the key to crossing the threshold stage. We grounded the theoretical concept of meaning-making as the critical step that could be achieved through individual cognitive divergence or collective cognitive consensus. We define meaning-making as a threshold stage that enables innovation from initiation to habitualisation by evolving unique ideas (Colyvas, 2007) or developing shared beliefs (Combe & Carrington, 2015) that make sense to the innovation adopters' institutionalisation process. The individual cognitive divergence dimension emphasizes the importance of being inclusive, while teachers hold different opinions of the innovation's meaning at the early stage of institutionalisation. However, the collective cognitive consensus dimension reinforces the power of similarities in objectives and beliefs in compelling teachers to form patterned behaviours in the early institutionalisation stage.

Meaning-Making Through Individual Cognitive Divergence.

Individual cognitive divergence refers to how human actors actively interact with technologies and evolve independent ideas of institutional routines at the micro-level (Baptista, 2009). In the educational context, previous norms and practices of learning and teaching shape the appropriation of teachers' daily routines, such as sending emails to students as a way of formal communication. Giving up an existing familiar practice for an unknown new practice is risky and needs additional effort (Raviola & Norbäck, 2013). Using new technology, some teachers are self-initiated into thinking about the new opportunities that the new tool might bring, which helps them create their reasons for adopting VLE enabled innovations.

A senior lecturer noted: “you do need a way to send out messages, and the forum is the way…you could use email…but you would need an email address group for the students, which you do not always have.” The pedagogical value of using an online forum is far beyond sending out announcements. According to another senior lecturer, “part of the benefit of the online discussion forum is that it gives students time to think before constructing an answer to another person, and my dream is to have students take part in conversation or discussions about topics.”

A similar phenomenon occurred in the other three innovations that completed institutionalisation. For example, in Innovation 2, some teachers collected online student course feedback because they needed it as evidence for academic promotion. Simultaneously, some appreciated the pedagogical value of reflecting on students’ voices. In Innovation 3, some language tutors piloted to use the of online assignments for paperless submission. They believed that creating a sustainable learning environment is their principle of faith. Teachers from other departments also started to adopt the innovation for different reasons. A senior lecturer from the Design School reflected, “online marking is important because it reduces the chances of loss [content]. It is a process with a lot more integrity….”

In the case of Innovation 18, one of the meaningful outcomes was the auto-generated attendance report for the government, which was done by paper previously. It reduced the administrative workload and accelerated international students' visa applications and renewal. Some teachers think that online attendance made it possible to "take attendance effectively in large classes." Regarding the potential analytical value of such data, a senior lecturer said: "I am sure there is a causal, there is a correlation [between the attendance and student performance] …if you look at the data…there are still lots of students who do not attend many classes who pass [the examinations]."

Different people have different reasons for doing something, as long as those reasons make sense (Colyvas, 2007). In the 15 faded innovations, most people failed to find a convincing reason to give up the old practice and adopt the new approach. Teachers' attitudes toward learning technology are the affective stances that might lead to technology use and innovation adoption (Wilson, 2021). For example, in Innovation 9, the University suggested that teachers and students use the VLE-based online chat for instant communication. However, some teachers argued, "no one will use the VLE for 24 hours, but we check our social media messages frequently." Social media (such as Reddit) plays a more sticker role in teachers' work and life in this digital era (Staudt Willet & Carpenter, 2020). We found that teachers gradually developed their cognition of what needs to be done and how it should be done in a meaningful way. The missing meaning will lead to resistance.

Meaning-Making Through Collective Cognitive Consensus.

Apart from divergent individual meanings, collectively agreed cognition was influential as a parallel dimension in the threshold stage. Collective cognitive consensus refers to a phenomenon in which a group of human actors shares the acknowledgement of the innovation, and through this, they give their actions meaning (McGrath et al., 2019). We found that some teachers do not have a specific purpose for themselves. Nonetheless, collective cognition promotes a standardized process that supports “calculative framing, engaging, and valorizing” (Slager et al., 2012, p. 763) in the institutionalisation process. In the University, teachers shared a student-centred active learning culture and adopted VLE enabled innovations to better support student engagement. A senior manager commented: “there are specific things that have come out of using Moodle, which have shaped what we do as a student-centred institution.”

Regarding paperless marking (Innovation 3), with the spread of the integrated learning course collaborations over time, more teachers observed the excellent practices. Some academic departments were influenced and cultivated a departmental learning culture that encouraged teachers to use the VLE-based online submission tool. A senior lecturer recalled that “…in my department, staff are not required but requested to provide assessment or possibly do marking…provide the feedback through the VLE.” The department staff followed the collectively shared value and started using the online submission tool to support student-centred learning. Another senior lecturer commented: “teachers are now giving scores online, which they traditionally [did] on paper…they write feedback on a Word [document], but now it is showing on [a] separate [online text] box.”

In the case of attendance (Innovation 18), a senior manager explained the university-wide consideration of promoting the innovation—

> *[In] about 2015…there was an assumption that students were failing their modules because they were not in the classroom. How do we know [that] they were not in the classroom? We need to have an attendance policy. Then, there was much discussion about how we should have a policy…after maybe two years of back and forth, it was decided that the best way of doing it would be to use the VLE. So, the students come in, scan a QR code…This was for both the local and international students.*

Implementing online attendance innovation was a collective decision made by a university committee with representatives from all the departments. Some teachers were influenced by external pressure to take online attendance initially. Cultural framing takeovers changed in tandem with the progressive spread of the action, inspiring reflection on meaningful outcomes, and thus turned passive individual reaction into active collective appreciation (Hirsch, 1986). As a senior lecturer commented—

> *When the policy [is] released, I do not take attendance with the expectation that the students will attend [the class] …I take attendance because I am required to…Earlier, we did not have a way of taking attendance in large classes, [but] we [now] have a way…which gives us a dataset…there would be a great deal of use.*

While the four innovations achieved habitualisation through the collective beliefs, no cognitive consensus emerged for the other 15 innovations to be habitualised. For example, Innovation 10 used an online lecture tool (bigbluebutton aka BBB) to support distance lecture delivery. The online lecture has become a new norm for many universities worldwide since COVID-19 (Green et al., 2020). However, it was not the same in 2015 when online lecture innovation was initiated. A senior lecturer told us: "five years ago, everyone taught face-to-face…only the iMBA program used BBB because the students were busy leaders, so we taught through the virtual classroom…the technology capacity was limited to only support a dozen students for one session…students cannot use a mobile phone to join…without a technological upgrade, we have to stop using it." The limited institutional resources (such as technical support and infrastructure investment) were prioritized to support more "popular" innovations, while the less "popular" and meaningful ones received less support and collective attention.

Section 4.5 Discussion and Conclusion

Section 4.5.1 Explaining The Cognitive Mechanism of Institutionalisation in An Extended Model

Our study contributes first and foremost to the emerging educational literature on the institutionalisation of VLE enabled innovations in HE. We extend the original three-stage institutionalisation model (Tolbert & Zucker, 1996) to a four-stage model (Figure 4.5) and unfold the underlying transition mechanism from VLE enabled innovation initiation to habitualisation. Through this process, we emphasise the importance of meaning in acquiring institutionalisation. More importantly, we conceptualise the threshold stage as "meaning-making" to explain the challenging phenomenon (the habitualisation stage has a higher rate of structural failure than other institutionalisation stages) that prior researchers highlighted (Hadjithoma & Karagiorgi, 2009; Wei, 2021). Our view of meaning-making is consistent with existing literature that considered it "as mediated knowledge building in action" (Twiner et al., 2021, p. 1).

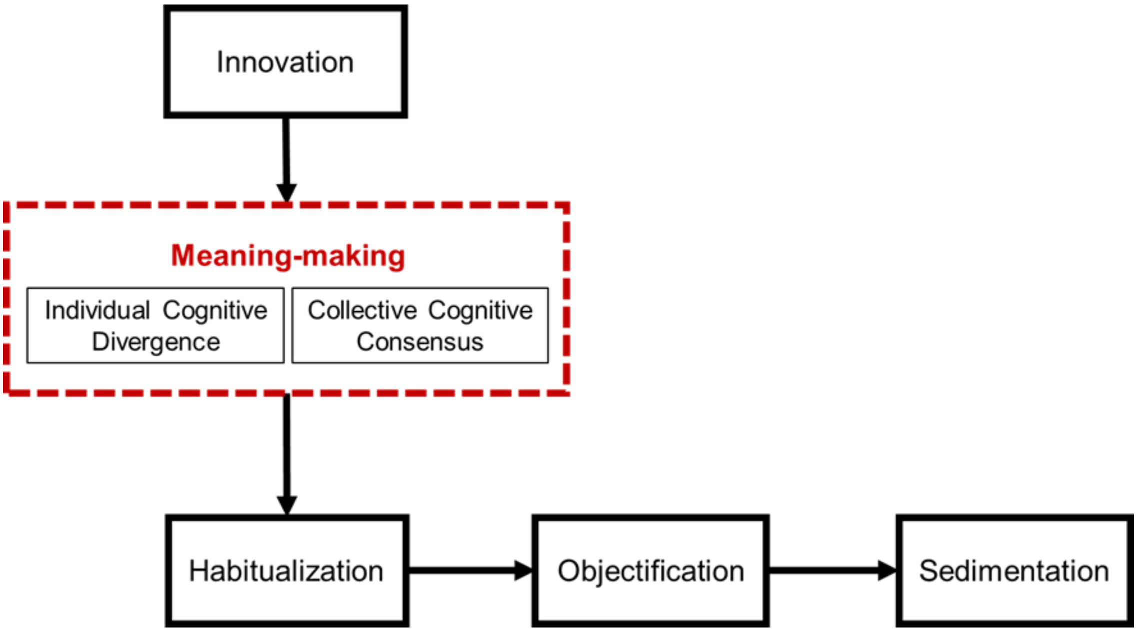


Figure 4.5 Our Extended Institutionalisation Process Model that Adapted from Tolbert and Zucker's (1996).

This study addresses the above problems by introducing the concept of meaning-making from the sociological literature to help interpret the critical but intangible cognitive changes in the VLE enabled innovation institutionalisation process. The idea of meaning-making originates from the sociology literature that indicated multiple worlds constructed differently but meaningful to people who concur with the statements (Goodman, 1978). We agree with sociology theorists' belief that the behaviours of human actors are affective, shifting their cognitive framework back and forth (Heise, 1979). This study contributes to the Social Cognitive Theory (Bandura, 1986b). The above ontological perspectives guide the investigation and help specify the cognitive conditions under which teachers form collective behavioural patterns and build "the connection between particular conditions and individuals' receptivity to cognitive reorientation and norm-breaking action" (Hinings & Tolbert, 2008, p. 486).

Section 4.5.2 The Diversity of Meaning-Making in The Institutionalisation Process

We argue that consistent meaning among teachers is not the only approach to institutionalisation; instead, divergent individual cognitions could also lead to institutionalisation. Our study reveals that teachers construct meaning (Twiner et al., 2021) through either individual cognitive divergence or collective cognitive consensus over time. Prior scholars have pointed out that many institutional analyses work assuming that collective consensus is the standard premise of institutionalisation (Greenwood et al., 2017). However, we argue that acquiring collective consensus (Combe & Carrington, 2015) is not the only way teachers develop the meaning of learning and teaching actions in the institutionalisation process. Individual teachers develop divergent understandings of institutional arrangements in a way that "makes sense" (Gioia & Chittipeddi, 1991) to them and thus achieve success in habitualised (Powell & Colyvas, 2008) learning and teaching routines.

Section 4.5.3 Practical Implications and Limitations

The proposed empirical institutionalisation model provides theoretical and practical implications. First, although this study only investigated VLE enabled innovations before the COVID-19 pandemic, it provides a robust evidence-based solution to overcome the institutional barriers of tapping into participants' intrinsic motivation for the widespread adoption of meaningful educational innovations (Lanford et al., 2019) for higher education institutions facing the same or more challenges in the COVID-19 pandemic. We need to know that it takes time for teachers to create compelling cognitive meaning of the action (either a unique reason or a shared belief), to give up existing habits, and adopt the educational transformation through the VLE enabled innovations. Especially in the COVID-19 with high uncertainty (Greener, 2020), we need to manage our expectations of teachers' uptake of the idea and the value of making extra efforts for the long-term educational transformation. Continuous institutional facilitating and pedagogical support on integrating educational technologies (like VLEs) into innovative practices can help the innovation get through the threshold institutionalisation process.

Second, the conception of meaning-making through divergent individual cognition and the collective cognitive consensus is instrumental in attracting the attention of decision-makers to sociological ideas while providing a more inclusive innovation environment in higher education. We would suggest that universities create a communicative work environment that supports bottom-up practical innovations and top-down strategic interventions. The future-oriented mindset of inclusivity and humanity is critical for contemporary teachers and educational leaders to acknowledge problems and refer to widely institutionalised procedures rather than only technical measures (Scott, 2014) in an environment with high uncertainty, ambiguity, complexity, and changeability (Luan et al., 2019; Xi, 2021).

We gain evidence-based insights from a longitudinal case study with rich grounded data regarding the limitations. Generalising the present study's results beyond its empirical context depends on how the meaning-making approaches can be shared with other HE populations globally. Our findings could add value to both theory development and practical improvements in other universities with high knowledge intensity, where their well-educated employees appreciate high-level autonomy and are open to institutional partnership arrangements and governance structures (Dodgson et al., 2021). Further, we encourage researchers to test and supplement the historical and process-oriented institutionalisation model with studies employing quantitative, multi-case comparison approaches to measure the various factors that might affect the VLE enabled innovation institutionalisation, such as educational standards (Barari et al., 2020), perceived task performance (Rienties, 2016) and cultural influence on VLE adoption (Li, Zhang, et al., 2021; Teo & Huang, 2019). We would suggest that future studies should also examine the invisible reciprocal relationships between the individual cognitive divergence and collective consensus in meaning systems and educational ideologies.

Section 4.5.4 Future Research About Technology Adoption and Educational Transition

Globalisation and digitalisation have made it increasingly difficult to understand the technology adoption and educational transition due to the dynamic uncertainty, ambiguity, complexity and changeability (UACC) that contemporary organizations encounter (Xi et al., 2012). Furthermore, the emerging digital education mode keeps disrupting the traditional education model with an increasingly non-traditional student population (Brown et al., 2020). Technology scholars who focus on process explored the interdependence of technical, social and institutional change in their studies of technological innovations, entrepreneurship, and industry emergence, but not particularly in higher education (Van de Ven & Hargrave, 2004). Bower (2019) extended the mediation (Latour, 2005) role of technology in higher education and developed the technology-mediated learning theory by emphasizing the asymmetry between humans and technology, connecting learning technologies with pedagogy for educational studies. Learning in itself is very complex, and the learning theories and pedagogies are constantly changing (Whitelock, 2019). Future research should focus on crossing the disciplinary boundaries between information technology and education by exploring the role technology and pedagogy play in educational change (Casanovas, 2010; Hsu et al., 2018; Kukulska-Hulme et al., 2021; Nworie, 2015).

More importantly, under the high pressure of the forced, rapid educational transitions during the current pandemic, lots of unexpected challenges and problems (e.g., digital inequality, technology constraints and pedagogical chaos) shocked the Higher Educational Institutions (HEIs) (Sandars et al., 2020;

Watermeyer et al., 2020; Zhang et al., 2020). The worldwide crisis brought extra pressures to the HEIs stakeholders in different countries; nevertheless, it exposed the underlying contradictions and discrepancies in a short period and thus provided great opportunities to accelerate the context-based investigation of technology adoption and educational change. Additionally, most of the literature on institutionalisation, learning pedagogy and technology adoption were originated and developed within Western contexts and based on Western logic, which calls for the further exploration of the different cultural contexts with more diversified theoretical models of organizational change (Jing & Van de Ven, 2014) and learning technologies adoption in higher education (Lee, 2016; McCoy et al., 2005).

Section 4.5.5 Conclusions

This study conceptualises the empirical findings of a 13-year longitudinal case study of VLE enabled innovations' institutionalisation. By analyzing how VLE based technologies become acceptable, enable innovations, and foster continuous transformation within an educational context, we found that innovation to habitualisation is the threshold stage for institutionalising VLE enabled innovations. The novelty of this study is in integrating what we call "meaning-making" before habitualisation to reveal the invisible process through which the VLE enabled innovations to acquire legitimacy through both individual cognitive divergence and collective cognitive consensus.

Section 4.6 Addendum

Chapter 4 is a published paper. According to the university policy, no amendments can be made. Therefore, this section includes the changes to address examiner's comments about revising the research question. The original research questions are “what is the threshold stage of the institutionalisation process of VLE enabled innovations, and how do the innovations become institutionalised in the threshold stage?” The revised research questions are “among the three stages of institutionalisation, which is the threshold stage of the institutionalisation process of VLE enabled innovations, and how do the innovations become institutionalised in the threshold stage?”

Based on the four-stage institutionalisation conceptual model of chapter 4, chapter 5 moves on to examine the process of “meaning-making” for an interdisciplinary emergency online teaching innovation during the COVID-19 disruption.

Chapter 5 Improving Interdisciplinary Online Course Design Through Action Learning: A Chinese Case Study

Section 5.1 Problem Statement

The coronavirus disease 2019 (COVID-19) crisis has significantly affected the growth of online teaching, making it a popular choice for educational institutions worldwide (Fawns et al., 2020). Teachers and students have learned to convert their day-to-day interactions from physical spaces to virtual environments. However, the online learning experience is mixed; quality teaching concerns have increased over time (Kazmer & Haythornthwaite, 2005; Oliver & Herrington, 2003; Watermeyer et al., 2020). Online teaching design, organisation, and delivery play a significant role in online learning success (Borup et al., 2020; Mayer, 2019). Universities worldwide are looking for productive ways to support teachers in improving their online teaching effectiveness. Previous researchers have reviewed teachers' roles and competencies (Evrim et al., 2011), beliefs and assumptions (McQuiggan, 2007), and digital nativity (F. Huang, T. Teo, & J. He, 2019) to transform online teaching practice, and they have drawn theoretical suggestions for teacher professional development (TPD) (Aubusson et al., 2009; Maher & Schuck, 2020).

The number of teachers in China has been proliferating over the years (Ministry of Education of the People's Republic of China, 2020). Notwithstanding, the TPD knowledge of online teaching has been insufficient in China, especially for teaching interdisciplinary courses. After the COVID-19 pandemic disrupted Chinese higher education in early 2020 (Zhang et al., 2020), the most experienced in-class teachers faced a novice situation that demanded them acquire new knowledge about online teaching (Teo & Huang, 2019). To improve TPD for teaching an interdisciplinary course online, we decided to engage in a self-organized action learning (AL) set to leverage our online teaching experiences and explore how teachers in novice situations can learn to improve online teaching vis-à-vis an interdisciplinary course. In choosing to apply AL, we emphasised teachers learning to teach as a developmental process. Notably, AL enabled us to review and reflect on past teaching experiences so that we could uncover our unknown assumptions and unnoticed counterproductive practices in teaching.

This AL case study follows qualitative methodology principles (Yin, 2018). Before introducing the case, we present our literature review on AL and discuss the rationale for using the AL method (Coghlan 2012). First, we introduce an interdisciplinary online course that drives the study. After that, we articulate why AL is selected as our self-initiated TPD tool. Ethical considerations and procedures for undertaking AL are also discussed. Then, we explain how we use Debattista's (2018) comprehensive rubric to develop a solid base of programmed wisdom on online teaching effectiveness. This foundational knowledge serves as a starting point for our inquiry. After clarifying the formative exploration process used in this case, we describe how we have applied Coghlan's (2012) "attentiveness to experience" empirical AL methods and used questioning insight to interrogate the programmed wisdom. We then summarise our reflections and conclusions about improving the teaching of interdisciplinary online courses. We revisit our use of AL in a novice situation and its implications for TPD-centered reflection on teachers' personal experiences to improve interdisciplinary online teaching effectiveness. Finally, we conclude the paper with a discussion of the implications, limitations, and future research.

Section 5.2 Literature Review and Framework of Applying AL

The AL theory promotes a question-driven, open-minded, critical, and flexible learning experience. Revans (1998) introduced the AL formula: L = P + Q, where "L" refers to learning, "P" represents the programmed knowledge, and "Q" connotes "questioning insight." The formula emphasizes the critical role of asking questions in explaining, understanding, and exploring new approaches to solve practical problems caused by obstacles hidden in the transition from theory to practice (Revans, 2016). Dilworth and Willis (2003) highlighted the value of "Q" and defined it as a key AL component to asking fresh questions, exposing the underlying assumptions to develop new connections and mental models. Coghlan (2012) indicated that the act of generating insight was the heart of AL, which represented the operation of the human cognitive process. In his words, "insight comes out of the process of questioning programmed knowledge in the light of experience" (Coghlan, 2012, p. 247). Previous scholars have already explored using empirical methods to pursue the effective "Q." For example, Coghlan's (2010) study generalized the different AL empirical methods, including generative insight, attentiveness to experience, and intelligent questions for understanding. Pedanik (2019) integrated Dewey's ecological psychology to assist learning groups in asking novel questions in their AL practice.

The original concept of AL is applicable in multiple contexts (Mumford, 1995) because of its value in solving practical problems (Dolapcioglu, 2020; Scott, 2017), such as in human resource management and leadership development (Brockbank, 2003). In recent decades, the use of AL in educational settings has increased. For example, some studies have shown how AL supports K-12 school teachers' TPD in a Western context (Aubusson et al., 2009; Maher & Schuck, 2020). Other studies have tried to highlight the transference of AL in non-Western educational practices (Burger & Trehan, 2018; Mughal et al., 2018). Upon reviewing the past 20 years' history of AL in China, Marquardt indicates that the ancient Confucian philosophy and culture have provided a good foundation for AL. He suggests that "China is reforming its entire education system to support innovation and entrepreneurship. Action learning will play an important role in the reform" (Marquardt, 2015, p. 332). Brook and Abbott have also explored the development of AL programs in China and emphasized the adaptability of AL in a Chinese context. They claim that "questioning comes easily, and the learners are actively and unselfconsciously engaged" (Brook & Abbott, 2020, p. 212).

Notably, AL is particularly suited to investigating unknown dimensions of a problem, its unfolding situation, or both. Before the pandemic, online teaching was not prevalent in China, and university TPD did not focus heavily on online teaching issues. The unpredictability of the pandemic has created much uncertainty and ambiguity in teachers' online teaching experiences. As an AL implementation process, Marquardt (2004) AL model includes six critical components: a problem, a diverse group, a reflective inquiry process, power to act, commitment to learning, and the presence of an AL coach—an outsider that helps the group reflect on what they are learning and how they are dealing with problems. Many studies have highlighted the importance of having an AL coach as an expert to provide guidance (Heron, 1999; Pedler & Abbott, 2008). Revans (2011) argues that learning coaches could easily “steal the learning”; he believes that if used in AL, such a person should initiate questioning insight but let the group take up their facilitation. Marquardt (2015) suggests that the higher education sector in China lacked AL coach experts. Brook and Abbott (2020) recommend that the role of the AL coach in the Chinese context is a new research area and needs more development.

Considering the concerns mentioned above and the exploratory nature of this study, the AL set in this study decided to apply the AL approach without involving an outside AL coach. Furthermore, due to practical external constraints in the case university, the AL set could not apply learning to a second interdisciplinary online course. Hence, this case study only implemented five elements of Marquardt’s framework, including identifying and working on fundamental issues and generating questions by conducting active listening, reflection, and peer feedback (e.g., group discussion).

There are different interpretations of the AL set. Some scholars frame it as peers who support one another to tackle their problem; other scholars interpret the set as a team of diverse members working on the same challenge (Haith & Whittingham, 2012; Shepherd, 2016). In this study, the AL set comprises three university instructors co-authors of this article. They come from different backgrounds, including management, education, and information technology. We (the AL set) endeavour to follow Coghlan’s (2012) empirical “attentiveness to experience” method, aiming to investigate a confronted problem with no evident solution. Ultimately, we produce recommendations for the online teaching of interdisciplinary courses.

Figure 5.1 illustrates how this case study partially adapts the Marquardt (2004) AL process to address TPD in online teaching.

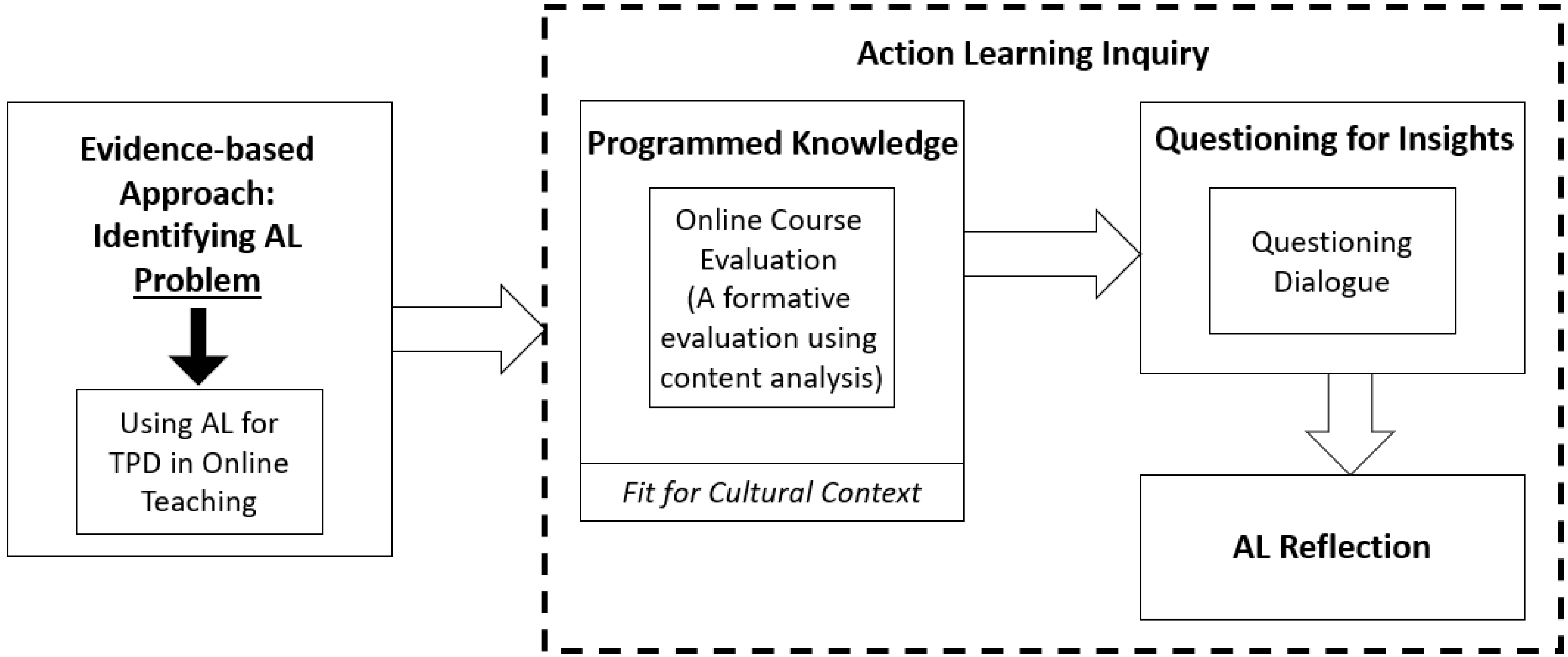


Figure 5.1 Action Learning for TPD in Online Teaching

Section 5.3 About the Case

Influenced by both Chinese and Western cultures, a Sino-British transnational university in China (hereafter, the University) has developed its teaching model and named it the *Research-Led Learning and Teaching* (RLLT) project (Zhang et al., 2017). The University encourages its teachers to apply the model in their teaching practices under the influence of both Chinese and Western cultures. The model echoed values reflected in AL. The RLLT model promotes learning that is driven by a significant real-world problem. The team-based component of the RLLT model aligns with AL's reliance on diverse team members to engage in problem-solving (Zhang et al., 2017). As the third component in the RLLT model, the feedback for improvement demonstrates the reflective inquiry process used in AL. Instead of conducting "research" in its traditional empirical sense, the University views "research" as a learning process to gain real experience and solve practical problems (Wang & Liu, 2020). The University's existing teaching culture created a nurturing ground for exploring the use of AL for TPD. The AL set decided to self-initiate this case study using AL in an innovative TPD pilot project. The AL set did not seek institutional sponsorship for the case study because there was a strong interest in conducting the study for their professional development.

Since the onset of the pandemic, university teaching and learning have been significantly impacted. When COVID-19 emerged in China in February 2020, the Chinese government issued a mandatory shutdown for all universities. At the time, no one knew when the campus would reopen. The university offered an optional, non-credit, interdisciplinary course delivered in English as a new online teaching initiative for undergraduate students in response to the urgent situation. To ensure that this last-minute initiative did not interfere with the regular academic schedule, the volunteer teaching team had only two weeks to prepare and another two weeks to deliver the online course. A total of 1,469 students from diverse domestic and international student populations were enrolled in the course. These undergraduate students were from 20 different majors across all four years. Notably, 11 lecturers (two of the lecturers are the authors of this study) in several relevant disciplines (e.g., education, health and environmental sciences, and international studies) volunteered to teach with the support of 45 academic advisors from different departments.

The online interdisciplinary course included four sub-topics: digital literacy, social responsibility, social innovation, and sustainable development. Each sub-topic was taught by different lecturers who focused on various disciplinary perspectives. According to the course design, each lecturer must compose a one-hour pre-recorded video under the designated topic and deliver online teaching activities in two weeks. Through a previously established e-learning platform (i.e., virtual learning environment or VLE), the University enabled teachers to apply a student-centred and activity-based lesson design with different online activity features, such as online discussion forums, interactive quizzes, and group projects. All the teaching materials (e.g., the pre-recorded lecture video, lecture slides), online activities, and digital behaviours were recorded automatically by the VLE, which provided first-hand low-inference data for analysis. One course coordinator, three administrative support staff, and a senior educational technologist (one of the authors of this study) shared the course's management responsibilities. The course coordinator handled the overall instructional design and was responsible for most communications with students, lecturers, and advisors, grouped into three separate clusters. Regarding the data collection, analysis, and reporting ethical considerations, the AL set consulted the University's ethics committee to ensure that the research complied with the University's research ethics policy and obtained an official approval letter before carrying out the study.

Section 5.4 Methodology

Section 5.4.1 Identifying the AL Issue Via an Evidence-Based Approach

The first step in applying AL to TPD is identifying the target issue. This case study applied an evidence-based approach. Previous studies have suggested that students' online engagement positively affects their academic performance (Asarta & Schmidt, 2017; Chung & Paredes, 2015; Li, Wang, et al., 2021). Following others' research conclusions, we initially examined the relationship between students' online engagement and their academic performance to examine the effectiveness of online teaching. After that, a Pearson correlation coefficient test was conducted. The result (r = 0.225) indicated an insignificant relationship between the students' online activity completion rates and final grades. This quantitative finding was inconsistent with prevailing literature, which suggested the significant positive impact of online engagement on academic performance (Grabe & Christopherson, 2008; Nemetz et al., 2017). After obtaining the quantitative findings, we decided to apply the AL tools to help yield new insights. However, we realized that our limited experience and foundational knowledge in online teaching were significant barriers to reflecting on our teaching experiences. Such a challenge has become a roadblock for further TPD initiatives. We could not find any similar case of fully online teaching at the University for our reference. Our traditional teaching experiences and assumptions of offline teaching also did not help us generate new insights in searching for a solution.

Section 5.4.2 Conducting AL for TPD: Inquiries of Post-Online-Teaching

In this case study, the AL set adopted a two-step approach. The first step was to generate programmed knowledge, which referred to “knowledge in current use, in books, in one’s mind, in an organization’s memory, lectures, case studies” (Marquardt & Waddill, 2004, p. 192). Since members of the AL set were novice practitioners of online teaching, we decided to start by gaining knowledge of online teaching from experts. We applied Debattista’s (2018) comprehensive rubric to evaluate online teaching effectiveness to learn from programmed wisdom about what might have gone wrong. We reviewed teaching materials and the auto-saved online records of teaching and learning behaviours, such as teachers’ online feedback to students, the statistics of students watching pre-recorded lectures, and the number of attempts to complete the online quizzes. Upon evaluating the online course’s content and online engagement behaviours, the second step of the AL practice was to reflect on the post-teaching experience using some of the empirical AL methods that were described in Coghlan’s study (2012): self-reflection served as a data source for online course evaluation in a content analysis loop. We performed an AL dialog to ask questions as an AL set, using the evaluation outcome as a reference. First, we compared and contrasted our pre-existing knowledge of online teaching to the evaluation outcome; after that, we asked what assumptions we had held to form our current view and additional insights or questions. The details of this two-step approach are described below.

Step I: Generating Programmed Knowledge: A Formative Evaluation.

To set the baseline for the critical questioning approach, we first obtained the programmed expert knowledge of the effective online teaching offered by Debattista's (2018) online learning evaluation rubric. Debattista examined and integrated online teaching policy guidelines from four higher education institutions to propose a rubric that organizes 44 specific measures into ten dimensions to determine online learning success (or failure). We applied the rubric to aid in the post-course evaluation. We collected and analyzed two types of data: course-related documents (e.g., emails, the Course Handbook) and VLE digital records (e.g., online user logs for teaching and learning activities). Both data sources reflected the instructors' teaching practices. Following Frey's (2018) three steps of content analysis, we applied a deductive method to generate an evaluative comparison between instructional experiences at the course organisation level and the individual lecturing level with the aid of NVivo 22 software. Debattista's (2018) online learning evaluation rubric served as the content analysis framework. The data analysis results indicated a distinct gap between the course's intended outcome and actual deliveries by lecturers (see details in Appendix 10).

In the ten dimensions of content evaluation (Debattista, 2018), five dimensions appeared at the course organisation-level and lecturers' delivery level, although the specific forms of deliveries varied. These five dimensions were instructional design, course opening, assessment of learning, interaction and community, and instructional resources for teaching and learning. Another five dimensions (i.e., technology design, course evaluation, course closing, learner support, and instructional design cycle) only appeared at the course level because they were under centralized management. For example, the technology platform and specific technology support belonged to the University's VLE. The course management team handled all the technology designs (e.g., technical support, interface, and access) at the course level.

We summarized the course organisation and delivery issues based on programmed knowledge from the post-course evaluation. We realized that the course management team designed and coordinated the online course according to most of the ten primary standards at the course organisation level. Nonetheless, they missed meeting three sub-standards: (1) academic integrity, (2) technical competencies in course opening, and (3) integrity in instructional resources for teaching and learning. At the delivery level, much information was missing, such as the technical design, course evaluation, course closing, learner support, and the instructional design cycle (Debattista 2018).

Step II: Questioning to Gain Insights.

Upon reviewing the programmed knowledge, we performed a questioning dialogue to understand why those issues occurred—the conversations were initiated by discussing the key findings from the online course evaluation. We designed a procedure following Coghlan’s (2012) suggestions on engaging in AL and applying the empirical method in the AL process for an unknown situation. First, the AL set organized meetings to brainstorm ideas to generate insights. However, we found no evident solution to the confronted problem based on our past experiences. After a two-hour discussion, we realized that we should agree on a list of the fundamental principles to support our dialogue. We shifted our discussion to defining, for example, what intelligent questions look like and how to propose them, how we can encourage members to challenge each other's ideas, and how we can weigh evidence to narrow down a shared judgment. After establishing a common ground for generating a dialectic discourse to facilitate learning, we organized further meetings to produce questions for insights. Rather than offering statements, we put our thoughts into a question format to show appreciation of the inquiry process (Watkins et al., 2019). Some excerpts of the dialogue are as follows (we coded our conversations as learners):

"According to the collected data, there was neither evidence of teaching practices that addressed role and behaviour expectations nor mentioned the required technical competencies. How did this affect the learning experience?" (Learner 3).

"Why were students not informed of the technical competencies needed to reach the learning outcomes successfully? Online activities on the VLE required students with different levels of technical competency to engage. Who should notify them? When should they be notified of this? What kind of support did they need?" (Learner 2).

"As an interdisciplinary course, why was there little evidence of the teaching team's communication? How could they ensure the same overall learning outcomes of the course? Was the gap between the course level design and lecture-level delivery related to the lack of communication between the course management team and the lecturers for the online course opening?" (Learner 1).

"Even though the course objectives and teaching strategies were well defined and distributed to all the lecturers, there was no discussion on their perceived understanding. In what ways would discussion enhance and hinder teaching effectiveness?" (Learner 3).

"Assumptions were never explicitly addressed; hence, there was no agreement on how the lecturer's teaching practices would complement the overall course. What assumptions did each lecturer hold?" (Learner 1).

"Did lectures have questions? Even if lecturers had questions, there was no official guidance on which functions in the VLE they should use to discuss their issues. How did they deal with their questions? Did unanswered questions affect teaching practices?" (Learner 2).

"I suspect that private conversations may occur between some lecturers. To what extent was this true? Could there be a way to benefit from their concerns if discussions did not involve every lecturer? Could we benefit from this collective knowledge?" (Learner 3).

Section 5.5 Findings: Reflection as Result of AL

Upon content analysis and questioning, we realized that lecturers designed their topics and applied their assumptions independently, which sometimes aligned and sometimes did not with the course coordinator's understanding. Though the lecturers knew the course was intended to address the interdisciplinary nature of the pandemic, when operationalizing their teaching practices, lecturers defaulted to their specific discipline mindset and did not integrate their teaching with that of other colleagues. Unlike the course coordinator, many lecturers had insufficient or no knowledge of the best practices for online teaching. The course coordinator and lecturers needed to communicate more effectively. More importantly, the course coordinator should consider the areas in which lecturers need support. Quality active listening requires sufficient interaction, in which teachers engage with each other to form a community of inquiry (Littleton & Whitelock, 2005) and develop their teaching ideas (Garrison & Kanuka, 2004). Several functions of VLE (e.g., online virtual classrooms, online discussion forums, online chats, and online messages) have been established to support the spread of knowledge. These functions allow lecturers to share questions, ideas, and practices (Brown & Duguid, 1998). However, only a few lecturers took the initiative to share their practices. Though the online course was delivered as a group, a true sense of teamwork was not fully achieved. Unlike single lecturer teaching, one of the critical necessities of online team teaching is the communication of ideas and practices among lecturers and their peers (Benjamin, 2000), which is particularly essential in an interdisciplinary course.

Section 5.6 Discussion and Conclusion

Section 5.6.1 AL In the Confucian Culture

Revans (2016) argued against programmed knowledge, pointing out that past knowledge can be misleading; his thought was that programmed knowledge often did not pertain to situations where first-hand wisdom was attained. However, this argument has certain cultural limitations. Like AL research that highlights the unique characteristics in a non-Western context, we think that Revans' approach "affords insufficient recognition of the culture" (Mughal et al., 2018, p. 49). We appreciate Marquardt's acknowledgement of Zisi, the grandson of Confucius, and his approach to the "Chinese version of the learning function," which is "remarkably close to Revans' description of AL." Zisi considered "widely programmed knowledge" the first key learning factor (Marquardt, 2015, p. 326). In a cultural context where the learners' mindsets are predominantly influenced by the

Confucian hierarchical obedience ideology (Ho & Crookall, 1995; Littlewood, 1999), studies show that learners need expert guidance to lead them to critical self-comparative reflection (Brook & Abbott, 2020; Chen, 1990). Such a phenomenon also aligns with TPD discoveries in the training of Western teachers in novice situations, such as the importance of content knowledge to novice teachers' curriculum planning and the pedagogical knowledge influence on novice teachers' teaching method (Hogan et al., 2003). This case study demonstrates that coupling question-driven inquiry with some programmed knowledge (as a foundational reference) can help initiate the critical thinking of the AL set. This provides a path toward evaluating the adaptability of past programmed wisdom, thus generating future solutions based on new insights.

Section 5.6.2 AL for Interdisciplinary Teaching

A benefit of adopting AL in the interdisciplinary online teaching case is that it integrates learning to solve problems, teaming, and leadership. Thus, it holds practical value in professional development because it is closely associated with organizational learning, knowledge management, and community of practice (CoP) (Wenger, 1998). For example, CoP is based on two fundamental premises: the activity-based nature of knowledge (practice) and the group-based character of organizational activities (communities) (Hislop, 2003; Wenger, 1998). When a group of teachers from multiple disciplines conducts online teaching on a bundle of topics, teachers of the same or similar topics can form sub-communities within the course, and different sub-communities of a discipline should coordinate with other disciplines. The "culture club" that is applied by educators to support staff professional development could promote intercultural communications and provide fruitful forms of CPD(Turner et al., 2020). In the technology-enhanced CoPs or culture clubs, VLE acts as a boundary object (Wenger, 1998) that constructs invisible lines (Li, Zhang, et al., 2021) between sub-communities (Keller, 2005). When online interdisciplinary teaching is effective, it is the outcome of group contributions, including the course coordinator's leadership and the cooperation of multidisciplinary lecturers, advisors, students, and administrative support teams. Hence, the interdisciplinary instructional design, delivery, and evaluation should include analyses of all stakeholders' learning needs, appropriate teaching strategies, and methods (Nguyen et al., 2020).

We conclude that using AL’s question-driven process, along with other tools, enriches the TPD of the AL set. As a result of this case study, we agreed on a list of practices to improve our online teaching practices. We conclude that this AL process can be utilized in TPD in higher education to deepen learning when members have varying backgrounds and experiences. We find that bringing teachers of multiple disciplines together to collaborate on an online course and post-online-teaching AL is an effective way to share and learn various teaching practices. The visual space and VLE’s technical capacity act as a platform to explore effective online interdisciplinary teaching, which may spark further innovative ideas and professional development in online education. In their study, Fuller and Bail found that team teaching offered a “positive benefit in developing synergy in content and pedagogies, continued instructor learning, and continuous reflection on instructional design” (Fuller & Bail, 2011, p. 72). Higher education institutions can use team teaching to promote interdisciplinary learning (Anderson, 2008; Letterman & Dugan, 2004). The best team teaching delivers an excellent learning experience to students (Anderson & Speck, 1988); it also offers colleagues the opportunity to learn from each other. Shibley stated that “team teaching (could) provide a means of focusing more on the process of learning instead of only on accumulating content knowledge” (Shibley, 2006, p. 271). However, pedagogical differences across disciplines have created teaching challenges in delivering team teaching in higher education (Shibley, 2006). White et al. (2002) describe team teaching as an experience of navigating through danger, which would embark on new pedagogical accomplishments when successful. Collinson (1999) considers interpersonal and intrapersonal knowledge essential in team teaching. Conversations that lead to colleagues’ higher awareness and understanding of their intra- and interpersonal limitations can enhance interdisciplinary teaching quality. Through meaningful exchange, instructors maintain their enthusiasm for teaching (Hartenian et al., 2001). Proactive teachers tend to search for new and different instructional strategies to improve the effectiveness of their instructions (Bain, 2004).

Section 5.6.3 AL For Novice Teaching Context

When a team of multidisciplinary lecturers enters a novice situation, where no one knows the definite correct answers, the traditional approach to discussions can reinforce the dilemma unless there is a way to open up new thinking. Furthermore, AL’s questioning insight can promote curiosity, help to examine assumptions that are otherwise non-evident due to cognitive biases, and lead to reframing teachers’ viewpoints. Additionally, AL’s questioning approach helps in this regard. Moreover, AL tools (e.g., learning of programmed knowledge) help counteract people’s silence influenced by power dynamics and concerns around the status. Using experts' opinions as references expands novice learners' thinking, preparing them to engage in critical reflection (Watkins et al., 2019).

After adapting the AL approach to investigate the online course, our reflections and analysis lead to the recognition that there are three potential areas for improvement: (1) developing an agreement, (2) creating an opportunity for members to ask questions and explore possibilities with each other, and (3) actively listening to and identifying where support is vital. Although the prevention of COVID-19 calls for social distancing among people, communication seems to be even more critical in designing and delivering a team-taught online course. Notwithstanding how rushed the situation is, a lack of communication could lead to ineffectiveness in students' learning experiences. Fostering teachers' proactive attitudes toward communication would reduce the risk of jeopardizing teaching quality. This idea might seem to decelerate the course design phase, which might seem impossible during the COVID-19 pandemic. It is essential to acknowledge that allowing time and space for exploration upfront can be beneficial in the future in connection to quality planning and action. Overall, our practices have extended the use of AL to teachers' TPD in a novice context, thereby inspiring professionals, practitioners, higher education institutions, and communities to gain new insights. Our study contributes to insights into how the AL model can be adapted for cultures where expertise or evidence-based decision-making and learning can work around power dynamics, making it difficult to question positional authority in inquiries about learning and change.

Section 5.6.4 Practical Recommendations Arising from Findings

We conclude the following critical points as practical recommendations to improve future interdisciplinary online teaching when educators teach in a novice context:

1) Pay attention to both content and process evaluation for online teaching effectiveness.
2) It is necessary to agree on students' role, behaviour expectations, and technical competence expectations to access and engage in online activities via the VLE.
3) Effectively pass on pedagogical principles and best practices of VLE from a small group of experts to broader academic practitioners.
4) Lecturers in higher education have varying understanding and experience in VLE practices. Some lecturers may be more experienced than others. Rather than relying solely on teaching training, there should be an advocate for sharing expertise among academic practitioners, such as offering CoP opportunities to share ideas from different disciplinary perspectives.
5) When an online course adopts a team-teaching approach, the course coordinator should provide efficient communication channels and hold discussions for lecturers to share ideas and learn from one another.
6) Lecturers who teach on the same topic should discuss their instructional design to ensure the synergy of online delivery.

7) Professional development efforts should motivate lecturers to generate productive instructional strategies and try innovative ideas and practices.
8) Clarifying the role of the online teaching coordinator and pre-course training is necessary to enhance the process dimension of online effectiveness.

Section 5.6.5 Implications, Limitations, and Future Research

This study contributes to AL studies in TPD with implications for the ultimate question of how to design and deliver effective interdisciplinary online teaching. It constitutes a partial but essential step in adapting AL in higher education, using a case example in the Chinese higher education context. The practice and findings generated have unavoidable cultural limitations like all case studies. We do not assume that the same approach would work in another cultural context automatically. We suggest that future studies should explore similar AL approaches in different cultures to examine Revans' suggestions regarding over-reliance on programmed knowledge. We believe that AL studies with a cultural lens could help AL practitioners rethink differences in cultural influences and individual beliefs about learning.

Further research could apply the complete AL cycle, including plan action and implementation steps (Marquardt, 2004; Revans, 1998) so that the gained insights through an iterative learning process. This study focuses on using AL with TPD in novice situations and relies on programmed knowledge as a tool. More studies are needed to explore whether and how applying AL (and AL tools) in TPD might facilitate productive learning for teachers.

Chapter 5 provides empirical evidence of the “meaning-making” process, in which university teachers using action learning as an effective professional development tool to identify problems of the emergency online teaching using VLE, learn from the expert-based programmed knowledge and gain insights from the critical questioning and reflection. To examine the “meaning-making” process with individual factors from student perspectives, chapter 6 moves on to introduce the study that investigated student perceived self-efficacy and justice in the VLE-enabled project-based learning during the COVID-19 disruption.

Chapter 6 Role Of Perceived Self-Efficacy in Automated Project Allocation: Measuring University Students' Perceptions of Justice in Interdisciplinary Project-Based Learning

Section 6.1 Problem Statement

In recent decades, project-based learning (PBL) has been recommended as an effective learning methodology to promote critical thinking in problem-solving and self-directed active learning in higher education (Cortázar et al., 2021; Li, Huijser, et al., 2022). However, perceived injustice has created many challenges for sustainable PBL, such as anxiety, low engagement, and negative emotions (Walsh et al., 2020; Zong et al., 2022). Universities have implemented digital-technology-assisted automated project allocation to tackle these challenges by providing students with adequate and equal learning opportunities to apply multidisciplinary knowledge and solve real-life problems in PBL (Basilotta Gómez-Pablos et al., 2017; Hou et al., 2016). Automated project allocation is designed to calculate a semi-randomized distribution solution that can automatically assign limited resources (e.g., materials and staffing) to a large group of students, considering their personalized preferences for project selection and supervisors' recommendations (Hussain et al., 2019). Although automated project allocation provides higher transparency and efficiency than manual allocation (Hussain et al., 2019), students' perceptions of justice continue to vary, and complaints about potential justice-related issues continue to occur.

Section 6.1.1 Organizational Justice

Justice theory originates from studies that measure organizational justice in three dimensions: procedural, distributive, and interactional (Folger & Cropanzano, 1998). Colquitt and Rodell (2015) extended these three dimensions to four: procedural, distributive, interpersonal, and informational justice. Following Colquitt and Rodell (2015), justice is defined here as perceived adherence to context-specific rules that reflect the appropriateness of a decision. Colquitt and Rodell (2015) highlighted the value of distinguishing the terms “justice” and “fairness” for different research focuses. They stated that justice has been commonly used in organisation-focused research to measure the extent to which an organisation is perceived as consistent, equal, respectful, and truthful in the decision-making environment. Fairness, in contrast, has been used in supervisor-focused research to assess the degree to which an employee’s manager or supervisor is perceived as fair individually (Colquitt & Rodell, 2015).

Most justice studies have applied the faceted justice approach, as it “grounds the phenomenon in a set of specific and actionable principles” (Colquitt & Rodell, 2015, p. 192). Procedural and distributive justice are most relevant to organizational allocation outcome measures (Adams, 1965; Leventhal, 1976, 1980; Tibaut & Walker, 1975). Social scientists have focused on evaluation or subjective judgment when referring to procedural justice (Folger & Cropanzano, 1998). For example, Leventhal (1976, 1980) developed six process characteristics—consistent, bias-free, accurate, correctable, representative, and ethical—that could increase an individual’s perceptions of procedural justice. Folger and Cropanzano (1998) defined distributive justice as an individual’s perception of the appropriateness of the outcomes or allocations that they receive. As a third dimension, interactional justice measures the quality of communication between superiors and subordinates (Bies & Moag, 1986) in performance evaluation decisions and explanations (Simons & Roberson, 2003). Studies that have separated interactional justice into informational and interpersonal justice have mainly focused on the agent–system model, which involves one's individual interactions with one's supervisor (Bies & Moag, 1986; Greenberg, 1993).

Section 6.1.2 Learning Equity

In organizational studies, equity has been discussed as a critical characteristic of distributive justice (Colquitt & Zipay, 2015). We view learning equity as an independent justice dimension that incorporates the educational context. Educational researchers have highlighted the importance of investigating the lens of equity and justice in learning and teaching in sustainable education (Thomas, 2021; Walsh et al., 2020). According to UNESCO (2018), there may be no universally convincing definition of equity in learning. Jacob and Holsinger distinguished the terms equity and equality, defining equity as "consider[ing] the social justice ramifications of education in relation to the fairness, justness and impartiality of its distribution at all levels or educational sub-sectors" and equality as "the state of being equal in terms of quantity, rank, status, value or degree" (Jacob & Holsinger, 2008, p. 4). Some educational studies have considered learning equity to be the principle of empowering every learner with more than equality of educational opportunity, that is, of also ensuring efficient and just treatment at the organizational level (Akmal & Pritchett, 2021; Strunk & Locke, 2019).

In equity theory, Adams (1965) defined inequity as interpersonally derived while considering equity as a crucial distributive principle of choice for university students. Leventhal argued that equity has a broader meaning: “a free and reasonable conformity to accept standards of natural right, law, and justice without prejudice, favoritism, or fraud and without rigor entailing undue hardship” (Leventhal, 1980, p. 5). Steil and Makowski defined equity as “the proportionality or contribution principle, distributes outcomes on the basis of valued contributions” (Steil & Makowski, 1989, p. 122). Following UNESCO, we define learning equity as an organizational justice principle to ensure that students’ learning opportunities are not limited by the “type of background one comes from and the type of resources one has access to” (UNESCO, 2018, p. 17).

Section 6.1.3 Automated Project Allocation in PBL

Since the 1980s, PBL has been gaining increased attention in higher education. It includes “a wide range of learning experiences from small ‘project options’ or exercises, to a ‘project orientation’ which forms the basis of an entire university education” (Morgan, 1983, p. 66). Blumenfeld and the team defined PBL as “a comprehensive perspective focused on teaching by engaging students in the investigation” (Blumenfeld et al., 1991, p. 371). Cortázar et al. (2021) highlighted the value of PBL for promoting critical thinking and motivating students to apply multidisciplinary knowledge and improve their problem-solving skills in real-life projects independently because PBL theory “draws theoretically on progressivism, constructivism, and situated learning” (Wan et al., 2020, p. 2). Final-year projects (FYPs) as typical PBL have been considered important to give undergraduate students a chance to work independently for a year and demonstrate their overall learning outcomes during the degree program (primarily for STEM programs) (Hussain et al., 2019).

PBL consists of three fundamental processes: planning, creating, and processing. Appropriate project allocation in the planning stage is the premise for a successful learning experience for students (Basilotta Gómez-Pablos et al., 2017; Hussain et al., 2019). However, with the rapid expansion of student populations worldwide, manual project allocation has plateaued in its ability to support the diverse learning preferences and multidisciplinary demands of students justly and efficiently (Cheung et al., 2004; Rees Lewis et al., 2018). Technologies such as automated project allocation have made significant contributions to optimizing procedures and facilitating interdisciplinary approaches in PBL (Bacon & Mujkic, 2016; Ismail et al., 2017). These technologies made contributions by enabling automated decision-making with high consistency (Schlicker et al., 2021). In other words, with the help of automated project allocation, universities can automatically allocate a large number of projects from a shared project pool, contributed by different disciplinary departments, to a large number of students. The organizational justice of the project allocation outcome relies on computer algorithms that perform allocations based on information inputs and constraints, such as students' desire to work with a particular supervisor or preference for a particular project area and supervisors' recommendations according to different students' experiences and skills (Hussain et al., 2019).

Although automated project allocation can efficiently calculate a semi-randomized distribution solution with high transparency by providing detailed information about the computer algorithm to all students, that is, with open access, some students continue to complain about automated project allocation outcomes. A few studies have investigated the potential reasons. For example, Manlove et al. (2022) investigated the problem from an algorithmic perspective and found the multiple supervisor condition adds complexity for an algorithm to be able to achieve maximum-size stable matching. Salami and Mamman (2016) pointed out that when automated project allocation outcomes fail to meet all student preferences and supervisors' research interests (which they are likely to fail to do given limited resources), the relationship between students and supervisors could become poor and unsatisfactory. Organizational justice achieved and applied by automated agents cannot fully represent the perceptions of justice reflected by human agents (Schlicker et al., 2021); humans may have different levels of satisfaction, influenced by their perception of justice (Ötting & Maier, 2018).

Section 6.1.4 Self-efficacy

Studies have found that self-efficacy influences human perceptions from different aspects, such as computer self-efficacy, which influences users' perceptions of technology's usefulness (Li, Zhang, et al., 2021; Yeşilyurt et al., 2016), and learning self-efficacy, which affects students' perceived learning effectiveness (Alghamdi et al., 2020; Sun & Hsu, 2019). As the central concept of social cognitive theory (Bandura, 2014), self-efficacy was initially defined as an individual's belief in their own ability to obtain a gain in a given task (Bandura, 1986a). The social cognitive theory emphasizes both learning and cognition in developing an individual's personality, and further developed the concept of self-efficacy as "people's judgments of their capabilities to organise and execute courses of action required to attain designated types of performances" (Bandura, 1986b). Following

Bandura (2014), we define self-efficacy as an individual's belief in their capability to self-control their learning motivation, confidence, cognition, thought patterns of reflection, and actions.

Educational studies in PBL research have discussed self-efficacy as a core construct because the theoretical foundation of self-efficacy is consistent with the constructivist pedagogical beliefs of PBL (Cyrus Rezvanifar & Amini, 2020; Geng et al., 2019). In a PBL context with large group of students and limited supervisors, students are expected to undertake project tasks based on the projects allocated to them. According to Bandura (1977), students with higher self-efficacy are more likely to take on complex tasks, and recover faster than those with lower self-efficacy if disappointed (e.g., by allocation outcome). Shin (2018) found positive effects of student self-efficacy in relation to PBL on students' learning motivation. Alamri (2021) found a significant relationship between the blended PBL approach and student self-efficacy on achieving good academic performance.

Section 6.1.5 The Present Research

A growing number of organizational scholars have turned their attention to "predicting justice rule adherence" using employee-centred predictors and "focused on predicting the act of being respectful, proper, truthful, and candid, making a justice-based measurement approach the appropriate choice, even as a dependent variable" (Colquitt & Rodell, 2015, p. 195). Self-efficacy, as the core concept of human cognition (Bandura, 1986a), has been investigated as a potential factor influencing perceived justice with fragments of evidence. For example, Aşkun et al. (2018) found a moderating effect of self-efficacy on the relationship between organizational justice and employee turnover. Marques et al. (2017) emphasized that human cognition, as the source of perceived justice that might influence decision recipients' perceptions, is critical for justice measurement and requires further exploration in educational context. Moreover, educational studies have discussed self-efficacy as an effective predictor of students' academic achievement and decision-making in PBL research (e.g., Cyrus Rezvanifar & Amini, 2020). As this literature indicates, it is vital to understand the potential connection between self-efficacy and organizational justice for sustainable PBL. However, investigations on this topic have been minimal. Therefore, we adopt the proposition that self-efficacy predicts organizational justice as a theoretical assumption for subsequent exploration in an empirical context.

Section 6.2 Method

Section 6.2.1 Research Context

In this article, we investigate our proposition through an exploratory mixed-method case study (Yin, 2018) at a Sino-British, English-medium instruction international university (hereafter, the University) in China. The University has adopted PBL for all undergraduate final-year programs and encourages interdisciplinary research-led learning and teaching. This case study consists of three phases (Figure 6.1).

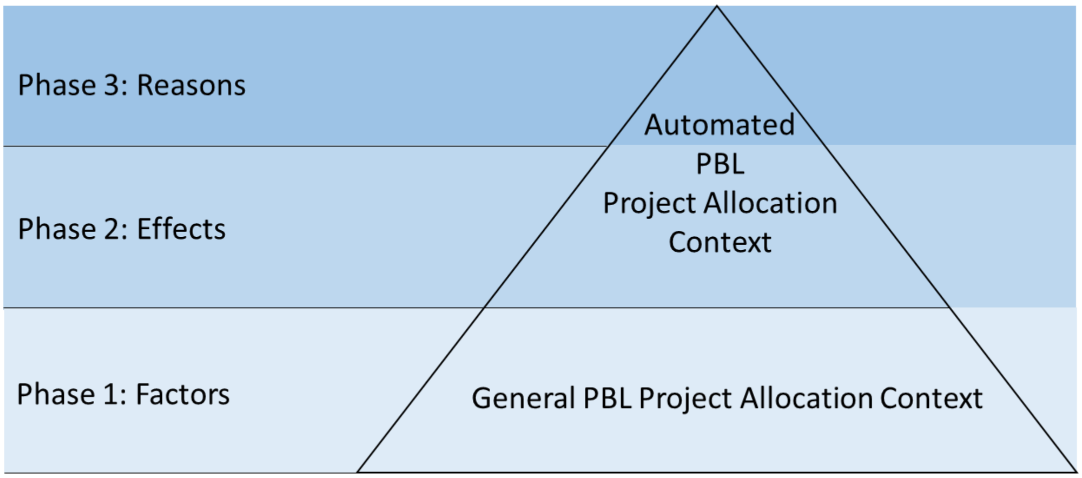


Figure 6.1 Research Design

In the first phase, we developed and evaluated a justice measurement tool to explore factors focusing on the general PBL project allocation context, including manual and automated practices. An online questionnaire with an integrated justice scale, the Perceived Self-Efficacy and Perceived Justice Survey (PSPJS), was administered to two cohorts of undergraduate students in an interdisciplinary PBL course. In the second phase, we focused on the automated PBL project allocation context to explore the effects of self-efficacy on its relationship with perceived justice. We applied the faceted justice approach to ground the phenomenon into actionable principles (Colquitt & Rodell, 2015) and divided organizational justice into dimensions. In the third phase, we explored the potential reasons for self-efficacy effects. The following research questions and hypotheses were investigated in three phases.

Phase 1:

RQ1. What factors are most relevant to justice measurements in PBL project allocations?

RQ2. How reliable are the scores produced by PSPJS as measured by correlation?

RQ3. How valid does PSPJS measure the constructs?

Phase 2:

RQ4. What are the effects of self-efficacy in the automated PBL project allocation context?

H1. Perceived self-efficacy predicts perceived procedural justice.

H2. Perceived self-efficacy predicts perceived distributive justice.

H3. Perceived self-efficacy predicts perceived learning equity.

Phase 3:

RQ5. What are the potential reasons for the self-efficacy effects in the automated PBL project allocation context?

Section 6.2.2 Phase 1 Method

The primary purpose of Phase 1 was to explore the factors most relevant to justice measurement in the general context of PBL project allocation (RQ1). The existing scales could not adequately support the measurements; thus, an integrated justice scale named the Perceived Self-Efficacy and Perceived Justice Survey (PSPJS) was developed, to incorporate context-specific rules following the scale development workflow adapted from the best practices introduced by Boateng et al. (2018). A scale evaluation was conducted to address RQ2-3. Quantitative analyses were conducted using SPSS Statistics 27 and Mplus 7.0 software.

Item Development.

We applied a deductive approach to develop, through a literature review, a pool of items to assess the existing scales and indicators of the identified domains (Boateng et al., 2018). As mentioned above, we assumed that self-efficacy and organizational justice were two connected domains of justice measurement in PBL project allocation. Although the existing scales have been used in many studies, they cannot adequately serve the purpose of measuring the potential relationships between self-efficacy and organizational justice in the PBL project allocation context. For example, Greco et al. (2022) developed a self-efficacy scale to measure university students' academic self-efficacy beliefs regarding the management of academic tasks. The scale was validated to measure general academic tasks (e.g., information searching, exam planning) but was not specified for project-based tasks, such as project management, solution implementation, and problem solving. Genç et al. (2021) assessed self-efficacy and organizational justice as separate dependent variables in an investigation of female school administrators. Aşkun et al. (2018) measured the moderating effects of self-efficacy on the relationship between perceptions of justice and turnover intentions in the workplace.

The emerging literature on self-efficacy has contributed to scale development and validation in the educational context. Nevertheless, the existing tools for self-efficacy measurement each have a specific focus. For example, Sun and Hsu (2019) modified the Motivated Strategies for Learning Questionnaire (Pintrich & De Groot, 1990) to measure C programming language-related self-efficacy, explicitly focusing on students' confidence in code-writing. Alghamdi et al. (2020) developed the "Self-Efficacy for Self-Directed Learning Scale" based on the Children's Multidimensional Self-Efficacy Scales (Bandura, 1986a; Zimmerman et al., 1992), which focused on online multitasking behaviours. Greco et al. (2022) developed a scale to assess Italian university students' self-efficacy beliefs regarding handling academic tasks. As mentioned previously, however, a scale designed for general academic tasks is inadequate for assessing project-oriented PBL tasks. Therefore, new scale items for PBL self-efficacy were developed for our specific purposes.

Following Colquitt and Rodell (2015), we extend the existing justice scale to incorporate context-specific rules for justice measurements in the PBL context. Students' learning opportunities should not be limited by their characteristics or conditions such as academic background, age, gender, and health. For example, if a student lacks the academic background required to conduct a PBL project, they should still be provided with equal opportunity to express their preferences on project allocation; the required knowledge can be developed with the support of a university. Regarding the existing equity scales, although various forms of equity principles have been discussed in the social psychological and sociological literature, they have only a minimal presence in empirical research (Colquitt & Rodell, 2015). Most equity scales in education studies are designed to measure K12-level learning (Nachbauer & Kyriakides, 2020; Omoeva et al., 2021) or national-level educational governance (UNESCO, 2018), and no existing equity scales have been designed for PBL in the higher education context. Therefore, new scale items for learning equity were developed to address this research’s specific context.

An initial pool of 46 questions was developed, including items that might not perfectly fit the context (Boateng et al., 2018). Item deduction analysis was conducted to reduce irrelevant items. The most commonly used justice scales, which included seven items for procedural justice, four items for distributive justice, four items for interpersonal justice, and five items for informational justice, were tailored to the general PBL project allocation context (including manual and automated) in item question development (Colquitt, 2001)—for example, “I find that the current practice of reviewing my FYP application submission (e.g., my choice, my priority) is efficient and helpful.” Equity theory (Adams, 1965) and comprehensive formulation (Leventhal, 1980) were used to develop 11 questions for learning equity. For example, “My learning opportunities are not limited by my gender.” Social cognitive theory (Bandura, 2014) and the guide for constructing self-efficacy scales (Bandura, 2006) were consulted for the 15 PBL self-efficacy item development questions. The Motivated Strategies for Learning Questionnaire

(Pintrich & De Groot, 1990) were referenced while tailoring the questions about student motivation and strategies relevant to self-efficacy, like “The FYP project allocation meets my expectation for learning.” The Academic Self-efficacy Scale (Greco et al., 2022) was referenced for general academic task questions, such as “I am able to structure and write a dissertation.”

All 46 items were rated on a 5-point Likert scale, as scholars have emphasized its benefit of capturing sufficient variance while maintaining simplicity (Dawis, 1987; Hinkin, 1998). Likert scale descriptions were aligned with the question context. For example, for a question like “I find the current practice of obtaining FYP supervisors’ information is efficient and helpful,” the description ranged from “1 = strongly disagree” to “5 = strongly agree.” For a question such as “I usually found the popular projects have been allocated before the project allocation starting date,” the description ranged from “1 = highly unlikely” to “5 = highly likely.”

To evaluate the face validity of the measure (Boateng et al., 2018), cognitive interviews were conducted with seven students from the target population who volunteered to pretest the initial questions. These cognitive interviews helped the research team identify cognitive ambiguity and modify the question texts according to students’ feedback on the readability and clarity of each survey item. For example, students suggested providing bilingual (English and Chinese) descriptions for all survey instructions and questions so that students with lower English language skills could benefit from reading the Chinese translation as a supplement. Moreover, students found that some questions were difficult to answer because they were irrelevant to the students’ learning experiences in the PBL course. For example, the PBL curriculum was project oriented, without traditional lectures or exams. Students had difficulty responding to self-efficacy questions about their in-class communication with professors and their exam preparations, because they did not have such experience in this class. Consequently, from the initial item pool we eliminated five self-efficacy questions about lectures or exam experience. Furthermore, three interpersonal justice questions and two informational justice questions were eliminated because students had not had formal interactions with unknown supervisors before receiving the project allocation outcome.

After face validation and pretesting, 36 items were included in the justice measurement. One researcher translated the English into Chinese and cross-checked it with two other researchers. The final online questionnaire comprised three sections: demographics (three items), justice measurement (36 items), and open-response questions (four items). Only the justice measurement section included questions on a 5-point Likert scale. The open-response section included four open questions to further clarify students' perceptions.

Participants and Procedure.

We administered an online questionnaire on a Moodle-based virtual learning environment (VLE) at the University. Two cohorts of fourth-year undergraduate students from an interdisciplinary PBL course in a STEM FYP program were surveyed using the same online questionnaire. The student participants in Sample 1 had started the course in September 2020 and were expected to graduate by July 2021. The student participants in Sample 2 had started the course in September 2021 and were expected to graduate by July 2022.

Sample 1. The University provided 58 supervisors to support 237 registered students, and expected every student to work on a different project topic. The background of project supervisors varies in discipline, experience, and available time; some supervisors might provide students with opportunities to do project work with companies. Therefore, supervisors and projects vary in popularity among students. The students underwent manual project allocation from late February to early March 2021 (weeks 1–2) and worked on the allocated project with the allocated supervisor from March 2021 to early June 2021 (weeks 3–16). In manual project allocation, students were encouraged to contact potential supervisors and express their project preferences. The course coordinator collected confirmed project topics and student information from the supervisors and manually allocated the remaining students to non-fully-booked supervisors. The course coordinator and school secretary provided procedural communication and information at the organizational level. Students could approach potential supervisors informally, but due to the heavy workload, supervisors were not expected to be involved in formal communication with students before confirming the project allocation outcomes.

All 237 registered students were invited to participate in the voluntary and anonymous online questionnaire from late May to mid-June 2021 (weeks 14–17) before the deadline for final thesis submission in mid-July 2021 (week 20). The survey took approximately five minutes to complete. All participants were guided to read and confirm the online consent form and participant information sheet before they took the survey, and were informed of their freedom to withdraw from the study at any stage. Ultimately, 229 of the 237 registered students responded to the online questionnaire, for a high response rate of 97%. Two hundred twenty-six responses were received. Therefore, the sample size for dataset 1 was 226 (Li, Lim, et al., 2022).

Sample 2. In September 2021, the University implemented a Moodle-based automated project allocation plugin (Fair Allocation) to support PBL across its campus. The PBL course (the same as that for Sample 1) piloted the new automated project allocation from September 2021. The University provided 70 supervisors to support 540 registered students with 590 projects in the project allocation option pool. Induction sessions and detailed instructions were provided to all registered students to help them better understand the process and algorithmic computing structure of the automated project-allocation solution.

The open-source fair allocation plugin was developed by the University of Ulm and the University of Münster, and customized by the Catalyst with funding support from the site university. The plugin uses a modified Edmonds–Karp algorithm. Using fair allocation, students can assign ranking scores to different projects and thus indicate their preferences and priorities regarding whether to take them up. The primary purpose is to distribute the students appropriately to the choices by maximizing overall satisfaction regarding the ratings. The automated project allocation tool allows the course coordinator to upload information on projects designed by the project supervisors in the first stage. Project supervisors can explain required support documents to students in advance. The supervisor will inform the recommended students to get a mutual agreement before submitting the recommendations to the system.

In the second stage, students can view the project information and submit up to 10 projects in order of their personal preferences. Finally, the system calculates a project allocation solution based on given conditions, such as students' preferences, supervisors' recommendations, and the capacity of each project. For example, Project A was a trendy among students. Ten students chose Project A as their first choice. However, each project can take only one student. The system randomly selected one out of the ten students as the final allocation result for project A. The remaining nine students' second choices were calculated, and the process was repeated until each student received a different project.

Automated project allocation was open the first two weeks of early September 2021 (weeks 1–2). The detailed workflow is illustrated in Figure 6.2. In the first round of automated project allocation, 459 of the 540 registered students placed their votes (the screenshot shows 557 users because there were some auditing students enrolled in the course). The remaining students were provided with the opportunity to join the second round of the automated project allocation by September 16, 2021. The allocation outcome was released in late September 2021 (Week 3).

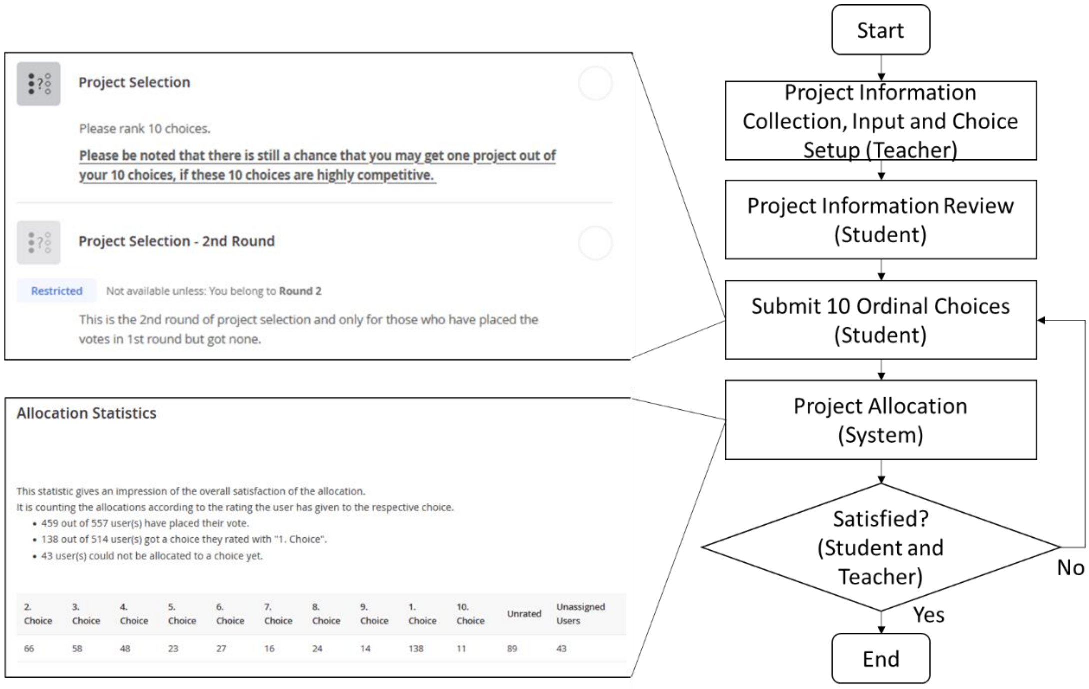


Figure 6.2 Workflow of The Interdisciplinary Automated Project Allocation

All 540 registered students were invited to participate in the voluntary, anonymous online questionnaire in December 2021 (weeks 14–15), before the end of the first semester of the academic year. The survey took approximately 5 minutes to complete. The online consent form and participation information sheet were provided with an online questionnaire, and all participants were informed of the ethical details. Ultimately, 540 registered students responded to the online questionnaire (100% response rate) and 537 responses were completed. The sample size for Dataset 2 was 537 (Li, Lim, et al., 2022).

Scale Evaluation.

Classical test theory (CTT) was used to conduct the inter-item and item-total correlations for item reduction analysis (Boateng et al., 2018; Worthington & Whittaker, 2006). All items for interpersonal justice and informational justice were eliminated because of poor correlation results (see details in the Results section). Exploratory factor analysis (EFA) was employed on Dataset 1 to examine the underlying factorial structure of the measurement instrument (Comrey & Lee, 1992; Gorsuch, 1983; Mulaik, 1972). To evaluate the new scales and address RQ2 and RQ3, we conducted a confirmatory factor analysis (CFA) using Datasets 1 and 2 (Li, Lim, et al., 2022) for psychometric assessment (Boateng et al., 2018). The Cronbach's alpha was calculated to assess the internal consistency of the scale items in terms of reliability.

Content validity was assessed before survey administration. Concurrent criterion and construct validity were assessed after survey administration. Latent variable correlation was calculated to examine concurrent validity. Average variance extracted (AVE) values were analyzed to assess convergent validity (Hair et al., 2017). Following the method of Fornell and Larcker (1981), discriminant validity was analyzed by comparing the variables' AVE and squared correlation coefficients.

Section 6.2.3 Phase 2 Method

The purpose of Phase 2 was to examine the effects of self-efficacy in the automated PBL project allocation context (RQ4). Structural equation modelling (SEM) provides a statistical approach for considering the measurement error in the observed indicator variables to estimate the unobservable latent variables (Wang & Wang, 2020). Specifically, Dataset 2 (Li, Lim, et al., 2022) was used for the SEM (Kline, 2011) analysis to investigate the effects of the latent variable self-efficacy in the estimated model. According to the literature, the sample size of Dataset 2 (N = 537) (Li, Lim, et al., 2022) was appropriate for SEM (Boomsma & Hoogland, 2001; Kline, 2005). We tested the following three hypotheses: H1. Perceived self-efficacy predicts perceived procedural justice; H2. Perceived self-efficacy predicts perceived distributive justice; H3. Perceived self-efficacy predicts perceived learning equity. Quantitative analyses were conducted using SPSS Statistics 27 and Mplus 7.0 software.

Section 6.2.4 Phase 3 Method

We explored potential reasons for the quantitative findings from Phases 1–2 in Phase 3. Qualitative analyses were conducted using NVivo 12 software. Regarding RQ5, we analyzed the responses to the four open questions in the online questionnaire and conducted face-to-face focus group interviews with ten volunteer Chinese students (male = 8, female = 2) to explore the potential reasons for the quantitative findings. Focus group interviews were selected to "elicit exchanges between participants as they construct perspectives and responses"

(Barbour, 2018, p. 1). Ethical approval was granted for the interviews, and all participants signed consent forms. Nine students participated in the automated project allocation and responded to the online questionnaire as part of Sample 1. One student contributed to Samples 1 and 2 of the questionnaire datasets (Li, Lim, et al., 2022). This student joined the manual allocation in the academic year 2020–2021 but was not satisfied with the project allocation outcome. Therefore, this student chose to join the automated allocation in the academic year 2021–2022. The researcher who conducted the interviews was from a different school and did not know any of the students. The students were encouraged to talk and interact with each other without restrictions, and the conversation was confidential.

Before the interviews, the participants reviewed their online questionnaire response records and recalled their memory of the project allocation. The researcher asked several semi-structured interview questions to direct the focus group discussion, such as “Do you remember the automated project allocation process you have experienced in March this year?” and “Are you satisfied with the project allocation outcome?” The focus group interviews lasted for 90 minutes. After the focus group interview, a 20-minute separate interview was conducted with the students who participated in the manual and automated project allocation to protect personal privacy. The local language, Mandarin, was used as the native language, and provided a flexible communication environment. The audio recordings were transcribed using AI-supported software. The Chinese text was manually translated into English by one of the researchers and crosschecked for accuracy by another researcher before data analysis. Thereafter, the translated scripts and open-question responses to the online questionnaire were imported into NVivo 12 for qualitative thematic analysis (Miles et al., 2014).

Section 6.3 Results and Discussion

Section 6.3.1 Phase 1 Results and Discussion

Participant Characteristics.

Overall, the participant characteristics of samples 1 and 2 indicate the typical population in an interdisciplinary PBL course for the final-year STEM undergraduate degree program at an international university in China. Specifically, the participants in Sample 1 were aged between 21–26 (M = 22, SD = 1.013), which is normal for a four-year undergraduate student population in China. The gender proportion (male = 175, female = 49, not reported = 2) is typical for a STEM program. The department distribution reflects the interdisciplinary nature of the PBL course. Most of the students were from local areas, which is common in international universities in China. Further details are provided in Table 6.1.

Table 6.1 Sample 1 Participant Descriptive Information

Demographic	Option	Count	Percentage
Gender	Male	175	77.4%
	Female	49	21.7%
	Not reported	2	0.9%
Department	Communications and Networking	14	6.2%
	Computing	112	49.6%
	Electrical and Electronic Engineering	65	28.8%
	Intelligent Science	25	11.1%
	Mechatronics and Robotics	10	4.4%
Nationality	Chinese	222	98.2%
	Non-Chinese	4	1.8%

Sample 2 was aged 18–27 (M = 21, SD = 0.933) and comprised a regular student population in a fourth-year undergraduate course. Table 6.2 presents a demographic overview of the descriptive information provided by the participants, which reflects characteristics similar to those of Sample 1.

Table 6.2 Sample 2 Participant Descriptive Information

Demographic	Option	Count	Percentage
Gender	Male	411	76.5%
	Female	119	22.2%
	Not reported	7	1.3%
Department	Communications and Networking	16	3.0%
	Computing	300	55.9%
	Electrical and Electronic Engineering	144	26.8%
	Intelligent Science	28	5.2%
	Mechatronics and Robotics	49	9.1%
Nationality	Chinese	521	97.0%
	Non-Chinese	16	3.0%

Exploratory factor analysis (EFA).

Dataset 1 (Li, Lim, et al., 2022) was used for item reduction analysis and factor extraction with EFA. All 36 Likert-scale items are included in this stage. Based on the inter-item and item-total correlation results, items with low correlations (p < .30) or low adjusted item–total correlations (p < .30) were eliminated from the item pool (Boateng et al., 2018). GEOMIN oblique rotation (Browne, 2001; Yates, 1987) was used to examine the factor loading matrix. Specifically, items without a primary rotated loading greater than 0.50 on any factor, and those with cross-loadings greater than 0.20 were removed (Cudeck & O'Dell, 1994; Kahn, 2006). Consequently, 18 items were eliminated from the analysis. For example, Q2 and Q15 were deleted because of their low correlation coefficient (0.292). Q16 was removed because of the low GEOMIN loadings (0.117, -0.047, 0.206, and 0.302). Four factors (perceived self-efficacy, procedural justice, distributive justice, and learning equity) were extracted according to Kaiser's criterion (eigenvalue > 1) (Wang & Wang, 2020). Appendix 11 shows the factor loadings and item statistics for Sample 1 with the 18 selected items.

Regarding item reduction, two classic justice dimensions (interpersonal and informational justice) were not measured, because all relevant items were eliminated through the item validation process. Initially, we tailored four original scale items for interpersonal justice and five for informational justice (Colquitt (2001). Nevertheless, these items were eliminated because of poor item validation results. These results may be relevant to the research context. As mentioned before, we explored project allocation outcomes in the PBL planning stage.

Students did not have formal interactions with their final supervisors before receiving the project allocation outcomes in the early stages.

Moreover, in the PBL planning stage, students' perceptions of justice were more organizational-and not supervisor-focused. According to Colquitt and Rodell (2015), interpersonal and informational justice dimensions are more suitable for the agent system model, which focuses on interactions with supervisors. Therefore, it is reasonable that students who did not approach potential supervisors found it difficult to respond to these questions, such as "Is he/she candid when communicating with you?" and "I find the current practice of communication for an FYP project is efficient and helpful." Consequently, these items are more likely to have low correlations and poor factor loadings as indicators of the latent variables.

Confirmatory factor analysis (CFA).

We conducted CFA on datasets 1–2 (Li, Lim, et al., 2022) to evaluate the scale. Appendix 12 shows the paired sample test results, which indicate no statistically significant differences between the two datasets (M is close to zero and $p > .05$). As shown in Table 6.3, all factor determinacies were more significant than 0.9, indicating good reliability of the scale in the two samples (Wang & Wang, 2020). According to Boateng et al. (2018), an alpha coefficient of 0.70 can be considered an acceptable reliability threshold. A score of 0.80 and 0.95 indicates the scale's psychometric quality. The alpha coefficients for the four variables in the two studies were between 0.94 and 0.97 (see Table 6.4), indicating excellent internal consistency and reliability.

Table 6.3 Survey Factor Determinacies (Sample 1 and Sample 2)

Factor	Determinacies (Sample 1)	Determinacies (Sample 2)
1. Perceived procedural justice (PPJ)	0.985	0.981
2. Perceived distributive justice (PDJ)	0.984	0.985
3. Perceived self-efficacy (PSE)	0.985	0.987
4. Perceived learning equity (PLE)	0.983	0.991

Table 6.4 Correlations, Reliabilities, Means, Standard Deviations, Average Variance Extracted Values of the Assessed Variables

Variable	1	2	3	4
Sample 1				
1. Perceived procedural justice (PPJ)	.947			
2. Perceived distributive justice (PDJ)	.804*	.959		
3. Perceived self-efficacy (PSE)	.657*	.669*	.964	
4. Perceived learning equity (PLE)	.594*	.606*	.714*	.946
M	4.482	4.493	4.518	4.649
SD	.765	.744	.654	.614
AVE	.583	.551	.425	.376
Sample 2				
1. Perceived procedural justice (PPJ)	.945			
2. Perceived distributive justice (PDJ)	.781*	.957		
3. Perceived self-efficacy (PSE)	.731*	.724*	.971	
4. Perceived learning equity (PLE)	.576*	.593*	.598*	.954
M	4.455	4.489	4.434	4.683
SD	.778	.762	.747	.586
AVE	.603	.579	.557	.342

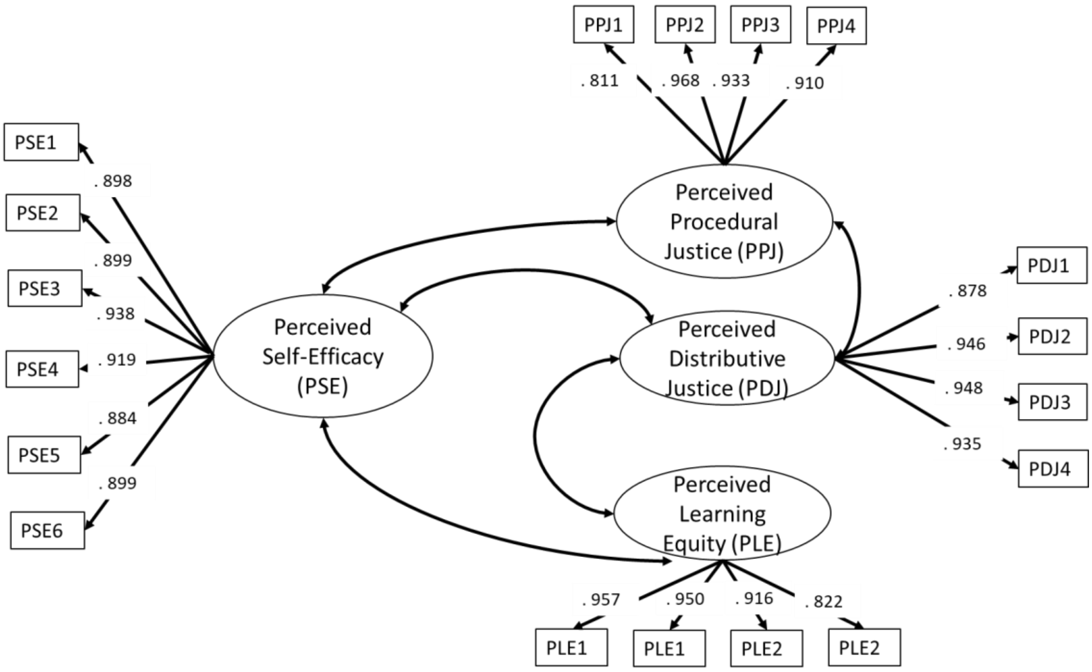
Note. *, $p < .05$.

Sample 1 N = 226.

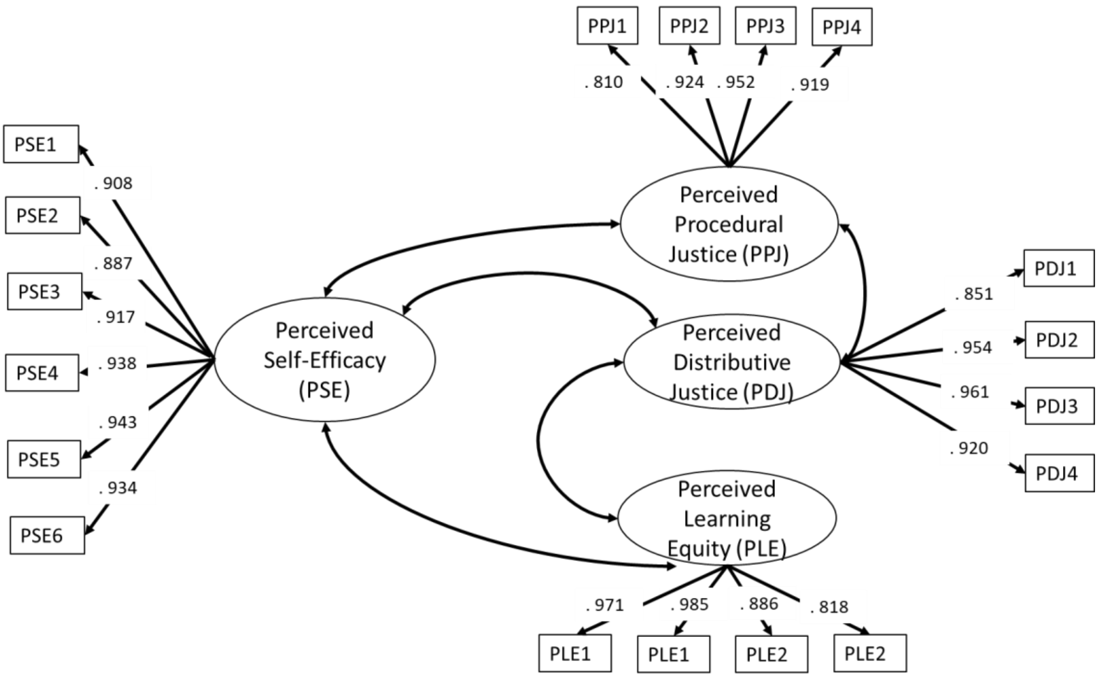
Sample 2 N = 537.

The numbers on the diagonal represent Cronbach's alpha of the scales. M = mean. SD = standard deviation. AVE = average variance extracted.

Correlations (see Appendix 13) were analyzed to examine the extent to which perceived self-efficacy (PSE) was associated with other constructs: perceived procedural justice (PPJ), perceived distributive justice (PDJ) and perceived learning equity (PLE). Table 6.4 shows the positive associations and moderate magnitudes between PSE and the other constructs. Regarding convergent validity, the variables' AVE values of PPJ, PDJ, and PSE exceeded the minimum threshold of 0.5 (Hair et al., 2017), which indicates that the variables explained more than half of the variance of the indicators. The AVE values for PLE were 0.376 and 0.342, indicating an explanation for more than one-third of the variance in the indicators. According to Hair et al. (2017), discriminant validity is acceptable, as all squared correlation coefficients are smaller or close to the AVE values for PSE and PLE. A four-factor model with correlated latent variables was designed based on an analysis of the two datasets (Li, Lim, et al., 2022) (see Figure 6.3 a and b). PSE was assigned six items, whereas the other three factors, PPJ, PDJ, and PLE, were each assigned four items. Each item had the highest factor loading. Appendix 14 shows the descriptive item statistics.



a)



b)

Figure 6.3 CFA Measurement Model

Section 6.3.2 Phase 2 Results and Discussion

Before conducting the SEM, the maximum likelihood method with robust standard errors was used to measure model fit (see Table 6.5).

Table 6.5 Model Fit Evaluation

Fit index	Recommended value (Wang & Wang, 2020)	Measurement model (Sample 1)	Measurement model (Sample 2)	Structural model (Sample 2)
Sample size	n/a	N = 226	N = 537	N = 537
Chi-squared	$p < .05$	683.597 ($p = 0$)	547.195 ($p = 0$)	213.533 ($p = 0$)
Degrees of freedom (df)	n/a	129	129	129
Chi-squared/df	< 5 preferable < 3	5.299	4.242	1.655
Comparative fit index (CFI)	> 0.90	0.905	0.968	0.976
Tucker Lewis index (TLI)	> 0.90	0.888	0.963	0.972
Root–mean–square error of approx. (RMSEA)	< 0.08	0.138	0.078	0.035
Standardized root–mean–square residual (SRMR)	< 0.08	0.04	0.035	0.035

We evaluated the acceptability of the models by comparing them with the recommended values (Wang & Wang, 2020) of the following fit indices: $\chi 2$ test statistic (chi-squared test of model fit), degrees of freedom (df), comparative fit index (CFI), Tucker–Lewis index (TLI), root–mean–square error of approximation (RMSEA), and standardized root–mean–square residual (SRMR). The $\chi 2$ test statistic has limitations in judging model fit (Wang & Wang, 2020). The ratio of $\chi 2$ to df, if in the range of 3–5, is generally interpreted as indicating adequate fit (Hair et al., 2010). For CFI and TLI, the recommended values are greater than 0.90 (Bentler, 1990; Quintana & Maxwell, 1999). Hu and Bentler (1999) suggested that 0.08 or below indicates a proper model fit. The results indicated that the four-factor CFA model fits Dataset 2 (Li, Lim, et al., 2022) (ratio = 4.242, CFI = 0.968, TLI = 0.963, RMSEA = 0.078, SRMR = 0.035) and is acceptable for SEM analysis.

The SEM analysis results in Table 6.5 indicate that the structural model also fits Dataset 2 (Li, Lim, et al., 2022) (ratio = 1.655, CFI = 0.976, TLI = 0.972, RMSEA = 0.035, SRMR = 0.035). Figure 6.5. presents the standardized test results of the hypothesized structural model (see Figure 6.4). The results indicated that the three relationships hypothesized in the conceptual model were statistically significant.

H1. Perceived self-efficacy was statistically positively associated with perceived procedural justice ($\beta = .752$, $p < .001$).

H2. Perceived self-efficacy was statistically positively associated with perceived distributive justice ($\beta = .747$, $p < .001$).

H3. Perceived self-efficacy was statistically positively associated with perceived learning equity ($\beta = .602$, $p < .001$).

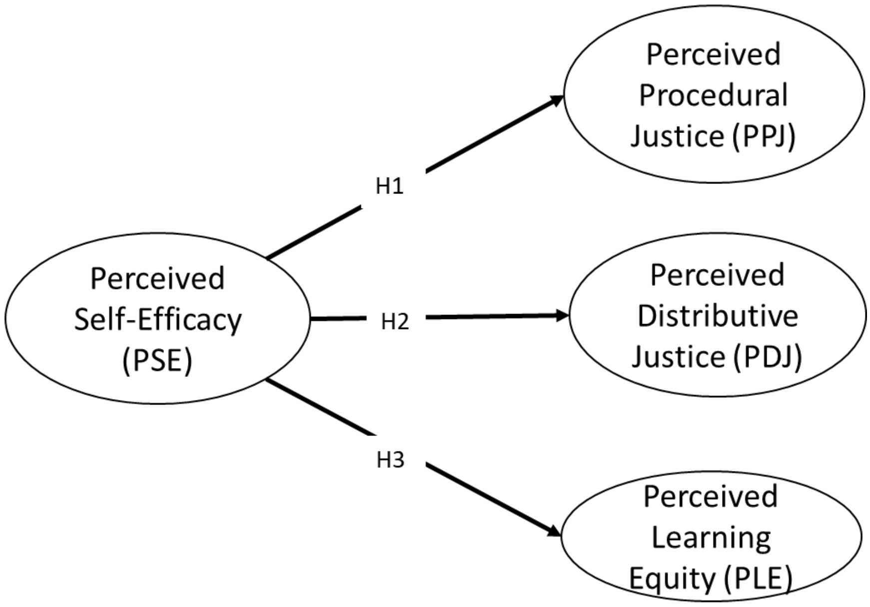
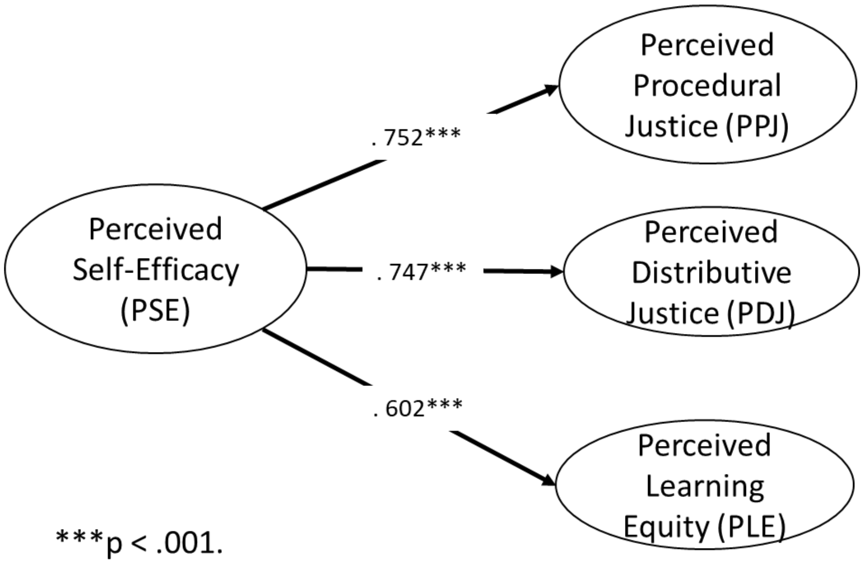


Figure 6.4 Hypothesized Model



***p < .001.

Figure 6.5 Results Model

Section 6.3.3 Phase 3 Results and Discussion

The confirmed structural model indicated that students with higher PSE tended to have higher levels of agreement on three aspects of automated project allocation justice: PPJ, PDJ, and PLE. In Phase 3, we explored the potential reasons for this phenomenon through a qualitative data analysis of the survey responses to open questions and focus group interviews. Following the thematic analysis method of Miles et al. (2014), three themes (confidence, metacognition, and reflection) were extracted to interpret the mechanism of the effects of self-efficacy on predicting students' perceived justice in automated PBL project allocation (see Table 6.6).

Table 6.6 Thematic Matrix with Student State Excerpt Samples

Themes	Mechanism	Student state excerpt sample (high self-efficacy)	Student state excerpt sample (low self-efficacy)
Confidence	The higher PSE, the greater confidence, the broader acceptance range, the higher PPJ.	"All the projects I chose were my favorite ones, so no matter what project I was finally allocated, the results were within my acceptable range."	"I think ten options may be a little bit too much. I finished making all the choices I wanted to make, and I found that there were still six more I needed to choose."
Metacognition	The higher PSE, the stronger metacognition, the more effort, the higher PDJ.	"It takes time to review each project because there are hundreds of projects for my major, but the outcome deserves it, it is relatively fair."	"I think there is too much project information. I just selected 2 preferred projects and selected the remaining ones randomly. I was not lucky enough to get the first 2 choices."
Reflection	The higher PSE, the deeper reflection, the more rational, the higher PLE.	"I think, overall, it is fair. I failed to get a fit project. I have been given equal opportunity to make a choice, but I did not submit my choice. "	"I got a project which is about Java programming, but I did not know Java. I cannot be successful because I did not get the right project."

Note. PSE = perceived self-efficacy; PPJ = perceived procedural justice; PDJ = perceived distributive justice; PLE = perceived learning equity.

Confidence.

In the focus group discussion, the student participants had an interesting debate regarding the number of choices given in the automated project allocation procedure. Some students thought it acceptable to make up to ten choices, while others disagreed and suggested reducing the number of options. A detailed student-state sample is presented in Table 6.6. Based on the focus group interviews, the research team checked students' self-efficacy scores and open-question responses to the online questionnaire to explore the underlying reasons. Statistically, 99.07% (532 out of 537) of the survey participants responded to the optional open question: "In which way do you think the current FYP allocation practice can be improved." Excluding 72 meaningless responses (e.g., "0," "null," and "N/A"), we analyzed the 95.34% (512 out of 537) meaningful responses to that question. Only 6.45% (33 out of 512) of the participants suggested reducing the choice option number, whereas 74.61% (382 out of 512) of the participants suggested increasing the choice option number, providing more information, or maintaining it as it was. The other (18.36%) participants made different suggestions (e.g., increasing the number of supervisors, starting the project earlier). The average self-efficacy score of students who requested more options or were satisfied with the current options (M = 4.49) was higher than that of students who suggested reducing the choice option number (M = 4.24).

A theme named "confidence" was extracted through thematic analysis to interpret potential reasons. This theme is proposed to explain the potential mechanism by which self-efficacy may influence students' perceived procedural justice through their confidence levels. Specifically, students with higher self-efficacy scores might have greater confidence in managing complex tasks (e.g., challenging projects) (Schaffer et al., 2012); thus, they might have a broader range of acceptable projects. In contrast, students with lower self-efficacy complained about being given too many choices to rank, because their scope of choice was relatively narrow. Students with a narrow scope of choice might have expected the automated project allocation process to fit their narrow preferences even in a random selection. It is challenging to achieve such unreasonable expectations. Consequently, students' perceived procedural justice may have been influenced by these unreasonable expectations, which may have been connected to their confidence in their knowledge to achieve good performance (Zong et al., 2022).

Metacognition.

Why does students' perceived self-efficacy affect their perceived distributive justice in automated PBL project allocation? One plausible explanation is that students with higher self-efficacy tend to have stronger metacognition and make more efforts (Karatas & Arpaci, 2021) (e.g., to read the project information and try approaching the supervisors informally) to figure out what is a "fit" project. According to Dori et al. (2018), students with stronger metacognition know more about learning. Stronger metacognition and more effort might help students make a cautious choice selection and gain a satisfactory distribution outcome, as any of the ten choices are more likely to be suitable for their learning. Statistically, 97.95% (526 out of 537) of the participants responded to the open question, "How much time and effort you have devoted to applying for an FYP project" with meaningful responses. A total of 44.13% (237 out of 537) of the participants reported spending more than a week on project allocation, while 49.35% (265 out of 537) spent less than a week. Supervisors recommended 4.66% (25 out of 537) of the participants before auto allocation. Therefore, they did not spend time checking the project information. The average self-efficacy score of students who spent more time (M = 4.48) was higher than that of the students who spent less time (M = 4.39).

We extracted a second theme we named “metacognition” through the thematic analysis to explain the potential mechanism. As the student state sample showed in Table 6.6, students with higher-level self-efficacy thought they deserved the time and effort to review each project before they chose, while students with lower-level self-efficacy spent less time on information checks and relied on luck. Students with lower self-efficacy are more likely to have weak metacognition (Dori et al., 2018) and might not clearly understand the purpose and pedagogical benefits of taking time to review projects and make choices. Therefore, they might not take the time to figure out what a “fit” project for themselves is and might perceive the distributive outcome as inappropriate if they were not lucky enough to be allocated a “fit” project, with the standard of “fit” being vague.

Reflection.

During the focus group discussion, students were guided to talk about their learning opportunities connected to their perceived learning equity. Why do the quantitative data indicate that students’ perceived self-efficacy influences their perceived learning equity? The focus group interview data and relevant questionnaire responses to the open-ended questions were analyzed to explore potential reasons. Statistically, we analyzed meaningful responses to the question, “How many opportunities have you been given before securing your FYP project” by 96.46% (518 out of 537) of participants. For the question “Do you think the FYP allocation influences your learning experiences? If so, how?" 97.77% of participants (525 out of 537) responded with meaningful answers. More than half of the students (55.12%) thought that the University had provided equal learning opportunities. The average self-efficacy score of these students ($M = 4.58$) was higher than that of other students ($M = 4.25$). Most students (83.24%) expressed that their learning experiences were not negatively affected by the project allocation outcomes. The average self-efficacy score of these students ($M = 4.5$) was higher than that of other students ($M = 4.09$).

Based on the qualitative data analysis, a third theme, "reflection," was extracted to interpret the potential mechanism. Students with higher self-efficacy may be able to engage in deeper reflection (Sekerdej & Szwed, 2021) and be more rational about their perceptions of learning equity when facing challenges. As shown in Table 6.6, students with higher self-efficacy scores critically reflected on their project choice behaviour when the project allocation outcome was unsatisfactory. These students thought that equal learning opportunities were provided. Another student agreed with this point and commented: "Everyone has a great opportunity to choose what they like, and there is no need to worry about the problem of communication between students and teachers, the situation wherein the teacher decides whom to choose will not arise." Students with lower self-efficacy scores blamed external conditions such as the required skills for the allocated project. They indicated that these external conditions limited the learning opportunities. However, employees might be expected to develop relevant skills to fulfil assigned tasks in the workplace environment. Quick learners with higher self-efficacy may be more adaptive and have a higher level of employability (Ab Halim, 2019).

Section 6.3.4 General Discussion

The main objectives of this paper are threefold: first, to explore the factors most relevant to justice measurement in the general PBL project allocation context; second, to investigate the effects of self-efficacy on students' perceptions of justice in the automated PBL project allocation context; and third, to explore the potential reasons for the effects of self-efficacy in an automated PBL project allocation context. The findings address five research questions, confirm three hypotheses, and contribute to the literature in three key aspects.

Theoretical Implications.

First, the findings contribute to the literature on computer and human behaviour by highlighting self-efficacy's critical role of affecting students' perceived justice in the context of automated PBL project allocation. Specifically, the fitting measurements of the PSPJS formulated in this research demonstrated a thorough multigroup exploratory analysis of factors contributing to the literature on PBL (Cortázar et al., 2021; Wan et al., 2020), measuring aspects of self-efficacy and three critical constructs of perceptions of justice based on a combination of social cognitive theory (Bandura, 2014), organizational justice theory (Folger & Cropanzano, 1998), and equity theory (Adams, 1965; Leventhal, 1980). Additionally, procedural justice, distributive justice, and learning equity, as crucial constructs of justice theory measuring students' perceptions of justice with significant factor loading scores, were consistent with prior studies in this field (Sadeghi & Kardan, 2015; Thomas, 2021). Furthermore, the PSPJS provides a practical measurement tool for researchers and educators to assess student perceptions of self-efficacy and justice. According to Drost (2011), a lengthy questionnaire may attenuate the consistency of accurate responses from participants because of boredom or fatigue. The PSPJS includes only 18 items, and it took approximately five minutes to complete, which would not add an extra burden to the survey participants (Worthington & Whittaker, 2006). PSPJS initiated and encouraged investigations into the relationship between student self-efficacy and perceptions of justice, critically missing information in education literature.

Second, the reliable and valid measurement scores produced by the PSPJS through multigroup CFAs contribute to the psychometric literature (Raykov & Marcoulides, 2011) that examines the implications for sustainable education (Greco et al., 2022; Liesbeth Noordegraaf-Eelens, 2019). Specifically, the scale validation results, such as the similar statistically significant scores of the factor determinacies for the two different samples and the paired sample test results, presented evidence to address threats to the validity of self-reported data (Mundai, 2011). The SEM analysis results confirmed this proposition, which is consistent with the findings of previous research, suggesting a connection between self-efficacy and perceptions of justice (Aşkun et al., 2018; Genç et al., 2021). The findings echo social cognitive theory (Bandura, 1986b) which emphasizes the environmental and cognitive factors that influence human learning behaviours (Day, 2019; Li, Zhang, et al., 2022).

Third, the new PBL self-efficacy and justice model contributes to the literature by conceptualizing factor interactions based on three significant associations. The conceptual model emphasizes the critical role of self-efficacy in predicting perceived procedural justice, distributive justice, and learning equity in promoting sustainable PBL (Basilotta Gómez-Pablos et al., 2017; Hussain et al., 2019). The three themes (confidence, metacognition, and reflection) extracted from the qualitative data analysis provided new insights into the effects of self-efficacy on perceived procedural justice, distributive justice, and learning equity in the higher education context. Additionally, this research contributes to the methodological literature by presenting the benefits of validated quantitative SEM (Kline, 2005) and grounded qualitative explanations (Miles et al., 2014) through a mixed method to develop the conceptual model.

Practical Implications.

The research findings remind us that student self-efficacy needs more attention as one of the critical factors that is most relevant in justice measurement in the PBL context. Teachers, managers, and decision-makers can gain a better understanding of students' perceptions of justice using the PSPJS and improve educational policies and guidelines for better learning and teaching support. When designing foundation programs for undergraduate students, self-efficacy should be included as a critical competence for better self-directed learning in an agile future learning ecology (Li, Huijser, et al., 2022; Sousa, 2021). Additionally, the descriptive statistics of the survey responses indicated an overall positive feedback on the automated project allocation solution. This result is consistent with Hussain et al. (2019), who suggested considering student preferences, supervisor suggestions, and resource constraints when designing the allocation technique. Our findings provide practical value for automated project allocation system design and student competence development policymaking. Specifically, knowing that student self-efficacy could predict their perceptions of justice in automated project allocation, more attention should be paid to improving the computer-human interaction-related experience (Latikka et al., 2019; Sasidharan & Santhanam, 2006) to support the development of self-efficacy, such as designing efficient project information search functions to help students prepare for the ranking of their choices of project. Student-centred supervision approaches, such as students producing audio recordings of the discussion summary (Voelkel et al., 2018), can be beneficial for students to develop their academic self-efficacy. Moreover, academic self-efficacy should be included as a critical competence that every student needs to develop through formal, informal and lifelong learning to meet the future needs of a sustainable society (Sousa, 2021).

Limitations and Future Development.

The first limitation is related to the scale development and evaluation. Some of the existing scale's questions were tailored for undergraduate students to better understand questions in the PBL project allocation context. For example, the original question for procedural justice, "Are those procedures based on accurate information?" was adapted to "I find the current practice of obtaining FYP application instructions (e.g., procedure, deadlines, contact) is efficient and helpful." Although we conducted cognitive interviews to test the items with the target population, expert judges were not involved in judging the tailored questions. Future studies should combine expert and target-population judgments for item validation. Second, the procedural and distributive justice items were tailored to the case context based on existing justice scales. The concurrent validity for the new scale was conducted using tailored justice scales, not the original version. Moreover, convergent and discriminant validity tests were conducted using tailored justice scales, which might have impacted the evaluation results.

Third, data were collected from a university with a large population from the same geographic region. Although the homogeneity of the study sample was increased by including two cohorts of final-year undergraduate students, future studies should collect data from a more diverse sample with a larger population across different regions and countries. Fourth, data were collected a few months after project allocation. Colquitt and Rodell state that "constructs are given meaning by a bracketing process wherein specific episodes are aggregated into some time period that warrants reflection and exploration" (Colquitt & Rodell, 2015, p. 189). Future studies should consider alternative approaches to assess a more extensive bracketing of multiple events. Fifth, self-efficacy may differ when the project allocation is manual vs. automated. We used only the manual context, part of the general project allocation context, for factor exploration. Future studies should investigate these differences and consider the context as a control variable. Finally, the focus group interview sample (N = 10) was relatively small compared with the survey sample (N = 537) in the automated PBL project allocation context. Future studies should consider more balanced and diverse sample sizes in order to achieve better representativeness.

Section 6.3.5 Conclusion

We conducted a mixed-method exploratory case study at a Sino-British international university in China to understand the factors and mechanisms that cause dissatisfaction and issues related to perceived justice in automated PBL project allocations. An integrated scale, the PSPJS, was developed to incorporate the general PBL project allocation context for justice measurements. Four key factors (PSE, PPJ, PDJ, and PLE) were extracted using quantitative EFAs and multi-group CFAs. The SEM analysis confirmed and established a new conceptual model in which self-efficacy predicted three critical constructs of justice perceptions with significant positive associations. This research gained insights from the survey open questions and focus group interviews, and proposed three themes (confidence, metacognition, and reflection) of the self-efficacy effects to interpret the potential mechanism of the quantitative associations. With the rapid globalisation and internationalisation of higher education, the increasing student population and COVID-19-related disruptions have created new challenges for teachers to leverage student creativity and guide them in applying multidisciplinary knowledge to solve complicated real-life problems (Greener, 2020; Huijser et al., 2019; Li, Wang, et al., 2022; Salmon, 2019). Future research is needed to explore the pedagogical implications of the proposed self-efficacy and justice model in supporting teachers' professional development to better support students in developing self-efficacy as a critical competency for sustainable future education.

As discussed above, this chapter emphasizes the critical role of student self-efficacy in influencing their perceptions of justice in using the VLE-enabled automated project allocation during the "meaning-making" stage of the innovation's institutionalisation. From a learning process perspective, chapter 6 examined the planning phase of the project-based learning while chapter 7 introduces a study examined the delivering phase of an inquiry-based learning. Chapter 7 also connects to the prior studies by providing the empirical evidence of the “meaning-making” process about students’ acceptance of using the VLE-based in-class quiz for interactive hybrid learning during the COVID-19 disruption.

Chapter 7 Understanding The Perceived Pedagogical Value of JazzQuiz in Interactive Hybrid Learning Among University Students: A Technology Acceptance Analysis

Section 7.1 Problem Statement

The global COVID-19 pandemic and its related disruptions have accelerated the transition in education from face-to-face to online or hybrid (Greener, 2020). In a hybrid learning environment based on the Technological Pedagogical and Content Knowledge (TPACK) model, continuous quality improvement and the community of inquiry, learning technologies (e.g. virtual learning environments [VLEs]) are expected to provide equal and interactive opportunities for both online and onsite students to achieve learning efficacy (Singh et al., 2022). Despite increasing support for the implementation of learning technologies to realise educational transition in higher education, actual learning efficacy still varies, primarily because of challenges such as the uncertainty of adopting new technology in a new learning environment (Chan et al., 2021; Ebner et al., 2020).

Technology acceptance theories, such as the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), which integrates the Technology Acceptance Model (TAM) (Davis, 1986) and other seven theories, have been widely used to assess the application and acceptance of learning technologies in the educational context (Li, Zhang, et al., 2021). Although many studies emphasise that students' perceptions are critical in understanding the technology adoption process (e.g. Almaiah et al., 2019; El-Masri & Tarhini, 2017), only a few studies explore the student perceptions of the pedagogical value of using the technology for learning (Farooq & Benade, 2019). For example, Ebadi et al. (2021) find that most students lose interest in using the student response system (SRS) because they find it distracting and lack effective teacher feedback (Voelkel et al., 2020), or feel pressured by time constraints for interactive learning. According to the literature, understanding students perceived pedagogical value (PPV) of using the learning technology is an important research direction (Li, Zhang, et al., 2021).

Additionally, as one of the key constructs to measure learning effectiveness, student academic performance has received limited attention in educational technology acceptance studies (Granic´ & Marangunic´, 2019).

To address the above problems, this study employed mixed methods in an explanatory case study to examine the relationships and mechanisms between students' PPV, their adoption of VLE-based SRS technology (JazzQuiz), and their academic performance. We used the UTAUT model and structural equation modelling (SEM) to examine the core constructs affecting technology acceptance and the interactive hybrid learning effectiveness. This study conceptualised five dimensions of the new construct PPV to determine the underlying mechanisms of the construct relationships in a new PPV model. The key findings contribute to the literature by highlighting the critical role of students' PPV in influencing technology acceptance and student academic performance in an interactive hybrid learning environment.

Section 7.2 Literature Review

Section 7.2.1 The Unified Theory of Acceptance and Use of Technology (UTAUT)

Several technology acceptance models have been developed in recent decades to investigate possible reasons for accepting or rejecting new technology (Granic´ & Marangunic´, 2019; Mortenson, 2016). The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) combines eight-core theories and models, including TAM (Davis, 1986). UTAUT has been widely used in higher education literature to study the acceptance of various technologies, including tablet PCs (Anderson et al., 2006), social media (Gruzd et al., 2012), open access publishing technology (Tandi Lwoga & Questier, 2014), e-learning systems (Kocaleva et al., 2015), web-based training systems (Sattari et al., 2017), open educational resources (Padhi, 2018), VLEs or learning management systems (Garone et al., 2019), mobile learning systems (Almaiah et al., 2019), and the Internet of Things (Almetere et al., 2020).

The original UTAUT model consists of six primary constructs: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Behavioural Intention (BI), and Usage Behaviour (UB). PE refers to the degree to which an individual user's perception of using the technology could help them achieve a gain in performance (Venkatesh et al., 2003). In the educational context, this construct has been used to measure student perception using technology for learning engagement and academic performance (e.g. Ameen et al., 2019). However, very few technology acceptance studies measure the link between expected and actual performance (Granic´ & Marangunic´, 2019).

EE measures the degree of an individual user's perception of the reduced efforts of using the technology (Nistor et al., 2019). SI indicates "the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh et al., 2003, p. 451). FC means "the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of the system" (Venkatesh et al., 2003, p. 453). BI is the acceptance instrument and the proxy for technology use behaviour, while UB indicates the actual use of the technology (Venkatesh et al., 2003).

Section 7.2.2 Perceived Pedagogical Value (PPV)

Considering VLE acceptance in higher education, which this study focuses on, Li, Zhang, et al. (2021) added more constructs to extend the model and pointed out the research gaps from pedagogical perspectives. Their review suggests future studies to examine the "link between the attributes of individual cognition and the pedagogical perspectives of VLE adoption" (Li, Zhang, et al., 2021, p. 12). Hazari and the team defined pedagogical value as students' "capacity to be engaged in learning by exhibiting interest in assignments, retaining more material, participating actively, being motivated, and collaborating" (Hazari et al., 2009, p. 188). Other terms have also been used to investigate pedagogical value. For example, Wang et al. (2010) coined "pedagogical usability" to denote the extent to which a VLE—called "Course Management System" in their study—supports an instructor in developing and implementing sound pedagogical practices based on the good practice principles in Chickering and Gamson (1987). They showed that the pedagogical usability of VLE is significantly impacted by how well the course content management and online forum are supported.

Among the limited literature on technology's pedagogical value, researchers investigated aspects such as individualised self-assessment quizzes (Brusilovsky & Sosnovsky, 2005), a "Wiki" for inquiry-based blended and collaborative learning (Daspit & D'Souza, 2012; Hazari et al., 2009), and discussion forums for dialogical pedagogy (Farooq & Benade, 2019). However, most of the above studies examining the pedagogical perspectives focus on teacher perceptions rather than student perceptions. This study proposes a new construct to address the research gaps, namely Perceived Pedagogical Value (PPV), to measure student perception of the value of learning technology from pedagogical perspectives.

Section 7.2.3 JazzQuiz

JazzQuiz (https://moodle.org/plugins/mod_jazzquiz) is an open-source component of a Moodle-based VLE that provides SRS functionality. SRS is an integrated technology solution to improve students' interactivity (Hung, 2017), extensive classroom participation (Heaslip et al., 2013), learning motivation, self-efficacy, and engagement in a flipped classroom setting (Liu et al., 2018). This concept has many aliases in the literature, such as clickers (Chien et al., 2016; Joshi et al., 2020; Kulkarni & Iwinski, 2016), innovative learning (Kim, 2017), learner response systems (Cho, 2018), and classroom response system (Sprenger & Schwaninger, 2021). Clickers were eventually replaced by web-based SRSs (González, 2018; Ingalls, 2018).

The quick development of mobile technology and a game-based student response system (GSRS), supported by a "bring your own device" model, seems to increase students' engagement, motivation, attention, and achievement while decreasing test anxiety levels (Morillas Barrio et al., 2016; Orhan Göksün & Gürsoy, 2019; Turan & Meral, 2018). In a blended learning setting, GSRS can significantly improve students' engagement, motivation, and concentration; however, the effect on learning retention (Holbrey, 2020; Ranieri et al., 2018), and academic results (Martínez-Jiménez et al., 2021), seems limited. Moreover, among emerging GSRS literature, most studies investigated commercial solutions such as Kahoot! (Ebadi et al., 2021; Reynolds & Taylor, 2020), while open-sourced solutions, such as JazzQuiz, have drawn limited attention.

Section 7.2.4 Research Questions

To address the above research gaps, this study examines the following research questions:

RQ1: What are the relationships between students' PPV, acceptance of JazzQuiz, and academic performance?

RQ2: How and why does students' PPV influence their acceptance of JazzQuiz and academic performance?

Section 7.3 Methodology

Section 7.3.1 Research Design

This study employed a mixed-methods design in an explanatory case study (Yin, 2018). The researchers assumed that the acceptance factors depend on the type of technology and the context in which the technology is applied (Nistor et al., 2019). SEM (Jöreskog, 1973; Kline, 2005) was applied to examine the factors and relationships, and qualitative data analysis (Miles et al., 2014) was used to explore the in-depth reasons and underlying mechanisms.

Section 7.3.2 Population and Sample

This study was conducted at an English Medium Instruction (EMI) University in mainland China with a history of using the Moodle-based VLE for more than 14 years. In a second-year computer science foundation course (CPT111 Java programming), 491 students (both online and onsite in a hybrid learning environment) joined the JazzQuiz-supported in-class interactive activities for the fall semester in six lectures (September to December 2021). In each lecture, students were given 5–10 multiple choice questions for knowledge check and synchronous interaction using the JazzQuiz. Of these students, 246 participated in the non-probability voluntary online questionnaire survey (Figure 7.1) and confirmed their participation through the online digital consent forms; 237 validated survey responses were returned. Six responses were eliminated from the dataset because of the information inconsistency; for example, one student answered “5” to report a high frequency of JazzQuiz usage, but the actual VLE log shows zero usage. Three responses were excluded because the participants did not take the final test. Participants were from five different countries, and the gender distribution (57 females and 180 males) is typical among computer science majors. Of the 237 participants, 14 volunteered to share their thoughts in semi-structured interviews (Table 7.1).

Section 2: Student Perceptions
第二部分：学生认知

Within the module, how well do the following behaviors, thoughts, and feelings describe you? Please answer using the following scale:
在这个课程中，以下行为、想法和感觉是否符合你的情况？请根据以下描述选择最合适的一个数字：

1. not at all characteristics of me /一点也不符合我的情况
2. not really characteristics of me /不是太符合我的情况
3. moderately characteristics of me /有一些符合我的情况
4. characteristics of me/ 符合我的情况
5. very characteristics of me /非常符合我的情况

1. I make sure to attend classes in-person / 我确保自己本人去上课:	☐1 ☐2 ☐3 ☐4 ☐5
2. I have fun in the in-class polling (JazzQuiz) activities / 我在该课堂投票活动中体会到了乐趣:	☐1 ☐2 ☐3 ☐4 ☐5
3. The in-class polling (JazzQuiz) activities in the course is helpful to my learning / 该课堂投票活动有助于我的学习:	☐1 ☐2 ☐3 ☐4 ☐5
4. I am motivated by the responses I get from the in-class polling (JazzQuiz) activities included in this module/ 该课堂投票活动给与的学习反馈激励了我:	☐1 ☐2 ☐3 ☐4 ☐5
5. The feedback I receive from the in-class polling (JazzQuiz) activities are meaningful / 该课堂投票活动给与我的学习反馈是有意义的:	☐1 ☐2 ☐3 ☐4 ☐5
6. The feedback from the in-class polling (JazzQuiz) activities help me to understand where I am having difficulties / 该课堂投票活动给与我的学习反馈帮我找到我的学习困难点:	☐1 ☐2 ☐3 ☐4 ☐5
7. The feedback from the in-class polling (JazzQuiz) activities help me to understand my learning performance compared to other students in the class / 该课堂投票活动给与我的学习反馈让我了解到我的学习成绩与班里其他同学的差异:	☐1 ☐2 ☐3 ☐4 ☐5
8. The in-class polling (JazzQuiz) functions are user friendly / 该课堂投票活动的功能很人性化:	☐1 ☐2 ☐3 ☐4 ☐5

Figure 7.1 Survey Example of Student Perceived Pedagogical Value and Technology Adoption

Table 7.1 Interview Questions

No.	Interview Questions
1	Do you think in-class engagement is important to your study? Follow up: Why yes or no?
2	At what point during the sessions did you feel most participatory? Follow up: Why this was so and what was happening at the time?
3	Do you have any suggestions to improve the current JazzQuiz function?
4	Do you understand the course material better after answering the in-class quiz and listening to the explanation of the solution? Follow up: Why yes or no?
5	Do you feel that answering in-class quiz during lectures help you remember the course material 1-2 months ago? Follow up: Why yes or no?

Section 7.3.3 Measure and Instruments

To examine the relationship between students' PPV, their acceptance of JazzQuiz, and their academic performance, this study applied SEM. Existing literature confirms that the sample size of this study (*N* = 237) is appropriate for SEM analysis (Boomsma & Hoogland, 2001; Kline, 2005). The observed indicator variables estimated the unobservable latent variables (i.e., the technology acceptance factors). Indicators were in the online questionnaire and were answered on a 5-point Likert scale from 1 – "not at all my characteristics" to 5 – "very much my characteristics".

This study used Mplus 7.0 software for the Confirmatory Factor Analysis (CFA) (Wang & Wang, 2020) to measure the validity and reliability of the model with six-core constructs: PPV, BI, EE, PE, SI, and FC. The proposed new construct is PPV, and the concept of "pedagogical value" originates from existing literature (Farooq & Benade, 2019; Hazari et al., 2009; Li, Zhang, et al., 2021; Tselios et al., 2011). PPV was defined as how a student perceives the value or meaning of using JazzQuiz for learning from a pedagogical perspective. This study measured the new construct with four observed indicators that were confirmed by the CFA measurement, such as "the feedback I receive from the in-class polling (JazzQuiz) activities are meaningful" (details in Appendix 15-16).

The questionnaire items for the other five core constructs were adapted from the validated questionnaire by Venkatesh et al. (2003) with slight language changes to fit the specific context. First, Behavioural Intention (BI) was measured by three observed indicators, with the adapted questionnaire item like "I am willing to use in-class polling (JazzQuiz)". Second, EE measures students' expectancy that technology reduces their effort (Nistor et al., 2019) and is measured by five observed indicators. Next, PE means the degree to which a student perceives that using the JazzQuiz will help them attain a gain in academic performance. It was measured by two observed indicators, acceptable for SEM (Bollen, 1989; Brown, 2015). Finally, SI was measured by two questions "my classmates encourage my participation in the in-class polling (JazzQuiz) activities". FC was disregarded for further analysis because of poor reliability. Overall, the confirmatory model (Figure 7.2) is acceptable with CFI = 0.973 (> 0.95), TLI = 0.963 (> 0.95), RMSEA = 0.073 (< 0.08) and SRMR = 0.029 (< 0.08) (Wang & Wang, 2020).

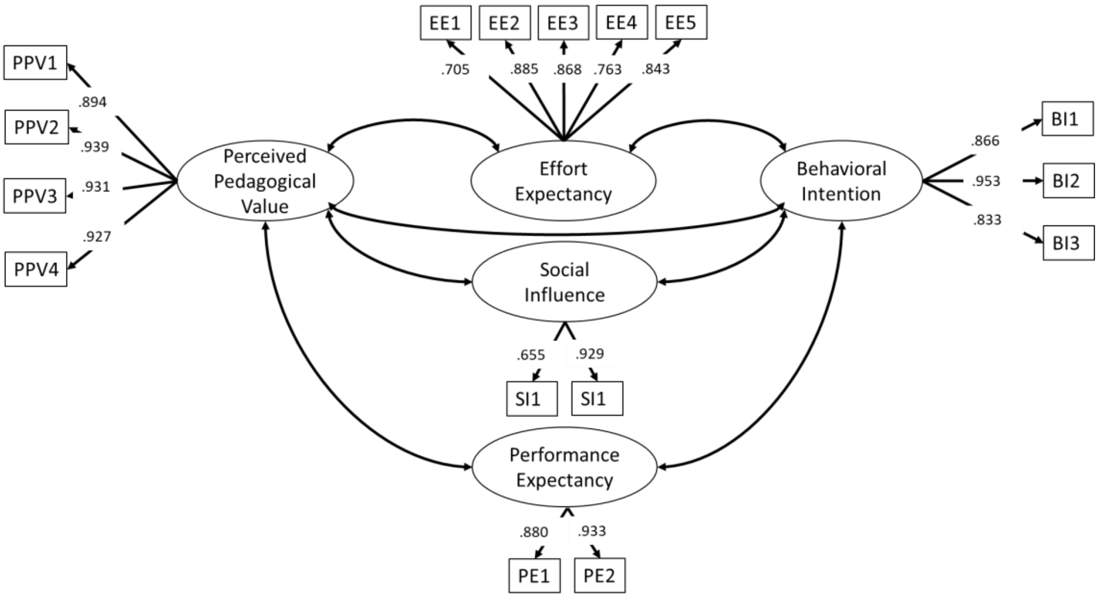


Figure 7.2 Confirmatory Model.

In the SEM analysis, this study included two other variables: student academic performance (labelled as Grade) and their actual attempts of JazzQuiz (i.e., user behaviour, labelled as UB). These two variables differ from those in the CFA in that they are single-observed indicators that can measure each factor with minimum measurement error (Bollen, 1989). As the two variables' data were not perfectly normally distributed in their original interval format, the researchers transformed them into a normally distributed ordinal format. The structural model is a good fit with CFI = 0.977 (> 0.95), TLI = 0.971 (> 0.95), RMSEA = 0.047 (< 0.05), and SRMR = 0.039 (< 0.08) (Wang & Wang, 2020). The detailed quantitative statistical information is provided in Appendix 16. Open-ended survey questions and semi-structured interviews were the main instruments to explore the in-depth reasons and underlying mechanisms of how PPV influences students' technology acceptance and academic performance.

Section 7.3.4 Data Collection and Analysis

The theoretical propositions of technology acceptance (Davis, 1986; Venkatesh et al., 2003) shaped our data collection plan and yielded a case study analytic strategy (Yin, 2018). The course lecturer introduced the study during classes, and invitations to participate were sent via the online announcement forum on the VLE course page and an auto email to all 491 registered students. This study obtained ethical approval from the university ethics committee. The online digital consent form and participant information sheet were provided with the link to the online questionnaire, integrated on the VLE course page. The researchers informed all the participants that they were free to withdraw from the study at any stage. The online questionnaire had three sections: (1) six demographics questions, (2) 20

Likert scale questions about student perceptions (3) two open-ended questions about student engagement details. The researchers provided the materials and communication information in both Chinese and English.

The course lecturer opened the online questionnaire two weeks before the end of the semester and sent a reminder one week later. After three weeks of the opening, the research team closed the online questionnaire and downloaded the data for further processing using Mplus 7 and SPSS 27. The researchers cross-checked the self-reported responses with the actual VLE user logs. Information mapping was performed with randomised participant numbers to avoid revealing participant identification.

After the CFA analysis, the research team identified validated indicators, eliminated unreliable variables, and specified the model with an acceptable model fit. In the final structural analysis, the five confirmed latent variables were measured with the two single indicator variables to examine the relationships between the constructs.

Next, the research team conducted semi-structured interviews in Chinese with 12 volunteered on-campus students during the break time of the last two lectures of the semester. Each interview took 20-30 minutes. In addition, the research team conducted interviews via online meeting and email in English with two volunteered students in other countries. The recorded interview audios were transcribed using an artificial intelligence software. Two researchers audited the transcripts, corrected the errors, and translated them into English manually. Other researchers cross-checked the transcriptions before analysing the qualitative data. The online questionnaire responses to the open-ended questions were included in the qualitative dataset to determine the reasons and mechanisms using Nvivo 12 software (Bazeley & Jackson, 2013). This study followed the fundamental qualitative data analysis principles (Miles et al., 2014) to process the data, design the data display matrix, and construct explanations for the relationships this study found during the SEM analysis.

Section 7.4 Results

Figure 7.3 shows the proposed PPV model for hybrid learning as the key findings of this study. The SEM quantitative data analysis results address the first research question about the relationships between students' PPV, acceptance of JazzQuiz (EE, PE, BI and UB) and their academic performance (grade). The qualitative data analysis results unfold the mechanisms and address the second research question about how and why students' PPV could influence their acceptance of JazzQuiz and their grade.

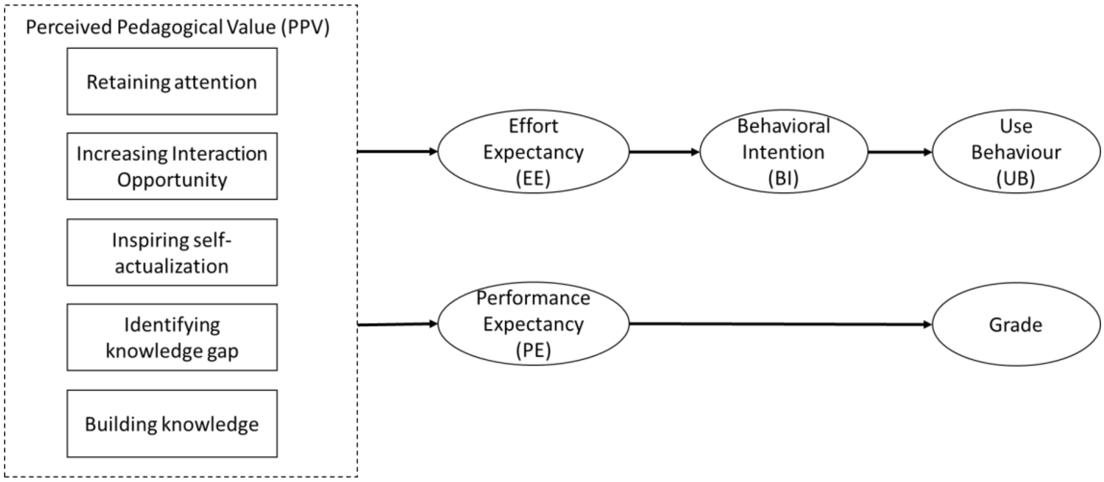
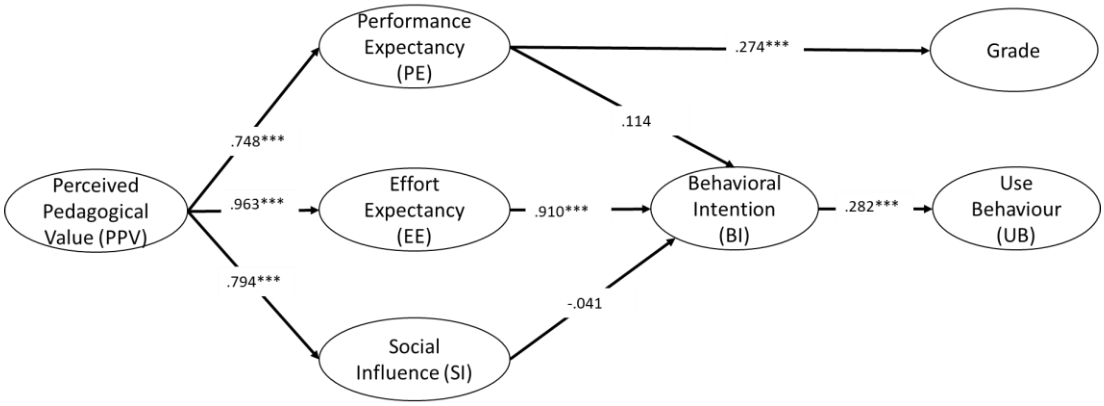


Figure 7.3 PPV Model for Hybrid Learning.

Section 7.4.1 Structural Equation Modelling Results

The SEM estimated a structural model (Figure 7.4) with seven constructs: (1) PPV, (2) PE, (3) EE, (4) SI, (5) BI, (6) UB, and (7) Grade. Table 7.2 shows the model fit summary, and Table 7.3 shows the standardised model results. The path coefficient between PPV and EE was significant with the most considerable effect ($\beta = .963$, $p < .001$), while the other two paths, PPV-PE ($\beta = .748$, $p < .001$) and PPV-SI ($\beta = .749$, $p < .001$), were also significant with a large effect. The path coefficients of EE-BI ($\beta = .910$, $p < .001$) and BI-UB ($\beta = .282$, $p < .001$) were also significant, which confirmed part of the UTAUT model (Venkatesh et al., 2003), while the effects of PE on BI ($\beta = .114$) and SI on BI ($\beta = -.041$) were minor and nonsignificant. Lastly, the PE-Grade ($\beta = .274$, $p < .001$) path coefficient was significant but with a small effect.



***p<0.001

Figure 7.4 SEM Model Results

Table 7.2 Model Fit Summary

Fit index	Recommended value (Hair et al., 2010; Wang & Wang, 2020)	Measurement model	Structural model
χ^2	$p < .05$	198.52 (p = .000)	185.44 (p = .0002)
Degrees of freedom (df)	n/a	88	122
χ^2/df	< 5 preferable < 3	2.26	1.52
Comparative fit index (CFI)	> 0.90 preferable > 0.95	0.973	0.977
Tucker Lewis index (TLI)	> 0.90	0.963	0.971
Root mean square error of approximation (RMSEA)	< 0.08	0.073	0.047
Root mean square residuals (RMSR)	< 0.10 preferable < 0.08	0.029	0.039

Table 7.3 Standardized Model Results

Variables	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
EE BY				
EE1	0.709	0.051	13.98	0
EE2	0.881	0.023	38.5	0
EE3	0.869	0.027	32.697	0
EE4	0.757	0.049	15.376	0
EE5	0.845	0.033	25.447	0
PPV BY				
PPV1	0.894	0.022	41.188	0
PPV2	0.937	0.015	62.294	0
PPV3	0.93	0.027	34.438	0
PPV4	0.927	0.018	51.248	0
PE BY				
PE1	0.879	0.025	35.755	0
PE2	0.934	0.027	35.038	0
SI BY				
SI1	0.667	0.043	15.376	0
SI2	0.919	0.034	26.707	0
BI BY				
BI1	0.866	0.024	36.775	0
BI2	0.953	0.011	88.028	0
BI3	0.834	0.037	22.488	0
BI ON				
EE	0.91	0.064	14.293	0
PE	0.114	0.061	1.876	0.061
SI	-0.041	0.061	-0.674	0.5
EE ON				
PPV	0.963	0.012	79.914	0
PE ON				
PPV	0.748	0.039	19.116	0
SI ON				
PPV	0.794	0.04	20.012	0
UB ON				
BI	0.282	0.053	5.286	0
GRADE ON				
PE	0.274	0.067	4.108	0

Section 7.4.2 Qualitative Analysis Results

Regarding the second research question, which is the underlying mechanisms of the confirmed SEM model, the researchers gained insights from the literature and empirical data (interviews and open-ended survey questions). This study conceptualised five dimensions in the explanatory matrix (Table 7.4) that associate PPV with technology acceptance and academic performance: (1) retaining attention, (2) increasing interaction opportunity, (3) inspiring self-actualisation, (4) identifying knowledge gaps, and (5) building knowledge.

Table 7.4 Explanatory Matrix of the Five Dimensions

Dimensions	Description	Excerpt Sample	Technological	Pedagogical
(1) Retaining attention	Students perceived using JazzQuiz as a helpful tool to retain their learning attention both online and onsite.	"It forces distracted students to focus during lectures" "Without this kind of quiz-like class participation, my enthusiasm and concentration in class may be reduced."	Students who consider the JazzQuiz valuable and easy to use as a simple alarm might be more likely to use the JazzQuiz.	Students who expect to retain attention through the JazzQuiz might have a better grade.
(2) Increasing interaction opportunity	Students believed that using JazzQuiz could enlarge student-teacher interactions both online and onsite.	"I was most involved when I participated in the quiz but gave the wrong answer, and the teacher explained it to me" "Classroom interaction is essential."	Students who prefer quicker and easier interactions might be more likely to use the JazzQuiz.	Students who have a higher expectation of learning from interactions through the JazzQuiz might have a better grade.
(3) Inspiring self-actualisation	Students could be inspired to achieve self-actualisation needs using JazzQuiz.	"Whether or not my grades get improved is less important. At least I think I have a deeper understanding", "It is a sense of accomplishment."	Students who pursue self-actualisation through practical approaches might be more likely to use the JazzQuiz.	Students who have a higher expectation of achieving self-actualisation through JazzQuiz might have a better grade.
(4) Identifying knowledge gap	Students believed that using the JazzQuiz could help them to identify knowledge gaps.	"There are many people who make the wrong choices, and everyone's mistakes are different" "Without a quiz, I probably would not have found this problem."	Students who plan to identify knowledge gaps with less extra effort might be more likely to use the JazzQuiz.	Students who have a higher expectation of identifying knowledge gaps through JazzQuiz might have a better grade.
(5) Building knowledge	Students considered the JazzQuiz as a meaningful tool to help build knowledge.	"When you are more engaged in learning, you will learn more actively because the problem you solve is your problem."	Students who perceive to build knowledge easier might be more likely to use the JazzQuiz.	Students with higher expectation of building knowledge through JazzQuiz might have a better grade.

Retaining Attention.

Students expressed their concerns regarding online or onsite distractions during lectures. They appreciated the value of using JazzQuiz as a reminder to pay more attention to the lecture through the interactive quiz activities. An online-attending international student commented (Table 7.4 shows part of the comment):

> *I believe that in-class engagement is extremely important in learning. It checks whether or not the student is fully comprehending the materials taught in class and forces distracted students to focus during lectures… This is in large part due to limitations as to how much student-teacher interactions there are in an online learning environment.*

Some students explained that they expect JazzQuiz to act as a simple alarm; therefore, they preferred spending less effort using JazzQuiz. Because JazzQuiz is quick to access via any mobile device and there is no extra login on the VLE, it reduces the effort for students (from the survey results, 94% of the student's rated ease of use 3–5 on a 5-level Likert scale), and most students were willing to use it (from the VLE log, 452 of 491 enrolled students used JazzQuiz during the semester).

Increasing Interaction Opportunity.

Students' expectation of using JazzQuiz is that it is more than just a reminder. The qualitative data show that many students mentioned the word "interaction". As the class population (491) is considerably large, traditional interactions (e.g., a teacher asking questions and students raising hands to answer) cannot provide equal and efficient opportunities for onsite and online participants.

Technology provides new opportunities to increase such interaction. Table 7.4 shows excerpt examples of students' perceptions of using JazzQuiz for interactive learning. The researchers found that students who better understand the pedagogical value of increasing the interaction opportunity via JazzQuiz also have a higher-level expectation of the reduced efforts of using the technology. Because the synchronous classes are time-constrained with limited opportunities for students to get learning feedback. Students expect to use JazzQuiz and get instant feedback through quicker interactions with the teacher and other students.

Inspiring Self-Actualisation.

Using JazzQuiz not only encouraged learning engagement but also inspired higher levels of learning motivation, which is "self-actualisation or self-fulfilment of the idiosyncratic and species-wide potentialities of the individual person", according to Maslow's Hierarchy of Needs Theory (Maslow, 1970). Examples are shown in Table 7.4. While most students aimed for improved academic performance, some found it hard to be satisfied only by getting good grades in formal examinations. They prefer challenging questions and consider a deep understanding of the knowledge for lifelong learning more critical. Some reported enjoying the feeling of solving the most difficult questions. The researchers found that students are more likely to use JazzQuiz when it can indicate the problematic levels of the questions efficiently. For example, if most of the students vote for the wrong option, the small number of students who vote for the right option would be rewarded with fulfilment of solving the tricky questions on their own. JazzQuiz can calculate and display the proportion immediately after the students submit their responses on their mobiles, which meet the students' effort expectancy on using the technology.

Therefore, using JazzQuiz can inspire students to achieve psychological fulfilment by solving difficult questions in front of their class peers.

Identifying Knowledge Gaps.

JazzQuiz has helped students achieve the primary learning outcomes that focus on knowledge inquiry and comprehension, according to the course handbook, such as "understanding the principles and practice of object-oriented analysis and the design in the construction of robust, maintainable programmes which satisfy their specifications" and "being aware of the need for a professional approach to design and the importance of good documentation to the finished programmes". Table 7.4 shows that students considered JazzQuiz a knowledge gap identifier and are more willing to use JazzQuiz if it can point out erroneous understandings, help students catch misinterpretation of lecture materials at an early stage, and demonstrate the statistical divergence of the class learning progress through the instant feedback.

Building Knowledge.

To achieve problem-based (Kek & Huijser, 2017) deep learning outcomes, according to the definition from the course handbook: "being competent to design, write, compile, test, debug, and execute straightforward programmes using a high level of language" and "appreciating the principles of object-oriented programming", students need to apply their knowledge in practice. They perceived JazzQuiz as helpful to better prepare themselves for future deep learning: "To be honest, I couldn't remember all of the material in this course, but the in-class quiz helped me learn and regain my memory about the previous lecture". As is shown in Table 7.4, students are more likely to use the JazzQuiz if they can have instant access to more lecture examples posed as formative assessments through the series of lectures. Besides, all the JazzQuiz interactions can be accessed easily in the lecture recordings for off-class knowledge review, which meets the students' high expectations of reducing their efforts to use the JazzQuiz for effective learning.

Student Performance.

According to the SEM results, students with a higher score of PPV are more likely to have higher expectations to achieve greater performance by using the JazzQuiz, which also predicts a good grade in the final lab test. Regarding the in-depth reason and mechanism of the quantitative results, the researchers gained insights from the above qualitative results. This study found that students have developed their metacognition of why to learn and how to learn effectively based on their perceptions of the pedagogical value of using JazzQuiz, which is the main reason for achieving the expected performance.

Section 7.5 Discussion and Implications

The novelty of the current study lies in its application and extension of the UTAUT model to assess the impact of student perceived pedagogical value on learning efficacy through the technology acceptance process in a hybrid learning environment. The quantitative model test provides scientific evidence and statistics to address the first research question about the key constructs and their relationships in a new PPV model. The qualitative analysis findings explain the in-depth mechanism. While most existing studies used the original TAM to examine classroom teaching and non-VLE-based SRS learning technologies (e.g., Sprenger & Schwaninger, 2021; Wu & Gao, 2011), this study confirmed the applicability of UTAUT to examine the VLE-based SRS acceptance in a hybrid learning environment.

Although the core UTAUT constructs (EE, PE) are closely related to the core TAM constructs (perceived ease of use, perceived usefulness), this study highlighted that the UTAUT constructs strongly indicate individual expectations associated with pedagogical metacognition (Karatas & Arpaci, 2021).

Additionally, this study proposed a new PPV model for interactive hybrid learning. The new construct of PPV supplements developing knowledge on EE predictors (Almetere et al., 2020; Salloum & Shaalan, 2019). In other words, students (online and onsite) who understand the pedagogical value of using SRS learning technology might have higher expectations of it, reducing efforts, thereby saving their time for effective learning. The inclusion of PPV as the earlier stage predictor extends the UTAUT model in the context of Chinese higher education. This finding may be generalisable to a broader educational context, where technology users are psychologically mature and have high levels of metacognition regarding learning and teaching (Karatas & Arpaci, 2021).

This study also contributes to the emerging literature on effective hybrid learning (Trede et al., 2019) by highlighting the hidden role of students' PPV and determining the underlying mechanisms of how PPV could influence students' EE to predict their technology use intention of interactive hybrid learning. The new PPV model raises awareness of pedagogical value studies among the overwhelming number of studies on technology adoption in higher education with other goals (Blundell et al., 2020; Li, Zhang, et al., 2021). Additionally, while acknowledging the importance of teacher development in TPACK (Farooq & Benade, 2019; Li, Wang, et al., 2022), this study highlights the value of student TPACK and metacognition development to promote student-centred self-directed learning for future education (Heo & Han, 2021; Huang, Teo, et al., 2020; Li, Huijser, et al., 2022).

The key findings of this study emphasise the critical impact of students' perception of the pedagogical value of JazzQuiz (i.e., retaining attention, increasing interaction opportunity, inspiring self-actualisation, identifying knowledge gaps, and building knowledge) in terms of technology acceptance and academic performance achievement. These findings could guide educational policy-making and strategy development to enhance interactive hybrid learning efficacy. For example, foundation pre-sessional courses that introduce the technological and pedagogical value of using diverse learning technologies are needed to develop students' metacognition for active learning across different disciplines. Continuous professional development programmes and community of practice activities should be included in the educational development policy to support teachers in developing their technological and pedagogical knowledge and skills for effective interactive learning design and delivery. Seamless system integration (e.g., single sign-on) between the VLE and independent learning technologies should be prioritized to provide quicker and easier access for both students and teachers. Finally, critically reflecting on student perceived effective feedback (Voelkel et al., 2020) and including students as the partner and co-creator of an interactive hybrid learning environment should be included in the university strategy to build a future-oriented sustainable learning ecosystem.

Section 7.6 Conclusion

To conclude, this mixed-method explanatory case study (Yin, 2018) addresses two research questions about the relationships and mechanisms between PPV and effective interactive hybrid learning, using an SEM quantitative model test (Kline, 2005; Wang & Wang, 2020) and a qualitative matrix induction (Miles et al., 2014) on technology acceptance. This study proposed a new PPV model and explained the mechanisms, emphasising the critical role of students' PPV in improving interactive hybrid learning efficacy using the VLE-based SRS, JazzQuiz. The results revealed that students who have a deeper understanding of the pedagogical value of JazzQuiz are more likely to use the technology with reduced efforts and achieve high academic performance.

This study contributes to the education sector's emerging interactive learning and technology acceptance literature. The insights gained from the new PPV model initiate a new direction for future studies on technological pedagogical perspectives. The main limitations are threefold. First, in the model test, the effect size of two relationships (PE with Grade and BI with UB) is smaller than the other core relationships. Future studies could explore the in-depth reasons and help more students achieve a performance gain. Second, the relationship between PE, SI and BI is not significant.

Further research is needed to explore the reasons and test the hypothesis with a larger sample size. Third, this case study was conducted in a Chinese EMI university. More empirical research is needed to explore the adaptation of the extended model with students using different learning technologies, majored in different disciplines and at different educational levels. Further technological development of the open-sourced JazzQuiz on Moodle is necessary to enrich the pedagogical values and reduce the learner's efforts for effective interactive learning.

Following the empirical findings from chapters 4-7, the next chapter (chapter 8) introduces a conceptual study that integrates the insights gained from the global literature and the contextual findings to reconceptualize the digital learning ecology model for agile future education.

Chapter 8 Disrupting the Disruption: A Digital Learning HeXie Ecology Model

Section 8.1 Problem Statement

Building on the Fourth Industrial Revolution (Schwab, 2016), Globalisation 4.0 (Schwab, 2018) has provided opportunities for industry and education to enhance their connections and collaboration, allowing higher education institutions to reconsider their business models, learning environments, technologies, and pedagogies in the process (Salmon, 2019; Williams et al., 2020). However, most universities have, until recently, been rather cautious about the continuous disruptions (e.g., new learning technologies, rapidly changing market demands, and political rules) and potential educational transformations (Collins & Halverson, 2008; Means, 2018). This situation changed dramatically in 2020 through the enforced impact of COVID-19. “Across the globe, higher education institutions have been radically reshaping teaching and learning in unprecedented ways, and with rare exceptions, education has moved into the online space at breakneck speed” (Green et al., 2020, p. 1). It is not that the opportunities have not been there to leverage online environments extensively before 2020, but universities as large organisations tend to be relatively conservative and change-averse. COVID-19 has forced considerable changes and disruptions, such as the determinants of students’ perceived learning outcomes and their satisfaction with online learning (Baber, 2020) and learner–content interactions (Kumar et al., 2021). It is difficult to predict where these changes will ultimately lead at this stage.

It is almost certain that we will see a significant decrease for at least the next two years in the numbers of students undertaking study abroad and exchange, and it is likely that, during this period, Virtual Exchange will become the new normal (Leask, 2020, p. 2).

Slow educational changes, especially when they can be seen to lag behind changes in wider society (Williams et al., 2020), have consequences for educational outcomes themselves, and the disruption caused by COVID-19 may therefore present somewhat of a silver lining in an educational context (Greener, 2020). Ultimately, it may be the disruption needed to cause an educational disruption, through which university education is opened up to a wider learning ecology (Sangrá et al., 2019). The concept of a learning ecology is “consistent with the Gestalt tradition, as part of which the [Bronfenbrenner’s] human ecology development model was developed, [whereby] the whole is larger than the sum of its parts” (Kek & Huijser, 2017, p. 5). Such an ecology can promote learner empowerment in terms of self-directing their learning pathways (Jackson, 2016), as it would include the formal learning environment of universities (both face-to-face and in the form of formal structures such as learning management systems or virtual learning environments). However, it would also connect seamlessly to the plethora of learning opportunities outside the formal higher education system, including digital learning spaces and platforms on the web (Sangrá et al., 2019).

The COVID-19 pandemic has disrupted higher education, allowing such a learning ecology to emerge. Salmon (2019) argues that the digital revolution has created considerable freedom to access information. In the context of open universities,

> It [the digital revolution] poses challenges but also opens up unprecedented opportunities for democratisation and accessibility. The transformation process has to maintain the referential of the profound incorporation of pedagogical and technological innovation based on research and seek new strategies of organisation and definition of quality, to guarantee its relevance and leadership in the pursuit of the massification of higher education (Cunha et al., 2020, p. 191).

As a result of the digital revolution, the knowledge students engage within universities becomes outdated more quickly due to accelerated innovation and knowledge development rates and is aided by ever-faster digital networks. Educational technology practitioners have proposed Next-generation digital learning environments to create a transformational shift in how universities design their learning ecosystems for students and teachers to have higher levels of digital resilience (Koh & Kan, 2020). Multiple disruptions imply that our conceptualisation of learning and teaching may need to change accordingly if we are to seise the learning opportunities that contemporary digital environments provide (Barana & Marchisio, 2021; Chou et al., 2021; Mustapha et al., 2021; Teo & Divakar, 2021; Zaman et al., 2021). “The agility provided by such an architecture can afford learners and instructors alike the opportunity to “think outside the box”, and reconceptualise their approaches to education” (Brown et al., 2020, p. 9). Society requires a more adaptive learning ecosystem to increase learners’ competence in a changing environment, strengthen universities’ resilience in disruptions, and reshape lifelong and life-wide education with on-demand, tailored, and personalised learning elements.

To address the question of how future universities could develop digital resilience to become more prepared for subsequent disruptions, this study synthesized a conceptual model based on the Problem-Based Learning (PBL) ecology (Kek & Huijser, 2017) with an extended layer of the Chinese HeXie concept (Xi, 2021). The model highlights the role of self-directed learning and digital resilience through formal, informal, and lifelong learning across a five-level ecosystem: the microsystem, mesosystem, exosystem, macrosystem, and chronosystem. It has been suggested that the nature of higher education is “to enable society to make progress through an understanding of itself and its world” (Dearing, 1997, p. 72), which implies that universities are separate from society but are capable of improving society from their enlightened position. This study discusses the significant but blurred lines of a learning ecology, as it can be seen as a paradox that an inherently conservative higher education system is positioned as being able to advance society in innovative ways. This study contributes to the literature by emphasizing that higher education has the potential to occupy that position, but only if it is integrated, in agile and reciprocal ways, into the society, it is meant to impact and vice versa. In other words, the boundaries and the constraints would need to be significantly blurred and become much more porous so that continuous exchanges and dynamic interactions between universities and their societal contexts become possible.

Section 8.2 Materials and Methods

This conceptual study employs a theory synthesis method to “achieve conceptual integration across multiple theories or literature streams”. It aims to “offer a new or enhanced view of a concept or phenomenon by linking previously unconnected or incompatible pieces in a novel way” (Jaakkola, 2020). Following Weick’s (1989) theoretical model development strategy, this study first reviews the extant literature to identify problems and challenges; second, it summarizes the theoretical model development needs and develops the research question.

Section 8.2.1 Challenges in Formal Learning Environments in the Digital Era

Formal learning has been “institutionally sponsored, classroom-based, and highly structured" in the past thirty years” (Marsick & Watkins, 2015, p. 12). Universities provide formal learning environments to facilitate institutionalised, chronologically graded, and hierarchically structured formal educational systems (Coombs & Ahmed, 1974). The critical assumption in the traditional conceptualisation of formal learning environments is that learning can be delivered or provided in a discrete, packaged manner, timed, clearly demarcated, and symbolised by the physical classroom walls and semester timetables (Nye & Clark, 2021). With the development of the World Wide Web (Web 1.0), the emergence of Virtual Learning Environments (VLEs) (Britain & Liber, 1999; Piccoli et al., 2001; Whitelock et al., 2000) extended formal learning beyond the physical classroom to an online environment with interactive activities, albeit a walled and password-protected one.

McGuire and Gubbins (2010) have argued that formal learning has been supplanted by activity-based and technology-based learning, suggesting that activity-based and technology-based learning are not formal learning. However, this is a limited conceptualisation of formal learning in modern digital learning environments. In other words, if designed in particular ways, formal online learning environments can be characterised by activity-based learning approaches, often within the walled garden of the VLEs. Thus, the emphasis should not be on supplanting formal education but on leveraging informal learning through innovative learning design to make learning overall more effective (Whitelock, 2013). Any approaches that could provide students with the systematic knowledge required to operate within complex structures (Guile & Griffith, 2001) beyond their formal studies and provide sufficient support during knowledge acquisition (Svensson et al., 2004) could be recognised as formal learning.

During the COVID-19 pandemic, students have relied on technology-based formal learning more than ever (Ebner et al., 2020). The digital disruption had started long before the pandemic caused an additional disruption (Flavin, 2020). Students have long been digitally connected in their everyday digital environments, which, in many ways, could be seen as informal learning spaces. For example, during the pandemic, students have been required to use their mobile devices to attend online lectures from isolated locations (i.e., home, student accommodation) and engage in online assessment activities (Antee, 2020; Li, Wang, et al., 2022). These can all be seen as formal learning. However, the same devices give students access to a much broader digital environment that provides potentially endless opportunities for learning beyond the formal learning context or deliberately integrating such opportunities into the formal learning environment (Pelletier et al., 2021).

A common assumption is that formal intentional learning is more standardized and should be supported by technologies designed for educational purposes (R. Huang et al., 2019). This assumption has stopped educational institutions from investigating the possibilities of using or leveraging disruptive technologies to enhance learning and teaching and even stimulate cutting edge innovation in education (Flavin, 2020). In other words, there is a tendency to categorise digital technologies into particular boxes such as education, communication, or social media, whereas in reality, the lines between them are blurred. Moreover, students will have to use and learn how to use various technologies when they graduate and upon entering employment or enterprise environments (Osmani et al., 2019). This suggests that we need a more comprehensive conceptualisation of educational technologies, one that recognises the potential of the overall digital environment as a learning environment rather than just the formal one. The latest pandemic-induced disruption may catalyze that kind of reconceptualisation (Ebner et al., 2020).

Centrally supported educational technologies are under institutional control and are characterised by limited uncertainty and high levels of standardisation (R. Huang et al., 2019). By promoting these supported centralised technologies, the university can provide institutional support with relatively few resources because their use is predictable and contained (Barari et al., 2020). From a business model perspective, there are institutional pressures for high efficiency and limited uncertainty, which explains the attraction of the notion of supported centralised technologies and the resistance to external and potentially disruptive technologies (Flavin, 2020). However, standardisation is sometimes the enemy of creativity and agility, which are some of the key attributes we expect students to graduate with (Huijser et al., 2019; Kek & Huijser, 2017). This raises whether a standardised digital environment can prepare students for life beyond their degree studies, which likely involves complex and constantly evolving contexts that require continuous searching for new opportunities and digital tools for business, creative solutions, and thus learning.

An example of a learning technology that is instructional controlled is Virtual Learning Environments (VLEs), which various universities have adopted to support teaching and learning (Barari et al., 2020). VLEs, as the institutional technologies that define formal learning environments, have reproduced mainly, rather than disrupted or transformed, learning and teaching practices (Christensen et al., 2008). Many studies have revealed that technologies provided by universities for formal learning have not been globally successful in terms of adoption and usage to justify their colossal investment (Alghatrifi, 2019; Blin & Munro, 2008; McGuire & Gubbins, 2010; Selwyn, 2007). Teachers and students prefer convenient and easy-to-use technologies, despite many of these technologies not being designed for educational purposes (e.g., Zoom, Microsoft Teams) and lacking institutional support (Flavin, 2016). Universities are positioned to remind teachers and students of the coexistence of institutionally supported and non-supported technologies (Keller, 2005). For example, the ABC learning development framework of the University College London (UCL) has highlighted three types of learning technologies: UCL supported, provided with limited or no support, and support provided locally in the division/department (UCL, 2020). The educational transformation of both teachers and students is crucial in the digital learning ecology so that they can feel comfortable using technology for learning and teaching, regardless of whether the university supports it (Blundell et al., 2020).

However, the contribution from these non-institutional disruptive technologies is largely unexamined (Flavin, 2016). For example, employers (i.e., industry and small companies) require graduates to work efficiently with valuable technologies and sometimes highly specialised ones (Osmani et al., 2019; Rahman & Haleem, 2018). Many of these technologies may not be commonly used in universities for learning and teaching, such as Facebook, Slack, or many mobile apps (Lopes et al., 2017). Of course, it is impossible to adopt all possible technologies in a formal learning environment. Nevertheless, it is possible to infuse the curriculum and learning approaches at university with the development of the students' ability to adopt and adapt to new technologies wherever possible and relevant. In this digital era, students should be adaptive to using a wide variety of technologies for both their learning and their future careers (Demaria et al., 2018; McGunagle & Zizka, 2020).

Section 8.2.2 New Opportunities in Informal and Lifelong Learning Environments in the Digital Era

The business model of higher education has changed over the years due to marketisation (del Cerro Santamaria, 2020; McCaig, 2018), which started with mass higher education (Robbins, 1963), the introduction of student tuition fees, and the trend of universities selling teaching and research as services with increasing student numbers and reduced budgets (Robbins, 1963; Schuller, 1995; Williams, 1997); the granting of university status to polytechnic colleges (Deem, 2004; Schuller, 1995; Williams et al., 2020; Williams, 1997); and the spread of the (UK)

Open University model (Daniel, 2019; Rienties et al., 2022). At the same time, deeper collaborations with industry are seeking to reduce the mismatch between the students' employability and the employers' expectations (Mello et al., 2021), for example, by focusing on entrepreneurial skills (Eesley et al., 2016; A. J. Li, 2017) or through work-integrated learning initiatives (Rook & McManus, 2020). Future education will not be limited to the above models, and a new social contract for education is needed (Sousa, 2021; Whitelock & Rienties, 2016).

New learning models emerged during the COVID-19 pandemic, providing additional opportunities for private contractors/partners to work more closely with universities and enhance collaborations in innovative learning design that leverage a broader learning ecology (Huijser & Fitzgerald, 2020). For instance, the University of Illinois at Chicago has started a university-industry partnership in developing hybrid courses based on their VLE (Pelletier et al., 2021). In China, Xi'an Jiaotong-Liverpool University (XJTLU) is piloting several new educational models, such as the "learning mall", with an integration of the physical campus and deep partnership with the industry for syntegrative education and online education (Xi, 2021). Syntegrative education is a new education model that XJTLU has used to develop globally competitive citizens and provide students opportunities to work in the industry alongside their degree, gaining industrial certificates and practical skills during the learning process (Xi, 2021). This has further opened a door for both universities and private partners to explore the possibilities of crossing the boundaries of informal and formal learning with seamless digital integrations between (and beyond) formal digital learning environments.

Section 8.2.3 The Need for a Reconceptualized Model

Teacher-centred learning has mainly been dominant in modern universities, perhaps even more so since the massification of higher education (Hornsby & Osman, 2014). Following the traditional way of teaching, teachers usually act as a “sage on a stage”, transmitting knowledge and information to students in a unilateral direction (Collins & Halverson, 2008; Salmon, 2019). Inspired by constructivist views on learning (Hannafin et al., 1997), more student-centred learning environments have emerged to encourage greater participation and collaboration between students who are required to take more responsibility for their formal, informal, and lifelong learning (Cannon & Newble, 2000; Czaplinski, 2020; Lea et al., 2003; Vermetten et al., 2002; Zhang & Xi, 2021).

The extant literature has raised questions on how teachers could change teaching approaches by adopting a more student-centred one (e.g., Czaplinski, 2020; Greener, 2020). However, on the one hand, the pandemic-related disruption has led teachers to adopt different teaching approaches (Ladson-Billings, 2021), while on the other hand, it may have added considerable stress to those teachers' lack of digital resilience during the COVID-19 pandemic (Rai, 2020, p. 1).

There is increasing recognition of the link between student-centred approaches and the active learning process related to self-directed learning (Czaplinski, 2020). Since Tough’s (1971) adult learning research project, the study of self-directed learning (SDL) has taken an adult focus, emphasising learner characteristics (Brockett & Hiemstra, 1991; Shapley, 2000) and the instructional process (Knowles, 1975; Long, 2009; Tough, 1979). Self-directed learning readiness has been defined as the degree to which the individual possesses the attitudes, abilities, and personality characteristics necessary for self-directed learning (Guglielmino, 1977).

In summary, the significant problems encountered in our literature review were the lack of a comprehensive theoretical model to build agile, responsive, and proactive approaches to developing student self-directed learning competencies across formal, informal, and lifelong learning environments in the digital era (Czaplinski, 2020). More recently, a growing body of literature has begun to identify the need to address self-directed learning across a lifespan in formal and informal learning environments (Carré et al., 2011; van der Walt, 2019). To develop students' self-directed learning capabilities, teachers need a reconceptualisation of learning environments that would make them fit for purpose and "force" teachers to focus more on what fit of purpose is (Scott, 2021). Regarding the challenges that teachers may face due to a potential disruption, this distinction raises a question: how could future universities gain digital resilience to disrupt the disruption? To answer this question, a digital learning HeXie ecology model has been proposed to build agile, responsive, and proactive approaches to develop students' self-directed learning competence.

Section 8.3 The Digital Learning HeXie Ecology Model

This study proposes a digital learning HeXie ecology model to cover the need for agile education, focusing on self-directed learning and digital resilience. The proposed model conceptualises the fluidity between formal, informal, and lifelong learning between the teacher and student, but it also supports a dynamic balance of the learning ecology through the HeXie education model (Figure 8.1). Further, the proposed model is based on the five levels of Bronfenbrenner's (1979) human ecology, which was further developed in Kek and Huijser (2017) agile Problem-Based Learning (PBL) ecology for learning. As an active learning approach, PBL "leverage[s] different systems in the agile ecology for learning [and] serve[s] as a curricular and pedagogical vehicle to facilitate the development of a particular way of being among students" (Huijser et al., 2019, p. 142), which includes skills and attributes such as critical reflection and creativity. The proposed model has additionally incorporated the HeXie concept, which supports higher education institutions to adopt an approach to overcome the challenges posed by potential disruptions (i.e., COVID-19) by focusing on the need to continually re-balance.

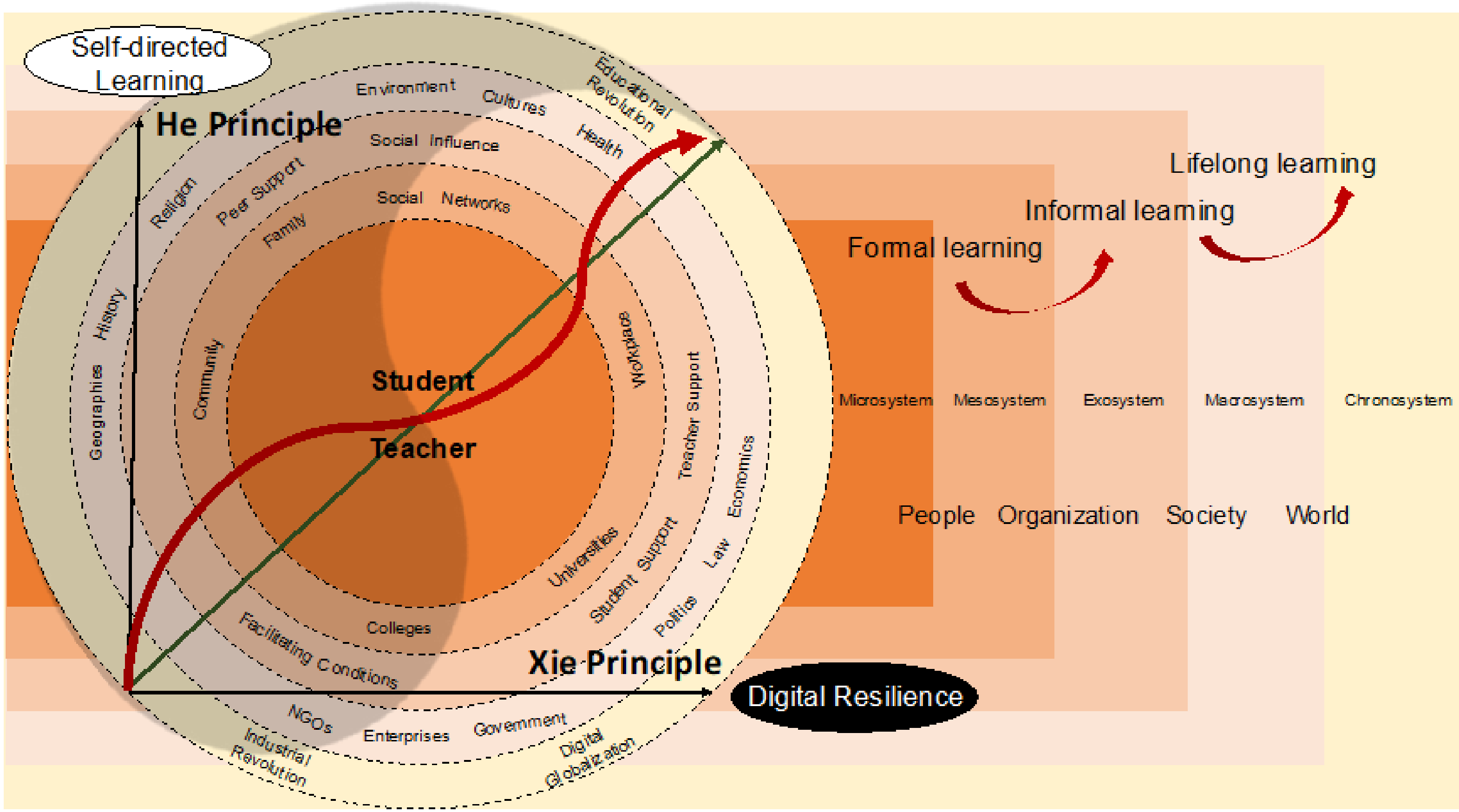


Figure 8.1 Digital Learning HeXie Ecology Model, Adapted from Kek and Huijser's Agile PBL Learning Ecology (2017) and Xi's HeXie Education Model (Xi, 2021).

Section 8.3.1 Self-Directed Learning in the Digital Learning Ecology

Following Carré (2012) research, we define self-directed learning as a dynamic combination of two dimensions: self-determined motivation to learn and self-regulation strategies and abilities in learning. Self-regulation refers to the abilities and strategies of self-regulation in learning, while self-determination refers to self-determined motivation to learn. When confronted with the COVID-19 disruption, many universities rapidly changed from traditional low digital context to high digital context online learning (Ebner et al., 2020; Yavuzalp & Bahcivan, 2021). Students with a higher level of digital resilience and greater self-directed learning readiness could adjust themselves (Kirschner & van Merriënboer, 2013) in the relatively isolated online learning environment by using digital learning technologies, e.g., an online calendar for time management, online tutorials to seek feedback from teachers, online peer support forums to discuss common issues and share information, and a range of other digital tools and resources that do not form part of the formal learning environment in a strict sense (Yavuzalp & Bahcivan, 2021).

The digital transformation of higher education may connect students' digital resilience with their self-directed learning readiness. This invites important caveats for it to work: firstly, students need to be digitally connected and capable, which means that they need to be comfortable navigating the potential that a digital learning ecology offers (Kek & Huijser, 2017). Secondly, there can be no assumption that self-directed learning simply happens because students are in a digital learning ecology. Instead, self-directed learning needs to be deliberately designed into formal learning environments and deliberately taught (Czaplinski, 2020).

The boundary between formal and informal learning environments is becoming increasingly blurred. However, the distinction between formal and informal learning environments is still rigidly maintained in many ways, as change is resisted and institutions hold on to the ways they have always done things (Rojas, 2020). Nevertheless, the recent COVID-19 disruption may have accelerated the exploration of a more expansive learning ecology that encourages higher-level self-directed learning across formal and informal learning environments. For example, in flipped classrooms, students can watch lecture videos or access learning resources provided in the formal learning environment, while well-designed formal learning environments will, at the same time, allow students to explore and draw on their sources for learning in informal learning environments (Limniou, 2021).

In this way, they have opportunities to ask questions and formally collaborate with peers in solving problems in a lab or classroom (formal learning in the formal environment). However, they can also simultaneously engage with other resources (and other learners) in informal digital learning environments. Indeed, this would be encouraged. The quick development of mobile technologies has enriched the learning opportunities in informal learning environments, as many students have ubiquitous access to digital learning (Virtanen et al., 2018). Watching a 2 min video explaining the epidemic of R-nought on a cell phone while taking a bus is a common format of informal learning. Students construct their knowledge from learning in an informal and a formal environment. Therefore, self-directed learning is a competence the student needs to develop urgently as a critical stakeholder, for which teachers, as the other key stakeholders, need to take responsibility.

Section 8.3.2 Digital Resilience in the Digital Learning Ecology

Formal and centralised technologies may take time to catch up to disruptive situations (Raza et al., 2020), but in the learning ecology that we discuss in this study, teachers and students as key stakeholders can use alternative solutions in an agile manner (Varga-Atkins, Sharpe, et al., 2021), which creates considerable resilience in the overall learning environment. Although some of these technologies are not explicitly designed for educational purposes, they can be used as part of the educational process, which adds authenticity in terms of what students will ultimately need to be able to do when they graduate. The transition from previous education modes to a new educational model in response to disruption is reliant on effective processes for the incorporation of a wide and ever-expanding range of technologies into the learning process. The biggest challenges include the continuous administrative burden of managing user accounts, keeping equal accessibility, providing user training, and support for different technologies.

However, in a disrupted learning environment, this is no longer solely an institutional responsibility but instead becomes a responsibility of everyone in the learning ecology, including students and teachers as the key stakeholders. In current formal learning environments, teachers and students alike become easily confused if clear instructions on using different technologies for different learning and teaching activities are not provided in advance. The expectation is that institutions provide both the technology and the training. We are suggesting here that this responsibility needs to shift if universities become more digitally resilient and better positioned to deal with disruptions in the future.

In addition, the richness of digital technology and the use of a wide range of alternative solutions beyond formal learning management systems could increase the university's digital resilience in supporting formal and informal learning and teaching. When disruptions occur, such as the COVID-19 pandemic, universities with limited digital resilience may face different challenges (e.g., lack of solid digital infrastructure to support large-group synchronous online learning). For example, given their different levels of technology adoption and limited preparation time, some universities hardly have had any centralised technologies throughout the COVID-19 pandemic (Fawns et al., 2020; Watermeyer et al., 2020; Zhang et al., 2020). Universities were thus forced to use whatever technologies were available (e.g., a range of different online conferencing technologies) to facilitate online learning and address the main problem of a lack of interaction with students.

On the other hand, universities that had already implemented centralised technologies for a long time might have relied on rigidified institutionalised practices (Raviola & Norbäck, 2013). It usually takes longer to make changes and upgrade existing technologies that form part of rigidified institutional infrastructures (Li, Zhang, et al., 2021). Thus, when disruption occurs, these institutions are often not agile enough to respond. By contrast, an agile educational ecology includes any potential digital tool that can be leveraged to support flexible learning. However, leveraging such digital tools requires astute learning designers to collaborate with academic content experts to develop a responsive, proactive, and agile learning design that is student-centred and that draws on both digital environments and tools that students are already familiar with and ones that they need to become familiar with. In short, such learning design oscillates between the push and pull of a range of ever-changing tools in a hugely dynamic and constantly disruptive digital (learning) environment. The word learning is in parentheses, as a digital environment requires the deliberate design to become an effective learning environment.

Section 8.3.3 HeXie Education Model in the Digital Learning Ecology

The HeXie education model reflects both oriental and occidental wisdom in education in the digital learning ecology. Figure 8.2 illustrates the full version of the HeXie education model (Xi, 2021) that our digital learning HeXie ecology model has integrated. The concept of “HeXie” originated from Chinese Confucianism (emphasis on harmony) (Corcoran, 2014; Tan, 2013) and Daoism (with an emphasis on the Yin and Yang balance) (Jing & Van de Ven, 2014). The HeXie education model was developed based on the HeXie theory (Xi et al., 2012; Xi & Ge, 2005) to couple formal and informal learning based on a lifelong plan with three steps: learning, growth, and conduct. The He principle emphasizes the importance of self-directed learning for innovative and dynamic actions, while the Xie principle focuses on design and planning for digital resilience. The two principles are coupled throughout the lifespan through three main steps (learning, growing, and conducting) in a mix of five learning types (inheritance learning, reflective cognition, exploratory integration, interest-driven accumulation, and mindset upgraded progress) to achieve the long-term vision and mission of the ability to face a rapidly changing world (Xi, 2021).

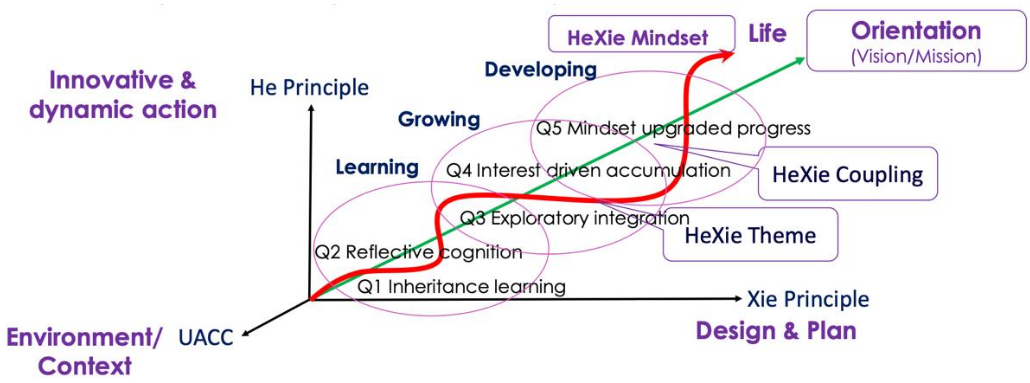


Figure 8.2 Adapted from Xi's HeXie Education Model (Xi, 2021).

The UACC in Figure 8.2 refers to uncertainty (Luan et al., 2019), ambiguity (Xi et al., 2012), changeability (Rojas, 2020), and complexity (Greenwood et al., 2011). Whatever disruptions we face, the essence of education is to help students understand themselves and have a vision and mission or life orientation. The digital learning ecology aims to help students learn knowledge and gain the capability to follow their dreams in a practical sense, while the life orientation is the intrinsic motivation for learning. In the original HeXie Management Theory (Xi et al., 2012; Xi & Ge, 2005), the HeXie Theme refers to the key stakeholders' essential tasks or core business in a specific period. Key stakeholders will need careful consideration about using the two principles to carry out the task or solve the problem.

The HeXie Theme refers to the key learning tasks a student needs to perform at different learning stages in the educational context. Students might face various challenges during their learning journey when taking on different learning tasks for specific periods (e.g., for undergraduate students, year 1–2 as a freshman or sophomore, year 3–4 as a senior student). Different HeXie Themes will need different activities to help students implement the plan or carry out specific learning tasks. Students are encouraged to critically think about the unique features of specific learning tasks and how they could use the two principles (He or Xie or both) and couple them with the HeXie Theme to develop themselves to achieve higher-level life orientation. For example, the Xie principle could better support learning with technologies (e.g., in-class polling or AI grading) to help with prior knowledge and explicit memory-focused learning. By contrast, the He principle could encourage critical thinking for the reflective cognition of the natural world, which requires higher learner autonomy. In a flipped classroom setting, the two principles are required to foster a self-directed, exploratory, constructive, active, experiential, research-led, and syntegrative learning environment.

In higher-level learning, such as self-interest driven accumulation towards ideals, competence development as a global citizen, and interdisciplinary collaboration to address “wicked problems” collectively (e.g., climate change), students will need to develop a growth mindset (Dweck, 2006) that aligns with the HeXie mindset. The HeXie mindset can be developed or nurtured by embracing the ontological and epistemological framework of HeXie Management Theory as a complex problem-solving paradigm. When facing a changing world with the UACC challenges, students will need to clearly understand their life orientation (i.e., vision and mission). Furthermore, they will need to set the core objectives and identify the critical learning tasks for each learning stage. Students can benefit from the Xie principle's systematic support through the dual rationality provided by the He and Xie principles (e.g., institutions, processes, and technologies). The He principle can help students better use the policies, culture, and emotions to develop a self-directed learning ability and co-create a humanistic learning environment with teachers and other stakeholders. Through HeXie coupling, students can work towards a vision, optimise, and evolve dynamically based on the HeXie Theme at each stage. Therefore, the HeXie mindset is critical to help students adapt to a future-oriented perspective while integrating the wisdom of the West and East to find the theme in each stage and address new trends and issues (Xi, 2021).

Section 8.3.4 The Five Levels of the Digital Learning Ecology

Bronfenbrenner's five levels consist of the microsystem, the mesosystem, the exosystem, the macrosystem, and the chronosystem. The following section explains the five levels of digital learning using the HeXie ecology model.

Microsystem

The microsystem refers to the formal learning environment where students engage with or are confronted with the curriculum design, physical learning spaces, teachers, and e-assessment (Whitelock et al., 2020) as well as formal digital (or virtual) learning spaces, such as the learning management system, and the online enrolment system. In other words, the microsystem is what we often think of as the university learning environment in a narrow sense. It relates to learning spaces where teachers and students engage with each other directly (Ellis & Goodyear, 2018). If the latter is indeed designed into the learning environment, it also includes pedagogy, formal learning technologies, and self-directed learning (Heo & Han, 2021). This might be influenced by individual factors such as age, emotion, (prior) knowledge, experience, and mindset (Li, Zhang, et al., 2021). Each of these could, in turn, be affected by institutional factors, cultures, and social backgrounds in the mesosystem (Huijser et al., 2019).

Mesosystem

The mesosystem level reflects a more comprehensive network system that includes higher education institutions, families, workplaces, social networks, and the wider community (Bond & Bedenlier, 2019). Digital technologies may straddle the boundaries between the microsystem and the mesosystem. For example, university students who have early access to the most commonly used technologies in workplaces might have a more significant opportunity to find jobs (McGunagle & Zizka, 2020). However, a university student's socioeconomic status, which is connected to family income, may influence their attitude (i.e., self-determination) and ability (i.e., self-regulation) to afford the devices and internet access needed to be able to use technology in formal or informal learning environments (social network and community) (Adhikari et al., 2016; Warschauer & Xu, 2018). University-supported centralised learning technologies could provide students with institutionally licensed services and learning spaces without extra personal cost. These open-source or cheap disrupting learning technologies can serve as alternatives and flexible supplements when centralised technologies encounter disruption. Therefore, when higher education institutions decide technologies and the institutional facilitation of technology-enhanced learning, factors such as access, equality, student employability, and social sustainability need to be considered to reduce the digital divide (Pelletier et al., 2021).

Exosystem

The exosystem refers to the broader support systems in the learning ecology, both formal and informal, and again, the boundaries between them are often blurred and fluid. This broader support system includes elements such as co-curricular student support (e.g., digital literacy, technology troubleshooting, user guides, instructions from teachers, teacher attitudes, institutional norms, regulations, culture, and cognition), teacher support (e.g., technology troubleshooting, user guides, professional development, student feedback, learning analytics, institutional norms, regulations, culture, and cognition), peer support (e.g., knowledge sharing, peer influence), facilitating conditions (e.g., supported

VLE, disruptive technologies, organisational structures, resources), and social influence (e.g., social norms, morality, culture). Leveraging this kind of available support requires initiative and proactive help-seeking where needed; in short, it requires self-directed learning skills, as discussed earlier.

Macrosystem

The macrosystem is the broader context in which the learning ecology is situated, for example, on a state, national, or global level. Thus, it includes the economy, government, enterprise, non-profit organisations, the natural environment, geographies, religion, culture, health, law, politics, and history. Clearly, during the disruption caused by the COVID-19 pandemic, the macro system has become more salient, but it affects all other systems to varying degrees. For example, universities became dependent on government regulations around international travel (e.g., concerning international students), and they became dependent on government funding (or lack thereof) to cover some of the losses caused by students not being able to travel and come to a physical campus (Pelletier et al., 2021). Again, within the learning ecology thus conceptualised, the notion of self-directed learning becomes very relevant, as it underlies the broader idea of developing lifelong learners who are agile, responsive, and proactive to rapidly changing contexts, including potential disruptions. For example, in a significant disruptive event such as COVID-19, self-directed learners would be able to quickly adapt to changing circumstances by developing their digital capabilities by quickly learning new online tools to help them continue their learning in a digital environment (Limniou et al., 2021).

Chronosystem

Finally, the chronosystem refers to broader historical movements and indeed, disruptions, including, for example, the industrial revolution (Schwab, 2016), the massification of higher education on a global scale (del Cerro Santamaria, 2020), and digital globalisation (Vaujany et al., 2019). For example, the earlier referred to Globalisation 4.0 (Salmon, 2019) would fit into the chronosystem, with a fluid spill-over into the macrosystem. Thus, the chronosystem refers to broad, often generational changes that occur at various times, which have a significant (often disruptive) impact. In some cases, they may be seen as paradigm shifts. The emergence of big data over the last decade is one example, and the impact of AI may be another that is still developing (Williams et al., 2020). Prior to that, the arrival of the World Wide Web in the 1990s and social media in the first decade of this century constitute other examples (Salmon, 2019). These types of disruptions can be mapped to particular eras, and their responses tend to be significant changes in the way higher education is approached. Again, self-directed learning is the central thread that cuts across the different systems as both a way of buffering against disruptions (and hence a form of resilience) and leveraging the potential that such disruptions may afford.

Section 8.3.5 Balancing the Disruption in the Digital Learning Ecology

The five systems that make up the learning ecology go through periods of relative calm, even in constant flux. However, when considering large-scale disruptions, another layer could be added to the learning as mentioned above ecology, which would focus on balancing the situations prior to the disruption and the post-disruption context. The static view examines how a system and its parts behave under equilibrium while all forces affecting it are in a dynamic balance

(Perry-Smith & Shalley, 2003). However, during a disruptive event, each element moves under the influence of forces that push it toward, away from, or between equilibria (Gibbons, 1992). The Chinese concept of HeXie could overlay the learning ecology as it draws attention to how balance can be restored in response to disruption or, more importantly, how a new and ideally more productive and relevant balance may be achieved. The balance here is universal, and other models have explored similar system thinking perspectives, such as Beer's Viable Systems Model (Beer, 1985) and Kaufman's Organizational Elements Model (Kaufman, 1988).

Overall, the proposed model in Figure 8.1 illustrates how the HeXie education model focuses on balancing each of the broad elements that relate to student learning in the overall digital learning ecology. The ecology itself is circular, which means that we can start anywhere, and the relationships are dynamic, depending on where we choose to target our analytical focus. In response to disruptions, however, each of the five systems in the learning ecology affects the others to varying degrees, and what this model allows us to do, with the help of the HeXie dimension, is to re-balance after a disruption. Importantly, re-balance refers to a new equilibrium, which is never the same as the equilibrium that existed prior to the disruption but which may offer new ways of imagining learning and teaching that are both fit for purpose and fit of purpose (Scott, 2021).

Section 8.4 Conclusions

This study focuses on the critical role of self-directed learning and digital resilience, where both teachers and students are key stakeholders as the co-creators of the digital learning ecology across the microsystem, mesosystem, exosystem, macrosystem, and chronosystem. It contributes to the PhD research programme by synthesizing the insights gained from the empirical studies and literature and leveraging the theoretical and practical contributions from an institutional field perspective (Scott, 2004).

Section 8.4.1 Implications

This study contributes to the emerging literature on digital learning ecology (Huijser et al., 2019; Reyna, 2011) by providing a holistic view across five ecosystems, while prior studies have made significant contributions in exploring the learning ecology within a specific ecosystem. Borge and Mercier developed a micro-ecological framework focusing on the microanalysis of individual interactions when different cognitive systems interact and modify different learning activities (Borge & Mercier, 2019). Further, the University of Illinois has worked on a digital learning ecology where computers are used as mediators in human social connections, as “computers could not simply be applied to education. It had to be (re)designed to align with the social construction that is education” (Dragonas et al., 2015, p. 352). Van den Beemt and Diepstraten reinforced the importance of creating information and communication technology-rich social environments in an exo-level learning ecology (van den Beemt & Diepstraten, 2016).

Regarding the practical implications, this study has proposed two new constructs: self-directed learning and digital resilience within a digital learning ecology, which may inspire new directions in digital learning analysis, for example, exploratory structural equation modelling through quantitative grounded theory. In terms of learning and teaching practices, the proposed conceptual model might serve as a framework to promote new educational development policy and encourage innovative pre-sessional and syntegrative programmes for students and more effective and agile professional development programmes for teachers.

More importantly, the proposed digital learning HeXie ecology model allows us to conceptualise learning across formal, informal, and lifelong learning in different levels of human ecology and what is needed in a learning environment in response to and in the aftermath of significant disruption. The main contribution to the current literature is that the proposed model has extended Kek and Huijser's (2017) PBL ecology for learning by adding another layer to the Chinese HeXie concept. This allows us to find a new equilibrium (or, indeed, new equilibria) concerning student learning.

Section 8.4.2 Limitations and Future Development

At this stage, this study has been conceived on a purely conceptual level. Although applying these ideas in practice is more complex, an increasing number of future-oriented universities have made varying degrees of progress (Pelletier et al., 2021; Xi, 2021). Future studies are therefore encouraged to test this model by applying it empirically in different contexts, such as by examining the association between students' self-directed learning ability and their digital resilience in a syntegrative education system based on industry-university partnerships and, in the process, testing the influence of teacher support for self-directed student learning and digital resilience development in formal and informal learning environments.

Based on the detailed elaborations from the prior chapters, chapter 9 summarises the conclusion from an integral perspective and discusses the key strengths, implications, limitations, and future research.

Chapter 9 Conclusion and Future Research

The main goal of this research programme was to explore the mechanism of educational change promoted by educational technology like VLEs and ultimately to address the grand challenges in HE. The present research programme conducted six sub-studies employing various methodologies (qualitative meta-analysis, grounded analysis, case study, quantitative factor exploratory and confirmatory analysis, structural equation modelling) to investigate (1) factors and relationships that influence VLE adoption across different countries, (2) institutionalisation of the VLE-enabled innovation, (3) evaluation of the VLE-enabled interdisciplinary online teaching, (4) factors and relationships that influence the justice of VLE-enabled automated PBL, (5) factors and relationships that influence students' acceptance to the VLE-enabled in-class quizzes, and (6) elements and relationships about the social need for a more agile and digitally resilient HE system where VLE plays a critical role.

The findings concerning factors, national cultural dimensions, institutional factors (normative facilitating, cognitive-cultural influence), and individual factors (perceived self-efficacy, perceived justice, perceived pedagogical value) emerged as reliable predictors of VLE adoption. A new survey scale was used developed for factor measurement. In terms of the institutional process for educational change, the research findings showed that the majority of VLE enabled educational innovations were abandoned or faded before the new practice could be habitualized by a broader scope of adopters. A dual dimensional process called "meaning-making" was a critical stage in the multi-stage institutionalisation process model. The case study under the Chinese cultural context supported the relevance of action learning in supporting teacher development and “meaning-making” for VLE-enabled online teaching. The existence and value of “meaning-making” were further evident in assessing students’ perceptions of justice and pedagogical value in using technology for effective learning. Finally, one of the more significant findings from these studies was that self-directed learning and digital resilience are critical elements in a new conceptual model of digital learning ecology for an agile and sustainable HE.

These results confirm previous findings and contribute to existing knowledge by strengthening our understanding of the hidden factors and underlying mechanisms that influence teachers' and students’ intention and actual behaviours of using the VLEs for quality and sustainable educational change in HE, particularly in China. The factor measurement tool and conceptual models developed through the present research programme add to a growing literature on technology-enhanced learning in HE. The key findings suggest that including teachers and students as the co-creators of future education is essential and continuous support for technological and pedagogical professional development for both teachers and students is needed.

Section 9.1 Key Strengths and Implications

This research programme set out with the primary objective of investigating the mechanism of how VLEs promote educational change in HE. Figure 9.1 shows an overview of the leading research findings of six studies that examine the central question from various perspectives. The key strengths of this research programme are its multi-level perspectives, diverse methodologies, rich data (both primary and second), factual findings and interdisciplinary contribution.

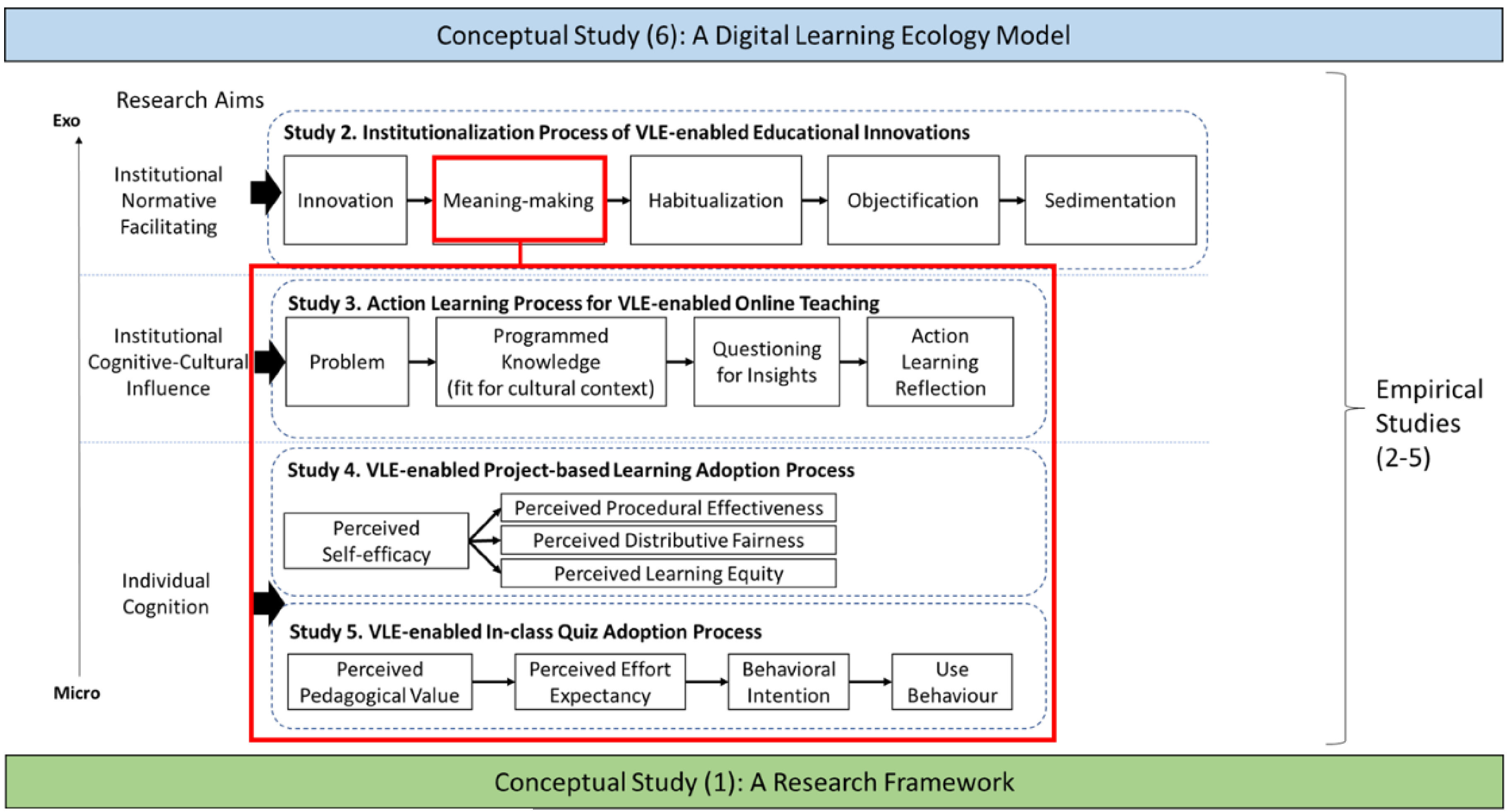


Figure 9.1 Overview of Research Findings

The first conceptual study systematically reviewed 145 empirical studies in the past 19 years across 42 countries and developed a research framework. The research framework extends the UTAUT model (Venkatesh et al., 2003) by categorizing the factors that might influence VLE adoption into two main themes: institutional (Scott, 2014) and individual. Additionally, the research framework highlights the critical role of national cultural dimensions (Hofstede et al., 2010) in the VLE adoption process. This study emphasizes the importance of investigating the VLE adoption process from the micro-strategy of the individual cognition to the meso-strategy of organisational learning environment development.

Drawing on the research framework, findings in four empirical studies (study 2,3,4 and 5) provide new understandings of factors and processes of VLE adoption and educational change in a Sino-British international university in China (XJTLU). The first empirical study (study 2 in chapter four) investigated the institutional normative facilitating aspects of the institutional factors at the organizational level (i.e., mesosystem) of the research framework. This mixed-method longitudinal case study examined the university's 13 years of educational change (data source includes 13 years' archival documents, VLE system logs, and 51 interviews with teachers and managers). The findings extend the existing three-stage institutionalisation model (Tolbert & Zucker, 1996) to a four-stage model by adding the "meaning-making" stage before habitualisation.

The key results confirm the prior studies that found the habitualisation stage has the highest failure rate (Hadjithoma & Karagiorgi, 2009; Wei, 2021). Additionally, the findings highlight the critical role of individual cognitive divergence (Colyvas, 2007) and collective cognitive consensus (Combe & Carrington, 2015) in the new stage of “meaning-making” to promote successful educational change. As is highlighted in Figure 9.1, the other three empirical studies investigated the “meaning-making” process from different stakeholders’ perspectives while examining the educational change using different learning technologies on the VLE.

Specifically, the second empirical study (study 3 in chapter five) unfolded teachers’ cognition and reflection in the “meaning-making” stage for the interdisciplinary online teaching innovation. This study was conducted to explore the institutional cognitive-cultural influence as the second institutional aspect of the research framework developed in study 1 and investigate effective teacher professional development approaches. This study connects to the first empirical study closely. It suggests teacher professional development as a critical area that requires more attention for Chinese universities to help teachers develop their technological and pedagogical knowledge for effective technology-enhanced learning and sustainable educational change. More importantly, this qualitative case study was the first to adopt the action learning (Marquardt, 2015; Revans, 2016) process for university teachers to evaluate the effectiveness of the VLE-enabled online teaching in the Confucian cultural context, where novice teachers respect and require expert guidance for critical questioning, reflection and problem-solving for professional development. Additionally, this study corroborates the ideas of Park and Mills (2014), who suggested the pedagogical value of using VLEs to support effective interdisciplinary teaching and learning.

While the first two empirical studies focus on teachers’ perspectives, the third empirical study (study 4 in chapter six) investigated 763 year-four undergraduate students’ perceptions of interdisciplinary project-based learning

(PBL) (Morgan, 1983) using the VLE to support automated project allocation (Hussain et al., 2019). This mixed-method study developed a validated and reliable measurement tool – perceived self-efficacy and perceived justice survey to examine the mechanism of student individual cognitions' impact on VLE-enabled PBL satisfaction and adoption. This study assessed students' perceptions in the "meaning-making" stage of the fair allocation innovation. Additionally, this study developed a new PBL concept model to unveil the significant associations between self-efficacy and justice perceptions. This finding is consistent with prior organizational studies in the industry context (Aşkun et al., 2018; Genç et al., 2021) and contributes to the literature on education, information technology and psychology. These results match those observed in earlier studies that highlight the importance of understanding students' perceptions in promoting successful VLE adoptions and educational innovations (e.g., Duygu Fındık-Coşkunçay, 2017; Herrador-Alcaide et al., 2019).

The fourth empirical study (study 5 in chapter seven) employed structural equation modelling to test the UTAUT model (Venkatesh et al., 2003) with 246 year-two undergraduate students in a Chinese context. This study investigated students' perceived pedagogical value of using the JazzQuiz technology at the "meaning-making" stage. The key findings extend our knowledge of VLE adoption by revealing and interpreting the hidden role of student perceived pedagogical value as a predictor of effort expectancy and behaviour intention in using the VLE in-class quiz for interactive hybrid learning. These results support previous studies (Almetere et al., 2020; Salloum & Shaalan, 2019) that stated the existence of predictors for effort expectancy in the UTAUT model. The research results confirm the generalizability of

UTAUT in a non-Western context and addressed the research gap of individual factors about the pedagogical value pointed out by the research framework of concept study 1. More importantly, this study developed a new conceptual model that accords with the findings from Karatas and Arpaci (2021), who emphasized the importance of pedagogical metacognition.

The final study (study 6 in chapter eight) employed a theory development method and reconceptualized the digital learning ecology at the institutional field level. This study contributes to the research programme by expanding the educational change context from an international university in China to a broader view from an ecological perspective. It highlights the balance between two key elements: self-directed learning and digital resilience. The two dimensions of self-directed learning (self-determined motivation to learn and self-regulation strategies and abilities in learning) (Carré, 2012) link to the two individual factors (individual cognition and individual digital capability) of the research framework in study 1. Furthermore, self-directed learning was also grounded in the prior empirical studies about student self-efficacy (study 4), student perceived pedagogical value (study 5) and teacher professional development to support student-centred active learning (study 3). The second key element, digital resilience, also accords with the individual digital capability (Varga-Atkins, Limniou, et al., 2021) of students and teachers as the critical factor influencing VLE adoption and educational change a micro-level. Regarding the mesosystem, digital resilience connects to the institutional factors and processes that were examined in study 2 and study 3. In other words, the organisational perspective's collective digital resilience is essential for HEIs to support the emerging needs of flexible learning and teaching (Frelin & Grannäs, 2022) responding to unforeseen disruptions.

Section 9.1.1 Theoretical Implications

The current research programme makes several noteworthy contributions to the literature by integrating and extending theories and models grounded in multidiscipline: Sociology, Education, Information Technology, and Psychology. The research findings from the six sub-studies unfold the mechanisms of institutional changes of technology-enabled educational innovations from multiple perspectives (culture, norm, and cognition) to address the central question about how technology could promote educational change in HE. Figure 9.2 illustrates an overview of the interconnected theories applied in each sub-study.

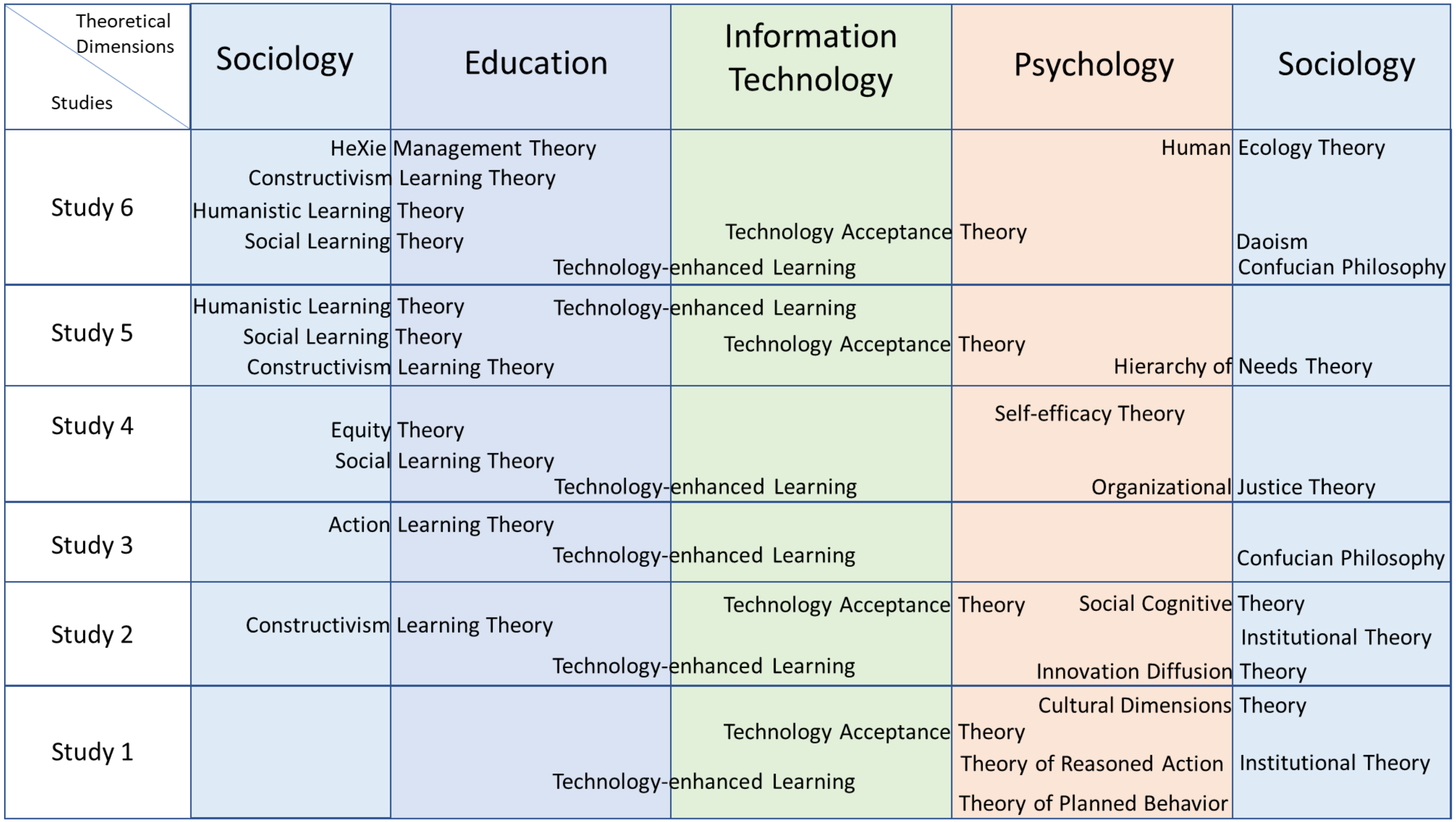


Figure 9.2 Overview of Theoretical Dimensions and Theories Applied in Each Study

As a first systematic review on VLE adoption and national culture in HE, study 1 provide a new theoretical direction for integrating multidisciplinary theories for technology-enhanced learning (TEL) studies. Specifically, bringing Hofstede's cultural dimensions theory (Hofstede et al., 2010) enriches the psychological aspect of technology acceptance theory (TAM) (Davis, 1986) from a sociological perspective, while the TAM was originated from the theory of reasoned action(Ajzen & Fishbein, 1980) and theory of planned behaviour (Ajzen, 1985). Furthermore, study 1 extends our knowledge from a holistic perspective by integrating the institutional theory (Scott, 2014) to conceptualise the non-individual factors and points out a new research direction of investigating the VLE adoption as an institutional change process, which study 2 further explored.

Study 2 contributes to the TEL studies by integrating the TAM, diffusion of innovation theory (Rogers, 2003), social cognitive theory (Bandura, 1986b), constructivism learning theory (Vygotsky, 1962) in an extended institutionalisation model to unfold the threshold mechanism of VLE-enabled educational change in HE. Three empirical studies have further investigated the new institutionalisation stage, "meaning-making". Study 3 proved that action learning could be used as a methodology to help university teachers develop the meaning of using the VLE for interdisciplinary online teaching. The research findings provide additional evidence in China concerning using the action learning theory (Revans, 1998) and the Confucian Philosophy (Chen, 1990) to support university teacher professional development for effective emergency online education (Hodges et al., 2020). Study 4 confirmed the argument in study 2 that individual cognitive divergence exists and is critical for individual learners to understand the innovative action in the educational change process. The findings demonstrate theoretical novelty in integrating the social learning theory (Bandura, 1977), self-efficacy theory (Bandura, 1986a), organizational justice theory (Folger & Cropanzano, 1998), and equity theory (Leventhal, 1980) to develop the perceived self-efficacy and perceived justice survey (PSPJS) and conceptualise the factor relationships in a technology-enhanced PBL model.

Study 5 provides empirical evidence of the “meaning-making” process in educational innovation using the in-class quiz technology for interactive hybrid learning. The findings of study 5 enhance our understanding of the UTAUT model (one of the vital technology acceptance theories). The extended UTAUT model integrates the social learning theory (Bandura, 1977), constructivism learning theory (Vygotsky, 1962), humanistic learning theory(Combs, 1982; Gould, 2012), and hierarchy of needs theory (Maslow, 1970) to explain the VLE adoption mechanism and highlight the importance of individual motivation and cognition for interactive hybrid learning in HE.

Finally, study 6 synthesised and expanded the abovementioned theories and empirical findings in a new digital learning ecology model across five human ecology systems (Bronfenbrenner, 1979). The institutionalisation process of the technology promoted educational change examined by four empirical studies from different perspectives at individual and organizational levels has been leveraged to the institutional field level(Scott, 2004). The results extend our understanding by adding a Chinese HeXie layer that originated from the Chinese Confucian Philosophy (Tan, 2013) and Daoism (Jing & Van de Ven, 2014) from the institutional perspective. The proposed digital learning HeXie ecology model integrates the problem-based learning ecology (Kek & Huijser, 2017) and the HeXie education model (Xi, 2021) that originated from the HeXie Management Theory (Xi et al., 2012).

Section 9.1.2 Practical Implications

This research programme provides evidence-based suggestions for educators, managers, decision-makers, and educational practitioners to develop sustainable and practical guidance, framework, and policy in the HE sectors. Stakeholders should be aware of the cultural obstacles and consider the following strategies to overcome the challenges in promoting VLE adoption and educational innovations: HEIs with a population that significantly influenced by high power-distance culture (such as Chinese) should enhance teacher professional development, because well-trained teachers with sufficient technological and pedagogical knowledge and skills could motivate novice teachers and students, support collective cognitive consensus and help widespread the good practices of using VLEs to enhance learning and teaching experiences; HEIs with a population that mainly influenced by low masculinity culture (such as Swedish) should organise community of practice and be inclusive to the divergent individual cognitions of the meaning of the different educational practices, and thus promote idea exchange and innovations; HEIs with a population that mostly affected by low uncertainty-avoidance culture (such as Chinese) should deliver pedagogical and technological professional development programme for teachers and students to develop their metacognition and digital resilience for effective self-directed learning; HEIs with a population that dominated by short-term-orientation culture (such as Australian) should enhance the technological facilitating and technical support to help teachers and students to overcome the short-term challenges first.

VLEs provide new learning opportunities that allow extensive group learning and teaching through interdisciplinary collaboration. Educators and curriculum designers should pay more attention to the holistic teaching process (e.g., continuous learner support, course-opening and closing communication) rather than only focusing on the teaching content. It is suggested that teachers clarify the expectations of student technical competence with comprehensive instructions as early as possible to ensure students' practical usage of learning technologies to achieve the expected learning outcomes. To overcome the teacher-to-teacher communication issues, educational development stakeholders should provide flexible and communicative platforms, such as the community of practice, to encourage interdisciplinary peer support and social networking. Educators can use action learning to identify and solve educational problems for teacher professional development. Teachers can use the PSPJS to assess students' self-efficacy and justice perceptions in VLE-enabled interdisciplinary learning regarding learner satisfaction. Being aware that self-efficacy is a crucial predictor of their perceptions of justice, policymakers should provide guidance and normative facilitating to develop student self-efficacy through formal and informal learning.

Practitioners of educational technology design and development should pay more attention to the non-technological factors that might influence users' intention and action toward adopting the technology. For example, while designing and developing the project allocation function in Moodle (fair allocation), practitioners should not only focus on the accuracy of the computing algorithm. Features supporting easier and quicker information search could improve students' efficiency in preparing the choice-making process and thus reduce the dissatisfaction with unnecessary perceptions of justice caused by negligence in choice making. More importantly, students' voice is critical, and both teachers and students should be surveyed during the needs analysis stage for the educational technology design and development. For example, the in-class interactive quiz function in Moodle (JazzQuiz) should be improved by adding the features that students are eager to have, such as a review report, a prominent answer display and a problematic level setting for adaptive learning.

Regarding the educational technology implementation, to build institutional digital resilience, HEIs managers and decision-makers should provide a flexible technological infrastructure that can support teachers and students using alternative solutions in an agile manner while encountering uncertain disruptions (such as the COVID-19). While keeping the VLEs as the centralized formal learning platform and integrating new features into the VLEs with the single sign-on solution to provide user consistency, informal emerging third-party technologies (e.g., Zoom, Teams, Mentimeter) that can be used as alternative solutions should be included in the institutional, technological infrastructure. The boundary between formal and informal learning is becoming a blur, and it is everyone's responsibility to co-create the future education system in the lifelong learning ecology.

Section 9.2 Limitations and Future Research

Several limitations to this research programme need to be acknowledged and future development will be discussed in this section.

Section 9.2.1 Single Case Study and Multiple Case Studies

Given the constraints of conducting a manageable and deliverable PhD research with limited time and resources during the COVID-19 lockdown disruptions, I conducted a single case study with multiple sub-cases in the same context (Yin, 2018). The data of the four empirical studies were collected from the same university, a Sino-British international university in China (XJTLU). The single case study has its strengths and limitations. In this PhD research, the main advantages and rationales for focusing on one case with multiple perspective examinations are twofold: (1) my insider role has provided data access that external researchers are hard to get; and (2) the complex phenomenon concerning VLE-enabled educational change XJTLU requires multiple and longitudinal investigations.

Regarding the limitation of the single case study, although the university has over 1500 international students (by 2021), the majority population (over 20,000) is from the same geographic region (China mainland). This setting limited the opportunities to understand the differences and the similarities between populations from different countries and regions. Future research will focus on multiple case studies to explore the research direction proposed by the systematic literature review study (study 1): national culture influences teachers and students' intention to accept and use VLEs in higher education worldwide. Specifically, future studies will seek opportunities to collect and analyse the data within China and across the countries to test the conceptual models developed in this PhD research. Comparing the multiple case studies could help clarify whether the findings are consistent and valuable and provide the literature with a significant influence from the contrasts and similarities (Gustafsson, 2017). In that way, the theory created by the single case study can be reinforced and supplemented when the arguments are more intensely grounded in several empirical pieces of evidence from diverse contexts (Eisenhardt, 2007).

Section 9.2.2 Cognitive Theoretical Approach and Social Constructivist Approach

As discussed above, the research framework developed in study 1 pointed out a research direction on social and cultural perspectives of technology adoption in higher education. However, there is limited space for a diverse social and cultural perspective examination and comparison in a single case context. This PhD research follows the cognitive theoretical approach (Duval et al., 2017). It proposes the cognitive "meaning-making" institutionalisation model that connects to each study. The model provides a better understanding of the educational change process that combines cognitive and constructivist behaviour logic. Future research will consider applying the sociocultural theory to examine the role of physical and psychological tools in structuring and supporting learning activities in a connected learning environment (Bower, 2019). In that way, the conceptual model proposed in this PhD research can be further developed and create a more convincing theory considering cognitive and sociocultural perspectives of educational change with technology.

Section 9.2.3 Other Research Methods

This research programme focus on qualitative methods with some mixed methods approaches. Mixed methods were conducted using the same sequential mixed methods design, which is first quantitative methods (to address the "what" questions) and then qualitative methods (to address the "why" questions). Future studies will employ other research methods to triangulate the findings, such as testing the proposed conceptual model using quantitative methods. Regarding the data source, this research programme was one of the very few studies (e.g., Kuo, 2016; Zyad, 2016) that used the system log data to measure the actual user behaviour on VLE. Implicit measures of the actual VLE usage were linked to the degree to which the users explored the platform but not their reported intention to use it. Objective behaviour measures should be preferred wherever possible (Belletier et al., 2018). Therefore, future studies will investigate using advanced technologies, such as artificial intelligence and big data-supported learning analytics, for more effective digital educational research.

Appendix 1 Abbreviations

Term	Full Name
AL	Action Learning
ARM	Academic Resistance Models
BI	Behavioural Intention
CET	Channel Expansion Theory
CFA	Confirmatory Factor Analysis
C-UTAUT	Compatibility UTAUT
DF	Perceived Distributive Fairness
df	Degrees of Freedom
DOI	Diffusion of Innovation Theory
ECM	Expectation-Confirmation Model
ECT	Expectation–Confirmation Theory
EE	Effort Expectancy
EFA	Exploratory Factor Analyses
EMI	English Medium Instruction
E-SAM	E-Services Acceptance Model
FC	Facilitating Conditions
FYP	Final-year Project
GSRS	Game-based Student Response System
HE	Higher Education
HEI	Higher Education Institution
HXMT	HeXie Management Theory
IC	Individual Cognition
ICH	Individual Characteristics
ICI	Institutional Cognitive-Cultural Influence
IDC	Individual Digital Capability
IDV	Individualism Index Value
IM	Igbaria's Model
INF	Institutional Normative Facilitating
IVR	Indulgence Versus Restraint Index Value
LE	Perceived Learning Equity
LTO	Long-Term Orientation Index Value
MAM	The Motivation and Acceptance Model
MAS	Masculinity Index Value
MM	Motivational Model
MPCU	Model of PC Utilisation
PBL	Project-based Learning
PBL	Problem-based Learning
PCIT	Perceived Characteristics of Innovating Theory
PDI	Power Distance Index Value
PE	Performance Expectancy
PE	Perceived Procedural Effectiveness
PPV	Perceived Pedagogical Value

PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSPJS	Perceived Self-efficacy and Perceived Justice Survey
RLLT	Research-Led Learning and Teaching
SCT	Social Cognitive Theory
SDL	Self-directed Learning
SDT	Self-Determination Theory
SE	Perceived Self-efficacy
SEM	Structural Equation Modelling
SI	Social Influence
SRS	Student Response System
TAM	Technology Acceptance Model
TAM2	Extension of Technology Acceptance Model
TAM3	Technology Acceptance Model 3
TEL	Technology-enhanced Learning
TEM	Technology Effectiveness Model
TIB	Theory of Interpersonal Behaviour
TPACK	Technological Pedagogical and Content Knowledge
TPB	Theory of Planned Behaviour
TPD	Teacher Professional Development
TRA	Theory of Reasoned Action
TTF	Task-Technology Fit
UACC	Uncertainty, Ambiguity, Changeability and Complexity
UAI	Uncertainty Avoidance Index Value
UB	Usage Behaviour
UCL	University College London
UGT	Uses and Gratification Theory
UOL	University of Liverpool
UTAUT	Unified Theory of Acceptance and Use of Technology
VLE	Virtual Learning Environment
XJTLU	Xi'an Jiaotong-Liverpool University

Appendix 2 Rights, Permissions and Authorship

Chapter 2 – Publication permissions and contribution statement

"A country's national culture affects virtual learning environment adoption in higher education: a systematic review (2001–2020)" is an accepted manuscript of an article published by Taylor & Francis in the Journal of Interactive Learning Environments on 14 August 2021, available online: https://doi.org/10.1080/10494820.2021.1967408.

Contribution statement

Na Li contributed as the first author in this peer-reviewed journal article. All data collection, analyses, project administration and much of the writing were undertaken by Na Li. Dr Xiaojun Zhang and Dr Maria Limniou provided advice and guidance on all stages of design, analysis, and writing.

Advisory team and co-author declaration

I declare that:

- the information above is accurate
- the advisory committee has agreed to the inclusion of this publication in the student's thesis
- all co-authors of the publication have reviewed the above information and have agreed to its veracity

Name	Dr Xiaojun Zhang	Dr Maria Limniou	Professor Youmin Xi
Role	Primary supervisor and co-author	Co-supervisor and co-author	Co-supervisor

Signature			

Chapter 4 – Publication permissions and contribution statement

“Meaning-making in virtual learning environment enabled educational innovations: A 13-year longitudinal case study” is an accepted manuscript of an article published by Taylor & Francis in the Journal of Interactive Learning Environments on 29 May 2022, available online: https://doi.org/10.1080/10494820.2022.2081582.

Contribution statement

Na Li contributed as the first author in this peer-reviewed journal article. In terms of contribution, all data collection, analyses, project administration and much of the writing were undertaken by Na Li. Dr Xiaojun Zhang and Dr Maria Limniou provided advice and guidance on all stages of design, analysis, and writing. Professor Youmin Xi contributed by providing advice and guidance on the writing stage.

Advisory team and co-author declaration

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- the advisory committee has agreed to the inclusion of this publication in the student’s thesis
- all co-authors of the publication have reviewed the above information and have agreed to its veracity

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Role	Primary supervisor and co-author	Co-supervisor and co-author	Co-supervisor and co-author
Signature			

Chapter 5 – Publication permissions and contribution statement

“Improving interdisciplinary online course design through action learning: a Chinese case study” is an accepted manuscript of an article published by Taylor & Francis in the Journal of Action Learning: Research and Practice on 10 November 2021, available online: https://doi.org/10.1080/14767333.2021.2002681.

Contribution statement

Na Li contributed as the first author in this peer-reviewed journal article. Na Li undertook all data collection, analyses, and much of the writing. Dr Qian Wang administered the project as the corresponding author and contributed to all design, analysis, and writing stages. Dr Jiajun Liu and Professor Victoria J. Marsick contributed by providing advice and guidance on analysis and writing.

Advisory team and co-author declaration

I declare that:

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- the advisory committee has agreed to the inclusion of this publication in the student’s thesis
- all co-authors of the publication have reviewed the above information and have agreed to its veracity

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Name	Dr Qian Wang	Dr Jiajun Liu	Professor Victoria J. Marsick
Role	Co-author	Co-author	Co-author
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<u>Chapter 6 – Publication permissions and contribution statement</u>

"The role of self-efficacy in automated project allocation: measuring university students' perceptions of justice for interdisciplinary project-based learning" is an accepted manuscript of an article published by Elsevier in the Journal of Computers in Human Behavior on 30 June 2022, available online: https://doi.org/10.1016/j.chb.2022.107381.

Contribution statement

Na Li contributed as the first author in this peer-reviewed journal article. In terms of contribution, all data collection, analyses, project administration and much of the writing were undertaken by Na Li. Dr Pengfei Song contributed as the corresponding author by organizing the technology application and student communications and providing advice and guidance on the design, analysis, and writing stages. Professor Eng Gee Lim, Dr Mark Leach and Dr Xiaojun Zhang contributed by providing advice and guidance on writing.

Advisory team and co-author declaration

I declare that:

- the information above is accurate
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Name	Professor Eng Gee Lim	Dr Mark Leach	Dr Pengfei Song
Role	Co-author	Co-author	Co-author
Signature			

Chapter 7 – Publication permissions and contribution statement

"Understanding the perceived pedagogical value of JazzQuiz in interactive hybrid learning among university students: a technology acceptance analysis" is currently submitted to the journal "Interactive Learning Environments" for consideration and undergoing peer review.

Contribution statement

Na Li is recorded as the primary author in the manuscript submission. In terms of contribution, all data collection, analyses, project administration and much of the writing were undertaken by Na Li. Dr Erick Purwanto contributed as the corresponding author by organizing the technology application and student communications, drafting the literature review, and providing design, analysis, and stage writing guidance. Dr Xiaojun Zhang, Ms Feng Cao, and Dr Kok Hoe Wong contributed by providing advice and guidance on writing. Mr Xiangru Chen assisted in the interview (e.g., audio transcription audit and translation) and drafted the participant paragraph.

Advisory team and co-author declaration

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Signature				

Chapter 8 – Publication permissions and contribution statement

Disrupting the Disruption: A Digital Learning HeXie Ecology Model is published as a journal article by Na Li, Henk Huijser, Youmin Xi, Maria Limniou, Xiaojun Zhang, and Megan Y.C.A. Kek. (2022) in Education Sciences on 18 January 2022, available on: https://doi.org/10.3390/educsci12020063. License to reproduce this work is granted by MDPI. This work is reproduced under a CC-BY Creative Commons attribution license which enables anyone to use the publication freely, given appropriate attribution to the author (s) and citing Education Sciences as the original publisher.

Contribution statement

Na Li contributed as the first author in this peer-reviewed journal article. Na Li undertook all analyses, project administration and much of the writing. Dr Henk Huijser provided advice and guidance on all stages of design, analysis, and writing. Professor Youmin Xi contributed by providing advice and guidance on analysis and writing. Dr Maria Limniou, Dr Xiaojun Zhang and Dr Megan Yih Chyn A Kek contributed by providing advice and guidance on writing.

Advisory team and co-author declaration

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Name	Dr. Henk Huijser	Dr. Megan Y.C.A. Kek
Role	Co-author	Co-author
Signature		

Appendix 3 Database Search Strings

Database	Boolean/Phrase:
Business Source Complete	AB ("acceptance" or "adoption") AND AB ("virtual learning environment" or "learning management system" or "course management system" or "learning content management system") AND AB ("higher education" or "university" or "college")
Education Research Complete	AB ("acceptance" or "adoption") AND AB ("virtual learning environment" or "learning management system" or "course management system" or "learning content management system") AND AB ("higher education" or "university" or " college ")
Emerald Insight	(content-type:article) AND (abstract:"virtual learning environment" OR (abstract:"learning management system")OR (abstract:"course management system")OR (abstract:"learning content management system")) AND (abstract:"higher education" OR (abstract:"university")OR (abstract:" college "))AND (abstract:"acceptance" OR (abstract:"adoption"))
ERIC	AB ("acceptance" or "adoption") AND AB ("virtual learning environment" or "learning management system" or "course management system" or "learning content management system") AND AB ("higher education" or "university" or " college ")
Scopus	TITLE-ABS-KEY ((“acceptance” OR “adoption”) AND (“higher education” OR “university” OR “college”) AND (“virtual learning environment” OR “learning management system” OR “course management system” OR “learning content management system”)) AND (LIMIT-TO (DOCTYPE, “ar”)) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j"))
Web of Science	#1, TS = ("virtual learning environment" OR "learning management system" OR "course management system" OR “learning content management system") #2, TS = (adoption* OR acceptance*) #3, TS = ("higher education" OR university*) Result = #1 AND #2 AND #3

Appendix 4 Coding Scheme of the Screening Procedure

Main codes	Description	Sub codes	Criteria
S0	Excluded based on title and abstract screening	S00	duplicate
		S01	not in English or does not have English translation
		S02	not an academic journal article
		S03	not peer-reviewed journal (i.e. without an editorial board, no clear peer-review process)
		S04	not empirical studies
		S05	not within the Higher Education context
		S06	not reporting factors that influencing VLE adoption
S1	Included based on title and abstract screening	S1	does not meet any of the exclusion criteria (S00-S07) and does not meet any of the inclusion criteria (S20-S24) for full-text analysis
S2	Need full-text analysis for double check	S20	no abstract for preview
		S21	the abstract is unclear if it is an empirical study
		S22	the abstract is unclear if it is within the Higher Education context
		S23	the abstract is unclear if the research reported factors that influencing VLE adoption
		S24	the abstract has no clue about the country nation where the study took place

Appendix 5 Coding Scheme of the Eligibility Procedure

Code name	Description
Full-text code	The name of the file with the ordered number. If a study consists of multiple studies, then code each study as "F [full-text code]-[sub code]" in a separate record. For example, the No. 6 study includes two studies, then they were coded with the name of F6-1 and F6-2.
Authors	Names of all the authors of the article, separated by commas
Year	Year of publication
Title	The full title of the article
Language	The language of the available full text, if not in English, then exclude from the dataset
Content-type	The type of the full text, if not an academic journal article, then exclude from the dataset
Journal title	The full title of the journal in which the article is published
Journal JCR impact factor	The latest impact factor from the Journal Citation Reports™, if the journal is not listed in the report, then exclude from the dataset
Journal editorial board	The editorial board information published on the journal website, if no editorial board information or detailed peer review process introduction, then exclude from the dataset
Context	The research context. If not in Higher Education, then exclude from the dataset
Number of studies	Studies with different organizations, or in different countries were listed as separate sub-studies with sub-code names. The total number of the studies was recorded in this code
Sample size	The number of participants in each study
Target group	The role of participants, i.e. teacher, student, manager, admin
Mean age	The mean age of the participants
Gender ratio	The percentage of females and males
Sample ethnicity	The ethnicity of the participants
Country nation	The country nation where the study took place
Research design	Quantitative, qualitative or mixed methods
Factors	The factors that influence the VLE adoption significantly, separated by commas
Number of factors	The total number of the significant factors that influence the VLE adoption
Influence	If the influence on VLE adoption is positive or negative, add the symbol "+" beside the factor name in the factors code field to indicate the positive influence and "-" for negative influence.
Effect sizes	The effect sizes for each significant relationship, if any, separated by commas
Dependent variables	The dependent variables that represented the VLE adoption in the study, separated by commas
Independent variables	The independent variables, if any, separated by commas

Appendix 6 List of Reviewed Articles

No.	Title
1	An Analysis of the Technology Acceptance Model in Understanding University Students' Behavioral Intention to Use e-Learning
2	A Structural Model for Students' Adoption of Learning Management Systems: An Empirical Investigation in the Higher Education Context
3	Assessing the Acceptance of a Blended Learning University Course
4	User Acceptance of a Proposed Self-Evaluation and Continuous Assessment System
5	Personal Learning Environments Acceptance Model: The Role of Need for Cognition, eLearning Satisfaction and Students' Perceptions
6	Computer Based Assessment Acceptance: A Cross-cultural Study in Greece and Mexico
7	Facebook Groups as an Academic Teaching Aid: Case Study and Recommendations for Educators
8	Exploring Learner Attitudes toward Web-based Recommendation Learning Service System for Interdisciplinary Applications
9	Examining the Factors Influencing Participants' Knowledge Sharing Behavior in Virtual Learning Communities
10	Towards the Successful Integration of E-Learning Systems in Higher Education in Iraq: A Student Perspective
11	Examination of students' acceptance of and intention to use learning management systems using extended TAM
12	Clustering university teaching staff through UTAUT: Implications for the acceptance of a new learning management system
13	On the use of extended TAM to assess students' acceptance and intent to use third-generation learning management systems
14	Combined longitudinal effects of attitude and subjective norms on student outcomes in a web-enhanced course: A structural equation modelling approach.
15	Factors predicting online university students' use of a mobile learning management system (m-LMS)
16	Chinese students' intentions to use the Internet-based technology for learning
17	Factors affecting the adoption of e-learning systems in Qatar and USA: Extending the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)
18	A large-scale implementation of predictive learning analytics in higher education: the teachers' role and perspective
19	Attitudes toward learning oral communication skills online: the importance of intrinsic interest and student-instructor differences
20	Students' perceptions of teacher impact on their self-directed language learning with technology beyond the classroom: cases of Hong Kong and U.S.
21	Electronic reading and digital library technologies: understanding learner expectation and usage intent for mobile learning
22	Factors that influence university students' intention to use Moodle: a study in Macau
23	Educational knowledge generation from administrative data
24	Higher education instructors' intention to use educational video games: an fsQCA approach
25	Interactive digital technologies' use in Southwest Nigerian universities
26	The adoption of mark-up tools in an interactive e-textbook reader
27	An exploratory study of adult learners' perceptions of online learning: Minority students in continuing education

28 The acceptance and use of a virtual learning environment in higher education: an empirical study in Turkey, and the UK
29 Feelings of satisfaction in mature students of financial accounting in a virtual learning environment: an experience of measurement in higher education
30 Drivers of Learning Management System Use in a South African Open and Distance Learning Institution
31 Is There an Optimal Design for On-Line MBA Courses?
32 An Experiential Learning Perspective on Students’ Satisfaction Model in a Flipped Classroom Context
33 How Am I Doing? Exploring On-Line Gradebook Monitoring as a Self-Regulated Learning Practice That Impacts Academic Achievement
34 How are universities involved in blended instruction?
35 Web-Based Virtual Learning Environments: A Research Framework and a Preliminary Assessment of Effectiveness in Basic IT Skills Training
36 An Investigation of Epistemological and Social Dimensions of Teaching in Online Learning Environments
37 The Influence of Individualism—Collectivism and Power Distance on Use of Feedback Channels and Consequences for Learning
38 Experiences and Challenges of International Students in Technology-Rich Learning Environments
39 Using the Community of Inquiry Framework to Introduce Wiki Environments in Blended Learning Pedagogies: Evidence From a Business Capstone Course
40 Learning with Technology: Using Discussion Forums to Augment a Traditional-Style Class
41 Exploring the role and influence of expectations in achieving VLE benefit success
42 University students’ behavioral intention to use mobile learning: Evaluating the technology acceptance model
43 Explaining university students’ effective use of e-learning platforms
44 Towards the integration of culture into the Unified Theory of Acceptance and Use of Technology
45 An empirical study on behavioural intention to reuse e-learning systems in rural China
46 Introducing a VLE into campus-based undergraduate teaching: Staff perspectives on its impact on teaching
47 A dataset of factors that influence preservice teachers’ intentions to use Web 2.0 technologies in future teaching practices
48 Using the Facebook group as a learning management system: An exploratory study
49 Out of class—out of mind? The use of a virtual learning environment to encourage student engagement in out of class activities.
50 Modelling the factors that affect individuals' utilisation of online learning systems: An empirical study combining the task technology fit model with the theory of planned behaviour.
51 Does a university teacher need to change e-learning beliefs and practices when using a social networking site? A longitudinal case study
52 A structural equation modelling of factors influencing student teachers' satisfaction with e-learning.
53 Web 2.0 and competence-oriented design of learning-Potentials and implications for higher education.
54 Understanding motivational system in open learning: Learners' engagement with a Traditional Chinese-based open educational resource system.
55 Digital technologies in resource constrained higher institutions of learning: a study on students’ acceptance and usability.

56 Student use and perception of technology enhanced learning in a mass lecture knowledge-rich domain first year undergraduate module.
57 Does e-learning service quality influence e-learning student satisfaction and loyalty? Evidence from Vietnam
58 Behavioral intention, use behavior and the acceptance of electronic learning systems: Differences between higher education and lifelong learning
59 Students' acceptance and readiness for E-learning in Northeastern Thailand
60 Investigating self-directed learning and technology readiness in blending learning environment
61 Blended learning motivation model for instructors in higher education institutions
62 Persuasive technology for enhanced learning behavior in higher education
63 User acceptance of virtual learning environments: A case study from three Northern European universities
64 The acceptance and use of a virtual learning environment in China
65 Using an adapted, task-level technology acceptance model to explain why instructors in higher education intend to use some learning management system tools more than others
66 The use of technology as one of the possible means of performing instructor tasks: Putting technology acceptance in context
67 Investigating e-learning system usage outcomes in the university context
68 Student and faculty inter-generational digital divide: Fact or fiction?
69 A Model of Business School Students' Acceptance of a Web-Based Course Management System
70 Effects of instructors' academic disciplines and prior experience with learning management systems: A study about the use of Canvas.
71 Assessing the determinants of flow experience in the adoption of learning management systems: the moderating role of perceived institutional support
72 Determinants of presence in 3D virtual worlds: A structural equation modelling analysis
73 Academic and student use of a learning management system: Implications for quality
74 Sharing instructors experience of learning management system: A technology perspective of user satisfaction in distance learning course
75 A proposed model for evaluating the success of WebCT course content management system
76 Observatory of students’ uses of computer-based tools
77 The adoption of a social learning system: Intrinsic value in the UTAUT model
78 Numbers Are Not Enough. Why e-Learning Analytics Failed to Inform an Institutional Strategic Plan
79 "I Am Fine with Any Technology, as Long as It Doesn't Make Trouble, so That I Can Concentrate on My Study": A Case Study of University Students' Attitude Strength Related to Educational Technology Acceptance
80 Embedding E-Learning in Geographical Practice
81 LMS Acceptance: The Instructor Role
82 Understanding university students’ behavioral intention to use Edmodo through the lens of an extended technology acceptance model
83 A task-technology fit view of learning management system impact
84 Multi-dimensional students' evaluation of e-learning systems in the higher education context: An empirical investigation
85 Evaluation of learning management system in medical education in time of COVID-19

86 Supporting orchestration of CSCL scenarios in web-based Distributed Learning Environments
87 The use of a mobile learning management system and academic achievement of online students
88 A multivariate investigation of gender differences in the number of online tests received-checking for perceived self-regulation
89 Students' Acceptance and Experiences of the New Learning Management System (LMS) – Wiseup
90 A structural equation model to evaluate students' learning and satisfaction
91 Toward explicit measures of intention to predict information system use: An exploratory study of the role of implicit attitudes
92 Predicting Virtual Learning Environment Adoption: A Case Study
93 Student perceptions and mobile technology adoption: implications for lower-income students shifting to digital
94 A case in customizing e-learning
95 An analysis of students' preparation for the virtual learning environment
96 Student LMS use and satisfaction in academic institutions: The organizational perspective
97 University Instructors' Acceptance of Electronic Courseware: An Application of the Technology Acceptance Model
98 E-learning system use and its outcomes: Moderating role of perceived compatibility
99 EFL Learnings' Perceptions of using LMS
100 Exploring the Drivers Predicting Behavioral Intention to Use m-Learning Management System: Partial Least Square Structural Equation Model
101 ``I am Still Learning'': Modeling LMS Critical Success Factors for Promoting Students' Experience and Satisfaction in a Blended Learning Environment
102 Integrating Student Trust in a Conceptual Model for Assessing Learning Management System Success in Higher Education: An Empirical Analysis
103 Modeling Educational Usage of Cloud-Based Tools in Virtual Learning Environments
104 Acceptance of Technology and its Impact on Teacher's Activities in Virtual Classroom: Integrating UTAUT and CoI into a Combined Model
105 Organizational culture and information systems adoption: A three-perspective approach
106 Professional identity and the adoption of learning management systems
107 A Model for Instructors' Adoption of Learning Management Systems: Empirical Validation in Higher Education Context
108 The challenges we face: A professional identity analysis of learning technology implementation
109 Investigating "VLE-effectiveness" in Languages
110 Learning Management System-Based Evaluation to Determine Academic Efficiency Performance
111 Structural Gender Deference in LMS Use Patterns among College Students
112 Investigating university students' intention to use mobile learning management systems in Sweden
113 Investigating university students' attitude and intention to use a learning management system from a self-determination perspective
114 Medical students' acceptance and perceptions of e-learning duringthe Covid-19 closure time in King Abdulaziz University, Jeddah
115 Embracing online education: exploring options for success
116 Adoption of the Mobile Campus in a Cyber University
117 Investigating the uptake of educational systems by academics using the technology to performance chain model

118 Diffusion of Innovations Approach to the Evaluation of Learning Management System Usage in an Open Distance Learning Institution
119 Investigating IT Faculty Resistance to Learning Management System Adoption Using Latent Variables in an Acceptance Technology Model
120 The Use of a Mobile Learning Management System at an Online University and Its Effect on Learning Satisfaction and Achievement
121 The influence of learning value on learning management system use: An extension of UTAUT2
122 The role of involvement in learning management system success
123 Using a web-based course-management system: an evaluation of management tasks and time implications for the instructor
124 Social Isolation and Acceptance of the Learning Management System (LMS) in the time of COVID-19 Pandemic: An Expansion of the UTAUT Model
125 Adopting Web-Based Learning and Teaching: A case study in higher education
126 The moderation effect of user-type (educators vs. students) in learning management system continuance
127 Experts on super innovators: understanding staff adoption of learning management systems
128 How students and instructors using a virtual learning environment perceive the fit between technology and task
129 Investigating factors affecting learner's perception toward online learning: Evidence from ClassStart Application in Thailand
130 Exploring factors influencing students’ continuance intention to use the learning management system (LMS): a multi-perspective framework
131 Antecedents of continued usage intentions of web-based learning management system in Tanzania
132 Why some teachers easily learn to use a new virtual learning environment: a technology acceptance perspective
133 A Model of system re- Configurability and Pedagogical usability in an e-learning Context: a Faculty Perspective
134 When technology speaks language: an evaluation of course management systems used in a language learning context

Appendix 7 Representative Data of Cultural Index and Factors

Country/ region	#	Number of factors in each theme					PDI	IDV	MAS	UAI	LTO	IVR
		ICH	IC	IDC	ICI	INF						
US	18	6	23	2	5	8	40	91	62	46	26	68
UK	12	1	11	0	6	10	35	89	66	35	51	69
Turkey	10	0	16	0	4	13	66	37	45	85	46	49
Australia	9	1	5	1	3	13	38	90	61	51	21	71
South Korea	9	5	12	0	4	3	60	18	39	85	100	29
Spain	8	0	9	0	0	7	57	51	42	85	48	44
China Mainland	7	0	11	1	5	4	80	20	66	30	87	24
China Taiwan	6	1	12	1	4	2	58	17	45	69	93	49
Finland	4	1	6	0	2	1	33	63	26	59	38	57
Malaysia	4	0	7	1	4	5	104	26	50	36	41	57
South Africa	4	0	5	1	1	8	49	65	63	49	34	63
United Arab Emirates	4	0	7	0	1	8	80	38	53	68	36	52
France	3	0	4	0	2	1	68	71	43	86	63	48
Netherlands	3	0	8	0	0	1	38	80	14	53	67	68
Thailand	3	0	3	0	2	2	64	20	34	64	32	45

Appendix 8 Excerpt Data Example of Digital Panel Data

Academic year	Number of formal courses	Number of newly integrated technologies in formal courses	Name of used technologies in formal courses (count of the technology number)
2006-2007	0	0	-
2007-2008	70	16	forum, questionnaire, assignment, workshop, wiki, choice, glossary. (7)
2008-2009	121	7	forum, questionnaire, assignment, wiki, choice, quiz. (6)
2009-2010	169	0	Same as last year. (6)
2010-2011	193	1	forum, questionnaire, assignment, workshop, wiki, choice, glossary, quiz, chat. (9)
2011-2012	315	0	forum, questionnaire, assignment, wiki, choice, glossary, quiz. (7)
2012-2013	415	0	Same as last year. (7)
2013-2014	496	0	Same as last year plus chat. (8)
2014-2015	670	20	forum, questionnaire, assignment, workshop, wiki, choice, glossary, quiz, chat, online lecture, active quiz, group choice, SCORM, peer assessment, Pearson, etherpad, podcast. (17)
2015-2016	837	4	Same as last year. (17)
2016-2017	862	2	Same as last year plus attendance. (18)
2017-2018	942	5	Same as last year. (18)
2018-2019	985	4	Same as last year plus double marking. (19)
2019-2020 Semester 1 (before COVID 19)	528	6	Same as last year without Pearson. (18)
Total	6603	65	

Appendix 9 Overview of Archival Document Data

Document category	Document format	Number of documents	Pages of the documents
Government policy (2006–2019)	Online web page	8	15
University governance (2006–2019)	Word, PDF	34	105
University academic quality assurance framework (2006–2019)	Word, PDF	42	201
University policies and procedures (2006–2019)	Word, PDF	177	304
Institutional strategies and plans (2006–2019)	Word, PDF	14	41
University communication notifications (2006–2019)	Email, PDF	69	102
VLE annual user survey feedback (2015–2019)	Online questionnaire responses	5	108
VLE annual course review reports (2015–2019)	Excel	5	20
VLE ticket support report (2015–2019)	Email, online web page	121	352
Total		475	1248

Appendix 10 Content Analysis Results of Course Evaluation

No.	The Comprehensive Rubric (Debattista 2018)		Example Quotations (Course Level)	Note	Example Quotations (Lecturer Level)
	Main Standards	Specific Sub-Standards			
1	Instructional design	Structure of learning	"…step 6: After all the groups have submitted their project, a link will be available for every student to view and peer evaluate the projects..." (doc).	L1, L2, L3, L5, L6	"In this lecture, there are eight lecture videos and eight online activities… " (L2, doc).
		Learning aims and objectives	"This online course aims to develop students' global citizenship by enhancing them to reflect on and respond appropriately to the outbreak of pneumonia…" (doc).	L1, L2, L6	"This lecture aims to develop students' global citizenship by prompting them to compare various practices haven undertaken by the west and the eastern societies in response to the outbreaks… " (L1, doc).
		Learning outcomes	"...students enrolled in this course will be able to learn and practice research skills such as research question identification, literature review, methods for data collection, and approach to data analysis… " (doc).	L1, L2, L5	"After this lecture, you should be able to: understand the importance of information literacy in the digital environment and how it promotes lifelong learning… " (L5, doc).

		Instructional strategies and methods	"…the research-led teaching and learning, emphasise that student has a clear understanding of the long-term meaning and value for the college study, start from practical problems… " (doc).	L1, L2, L3, L6	"...the lecture aligns with research-led teaching and learning principles…" (L3, doc).
		Accessibility	"Attend the online lectures and workshops (the schedule and the topic of the lectures and workshops will be available on the ICE page), read the recommended references (available on ICE page)" (doc).	L1, L2	"Students can access this lecture from anywhere at any time with their own learning pace on ICE... " (L2, doc).
2	Course opening	Role	"Lecturers do not need to indoctrinate everything in class…Lecturers teach students professional knowledge, how to search for information; method, tool, etc..." (doc).	N/A	N/A
		Description	"All UG students are welcome to enrol in this module as individuals or in groups on a voluntary basis..." (doc).	L1, L2	"This Digital Literacy online lecture is for anyone who wants to learn the fundamentals of using digital technologies to make effective use of information online for research-led learning… " (L2, doc).

		Behaviour	"...you should allocate time properly, plan with the adviser strategically, and communicate efficiently by make full preparations before the video meeting…" (doc).	N/A	N/A
		Integrity	N/A	L1, L2, L3, L5, L6, L8	"… the open resources of COVID-19 are for access from …you need to consider the academic integrity before you make use of any information you get... " (L5, video).
		Technical competences	N/A	N/A	N/A
		Ownership	"…find extra sources…any other topic approved by advisor..."	L2	"Please share your own learning goals and ideas in the online brainstorming activity... " (L2, video).
3	Assessment of learning	Goals and objectives	"…In the peer assessment, you will be asked to give a mark and you may write down your evaluation comments…" (doc).	L1, L2	"... take the online quiz about digital footprint knowledge check…" (L2, VLE).
		Strategies	"…the setting of these dimensions is closely related to the learning outcome of the course..." (doc).	N/A	N/A
		Grading	"The final score of the projects will be made up	L1, L2	"This quiz is not part of the course grade…the online

			of students' peer review score and teachers' marking…" (doc).		quiz will be auto-graded with auto feedbacks ... " (L1, video).
		Feedback	"...we will display the Distinction assignments on ICE to the whole university for further discussion…" (doc).	L1, L2	"…lecture delivery feedback activities..." (L2, doc).
		Management	"…will receive a different percentage accounting for the final grade..." (doc).	L1, L2	"…all the grade and feedbacks are accessible for you to track your learning progress on ICE..." (L2, video).
		Fostering	"You are welcome to make comments or raise questions to discuss further about the topics and this course..." (doc).	L1, L2, L3	"Please post your feedback in the discussion forum… " (L3, VLE).
4	Interaction and community	Management	"...Students have the initiative to form teams…" (doc).	L1, L2	"All the other students who successfully unlocked this activity will be able to join you with the brainstorm… " (L2, VLE).
		Peer learning	"…each team member has clear and independent tasks, also have dependent channel to ensure information exchange and in-depth cooperation…" (doc).	L2, L8	"...70% Experience; 20% Education; 10% Peer Learning..." (L8, doc).

		Provision	"…select a group leader…every student to view and peer evaluate... you will be asked to give a mark..." (doc).	L1, L2, L3, L4, L5, L6, L7, L8, L9, L10	“By completing this forum activity, you will be able to unlock the resource folder…” (L2, VLE).
		Application	"…the schedule and lecture topics are available on the ICE page in the section of Lectures… " (doc).	L1, L2, L3, L5, L6, L7, L8	"...each of my lecture videos will introduce the application of the resources... " (L1, video).
5	Instructional resources for teaching and learning	Entitlement	"…this is a non-credit optional online course open to all undergraduate students..." (doc).	L1, L2, L3, L5, L6, L7, L8	"…the following links to the open education resources are for you to investigate further…" (L5, video).
		Variety	"…teaching activities: video lecturing, reading tasks, online quiz, forum discussion..." (doc).	L1, L2, L3, L5, L6, L7, L8, L9	“…in this lecture, I have prepared videos for each of the topics; after each video, you will find the recommended readings from... ” (L3, video).
		Openness	“Find extra sources or do any other brainstorming activities to develop more ideas… ” (doc).	L1, L2, L3, L5, L6, L7, L8	"…please search and find your resources for research-led learning… " (L6, video).
		Academic integrity	N/A	L1, L2, L3, L5, L6, L7, L8	"...the best practice of using third-party resources is …" (L3, video).
6	Learner support	Instructional support	"students can get teachers' guidance of research skills, professional knowledge, soft skill, self-reflection..." (doc).	N/A	N/A

		Academic support	"Communicate with your advisor and your advisor will provide suggestions on your research question and project plan…" (doc).	N/A	N/A
		Technical support	"Solution for video access denied issue and video quiz issue, please click here…" (VLE).	N/A	N/A
		Administrative support	"Please read this document very carefully because all the possible questions have been listed here..." (doc).	N/A	N/A
		Support	"...Platforms used in the course: ICE Course page; Mediasite; Email System..." (doc).	N/A	N/A
7	Technology design	Centricity	"…ICE... is an online platform designed to support and enhance learning and teaching at ...University..."	N/A	N/A
		Openness	"…ICE is based on a world famous open source virtual learning environment Moodle..." (VLE).	N/A	N/A
		Authentication	"…use the university account to log in..." (VLE).	N/A	N/A

		Access	"…access ICE anytime, anywhere and stay up-to-date with your modules, view important resources, submit assignments, and much more..." (VLE).	N/A	N/A
		Interface	"…you can find your course page on the dashboard…click the activity hyperlink on the menu..." (VLE).	N/A	N/A
		Investment	"…you can access to ICE via web browser..." (VLE).	N/A	N/A
		Management	"… the Educational Technologies Team manage and support ICE..." (VLE).	N/A	N/A
8	Course evaluation	Entitlement	"...teachers and students should reflect and summarise at the end of the course..." (doc).	N/A	N/A
9	Course closing	Assessment	"All the grades have been shared with you in the previous email from ICE and all the assignments of 'Distinction' have been uploaded to the section of 'Open Discussion'..." (doc).	N/A	N/A
		Resolution	"...in this FAQ…please read this document very	N/A	N/A

			carefully because all the possible questions have been listed here..." (doc).		
		Archiving	"...it’s also the time to close the loop for the Short Course…" (doc).	N/A	N/A
		Academic review	"Online lectures should not be offered in a simple one-way manner…When teaching online, the lecture sources can be made up of various types to enable 'multi-model' teaching..." (doc).	N/A	N/A
10	Instructional design cycle	Technical review	"In general, the ICE system and the Mediasite have proved to be very helpful and efficient for online teaching..." (doc).	N/A	N/A
		Administrative review	"It is evident from this course that online education requires more careful and detailed guidance for students regarding the procedures and requirements due to the lack of instant, face-to-face communication …" (doc).	N/A	N/A

Note. L = Lecturer

Appendix 11 Factor Loadings

Construct	Item	M	SD	Factor loading
Perceived procedural justice	(1) I find the current practice of obtaining FYP application instructions (e.g., procedure, deadlines, contact) is efficient and helpful.	4.46	0.78	.569*
	(2) I find the current practice of obtaining FYP application result is efficient and helpful.	4.50	0.77	.935*
	(3) I find the current practice of applying for an FYP project is efficient and helpful.	4.49	0.78	.925*
	(4) Overall, I find the current FYP allocation process is efficient and beneficial.	4.49	0.73	.653*
Perceived distributive justice	(1) I feel that I'm being treated equally in terms of information sharing.	4.48	0.76	.500*
	(2) I feel that I'm being treated equally to have the same opportunity to express my personal preference and priority on the project choice.	4.49	0.76	.845*
	(3) I feel that I'm being treated equally to have the same opportunity to express my personal preference and priority on the supervisor choice.	4.47	0.76	1.023*
	(4) I feel that I'm being treated equally when decisions are made to the final supervisor allocation.	4.53	0.70	.708*

Perceived self-efficacy	(1) I am able to identify and formulate a substantial research problem and produce a plan to address the problem.	4.48	0.69	.874*
	(2) I am able to locate and perform a review of project-related literature.	4.50	0.65	.785*
	(3) I am able to design, implement, and test solution (s) to the identified research problem.	4.52	0.66	.889*
	(4) I am able to evaluate in a critical fashion the work done and place it in the context of related work.	4.51	0.69	.748*
	(5) I am able to prepare and deliver a formal presentation with a demonstration of the project using suitable means.	4.53	0.64	.702*
	(6) I am able to structure and write a dissertation.	4.56	0.60	.747*
Perceived learning equity	(1) My learning opportunity is not limited by my gender.	4.69	0.56	.865*
	(2) My learning opportunity is not limited by my race.	4.69	0.56	.898*
	(3) My learning opportunity is not limited by my age.	4.64	0.62	.841*
	(4) My learning opportunity is not limited by my health condition.	4.58	0.73	.657*

Note. N = 226. * Refers to significant at the 5% level.

Appendix 12 Paired Samples Test Results

Construct	Item	Differences Mean	Differences SD	Sig. (2-tailed)
Perceived procedural justice	1	-0.04	1.08	0.581
	2	0.01	1.12	0.858
	3	0.04	1.17	0.610
	4	0.08	1.15	0.327
Perceived distributive justice	1	-0.02	1.08	0.806
	2	-0.01	1.11	0.904
	3	-0.02	1.12	0.767
	4	0.04	1.07	0.533
Perceived self-efficacy	1	0.04	1.04	0.523
	2	0.05	0.97	0.452
	3	0.09	1.06	0.187
	4	0.12	1.11	0.094
	5	0.10	1.06	0.152
	6	0.13	1.01	0.058
Perceived learning equity	1	-0.03	0.81	0.623
	2	-0.04	0.79	0.500
	3	-0.05	0.87	0.359
	4	-0.08	0.98	0.200

Appendix 13 GEOMIN Factor Correlations

Survey factor	2020				2021			
	1	2	3	4	1	2	3	4
1	1				1			
2	.804*	1			.781*	1		
3	.657*	.669*	1		.731*	.724*	1	
4	.594*	.606*	.714*	1	.576*	.593*	.598*	1

Appendix 14 Item Descriptive Statistics

Item	Mean (2020, N = 226)	SD (2020, N = 226)	Mean (2021, N = 537)	SD (2021, N = 537)
Q3	4.4558	0.77762	4.4823	0.74823
Q5	4.4956	0.77315	4.4544	0.76677
Q6	4.4912	0.77884	4.4432	0.79471
Q9	4.4867	0.7317	4.4413	0.80159
Q10	4.4823	0.75551	4.4916	0.76076
Q11	4.4912	0.76153	4.4916	0.76321
Q12	4.4735	0.76111	4.4842	0.78002
Q14	4.5265	0.70029	4.4898	0.74337
Q20	4.4823	0.68776	4.4451	0.73382
Q22	4.5044	0.64806	4.4581	0.73721
Q23	4.5177	0.66141	4.419	0.76139
Q24	4.5133	0.69429	4.4134	0.75832
Q25	4.531	0.64043	4.4413	0.75112
Q26	4.5575	0.59536	4.4283	0.74249
Q28	4.6903	0.55904	4.7095	0.5643
Q29	4.6858	0.56053	4.7132	0.54948
Q33	4.6372	0.61913	4.6741	0.59219
Q34	4.5841	0.73304	4.6369	0.64094

Appendix 15 Online Questionnaire Item Excerpt Samples

Codes	Item
Perceived Pedagogical Value	
PPV1 (Q2)	I have fun in the in-class polling (JazzQuiz) activities
PPV2 (Q3)	The in-class polling (JazzQuiz) activities in the module is helpful to my learning
PPV3 (Q4)	I am motivated by the responses I get from the in-class polling (JazzQuiz) activities included in this module
PPV4 (Q5)	The feedback I receive from the in-class polling (JazzQuiz) activities are meaningful
Effort Expectancy	
EE1 (Q1)	I make sure to attend classes in-person
EE2 (Q8)	The in-class polling (JazzQuiz) functions are user friendly
EE3 (Q9)	The in-class polling (JazzQuiz) is easy to use
EE4 (Q13)	The university technological support encourages my participation in the in-class polling (JazzQuiz) activities
EE5 (Q14)	I have good digital skills to use in-class polling (JazzQuiz)
Performance Expectancy	
PE1 (Q19)	How active are you in this module?
PE2 (Q20)	How active are you in this module compared to other modules you are taking?
Social Influence	
SI1 (Q12)	My classmates encourage my participation in the in-class polling (JazzQuiz)activities
SI2 (Q18)	I have gotten to know other students in this class very well
Behavioral Intention	
BI1 (Q15)	I take the in-class polling (JazzQuiz) activities frequently in this module
BI2 (Q16)	I am willing to use in-class polling (JazzQuiz)
BI3 (Q17)	I am open to try different new technologies

Appendix 16 Variable Univariate Higher-order Moment

Descriptive Statistics

Variable /Sample Size	Mean/ Variance	Skewness/ Kurtosis	Minimum/ Maximum	% With Min /Max	20% / 60%	Percentiles 40%/80%	Median
Q1	4.262	-1.522	1	5.06%	3	5	5
237	1.223	1.573	5	60.34%	5	5	
Q2	3.958	-0.907	1	4.64%	3	4	4
237	1.256	0.125	5	42.19%	5	5	
Q3	4.072	-1.234	1	4.64%	3	4	4
237	1.105	1.206	5	42.62%	5	5	
Q4	4	-1.023	1	4.64%	3	4	4
237	1.198	0.479	5	42.19%	5	5	
Q5	4.076	-1.117	1	3.80%	3	4	4
237	1.117	0.749	5	44.73%	5	5	
Q8	3.992	-0.955	1	4.64%	3	4	4
237	1.24	0.245	5	43.88%	5	5	
Q9	4.245	-1.498	1	3.80%	4	4	5
237	1.029	1.945	5	53.16%	5	5	
Q12	3.603	-0.49	1	7.59%	2	3	4
237	1.657	-0.904	5	33.76%	4	5	
Q13	3.983	-0.93	1	4.22%	3	4	4
237	1.325	-0.05	5	45.15%	5	5	
Q14	4.169	-1.238	1	3.38%	3	4	5
237	1.119	0.898	5	51.48%	5	5	
Q15	3.954	-0.925	1	5.06%	3	4	4
237	1.437	-0.174	5	45.57%	5	5	
Q16	4.118	-1.148	1	3.80%	3	4	5
237	1.193	0.588	5	50.21%	5	5	
Q17	4.333	-1.677	1	3.80%	4	5	5
237	1.058	2.294	5	61.18%	5	5	
Q18	3.042	0.112	1	16.46%	2	3	3
237	1.939	-1.183	5	24.89%	3	5	
Q19	3.624	-0.385	1	4.22%	3	3	4
237	1.205	-0.491	5	27.00%	4	5	
Q20	3.819	-0.636	1	3.38%	3	4	4
237	1.17	-0.275	5	33.33%	4	5	
GRADE	2.667	-0.528	1	16.03%	2	3	3
237	0.847	-0.55	4	15.19%	3	3	
UB	2.443	0.266	1	18.57%	2	2	2
237	1.074	-1.112	4	22.78%	2	4	

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