LEADING CHANGE FOR SUSTAINABILITY IN SCHOOLS: DESIGNING A COMPUTER SIMULATION FOR VIETNAM CONTEXT

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on
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ABSTRACT

The challenge to educate the next generation of citizens for sustainable development requires educators to develop and use new active learning approaches that impact the knowledge skills and attitudes of learners. This thesis presents a comprehensive research and development project aimed at redesigning and adapting the Leading Change for Sustainability – Business (LCS-B) simulation for use in the Vietnamese educational context. The thesis is comprised of four related research that describe the redesign process and outcome.

Chapter 2 consisted of a bibliometric review of research on education for sustainable development (ESD) in K-12 schools. While this systematic review identified a growing literature on education for sustainable development, it was noted that the literature has been dominated by contributions from Western developed nations where sustainability problems and solutions may differ from those encountered in developing societies. The review also highlighted a tendency for scholars in this literature to emphasize commentary and critique and a need for more empirical research on teaching and learning methods on sustainability issues.

In Chapter 3, the researcher used an integrative review method to analyze the whole-school approach to sustainability. This review analyzed conceptual models and practices employed in whole school approaches to educating for sustainability in four different countries. This review yielded actionable principles that could be used to inform the whole school approach to ESD in the new Leading Change for Sustainability in Schools simulation.

Chapter 4 presents the comprehensive research and development (R&D) approach that was used to create the new simulation. This R&D process consisted of eight steps, covering review and planning, design, testing, evaluation, and dissemination. The redesign of the existing business simulation required two significant adaptations. In the first step, the existing simulation needed to be redesigned to reconceptualize the implementation of sustainability from a business organization to that of a K-12 school system. In the second step, the new K-12 schools simulation was culturally adapted in order to make it applicable to educators in Vietnam. The result was a new culturally-adapted, Leading Change for Sustainability in Schools-Vietnam computer simulation presented in the Vietnamese language. The description of the R&D project presented in Chapter 4 includes student perception data drawn from a mixed methods study of a training intervention conducted with 32 graduate students in a Master's degree program in educational administration in Ho Chi Minh City, Vietnam. The mixed data supported the viability of the new simulation and also offered recommendations for revision of the simulation and teaching approach used with it.

Chapter 5 was comprised of a quasi-experimental, mixed-method research study of the efficacy of the LCSS-V simulation for use with K-12 educators, teachers, and administrators in Vietnam. The study evaluated change in learners' knowledge of change management for sustainability, attitudes towards sustainability, and skill performance resulting from a four-week learning module built around the LCSS-V simulation. The results demonstrated significant improvement in learners' outcomes after using the LCSS-V simulation, providing evidence of its effectiveness.

This study also contributes to the literature on simulation-based learning and teaching for sustainability, offering an innovative and effective teaching method for educators in Vietnam. It is worth noting that the LCSS-V simulation was designed to address specific challenges for sustainability in the Vietnamese educational context.

KEYWORDS: Education for Sustainable Development, Whole School Approach, Leading Change for Sustainability, Simulation-Based Learning, Vietnam, Active Learning

270 pages

CONTENTS

CONTENTS (cont.)

CONTENTS (cont.)

CONTENTS (cont.)

CONTENTS (cont.)

CONTENTS (cont.)

CONTENTS (cont.)

LIST OF TABLES

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LIST OF FIGURES

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CHAPTER I
INTRODUCTION

1.1 Purpose of the Dissertation Research

People are living in a fast-changing era with high uncertainty. Sustainability has recently become an emerging agenda worldwide (Caradonna, 2014; Sachs, 2015). The rapidly-growing global economy has had many unanticipated, negative effects on the planet, and Mother Nature appears to be fighting back. The Covid-19 pandemic, for example, has had a severe negative impact on world development, with both known and unknown impacts on social stability, health, safety, and the world economy.

The global pandemic led to school closures in over 190 countries in the education sector, affecting 1.6 billion students from all levels (United Nations, 2020). Now more than ever, the world needs to be able to respond and adapt quickly to unprecedented crises. To mitigate damaging consequences, one of the constructive ways is to prepare people with the ability to cope with a crisis by building more resilient educational systems (United Nations, 2020). People must learn how to transform their thinking and behave sustainably if they, as a species, wish to survive.

Education plays a crucial role in solving future problems and developing a new path to sustainable growth (Bertschy et al., 2013; Leal Filho et al., 2015; UNESCO, 1997). Born from that need, education for sustainable development (ESD) is an educational approach that prepares learners to understand the current concerns, take action, and deal with change and uncertainty. It is a tool that empowers learners to make more reasonable decisions and responsible actions for the environment, economy, and society for both the present and future (Rieckmann, 2017).

Education for Sustainable Development (ESD) has gained widespread recognition since its formal launch by UNESCO in 1992 (Leicht et al., 2018). It has transformed from a policy-driven approach to a practice-oriented one that addresses environmental, social, and economic issues, facing global society. It is acknowledged in many emerging programs. For example, the United Nations has proposed 17

Sustainable Development Goals (SDGs) to provide an important set of contemporary global targets for the international community to achieve by 2030 (UNESCO, 2015). This agenda 2030 adoption is an opportunity to bring ESD practices into reality through Goal 4, 'Quality Education'. Education is a shared global mechanism for good and a key enabler for all 17 Sustainable Development Goals (Rieckmann, 2017). Recently in 2020, UNESCO proposed a new global framework, 'ESD for 2030', to reorient and embrace education in all activities aimed at achieving sustainability and the SDGs (UNESCO, 2020).

Educators take on different roles while implementing ESD. It is not only about what they teach, but also about how they teach, and their relationship with students. They impart knowledge about sustainability, develop employability skills, facilitate learning, and support students' personal development. Educators are represented as agents of social change.

The fundamental and significant transformation to sustainable development requires complex, systemic changes from the individual to the social system levels. Undeniably, with traditional teaching methods, a single aspect of the issues may lead to missing many connections and interactions which can be explored to solve sustainability-related problems on an interdisciplinary basis (Hofstein et al., 2011; Hopkinson & James, 2010). It would suggest a requirement for an innovative and more powerful tool to train and prepare educators to understand how to succeed in school change to sustainability.

One approach that has emerged in the effort to develop education for sustainability is using simulations and serious games (Hallinger et al., 2020). Simulation-based learning is ideally suited to motivate, inform and change learner attitudes and behaviors (Crookall, 2013; Faria, 2001; Hallinger & Wang, 2019). Furthermore, simulations not only prepare learners to deal with complex problems but also have the potential to enhance learner capacities to think critically about future scenarios (Figueiró & Raufflet, 2015). Acknowledging this promise has led to the design of simulations and serious games that aim to prepare learners with capacities for addressing sustainability issues (Aragon-Correa et al., 2017; Gatti et al., 2019; Ulrich, 1997).

The Leading Change for Sustainability simulation is developed on an online platform that prepares learners with the knowledge and skills needed to foster sustainable transformation in business organizations (Hallinger, 2018). This online simulation challenges current and prospective business managers to consider transforming their companies to succeed in the 'triple bottom line' of social, environmental, and economic goals. The simulation places learners in the role of a project management team in a company that has set a goal of becoming more sustainable in its policies and practices. Learners are given a budget of time and money to spend on various activities to inform, motivate, prepare, and support the company's stakeholders as they embrace sustainable practices. The interactive simulation provides continuous feedback to learners as they play over three simulated years. Learners' success in achieving the simulation goals is determined by change theories that shape the decision rules embedded in the simulation. After the three simulated years, the learners' strategy for 'leading the change towards sustainability' is assessed in terms of change in both stakeholder behaviors and the company's outputs on the triple bottom line of economic, social, and environmental impacts (Hallinger, 2018).

1.2 Scope and Significance of the Research

There is an urgent need to develop more powerful tools for teaching and learning about sustainability (Crookall, 2010; Leal Filho et al., 2015). Currently, educators lack validated educational methods and tools to enhance learner attitudes about sustainability and prepare them with the knowledge and skills needed to address the world's sustainability challenges. While simulations and serious games have shown some potential for meeting this challenge (Crookall, 2013), they similarly suffer from a lack of research validation (Hallinger & Wang, 2019; Hallinger et al., 2020).

This study focused on redesigning the existing 'business version' of the Leading Change for Sustainability simulation for the education sector in Vietnam. The assessments conducted in this research project provide formative and summative evaluations of the new version Leading Change for Sustainability in Schools simulation as a learning tool. Formative assessments were employed to gain insights into the utility and cultural validity of the simulation from the point of view of potential users. The

summative evaluation was conducted through a quasi-experimental assessment of learners in Vietnam. The quasi-experimental research examined changes in learners' knowledge, attitudes, and skills in key areas related to sustainability and change management.

The research yielded a suitable product that can be used in various educational programs in Vietnam. The research also contributed findings relevant to the broader field of simulation-based learning (Hallinger & Nguyen, 2020; Hallinger & Wang, 2019). This interdisciplinary feature of the project further extends the applicability of the project and its potential for publishing its results in journals in the fields of sustainability science, education, and simulation-based learning.

1.3 Organization and Structure of the Dissertation

The broad goal of this research and development project was to redesign the Leading Change for Sustainability business simulation for use in the Vietnamese K-12 educational context. More specifically, the research objectives were to:

1. Gather knowledge about education for sustainable development and managing change for sustainability in schools.

2. Revise an existing computer simulation – *Leading Change for Sustainability* for use in the training of school principals and teachers in Vietnam;

3. Produce and test the viability of a culturally adapted version of the simulation *Leading Change for Sustainability in Schools (Vietnam)* through using a research and development process.

4. Evaluate the learning effectiveness of the *Leading Change for Sustainability in Schools simulation (Vietnam)* through a quasi-experimental, mixed methods design.

This research is comprised of six chapters. This introductory chapter is followed by five more chapters.

- Chapter 2: *Mapping the Landscape and Structure of Research on Education for Sustainable Development: A Bibliometric Review* (Hallinger & Nguyen, 2020). This published paper provides a systematic review of the literature on education for sustainable development in K-12 schooling.

- Chapter 3: *Whole School Approaches to Education for Sustainable Development: A Review of the Research.* This chapter examines a range of 'whole school approach' models that have evolved in different societies, including Thailand, Sweden, the United States, and Australia. This systematic review examined the range of conceptual and empirical research which describes efforts to implement whole school approaches to sustainability in these four nations. The review applies a comparative framework to identify the distinctive approaches that have evolved in each of these societies.

- Chapter 4: *Creating the Leading Change for Sustainability in Schools Simulation (Vietnam): A Research and Development Project*. This chapter describes the research and development (R&D) process used to develop the new *Leading Change for Sustainability in Schools (Vietnam)* simulation designed for the education sector in Vietnam. This chapter includes a description of the R&D process used in the development of the new simulation as well as the results of formative evaluation in a field test with educators in Vietnam. The focus of the formative evaluation is on the viability and cultural relevance of the *Leading Change for Sustainability in Schools (Vietnam)* simulation as a learning tool for use in preparing Vietnamese educators for sustainability challenges.

- Chapter 5: *Teaching and Learning about Sustainability: Evaluating the Effectiveness of the Leading Change for Sustainability in Schools Simulation (Vietnam)*. This chapter describes the quasi-experimental study used to examine the efficacy of the *Leading Change for Sustainability in Schools simulation (Vietnam)* in changing learners' knowledge, attitudes, and skills related to managing the change for sustainability.

- Chapter 6: *Conclusion;* This chapter summarizes the findings of the four main Chapters comprising the dissertation and places their contribution in perspective with respect to the fields of simulation-based learning and education for sustainable development.

1.4 Definitions of Key Terms

1.4.1 Change Management

Change management is identified as "the process of continually renewing an organization's direction, structure, and capabilities to serve the ever-changing needs of external and internal customers" (Moran & Brightman, 2000, p. 66). Change management is built upon two assumptions. First, it is possible to close the gap between the goals or intentions of change efforts and actual outcomes through an intentionally designed process of planning, project management, and execution. Second, change management can benefit from the intentional application of theory and lessons gained from the practical experience of past change implementation efforts. Thus, this research project incorporates theories and lessons from the past into a tool for teaching stakeholders how to successfully implement changes associated with making organizations more sustainable. This definition is customized for the education sector in this research, as business and education leaders have much in common when dealing with sustainable changes (Fullan, 2002).

1.4.2 Education for Sustainable Development (ESD)

Being a multidisciplinary knowledge area, ESD's history can be traced back to efforts by the United Nations to develop an international sustainability agenda rather than driven by an educational community. Various terms have been used for ESD, including 'Sustainability Education', 'Education for Sustainable Development', and 'Education for Sustainability'. However, Burnes (2009) has suggested that while these terms are employed alternately, they all reflect the same goal. In this research, the term 'Education for Sustainable Development' or ESD is employed to encompass these related concepts. ESD in this research was defined as "… a way of learning that empowers people to make informed decisions and responsible actions for environmental integrity, economic viability, and a just society, for present and future generations" (Rieckmann, 2017, p.7). It is classified as "a process of learning how to make decisions that consider the long-term future of the economy, ecology, and equity of all communities" (UNESCO, 2006, p. 16).

1.4.3 Simulation

As an essential learning method used in education and training, simulations and serious games present an active, highly engaging form of experiential learning (Gosen & Washbush, 2004). Simulation is used to describe "a technique (not a technology) to replace and amplify real experiences with guided ones" (Lateef, 2010, p. 348). Simulations can be constructed on many platforms, such as live role plays, board games, standalone computers, online platforms, and mobile applications (Hallinger et al., 2020). Although simulation and educational games have different characteristics, in this research, those terms are employed as interchangeable concepts (Faria, 2001; Feinstein & Cannon, 2002; Klassen & Willoughby, 2003).

1.4.4 Sufficiency Economy Philosophy

In Thailand, the Sufficiency Economy Philosophy (SEP) was developed by His Majesty the King Bhumibol Adulyadej over 60 years as an internationally recognized approach to sustainability (United Nations Development Programme, 2007; Wedchayanon & Chorkaew, 2014; Wibulswasdi et al., 2011). SEP has served as a guiding framework to promote and achieve the implementation of UN Sustainable Development Goals (SDGSs) in Thailand at the individual, organizational, community, and national levels (Pramudwinai, 2017). Bergsteiner and Dharmapiya (2016) analyzed the SEP model as a means of explaining the process of transforming organizations to become more sustainable. Applied in many industries and sectors in daily life, this model is a "structured, step-by-step process to guide change and help people adopt the (SE) philosophy" (Bergsteiner & Dharmapiya 2016, p. 46).

1.4.5 The Whole School Approach to Sustainability

The whole school-to-sustainability approach refers to implementing sustainability education across campus, curriculum, and community (Tilbury & Cooke, 2005). The holistic approach appears most effective when it builds on the existing school culture, goals, values, and surrounding communities (Bolstad et al., 2004). Whole school approaches to sustainability involve:

> *Schools (and/or institutions) tackling a range of complex and diverse issues such as school governance, pedagogy,*

> *resource consumption, community outreach, curriculum development, and landscaping that will assist schools to become more sustainable. (Ferreira et al., 2006, p. 16)*

This research interchangeably uses the phrase "whole school approach to sustainability" as the exact meaning of the phrase "whole school approach to education for sustainable development", "sustainable educational organization," or "sustainable school".

1.5 Research Ethics

In this research, ethical standards were observed. Participants were requested to grant written informed consent for all interviews, surveys, and observations conducted. The purpose of the study and data collection procedure was thoroughly explained to the potential participants prior to obtaining their consent. The consent form emphasized that participation was voluntary and that refusal or withdrawal from the study would have no adverse consequences on their identity, career, or academic performance.

The research data were kept confidential in accordance with the regulations of Mahidol University and were to be used solely for academic purposes. Personal identity was never disclosed in any publication or presentation, and all identifiable research data were assigned codes (i.e., identified only by a code number or class id). The study was reviewed and received ethical approval from the Institutional Review Board (IRB) at Mahidol University's Institute for Population and Social Research, located in Salaya, Phutthamonthon, Nakhon Pathom 73170, Thailand.

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CHAPTER II
MAPPING THE LANDSCAPE AND STRUCTURE OF RESEARCH ON EDUCATION FOR SUSTAINABLE DEVELOPMENT: A BIBLIOMETRIC REVIEW[1]

2.1 Introduction

Few educational research and practice trends have emerged over the past 30 years with wider global reach than "Education for sustainable development" (ESD). Launched under the rubric of "environmental education" during the 1980s, ESD has gradually incorporated a broader range of concerns that bear upon global society's social, economic, and environmental sustainability (Jickling & Wals, 2012; Scott, 2015). Over time, concerns for health, equity, peace, and social justice have been incorporated into the emerging field of education for sustainable development (Barry et al., 2013; Hoelscher et al., 2004; Kopnina & Cherniak, 2016; McKeown & Hopkins, 2003; Öhman, 2006). Spurred on by a series of international policy reports (Brundtland et al., 1987; UNESCO, 2005, 2015), ESD has matured into a recognized field of education research and practice and a key sub-field of sustainability science (Aikens et al., 2016; ALam, 2022; Breßler & Kappler, 2017; Jickling & Wals, 2012; Scott, 2015).

To date, published reviews of research on "education for sustainable development" have focused on subsets of the literature such as sustainability in early childhood education (Davis, 2009; Hedefalk et al., 2015; Somerville & Williams, 2015), sustainable change (Fullan, 2005; Hargreaves & Goodson, 2006), citizenship education (Dobson, 2003), teacher education (Chinedu et al., 2018; Pipere et al., 2015; Summers et al., 2005), and teaching and learning methods (Boström et al., 2018; Gough & Scott, 2003; Rickinson, 2001; Stanitsas et al., 2019). While bibliometric reviews have been conducted on the ESD knowledge base in higher education, there are sufficient differences to warrant a separate examination of ESD in K-12 schools (Hallinger &

[1] An earlier version of this chapter was published in *Sustainability* (Hallinger & Nguyen, 2020)

Chatpinyakoop, 2019).

This systematic review of research sought to document and synthesize patterns in knowledge production on education for sustainable development in K-12 schooling. The review addressed the following research questions:

1. What is the volume, growth trajectory, geographic distribution, and composition of English-language scholarship on education for sustainable development (ESD) in K-12 schools?

2. What authors and articles have evidenced the greatest impact on English-language discourse in education for sustainable development at the K-12 level?

3. What is the intellectual structure of this English-language ESD knowledge base?

The chapter review employed science mapping to analyze 1842 Scopus-indexed documents published in English (Van Eck & Waltman, 2014; White & McCain, 1998). Data analyses included descriptive statistics, citation analysis, and co-citation analysis. The analyses sought to gain a comprehensive perspective on the ESD knowledge base in K12 schools since its emergence in the early 1990s.

2.2 Background

In 1987, The Brundtland Commission, or more formally the World Commission on Environment and Development (WCED), was organized to unify countries in a common pursuit of "sustainable development". The WCED aimed to define the concept of sustainable development, increase global awareness of sustainability-related problems, and prompt action towards the identification and implementation of solutions.

Publication of the Brundtland Commission's report (Brundtland et al., 1987), "Our Common Future", was followed five years later by the Earth Summit in Rio de Janeiro, Brazil. It is where the term Education for Sustainable Development (ESD) first emerged in the sustainability lexicon. A related plan, "Educating for a Sustainable Future: Environment Population and Development", was proposed by the United Nations in the same year (Huckle & Wals, 2015). A decade later, in 2002, UNESCO launched the "United Nations Decade of Education for Sustainable Development"

(UNDESD).

This evolution in global interest in ESD began with raising awareness, moving to capacity building, experimentation, and finally, implementing recommended practices (Kopnina & Meijers, 2014; Pauw et al., 2015). After the UNDESD, the United Nations launched the 2030 Agenda for Sustainable Development. This Agenda proposed 17 Sustainable Development Goals (SDGs) for worldwide implementation. The fourth SDG focuses on achieving the delivery of "Quality Education" for all. More specifically, target 4.7 of the quality education goal stated:

> *By 2030, ensure that all learners acquire knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development. (UNESCO, 2015, p. 48)*

These historical events highlight the increasingly prominent role that education has assumed in the global movement towards sustainable development. In 2019, ESD is not only accepted as one of the 17 Sustainable Development Goals (SDGs), but also recognized as an instrumental means of accomplishing the other 16 goals (Jickling & Wals, 2008, 2012; Sachs, 2015). Over time, a global network of educators and researchers from different disciplines has joined this effort to address the goals of ESD (Jickling & Wals, 2008; Pipere et al., 2015; Reid & Scott, 2006). This has resulted in the adoption of numerous policies and programs to enhance teacher and student knowledge and attitudes in this domain (Chinedu et al., 2018; Summers et al., 2005; Wiek et al., 2011).

For this review, the author adopted the following conceptual definition of "education for sustainable development" in K-12 schooling. ESD consists of educational programs, curricula, and teaching and learning practices that enhance student values, understanding, and capabilities in relation to the challenges of social, environmental, and health sustainability (Breßler & Kappler, 2017; Huckle & Wals,

2015; Scott, 2015; UNESCO, 2015). This definition recognizes the need for both content and processes of education that engage learners in developing a deeper appreciation of how human behavior impacts the sustainability of society and the planet.

2.3 Method

This review used science mapping to examine trends in ESD-related documents published since the emergence of this movement in the early 1990s. Science mapping involves the analysis of bibliographic data associated with a corpus of documents drawn from a field of study (Zupic & Čater, 2015). Science mapping aims to illuminate a knowledge base's evolution and structural composition (White & McCain, 1998). Thus, reviews grounded in science mapping serve a different purpose than reviews that employ narrative synthesis or meta-analysis, which seek to integrate substantive findings within a field of research (Zupic & Čater, 2015).

2.3.1 Search Criteria and Identification of Sources

The author selected the Scopus database as the source of documents for this review. Scopus was chosen because it employs a consistent standard in selecting documents for inclusion in its index. Moreover, it features a wider range of documents than the Web of Science for reviews of research in education and the social sciences (Hallinger & Chatpinyakoop, 2019; Mongeon & Paul-Hus, 2016). Finally, it offers more sophisticated capabilities for the export of bibliographic data than Google Scholar.

Despite these strengths, Scopus also has a crucial limitation. Its coverage is comprised primarily of English-language documents. This is relevant for a review of a field such as ESD, where research documents may also be authored in other languages (e.g., Chinese, French, Spanish, Bahasa Indonesia, etc.). With this in mind, the researcher acknowledges from the outset that developing a comprehensive global picture of the literature on ESD will require complementary reviews of alternate language literature.

The search for documents in Scopus encompassed journal articles, books, book chapters, and conference proceedings. No boundary was set on the time period of publication; the Scopus search continued up to the end of 2018. The topical focus of the

review was delimited to “education for sustainable development in K-12 schooling”. ESD documents with a focus on higher education or sustainability science were excluded. The one exception to this decision rule concerned papers focusing on “teacher training for ESD in higher education programs”, which was deemed directly relevant to the purpose of this review.

The researcher employed a single broad search term (i.e., “education for sustainable development”) rather than a series of discrete search terms that presupposed a particular definition for ESD (e.g., inclusive education, peace education, etc.). The keyword terms used in the Scopus search were as follows:

(TITLE-ABS-KEY ("sustainable development") AND TITLE-ABS-KEY (school) AND NOT TITLE-ABS-KEY ("higher education") AND NOT TITLE-ABS-KEY (university))

The researcher followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for the document search (Moher et al., 2015). PRISMA requires the reviewers to make explicit all steps in the search and screening process (see Figure 2.1). The initial Scopus search yielded 2066 documents. The researcher excluded 41 documents based on ineligible document types (e.g., notes, editorials). Following this filtering, the researcher inspected the title and abstract of each document to determine its topical relevance. This led to the deletion of an additional 183 documents from the Scopus list. These typically focused on ESD in higher education or peripheral topics (e.g., teaching with IT). The final database was comprised of 1842 Scopus-indexed documents of mixed types, focusing on ESD in K-12 schooling (see Figure 2.1).

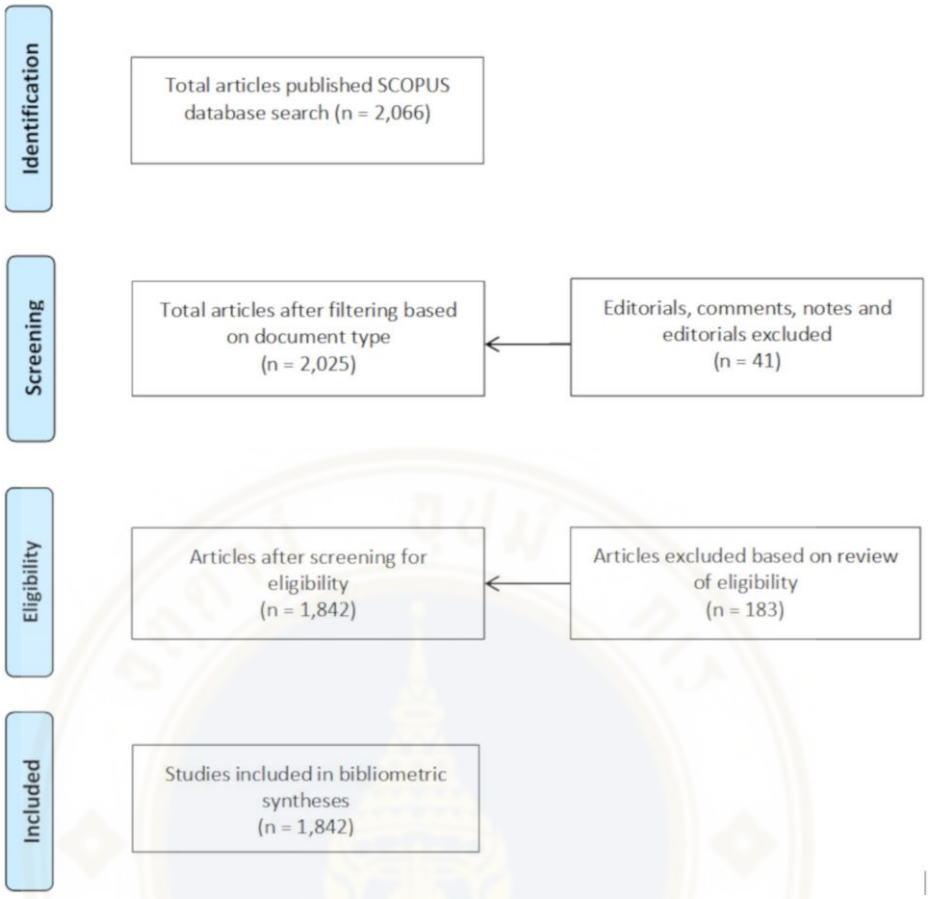

Figure 2.1 PRISMA Flow Diagram Detailing Steps in the Identification and Screening of Sources for Review of ESD

2.3.2 Data Analysis

Meta-data related to the 1842 ESD documents were exported from Scopus into a master Excel file. Excel was used to conduct descriptive statistical analyses aimed at documenting the landscape of ESD scholarship (e.g., growth trajectory, geographical distribution, and types of research papers). Data in the master Excel file were subsequently uploaded into VOSviewer, a bibliometric software package used for science mapping (Van Eck & Waltman, 2014). Bibliometric analyses conducted in VOSviewer included author and document citation analysis and author co-citation analysis.

Citation analysis has long been employed to identify prominent authors and documents within domains of knowledge (Zupic & Čater, 2015). Citation analyses conducted in VOSviewer, computed the frequency with which authors and documents

in the review database (i.e., the 1842 documents) had been cited in other Scopus documents. These are referred to as "Scopus citations" since the citations are limited to citations by documents covered in the Scopus index.

Author co-citation analysis was used to generate "co-citation counts" and to visualize the intellectual structure of the literature in a network map (White & McCain, 1998; Zupic & Čater, 2015). Author co-citation is the frequency with which two authors are cited together in the "reference lists" of documents in the review database (Small, 1973). A key differentiating feature of co-citation analysis is the source of citation data. Thus, unlike citation analysis, the results are not bounded by the scope of the source index (i.e., Scopus).

Co-citation analysis also has the ability to "visualize similarities" among authors. Small (1973) proposed that when two authors are frequently cited together by other authors (i.e., co-cited), they tend to share an intellectual similarity. VOSviewer creates matrices of co-citation frequencies as the input for co-citation mapping and the "visualization of similarities" or VOS (Van Eck & Waltman, 2014). This review used author co-citation analysis to visualize relationships among frequently co-cited authors in the K-12 ESD knowledge base (Van Eck & Waltman, 2014; Zaby, 2019; Zupic & Čater, 2015).

2.4 Results

In this section, the findings are presented sequentially with respect to each of the research questions.

2.4.1 Topographical Landscape of the ESD Knowledge Base

The first research question focused on documenting the volume, growth trajectory, geographical distribution, and types of papers comprising the ESD knowledge base. The 1842 Scopus-indexed documents comprised 1408 journal articles, 203 book chapters, 195 conference papers, and 36 books. The journal articles were published in 397 different journals specializing in general education, environmental education, science education, geography, sustainability, and cultural studies (not tabled). For example, diverse journals publishing articles on ESD in K-12 schools

included *Environmental Education Research, International Review of Education, Journal of Cleaner Production, International Journal of Early Childhood, Research in Science Education, Teaching Geography, BMC Public Health, and the International Journal of Engineering Education.* This breath of journal foci suggests that the use of ESD in K-12 schools has attracted significant cross-disciplinary interest among scholars and practitioners.

As indicated in Figure 2.2, 31 Scopus-indexed ESD documents were published during the 1990s (Disinger, 1990; Huckle & Sterling, 1996; Tilbury, 1995). A trend of gradual growth in scholarly publication continued until 2005, when the launch of the UNDESD sparked a sudden increase in ESD publications (see Figure 2.2). During the UNDESD, 890 documents were published in Scopus-indexed sources. This growth trend has accelerated further in recent years, with 688 documents published between 2015 and 2018.

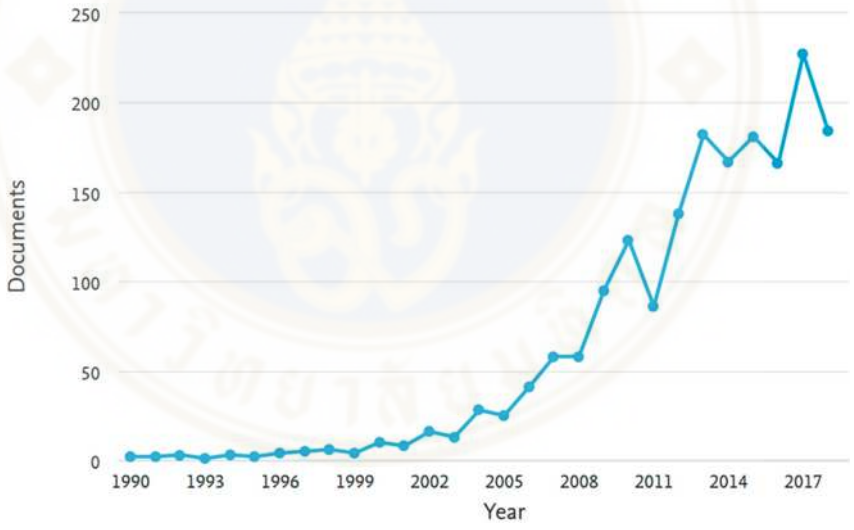

Figure 2.2 Growth Trajectory of the Literature on ESD in K-12 Schooling, 1990–2018 (n = 1842)

Our next analyses examined the geographic distribution of the ESD literature. The heat map in Figure 2.3 shows that this is becoming a global literature. Nonetheless, authorship of publications on ESD has been concentrated in economically developed, Anglo-American-European societies. Leading contributors to the ESD knowledge base have come from the United Kingdom (272), the United States (281),

Australia (205), Sweden (122), Germany (119), Canada (94), and the Netherlands (72). In contrast, only 25% of these ESD documents were authored in developing societies. At the same time, it was also observed that an increasing proportion of studies coming from Asia (e.g., China, Japan, Malaysia, Hong Kong, India, Israel, Thailand, and Indonesia), Africa (e.g., South Africa, Nigeria, Kenya, and Tanzania), and Latin America (e.g., Brazil) in recent years. Indeed, over 80% of the documents authored in developing societies were published since 2010.

Figure 2.3 Global Distribution of Literature on ESD in K-12 schools, 1990–2018 (n = 1842)

Next, the researcher examined the "types of research papers" that comprise the ESD literature. Any scientific literature is comprised of a distribution of conceptual, commentary (i.e., critique, personal experience, prescriptive), empirical (data-based studies), and research review papers. Although there is no optimal distribution that applies to all literature, the balance among these types of research papers can offer insight into the status of the current knowledge base and suggest implications for further development.

Given the large number of documents in our ESD database, the researcher coded and analyzed a sample of papers rather than the whole database. Cochrane's formula (Cochran, 1977) was used to calculate the sample size of documents needed to

obtain a 95% confidence interval. Then the researcher randomly selected and coded 288 of the documents as one of the four types of documents specified above. The Scopus-indexed ESD literature comprised 43.9% commentaries, 37.1% empirical studies, 17.7% conceptual essays, and 1.3% research reviews. This distribution suggested a surprisingly low proportion of empirical studies compared with other education literatures (Hallinger & Chen, 2015).

The researcher conducted further analysis of the empirical studies in this sample of ESD research to identify the distribution of research methods employed in this literature. The results indicated a distinct preference for qualitative and descriptive quantitative research methods (i.e., tests showing mean and distributions). In total, only five percent of the full ESD corpus consisted of studies that used quantitative methods capable of testing hypotheses or assessing the impact of ESD programs, curricula, and teaching methods (not tabled). Notably, however, 71% of the studies that used inferential statistics were conducted in the last decade. This compared with none during the 1990s and 29% during the 2000s. While descriptive studies (i.e., qualitative and descriptive quantitative) have a useful place in any knowledge base, advancing knowledge also requires a critical mass of inferential studies examining the effectiveness and impact of programs and practices (Bridges, 1982; Hallinger & Chen, 2015).

2.4.2 Analysis of Influential Authors and Documents

The next analyses documented author contributions to the ESD knowledge base from the perspectives of "productivity" and "citation impact". As indicated in Table 2.1 Wals (20), Kopnina (18), Tilbury (14), Davis (14), Gericke (14), and Bögeholz (14) have been the leading contributors to this literature in terms of the number of authored papers in our review database. The most "influential scholars" in the ESD literature, measured by total Scopus citations, were Wals, Tilbury, Kopnina, Jickling, Sterling, Davis, and Öhman, each of whom achieved over 200 Scopus citations from their ESD publications (see Table 2.1). Consistent with the earlier geographical analysis, the 20 most highly-cited ESD authors all came from Anglo-American-European societies. None were associated with institutions in developing societies.

Table 2.1 Rank Order of the 20 Most Cited Authors Publishing Two or More Documents on ESD in K-12 Schools, 1990–2018.

Rank	Author	Focus	Docu-ments	Scopus Citations	CPDs[1]
1	Dobson, A.	Social/ESD	2	665	333
2	Hargeaves, A.	ESD	5	588	118
3	Wals, A.	ESD	20	578	28.9
4	Tilbury, D.	ESD	14	359	25.6
5	Kopnina, H.	Env. Ed.	18	317	17.6
6	Jickling, B.	Env. Ed.	6	314	52.3
7	Sterling, S.	ESD	10	292	29.2
8	Davis, J.	Env.Ed./ESD	14	230	16.4
9	Öhman, J.	Env. Ed.	10	230	23.0
10	Scott, W.	ESD	8	183	22.9
11	Eilks, I.	Science Ed.	12	180	15.0
12	Bögeholz, S.	Science Ed.	14	161	11.5
13	Gericke, N.	Science, ESD	14	156	11.1
14	Gough, A.	Ed./ESD	10	131	13.1
15	Burmeister, M.	Science ESD	6	131	21.8
16	Schnack, K.	Education	2	128	64.0
17	Jacobson, S.	Env. Ed.	2	127	64
18	Rauch, F.	ESD	6	119	19.8
19	Dillon, J.	Education	4	107	26.8
20	Reid, A.	Env. Ed.	9	106	11.8

[1] CPDs=citations per document; Env. Ed.=environmental education; ESD=education for sustainable development; Ed.= education

Next, citation analysis of documents was to ascertain the most influential research papers in the K-12 ESD literature (see Table 2.2). First, it was noted that the magnitude of Scopus citations was relatively low even among the 20 most frequently cited documents. This suggests that this literature has yet to gain a broader impact. Second, the highly-cited documents in Table 2.2 are again dominated by Anglo-European scholars. Third, although the highly-cited documents reflect the roots of ESD in environmental education (Jacobson et al., 2015; Jickling & Wals, 2008; Kopnina, 2012; Tilbury, 1995), they also include other foci encompassed in our conceptual definition of ESD. These include general school education (Tilbury, 1995), health education (Barry et al., 2013; Scott, 2015), as well as specialized subjects such as science and citizenship education (Oulton et al., 2004).

Finally, it noted that conceptual papers dominate this list. Only three of the

papers in Table 2.4 were empirical studies, and none were research reviews. This was surprising since research reviews often overlook lists of highly-cited documents in bibliometric reviews. The paucity of research reviews is likely related to the relatively low number of empirical studies. Without a critical mass of empirical research, there is only a limited basis for research reviews.

Table 2.2 Rank Order of the 20 Most Highly-Cited K-12 ESD Documents, 1990–2018

Rank	Document	Topic	Type[2]	Scopus Citations[1]
1	Dobson (2003). Social justice and environmental sustainability: Ne'er the twain shall meet.	ESD; Env. Ed.	Con	522
2	Hargreaves and Shirley (2009). The fourth way: The inspiring future for educational change.	Change	Con	250
3	Keesstra et al. (2016). The significance of soils and soil science towards realization of UN SDGs.	Env. Ed.	Com	250
4	Hargreaves and Goodson. (2006). Educational change over time?	Change	Emp	189
5	Tilbury. (1995). Environmental education for sustainability.	Env. Ed.	Con	177
6	Jickling and Wals. (2008). Globalization and environmental education	Env. Ed.	Con	176
7	Wals (2007). Learning in a changing world and changing in a learning world.	ESD	Con	151
8	Dobson (2007). Environmental citizenship: towards sustainable development.	Citizen Ed.; Env. Ed.	Con	143
9	Jacobson et al. (2015). Conservation education and outreach techniques.	Env. Ed.	Com	126
10	Gough and Scott. (2003). Sustainable development and learning.	ESD	Con	119
11	Hoelscher et al. (2004). School-based health education programs can be maintained over time.	Health	Emp	115
12	Mogensen and Schnack (2010). The action competence approach and the "new" discourses of ESD.	ESD; Env. Ed.	Con	105

[1] SCOPUS citations at the time of the review. [2] Type of document: con—conceptual, com—commentary, emp—empirical, rev—review.

Table 2.2 Rank Order of the 20 Most Highly-Cited K-12 ESD Documents, 1990–2018 (cont.)

Rank	Document	Topic	Type[2]	Scopus Citations[1]
13	Jickling (1992) Why I don't want my children to be educated for sustainable development.	ESD	Com	102
14	Hargreaves and Fink (2004). The seven principles of sustainable leadership.	ESD	Con	101
15	Barry et al. (2013). A systematic review of effectiveness of mental health interventions for young children.	Health	Rev	100
16	Kopnina (2012). ESD: The turn away from "environment" in environmental education?	Env Ed.	Emp	99
17	Oulton et al. (2004). Controversial issues-teachers' attitudes and practices in citizenship education.	Citizen Ed.	Com	95
18	Dale and Newman (2005). Sustainable development, education and literacy.	ESD	Con	94
19	Sterling (2010). Learning for resilience, or the resilient learner?	ESD	Con	82
20	Burmeister et al. (2012). Education for Sustainable Development (ESD) and chemistry education.	ESD; Env. Ed.	Con	70

[1] SCOPUS citations at the time of the review. [2] Type of document: con—conceptual, com—commentary, emp—empirical, rev—review.

2.4.3 Intellectual Structure of the ESD Knowledge Base

Our third research question sought to illuminate the intellectual structure underlying published ESD theory and research. Using a threshold of 50 co-citations, VOSviewer generated a co-citation map that displays the 94 most frequently "co-cited authors" in the ESD literature (see Figure 2.4). Size of the author "nodes" on the co-citation map in Figure 2.4 reflects the magnitude of author citations in the reference lists of the review documents. The proximity of author nodes indicates the frequency of co-citation and, therefore, the degree of intellectual affiliation between authors. The colored clusters of authors represent the conceptual pillars or "schools of thought" that make up the ESD knowledge base (White & McCain, 1998; Zupic & Čater, 2015).

The co-citation map in Figure 2.4 shows three distinctive but interconnected "schools of thought" in the ESD knowledge base: Education for Sustainable Development, Teaching and Learning for Sustainability, and Developing a

Sustainability Mindset. As indicated on the map, these schools vary in terms of the number of scholars, author dispersion, author prominence, and density of links among authors both within and between clusters.

The red cluster represents a school of authors who have written broadly on Education for Sustainable Development. Not only is this the largest school within the ESD knowledge base, but it also contains several of the most frequently co-cited authors in this literature (i.e., Wals, Tilbury, Sterling, Huckle, Scott, Fien, Reid). Its "central location" on the map suggests that this school is the "conceptual anchor" of the ESD literature. This is reflected in publications that have offered definitions of education for sustainable development (Gough & Scott, 2006; Huckle & Sterling, 1996; Tilbury, 1995), and charted its evolution (Huckle & Wals, 2015; Jickling & Wals, 2012).

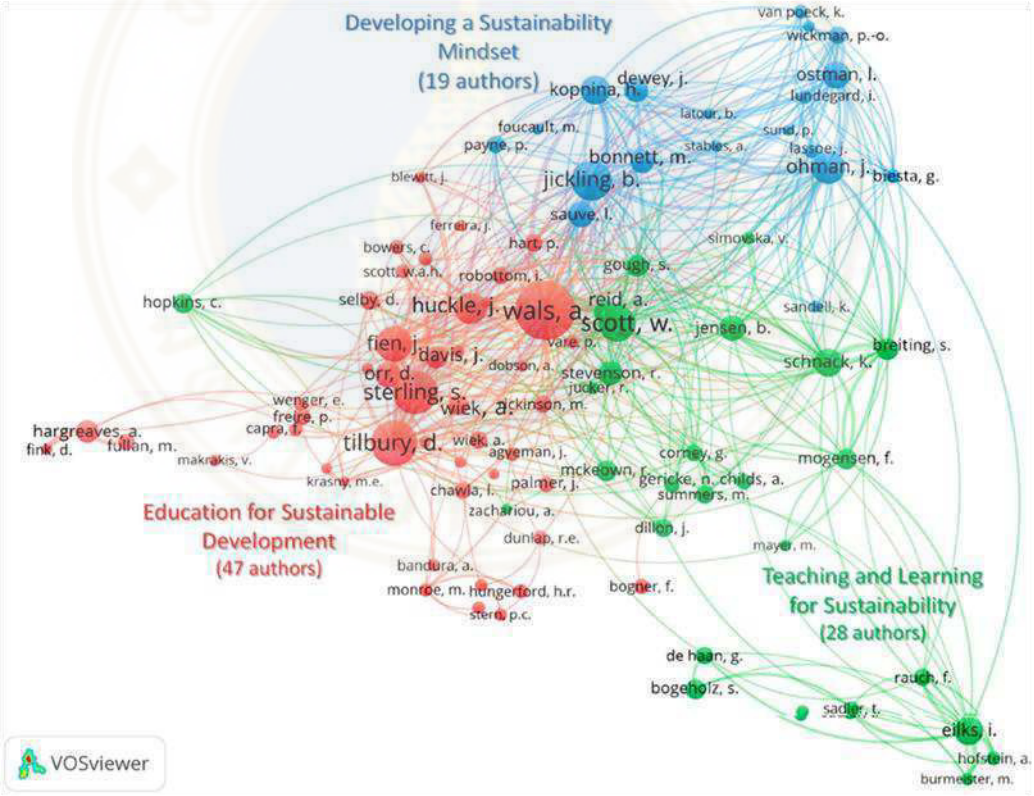

Figure 2.4 Author Co-Citation Map of the literature on ESD (author co-citation network 53,696 authors; threshold of 50 citations; display 94 authors; 3 clusters; 3622 links)

The central location of Wals, Scott, and Reid on the map and the density of their cross-cluster linkages highlight their role as "boundary spanning scholars" who have integrated conceptual contributions across all three of the schools. A small sub-school in the left-hand region of the school consists of scholars who have focused on leadership and change for ESD (i.e., Hargreaves, Fullan, Fink) (Fullan, 2005; Hargreaves & Fink, 2004; Hargreaves & Shirley, 2009).

The green cluster is comprised of scholars who have focused on "Teaching and Learning for Sustainability". It is interesting to note that most of the empirical papers in this sub-school were qualitative or quantitative-descriptive studies. Relatively few empirical studies have examined the impact or effectiveness of different ESD curriculum, teaching, and learning methods. As suggested by the dispersion of authors within this school, this school comprises three sub-clusters reflecting discrete but related lines of inquiry.

The first line of inquiry has examined how teachers organize the curriculum in teaching for sustainability and to overcome obstacles to integrating ESD into their classrooms (Burmeister et al., 2012; Summers et al., 2003; Wiek et al., 2011). This sub-school includes studies of teacher and student knowledge and attitudes as well as alternative approaches to curriculum design and teaching and learning methods (Balsiger et al., 2017; De Haan, 2010; Eilks, 2015). Again, as noted above, this line of inquiry is dominated by descriptive and prescriptive papers, with a lack of strong evaluative research that offers insights into the efficacy of different approaches to teaching and learning for sustainability (Davis, 2009; Rickinson, 2001; Stanitsas et al., 2019).

A second sub-school concerns the preparation and training of teachers with the knowledge and attitudes needed to teach sustainability content (Corney, 2006; Corney & Reid, 2007; Ferreira et al., 2007). Research conducted within this sub-school has theorized on the ESD-related competencies needed by teachers (Rauch & Steiner, 2013), explored different models of teacher education for sustainability (Ferreira et al., 2007; Summers et al., 2005), and examined the efficacy of teacher education programs focusing on sustainability (Chinedu et al., 2018; Corney, 2006). This research finds that the whole school, action research, and adaptation models have gained the greatest acceptance (Chinedu et al., 2018; Ferreira et al., 2007; Pipere et al., 2015; Summers et

al., 2005).

The third sub-school consists of scholars who have developed "action competence" as a focus for ESD in K-12 education. The key scholars representing this sub-school include Jensen, Mogensen, Breiting, and Schnack. Jensen and Schnack defined action competence as education that "builds up students' abilities to act—their action competence—with reference to environmental concerns" (Jensen & Schnack, 1997). Rather than seeing the goal of ESD as only changing individual behavior, proponents of this school highlight the goal of enabling students (citizens) to change structural features of society that cause environmental and social problems that threaten sustainability (Mogensen & Breiting, 2005; Mogensen et al., 2005; Mogensen & Schnack, 2010).

The blue cluster represents a school of thought focused on Developing a Sustainability Mindset. Led by Jickling, Kopnina, Öhman, Bonnett, Dewey, Ostman, and Wickman, this school emphasizes the social, ethical, political, and moral dimensions of ESD (Bonnett, 2002; Gough & Scott, 2006; Kopnina & Cherniak, 2016; Öhman, 2006; Sund & Öhman, 2014). The genesis of this cluster can be traced to the research of scholars such as Jickling and Kopnina on environmental education (Jickling & Spork, 1998; Kopnina, 2014). Authors writing in this school view the goal of ESD as creating a consciousness or mindset among learners that will overcome taught biases and inform future decision-making in their lives (Crist & Kopnina, 2014). Although none of his writings were included in our database, John Dewey's location in this cluster highlights his influence on the scholars in this school. More specifically, Dewey's conceptions of education for democracy (Dewey, 1923) and experiential learning (Dewey, 1986) have shaped this school's conceptualizations of ESD.

2.5 Discussion

This systematic review sought to document and synthesize research trends in the knowledge base on education for sustainable development in K-12 schooling. The review used science mapping to examine 1842 Scopus-indexed documents published over the past 30 years. This closing section highlights the study's limitations, interprets the main findings, and discusses implications for future research.

2.5.1 Limitations of the Review

It was reiterated that bibliometric analysis does not focus on substantive findings reported by documents. Rather this method was used to document and analyze trends in ESD knowledge production. Therefore, this review did not synthesize the results of ESD studies.

Another limitation arises from our decision to limit the review to sources included in the Scopus database. This impacted the validity of the review in two specific ways. First, while Scopus offers broad coverage of peer-reviewed journals, it is less comprehensive in its coverage of books, book chapters, and conference reports. Second, the review's focus on English language sources meant that documents published in other languages were not included in our analysis of the literature (e.g., Chinese, French, Spanish, Portuguese, Malay). This is a potentially significant limitation in light of the finding that the reviewed literature was heavily weighted towards documents authored in developed Western countries. Readers should interpret our results with these limitations in mind.

2.5.2 Interpretation of the Findings

The review identified a moderately sized corpus comprised of 1842 Scopus-indexed, ESD-related documents published between 1990 and 2018. The recent growth trajectory in ESD scholarship has been one of rapid ascent, suggesting that it is a literature of recent vintage. The roots of this literature in environmental education were apparent in early ESD documents published during the 1990s. Nonetheless, as the ESD literature grew during the 2000s, it attracted scholars from more diverse fields, such as health education (Barry et al., 2013), science education (Henriques et al., 2011), and inclusive education (Kopnina, 2012). This evolution is consistent with trends in the broader literature on sustainable development, whereby scholars increasingly focus on social as well as environmental concerns (Hallinger & Chatpinyakoop, 2019; Hassan et al., 2014; Zaby, 2019).

The data presented in this review suggest that ESD is gaining interest among a global community of scholars. It is due, in part, to the efforts of international organizations (e.g., United Nations, UNESCO, OECD). At the same time, however, it was found that the ESD literature is concentrated in Anglo-American-European

societies. This finding was affirmed in both geographical and citation analyses. For example, only 25% of the EDS literature was authored in developing societies, and no highly-cited authors or documents came from developing societies (see Table 2.1 Table 2.2). European scholars have generally led the way in developing the discourse on ESD.

This geographical imbalance in the ESD literature is problematic for several reasons. First, international assessments have concluded that sustainability challenges will have the most severe effects on developing societies (Elliot & Lavarack, 2012; Sachs, 2015). The lack of information on how educational content, processes, and systems can be adapted to support sustainability solutions in developing societies places them at a disadvantage. This problem is exacerbated by the observation that "interpretations" of ESD and related "solutions" sourced from developed societies (e.g., Sweden, Germany, UK, USA, Australia) may not always "fit" or be deemed practical in developing societies (Cohen, 2006; Hallinger & Suriyankietkaew, 2018). Cultural values, institutional policies, and financial resources cohere to create a "different context" for addressing sustainability challenges in developing societies (Cohen, 2006; Hattingh & Attfield, 2002; Roy et al., 2014).

Cross-national experience gleaned from developed societies is, of course, relevant. However, the need to contextualize policies and practices highlights an urgent need for greater diversification of the ESD knowledge base. Indeed, the kinds of curriculum and instructional approaches adopted in Western societies do not always find a similar uptake in developing societies. Teacher and student attitudes towards novel approaches to teaching and learning differ across cultures (Biggs, 2001).

The research reveals that the ESD knowledge base appears overly weighted towards prescriptive commentaries and descriptive research. While the researcher is not advocating for "blind empiricism", a mature knowledge base requires a critical mass of research that examines problems empirically, tests the utility of prescriptions, and validates theories. Thus, the next generation of ESD literature needs more empirical research that describes and analyzes ESD implementation in diverse contexts. Although continuing conceptual critiques of developments in ESD are warranted, the field urgently needs research that offers insights into patterns of curricular and instructional practice and their efficacy in achieving the goals of ESD. This will require a critical mass of qualitative, mixed methods, and more sophisticated quantitative studies using a

wider variety of research designs.

Based on a combination of productivity, citation, and co-citation analyses, the review identified Arjen Wals (Huckle & Wals, 2015), Bob Jickling (Jickling, 2016; Jickling & Wals, 2012), Daniella Tilbury (Tilbury, 2015, 2019), Helen Kopnina (Kopnina, 2014, 2020), Stephen Sterling (Jickling & Sterling, 2017; Sterling, 2016), William Scott (2015, 2018), and Johann Öhman (Öhman, 2006; Öhman & Östman, 2019) as the most influential scholars in the emergent ESD literature. Author co-citation analysis further identified John Dewey's scholarship on democratic and experiential education as foundation stones in the ESD literature. Quite correctly, in 2011, Armstrong posited that ESD is the next chapter in the evolution of progressive education launched by Dewey a century ago (Armstrong, 2011).

Document citation analyses documented the roots of ESD in environmental education and its gradual expansion into related fields of public health, science, geography, special education, and early childhood education. These analyses further identified seminal papers in this field. These included the Brundtland Report as well as conceptual papers authored by Jickling and Wals (2008), Jensen and Schnack (Jensen & Schnack, 1997), and Bonnett (Bonnett, 2002).

Our final analyses sought to illuminate the "intellectual structure" of the ESD knowledge base (White & McCain, 1998; Zupic & Čater, 2015). The researcher found that the ESD knowledge base comprises three schools of thought of varying size and impact. The largest and most influential school is comprised of a constellation of scholars who have focused on defining and critiquing Education for Sustainable Development. Other schools of thought have focused on Developing a Sustainability Mindset and Teaching and Learning for Sustainable Development. These schools of thought, self-organized by the contributing scholars, were identified inductively through author co-citation analysis. These empirically derived findings complement trends reported in previous reviews of the ESD literature that used traditional research synthesis methods (Aikens et al., 2016; Salas-Zapata et al., 2018; Scott, 2015; Somerville & Williams, 2015; Summers et al., 2003).

2.6 Conclusions

In conclusion, this review offers several recommendations. The "geographical imbalance" documented in this literature argues for measures that both stimulate and prioritize ESD research from developing societies. Measures designed to stimulate research on ESD in developing societies could, for example, take the form of research grants programs launched by foundations (e.g., Ford Foundation, Asia Foundation) and international organizations (e.g., OECD, World Bank, UNESCO). Capacity-building strategies aimed at scholars in developing societies could include post-doctoral fellowships as well as the formation of research centers and networks that explicitly prioritize and support scholarships and capacity development among scholars in developing societies. Journals may also wish to more actively capture and highlight research on ESD in developing societies through special issues. These practical steps represent stepping stones towards a more diverse global knowledge base in ESD.

A second implication follows from the lack of a critical mass of empirical research in the ESD knowledge base. Although conceptual and commentary papers form an essential portion of any "mature" knowledge base, at some point, both policymakers and practitioners also need guidance on "what works"; when, how, and under what conditions. This must be addressed in the coming years. Otherwise, this field will be in danger of being dismissed as an academic wonderland of critique and prescription divorced from practice in schools.

Third, findings arising from citation analyses offer useful information for scholars working in this emerging field. For example, the author and document citation analyses could be used to generate an initial "reading list" for new scholars. This would reduce the start-up time required for scholars entering this field of education research. Similarly, the schools of thought identified through the author co-citation analysis highlight the influential conceptual streams of inquiry that have emerged in this field of sustainability scholarship.

Finally, as noted earlier, this review was limited to the English language literature on ESD. As such, it offers an incomplete picture of global ESD scholarship. This review should, therefore, be complemented by future efforts to capture and disseminate findings reported in literature published in other languages.

CHAPTER III
WHOLE SCHOOL APPROACHES TO EDUCATION FOR SUSTAINABLE DEVELOPMENT: A REVIEW OF THE RESEARCH

3.1 Introduction

Sustainability has become a new agenda for societies worldwide over the past several decades (Caradonna, 2014). Education plays a pivotal role in confronting future challenges and creating a new path towards sustainable development (Bertschy et al., 2013; Leal Filho et al., 2015; UNESCO, 1997). However, there are many approaches to education, and not all focus on sustainability. Education for sustainable development (ESD) is ideally a key tool that empowers learners to make more reasonable decisions and responsible actions for the environment, economy, and society for both the present and future (Rieckmann, 2017).

In the recent past, the increasing focus on education for sustainable development has yielded calls for evidence on how different ESD approaches contribute to quality education (Leal Filho et al., 2015). ESD approaches vary in terms of their goals or focus (e.g., environment versus social concerns) as well as through their means (e.g., integrated or subject-oriented). A recent bibliometric review of research also found that different approaches to ESD have evolved in various countries (Hallinger & Nguyen, 2020).

In this review, the author examines a range of 'whole school approaches' to ESD that have evolved in different societies, including Thailand, Sweden, the United States, and Australia. The ESD approach adopted in Thailand was selected as a primary focus for the review based on the need to develop ESD approaches that respond to developing societies' unique needs and constraints.

Therefore, this study sought to document and synthesize literature on whole school approaches to education for sustainable development. This review set out to answer the following research questions:

1. What key features describe whole school approaches to education for sustainable development?

2. What has research found concerning the implementation and efficacy of efforts to apply the Sufficiency Economy Philosophy (SEP) education model for sustainable development in Thailand?

3. What has research found concerning the implementation and efficacy of whole school approaches of education for sustainable development used in Australia, the United States, and Sweden?

4. What distinctive features distinguish these whole school approaches of education for sustainable development?

This systematic review of research examined the range of conceptual and empirical research which describes efforts to implement whole school approaches to ESD in these four nations. The review applies a comparative framework to identify the distinctive approaches that have evolved in each of these societies. Finally, the study seeks to understand what can be learned from research and practice on whole school approaches to ESD.

3.2 Conceptual Background

3.2.1 Education for Sustainable Development

In 1987, the World Commission on Environment and Development (WCED), so-called The Brundtland Commission, was organized to unify countries from all over the world in a common pursuit of sustainable development. By declaring Our Common Future report, the WCED aims to define the concept of sustainable development, identify and increase global awareness of sustainability-related problems, and prompt action towards identifying and implementing solutions (Brundtland et al., 1987). Five years later, at the Earth Summit in Rio de Janeiro, Brazil, the term "Education for Sustainable Development" (ESD) emerged in the sustainability lexicon as a new concept.

Later in 2002, UNESCO initiated the "United Nations Decade of Education for Sustainable Development" from 2005 to 2014 (UNDESD). After the UNDESD in

2014, UNESCO endorsed the Global Action Programme (GAP) on Education for Sustainable Development (ESD) to call for collective actions in the education sector so that the progress towards sustainable development is able to accelerate worldwide. Furthermore, in 2015 the United Nations proposed the 2030 Agenda for Sustainable Development with 17 Sustainable Development Goals for international implementation. These include goal 4, "Quality Education".

These historical events illustrate the increasingly influential role that education has played in the sustainable development movement worldwide. Education for sustainable development has grown from its early roots in environmental education (Jickling & Wals, 2008; Sherren, 2008). It started with raising awareness about sustainability, building sustainability competencies, experimenting, and implementing exemplary practices in schools (Kopnina & Meijers, 2014; Pauw et al., 2015).

Therefore, this review adopts the following ESD conceptual definition in K-12 schooling. ESD includes educational programs, curricula, and teaching and learning practices that enhance student values, understanding, and capabilities concerning the challenges of social, environmental, and health sustainability (Huckle & Wals, 2015; Scott, 2015; UNESCO, 2015). The need for content and education processes is highlighted to engage learners in developing a deeper appreciation of how human behavior impacts the sustainability of people and the planet (Hallinger & Nguyen, 2020).

3.2.2 The Whole School Approaches to Education for Sustainable Development

Whole school approaches represent an increasingly influential theme in the ESD movement (Hallinger & Nguyen, 2020; Tilbury & Wortman, 2005). Emerging gradually over the last few decades, whole-school approaches to sustainability seek to reorient basic features of the school around sustainability goals (Tilbury & Wortman, 2005; UNESCO, 2002). The whole school approaches have spread across continents, covering beyond school grounds improvement and environmental education, connecting governance, resource allocation, stakeholder involvement, curriculum, teaching and learning process, and community partnership (Tilbury & Wortman, 2005).

Despite the global growth of whole school approaches to ESD, there is no one-size-fits-all model for sustainable schooling. Indeed, different emerging approaches have reflected the contexts and priorities of other societies. This review uses the phrase "whole school approach to education for sustainable development" interchangeably as the same meaning of phrase "whole school approach to sustainability", "sustainable educational organization" or "sustainable school".

According to the UNESCO Associated Schools Network, the concept of a whole-school approach to sustainability encompasses the inclusion of all stakeholders within the school community, including students, staff, and partners. This approach not only addresses the educational needs of learners through the curriculum, but also encompasses all facets of school life. Implementing a whole-school approach requires collective and collaborative efforts from the school community to enhance student learning, behavior, well-being, and the conditions that support these outcomes (UNESCO, 2018).

Whole school ESD approaches seek to provide opportunities for students and staff to contribute to sustainable living as models of good practice and demonstrate good practices to stakeholders in the community. Gough (2005) defined a sustainable school as an organization that "integrates changes to the practical operations of the school with sustainability issues in the curriculum and helps to build links with local communities" (p. 340). For example, in the UK, high standards of achievement and behavior were integrated into sustainable schools to pursue healthier and more sustainable living and better environmental awareness and community involvement (Hm Government, 2005). Similarly, Breiting, Mayer, and Mogensen (2005) stated that sustainable schools "have chosen ESD as a central part of their mission and their educational plan" (p.4).

Thus, despite the differentiation of ESD implementation in various societies, sustainable schools have begun to develop common characteristics on a global scale. As a modern educational paradigm, ESD demands a deep level of change among main stakeholders in school processes, affecting both schools and the wider community's environmental, social, technical, and cultural dimensions. This review aims to uncover, critique, and illustrate the critical dimensions of whole school approaches to sustainability that has evolved in several different international contexts.

3.3 Method

For this review of research, the author used the meta-synthesis method to synthesize key features of these ESD approaches (Jensen & Allen, 1996). Among methods for conducting a literature review, meta-synthesis is considered a systematic method because findings and insights from a range of studies on a topic can be evaluated and presented consistently (Thorne et al., 2004). Meta-synthesis aims to gain understanding by comparing and synthesizing findings from multiple studies. Generally, meta-synthesis combines commonalities and contradictions across relevant studies to provide a transformative understanding of a topic or phenomenon of interest (Alam, 2022; Jensen & Allen, 1996; Thorne et al., 2004; Walsh & Downe, 2005). The review focuses on several countries that have accumulated significant research on ESD (i.e., the USA, Australia, and Sweden) (Hallinger & Nguyen, 2020). Moreover, the author added Thailand as a point of contrast because developing societies lack ESD research (Hallinger & Nguyen, 2020).

Mathar (2015) stated that whole school approaches should include legal and policy framework, school facilities, human resources, condition of students (background, learning processes, and outcomes), integration into the community, partnerships, and collaboration. Mogren & Gericke (2017a) identified collaborative interaction, school development processes, student-centered education, cooperation with local society, and proactive leadership as critical dimensions of a whole school approach.

In the education sector, a Google Scholar search identified 12 studies on SEP implementation in Thai schools. However, since only three studies focused specifically on the Virtuous School Project (Dharmapiya & Saratun, 2015; Suriyankietkaew & Hallinger, 2018; Saratun & Dharmapiya, 2020), the author decided to include the whole literature on the use of SEP in Thai education. The full set of identified empirical studies is shown in Appendix A.

A Google Scholar search identified studies on the whole school ESD approaches used in the USA, Australia, and Sweden. The full set of identified empirical studies is listed in Appendix B. Regardless of the research design, and these studies conducted quantitative research method (Berglund et al., 2014; Ferreira & Davis, 2012; Mc Key, 2017; Olsson et al., 2015; Pauw et al., 2015; Sterrett, Imig, & Moore, 2014).

Six studies conducted qualitative research method (Borg, 2017; Evans, 2015; Mogren & Gericke, 2017a; Pepper, 2014; Potter, 2007; Sterrett & Imig, 2015), while six studies used mixed method (Australian EfS Alliance, 2014; Kennelly, 2012; Lewis, Baudains, & Mansfield, 2009; Mogren & Gericke, 2017b; Rickinson, Hall, & Reid, 2014; Salter, 2103; Warner & Elser, 2015). Besides, most of the empirical studies used cross-sectional designs. Most quantitative studies have relied on descriptive statistics and correlational analysis; only one study conducted an advanced statistical method with structural equation modeling (Pauw et al., 2015). Thus, the majority of studies are consistent with the broader ESD literature dominated by descriptive research methods (Hallinger & Nguyen, 2020).

Drawing upon these perspectives, the author analyzed each school ESD model using a standard set of categories related to this review's research questions. Those categories are structured as follows: 1) Background, 2) Values/Principles, 3) Curriculum, Instruction, and School Management, and 4) Distinctive Features. The review is formulated as a comparative review in which the whole school approach adopted in Thailand is presented first to provide greater depth. Then the whole school approaches adopted in the USA, Sweden, and Australia are presented. Finally, the distinctive features of these approaches are discussed and compared.

3.4 Results

Before the analysis begins, a summary of a descriptive feature of the four models is presented below in Table 3.1. As suggested by the data presented in Table 3.1, these approaches were initiated between 2000 and 2012. Moreover, as indicated in Table 3.1, even though this review intends to focus on whole-school ESD in K-12 schooling, many of the initiatives extend into tertiary education (e.g., the USA, Sweden). The following analysis seeks to identify and discuss common and distinctive features of these four whole-school approaches to sustainability.

Table 3.1 Summary of Four Whole School Approaches to Education for Sustainable Development

Model	Nation	Setting	Management	Key policy
Australian Sustainable Schools Initiative	Australia	K-10	Dept of Agriculture, Water and Environment (till 2011), Aust. Edu. for Sustainability Alliance	Env Ed for a Sustainable Future: National Action Plan, National Action Plan for EfS, Living Sustainably
Green Ribbon Schools Award	USA	All levels	Dept of Education	3 pillars criteria, ESD-GRS framework
Schools for Sustainable Development Award	Sweden	All levels	Swedish National Agency for Education	National curricula
Sufficiency-based Schools	Thailand	K-12	Ministry of Education & Virtuous Youth Foundation	Sufficiency Economy Philosophy; voluntary

Whole-school approaches used internationally in education for sustainable development are reviewed. Significant research on using whole school ESD approaches was recognized in many nations (e.g., the USA, England, Japan, Australia, Sweden, Turkey, Germany, and Canada). However, space limitations led the author to focus on how ESD has been conceptualized and implemented in just three countries: the USA, Australia, and Sweden. These countries were selected based on the significance of their contributions to the global literature on education for sustainable development identified in a recent review of this literature (Hallinger & Nguyen, 2020). While each whole school ESD approach has its distinctive histories and foci (e.g., differing degrees of operations, curriculum, and pedagogy), these approaches used in these societies are analyzed using the same framework: 1) background, 2) values/ principles, 3) curriculum, instruction, and school management, 4) distinctive features.

3.4.1 Sufficiency-Based Schools (Thailand)

Concurrent with United Nations-initiated efforts to promote sustainable development, Thailand has adopted the Sufficiency Economy Philosophy (SEP) as a related approach to sustainably developing (Piboolsravut, 2004; Wedchayanon &

Chorkaew, 2014). The Sufficiency Economy Philosophy (SEP) was developed by His Majesty King Bhumibol Adulyadej through over 60 years (Piboolsravut, 2004; Wibulswasdi, Piboolsravut, & Pootrakool, 2011).

3.4.1.1 Background of the SEP Model of ESD. Although SEP was formulated out of Thailand's local experience, this philosophy of sustainable development aligns with UN initiatives toward sustainability (Dharmapiya & Saratun, 2015; UNDP, 2007; UNESCO, 2013). Over the subsequent decades, SEP has served as a guiding framework to promote and achieve the implementation of UN SDGSs at all levels of Thai society (Ministry of Foreign Affairs, 2016). For example, SEP has been applied across various sectors such as agriculture, business, education, environmental conservation, and community development in Thailand (Barua & Tejativaddhana, 2019; Issarawornrawanich & Wuttichindanon, 2019; Mongsawad, 2012; Wibulswasdi et al., 2011).

Indeed, SEP has been widely adopted as a "people-centered approach to sustainable development" (Wedchayanon & Chorkaew, 2014; Wibulswasdi et al., 2011). The SEP approach has been shaped by the Buddhist concept of 'the middle path', which seeks to avoid extremes in emotions and actions (Oaas, 2013; Wibulswasdi et al., 2011). Consistent with the core precepts of Buddhism, the SEP model is based on the values fo moderation, reasonableness, prudence, and generosity (Kantabutra, 2014; Piboolsravut, 2004; Whietley, 2010).

The SEP philosophy has also been integrated into the educational system of Thailand. Specific efforts have been undertaken to embed the SEP approach in both K-12 (Dharmapiya & Saratun, 2015; Suriyankietkaew & Hallinger, 2018; Yuenyong & Narjaikaew, 2009) and higher education (Choochom, 2015; Jairak, Praneetpolgrang, & Subsermsri, 2015). In 2006, Thailand's Ministry of Education coordinated with a local foundation to create a nationwide project termed the Virtuous Schools Project that was explicitly guided by the values and principles of the Sufficiency Economy Philosophy (Dharmapiya & Saratun, 2015; Ministry of Education Thailand, 2011). The project's goals were to develop the capacity of schools to reorient school-level curricula as well as teaching and school management practices around the SEP values and principles (Dharmapiya & Saratun, 2015). As a whole school approach to educating for sustainability (Tilbury & Wortman, 2005), the project aimed at developing Thai students

into life-long learners capable of adopting self-reliant lifestyles characterized by responsible consumption, environmental consciousness, and wiser use of the nation's natural and human resources (Dharmapiya & Saratun, 2015; Saratun & Dharmapiya, 2020; Tungkasamit, Silanoi, Nethanomsak, & Pimthong, 2014; Yuenyong & Narjaikaew, 2009).

Over the next decade, the Virtuous Schools Project was implemented across Thailand at the primary, middle, and secondary school levels (Dharmapiya & Saratun, 2015; Sufficiency School Centre, 2015). This sufficiency-based school model accredits schools at the three levels. Basic certification is awarded to schools where SEP values, principles, and practices are introduced and gradually integrated into school and classroom-level practices. 'Best Practice Schools' are certified based upon significant longer-term integration of SEP practices. The highest ranking is the Sufficiency Education Learning Center (SELC), where the school becomes a community hub capable of advising, mentoring, and coaching other schools wishing to become SEP certified. As of 2020, there were around 21,000 schools with Basic certification, 724 Best Practice Schools, and 205 SELCs in Thailand (Saratun & Dharmapiya, 2020).

In 2018, Funding of the Virtuous Schools Project was discontinued due to changes in the political environment in Thailand (Saratun & Dharmapiya, 2020). Nonetheless, practices associated with the SEP approach to education continue to support K-12 and higher education throughout Thailand (Barua & Tejativaddhana, 2019; Suriyankietkaew & Hallinger, 2018; Saratun & Dharmapiya, 2020).

3.4.1.2 Values/Principles of SEP Education. The SEP model proposes two pre-conditions (i.e., knowledge and virtue) necessary to achieve sufficiency (Bergsteiner & Dharmapiya, 2016). Relevant knowledge is not limited to scientific literacy but includes 'local wisdom', which refers to knowledge grounded in solutions crafted in response to local problems in diverse fields. It may include agriculture, water resource management, pollution control, land management, and product development (Yuenyong & Narjaikaew, 2009). The emphasis on incorporating local wisdom into the school curriculum in concert with technological and scientific knowledge distinguishes sufficiency-based schools from some other whole school ESD models. Moreover, it is a shift in the philosophy of Thai education, which traditionally

emphasizes formal knowledge with limited connections to the world outside of schools (Fry & Bi, 2013; Silanoi, 2012).

As suggested above, the development of virtue or morality is embedded in Thailand's SEP-oriented curriculum. Additional virtues that have received emphasis include honesty, self-discipline, love for learning, balanced life choices, hard work, pride in being Thai, conservation of resources, personal responsibility, and public-mindedness (Tungkasamit et al., 2014). As implied above, a central feature of the SEP model of ESD is that school leaders and teachers should act as role models demonstrating these virtues in their own individual and collective behavior in the school and community (Chusorn et al., 2017; Oaas, 2013; Silanoi, 2012; Treputtharat et al., 2013).

3.4.1.3 Curriculum, Instruction, and School Management. As a whole school approach to ESD, the SEP model has been implemented with the explicit goals of changing curriculum, instruction, and school management in Thailand (Dharmapiya & Saratun, 2015; Treputtharat et al., 2013; Tungkasamit et al., 2014). Indeed, as a kind of school improvement program, the VSP project aimed at changing the culture of Thai schools in line with values espoused by the SEP (Ariratana et al., 2013; Oaas, 2013; Suriyankietkaew & Hallinger, 2018; Thanomwan & Buncha, 2014). Thus, the project incorporated effective training for teachers and school administrators in philosophy and associated educational methods (Ariratana et al., 2013; Chusorn et al., 2017; Dharmapiya & Saratun, 2015; Treputtharat et al., 2013; Yuenyong & Narjaikaew, 2009).

The curriculum framework adopted by the Virtuous Schools Project represents an integrated curriculum encompassing eight school subjects in Grades 1-12 (Dharmapiya & Saratun, 2015). The primary school curriculum content focuses on household and group/school issues. These include basic life-related domains such as learning self-reliance in daily life, analyzing family expenditures, and practicing cooperation. Secondary schools gradually widen content and activities to address social, economic, and environmental problems at the community, country, and global levels (Dharmapiya & Saratun, 2015). In addition, community members are often invited as experts in local wisdom, sharing their knowledge with students on addressing practical challenges and cultural traditions (Saratun & Dharmapiya, 2020). These features of the

SEP curriculum aim to enhance the beneficial outcomes of schooling and help students gain pride and respect for Thai traditions and knowledge in their communities (Oaas, 2013; Tungkasamit et al., 2014).

This values-based framework incorporates 23 SEP-based action principles (Avery & Bergsteiner, 2012; Saratun & Dharmapiya, 2020). Unlike some other whole school approaches, the SEP curriculum approach is grounded in an explicit effort to develop deeper learning of values, norms, and practices associated not only with environmental and social sustainability but also with national culture and local wisdom (Dharmapiya & Saratun, 2015; Oaas, 2013; Whietley, 2010). For example, students learn from royal projects such as check dam building, water reservoir, forest planting, and soil stabilization (Yuenyong & Narjaikaew, 2009). Cultural activities engage students in exploring the national cultural heritage, norms, and traditions (Silanoi, 2012). For example, students learn about Thai etiquette, ancient traditions, and cultural pride (Dharmapiya & Saratun, 2015; Saratun & Dharmapiya, 2020).

Thus, the curriculum seeks to infuse Thai values derived from Buddhism into the teaching and learning process. Across all subjects, activities encourage students to learn the value of 'human merit', emphasizing five aspects: love, mercy, truth, good conduct, peace, and non-oppression (Oaas, 2013; Yuenyong & Narjaikaew, 2009). Developing these virtues within the context of SEP creates a 'sustainability consciousness' among learners (Oaas, 2013).

In terms of instruction, the SEP whole school model embraces the "QPAR model" (Question-Plan-Action-Reflection), a form of experiential learning (Dharmapiya & Saratun, 2015). Students' real-life assignments are used to embed values learned from experience rather than through traditional lectures and rote learning that predominate in Thai schools (Yuenyong & Narjaikaew, 2009). School activities are organized through four categories that align with the major educational goals of the Virtuous Schools Project: economic activities, teamwork, environment, and culture (Dharmapiya & Saratun, 2015). The impact of school activities is assessed by examining whether students employ knowledge in line with these virtues and for the benefit of the school and community (Tungkasamit et al., 2013). Thus, the VSP curriculum evidences an 'outcomes' orientation concerning teaching and learning.

For instance, to educate students for ‘economic sustainability’, schools design activities that help students (and teachers) manage money and resources according to the espoused values of prudence and moderation (Sufficiency School Centre, 2015). In Thailand, where teacher debt has been a persistent problem, SEP values have been incorporated into teacher training to budget their living expenses. Notably, these activities are embedded in the curriculum and modeled in the school's operation (Ariratana et al., 2013; Treputtharat et al., 2013). At the school level, initiatives include learning to spend in moderation, reducing energy usage, and engaging students in producing food for school lunches and the local community. School-level decision-making aims to model similar ‘virtues’, thereby enhancing the sustainability consciousness of the ‘whole school’ and members of the community (Dharmapiya & Saratun, 2015; Oaas, 2013; Thanomwan & Buncha, 2014; Treputtharat et al., 2013; Tungkasamit et al., 2013).

Educational administration assumes a significant function throughout the implementation of SEP. School administrators and teacher leaders are encouraged to become more intentional in acting as role models for the characteristics desired of students (Chusorn et al., 2017; Saratun & Dharmapiya, 2020; Tungkasamit et al., 2014). Virtuous schools seek to sustain the success of this whole school model by embedding ‘sustainable leadership’ as a performance driver for the development of sufficiency-based schools (Dharmapiya & Saratun, 2015). School leadership emphasizes education quality, shared decision-making, and stakeholder empowerment to engage the active participation of teachers, staff, and community members (Suriyankietkaew & Hallinger, 2018; Saratun & Dharmapiya, 2020; Thanomwan & Buncha, 2014; Treputtharat et al., 2013).

Making a successful transition to SEP schooling requires school leaders is develop a clear vision of what the concept means and looks like in practice (Saratun & Dharmapiya, 2020). It also requires school leaders to develop competencies that enable them to support the integration of SEP virtues in the daily life of the schools (Dharmapiya & Saratun, 2015; Treputtharat et al., 2013; Tungkasamit et al., 2014). To support the development of these ‘new norms’, the VSP project has emphasized networking among schools as means of providing professional development for teachers

and sharing innovative practices among school leaders and teachers (Ariratana et al., 2013; Saratun & Dharmapiya, 2020; Treputtharat et al., 2013).

3.4.1.4 Distinctive Features of SEP Whole School Education in Thailand. In the education sector, SEP provides a set of value-based principles used to create a whole school educational model for sustainable development. Thailand's approach to education for sustainable development is grounded in a coherent philosophy that has been applied in different forms and degrees across all levels of the nation's educational system. The SEP model of ESD aims to develop student graduates capable of leading a satisfying life grounded in economic sufficiency, social cohesion, environmental awareness, and cultural traditions (Saratun & Dharmapiya, 2020).

The distinctiveness of the SEP approach to education begins with a clear set of positive values or 'virtues' that are proposed to underlie the economic, social, environmental, and cultural sustainability of a society (Dharmapiya & Saratun, 2015; Saratun & Dharmapiya, 2020; Suriyankietkaew & Hallinger, 2018; Yiengprugsawan et al., 2009). In particular, the inclusion of 'cultural sustainability' in this whole school model sets this approach from others discussed in this chapter.

These virtues form the foundation of an integrated set of curricular, instructional, and management practices designed to embed SEP values in a school (Treputtharatet al., 2013). Indeed, this whole school approach aims explicitly at developing 'sustainability consciousness' which is comprised of an interlocking set of values, attitudes, knowledge, and behaviors (Oaas, 2013). These schools help create a new generation equipped with the skills and knowledge to live sustainably and promote self-sufficiency in the community. Also worthy of note is that this model focuses not only on students but also on enhancing the capacity of teachers, staff, and administrators to provide living models of SEP values in their own lives and the operation of the school (Saratun & Dharmapiya, 2020; Thanomwan & Buncha, 2014).

For school leaders, vision and shared leadership were highlighted across studies when integrating SEP principles in schools. Multiple studies emphasize the necessity of leadership (e.g., vision, motivation, role model) and management (e.g., budget, safety, cleanliness) practices that align with the SEP virtues. Thus, school leaders who embrace the SEP approach are expected to model SEP virtues in their

personal and professional practices related to school budgeting, staff empowerment, and community engagement.

Although some qualitative and quantitative research has been conducted on this school model, it has yet to be validated in terms of its impact on learners during the learning process. While some research has validated the 'sustained' adoption of this whole school approach, its longer-term viability and comparison research with other schools remains to be studied.

3.4.2 Selected International Whole School Approaches to ESD

3.4.2.1 Background. As one of the world's biggest economies, the USA faces many sustainability challenges. Furthermore, this country is slower to embrace sustainability (McKeown & Nolet, 2013). Besides, there is often no clear distinction between ESD and Environmental Education (EE) (Feinstein & Carlton, 2013). Especially as a decentralized system, the USA relies on schools to volunteer in greening-related programs. However, ESD has recently been considered a solution-based paradigm in K-12 education in the USA (Coyle, 2020; Feinstein & Carlton, 2013; Warner & Elser, 2015). Green Ribbon School Award is one of the most significant ESD initiatives to emerge in the USA. In 2011, the US Department of Education proposed the Green Ribbon School Award program (ED-GRS) to honor sustainable schools, standardize school sustainability initiatives across the country, and encourage more schools to adopt sustainable practices (Sterrett, Imig, & Moore, 2014). This initiative encourages schools to partner with other organizations, such as state agencies, local businesses, and community organizations, to ensure suitable expertise and collaboration (Sterrett & Imig, 2015).

The Green Ribbon School Award acknowledges and validates the school by recognizing the hard work of stakeholders in schools in pursuing exemplary achievements for sustainability (Marable, 2014). The award is recognized by the submission procedure, comprising three stages. As of 2019, 420 schools, 76 districts, and 44 postsecondary institutions had gained this award in the USA. About 30 states voluntarily sought to participate in this initiative, and close to 50% of Green Schools have educated the most disadvantaged student populations (USA Department of Education, 2019). Up to 2021, less than 1% of schools in the USA have achieved the

ED-GRS award (Plevyak, 2022). As of 2023, a total of 542 schools, 108 districts, and 62 postsecondary institutions have been recognized with an ED-GRS for their efforts in promoting sustainability in education (U.S. Department of Education, 2023). Note that the ED-GRS is not designed to certify as many schools as possible. Instead, it is a recognition award that highlights schools and institutions demonstrating innovative and effective practices in promoting sustainability and environmental education. Every year, state educational agencies have the opportunity to nominate up to five school or district candidates for early learning through 12th grade, as well as one postsecondary institution. This process enables the Department of Education to showcase diverse and innovative practices from across the country.

Sweden has a long history of substantial involvement in outdoor and nature-friendly education (Breiting & Wickenberg, 2010; Cars & West, 2014; Östman & Östman, 2013). The goals of Swedish environmental education are to increase student awareness of their relationship with the environment and develop the ability to evaluate their impact on the surrounding environment. This strong foundation in environmental education and awareness has eased the integration of ESD into Swedish education (Cars & West, 2015). In Sweden, several significant initiatives have been aimed at promoting ESD. These include the Schools for Sustainable Development Award (Swedish National Agency for Education), the Green Flag Award (Keep Sweden Tidy Foundation), and School on Sustainable Way (World Wide Fund for Nature) (Cars & West, 2015). In this section, the author focuses on the national Schools for Sustainable Development Award because it is a government initiative recognized as a "Good Practice in Education for Sustainable Development" in the UNECE region (UNESCO & UNECE, 2007).

In 1998, based on Agenda 21 of UNESCO, the Swedish National Agency for Education developed Green School Award program (1997-2004). It sought to recognize and promote a whole-school approach to environmental education in Sweden (Evans, 2015). In 2004, the government revised the criteria in this award from a sole focus on ecological sustainability towards a broader and process-oriented view encompassing the triple bottom-line dimensions of ESD (Ferreira, Ryan & Tilbury, 2006). As a result, in 2005, The Swedish National Agency for Education launched the ''Schools for Sustainable Development Award'', implemented with other organizations such as the Regional Centre of Expertise on ESD, the Swedish National Agency for

School Improvement, and Uppsala University (UNESCO & UNECE, 2007). Upon completing and recording its program, a school can be accepted for a 1–3 year distinction and can choose to renew the award (Cars & West, 2015). As of 2015, around 250 schools had received the awards (Evans, 2015). Some municipalities aimed to involve all public preschools and schools in their region in applying for the prize (Östman & Östman, 2013). It suggests the widespread attention this whole school approach to ESD has gained in Sweden (Mogren, Gericke, & Scherp, 2019; Olsson, Gericke, & Chang Rundgren, 2016).

A decade ago, in Australia, the central government set the broad goal: "All Australians have the awareness, knowledge, skills, values, and motivation to live sustainably" (Australian Government, 2009, p. 19). This goal recognizes prior efforts in environmental education in Australia over the last decades (Ferreira, Ryan, & Tilbury, 2007). In 2004, the Department of the Environment and Heritage commissioned an international review of whole-school sustainability initiatives. The report concluded that the whole school approach is essential to step forward sustainable community (Henderson & Tilbury, 2004). From that, the Australian educational system was reoriented to a broader approach to sustainability than only environmental education (Henderson & Tilbury, 2004; Tilbury & Cooke, 2005). Currently, sustainability is one of three cross-curriculum priorities in the Australian Curriculum, mapping and embedding through categories of Primary, Secondary, and K-10 curriculum (Australian Curriculum Assessment and Reporting Authority, 2020).

As a partnership of the Australian Government and the States and Territories, the Australian Sustainable Schools Initiative (AuSSI) was started in 2004. This has provided qualified schools and their communities to develop new lifestyles sustainably and a culture of sustainability through a whole school approach (Davis & Ferreira, 2009). This initiative has engaged multifaceted stakeholders in a whole-of-school approach through experiential learning and school resources management (Tilbury & Cooke, 2005). This initiative allows each state and territory to implement ESD in different flexible ways (Davis & Ferreira, 2009). Furthermore, AuSSI connects and integrates with other existing sustainability programs. By 2009, approximately 25% of all Australian schools participated in AuSSI (Davis & Ferriera, 2009). In sum, AuSSI

has significantly impacted ESD in Australian schools in a more localized way (Australian Education for Sustainability Alliance, 2014).

3.4.2.2 Values/Principles. In the USA, the Green School Award is based on three fundamental value-related goals: 1) reduce environmental impact, 2) improve health and wellness, and 3) provide sustainability education. When considered in light of the triple bottom line, this whole school approach can be linked to social (e.g., civic skills), environmental (e.g., green career pathway), and economic capability (e.g., emphasis on STEM education) (USA Department of Education, 2019). Attainment of these schools' ability to embed these values in the schools is measured in reference to criteria provided by the Department of Education in 2012. It validates the shift from an earlier focus on 'environmental education' to a broader conceptualization of education for sustainable development (McKey, 2017; Warner & Elser, 2015).

In Sweden, the Schools for Sustainable Development Award has covered the three dimensions of sustainability. For example, the award encompasses environmental sustainability, including climate change, biodiversity, and disaster reduction (Östman & Östman, 2013). The award also encourages schools to address economic sustainability by promoting student awareness of corporate responsibility, sustainable urbanization, rural development, sustainable consumption, and sustainable tourism (Borg, 2017). Finally, this initiative emphasizes socio-cultural sustainability through its attention to gender equality, health promotion, HIV/AIDS, citizenship, peace and human rights, policy and governance, intercultural understanding, cultural diversity, indigenous knowledge, and regional/ international cooperation (UNESCO & UNECE, 2007).

In Australia, the triple bottom line framework has influenced the AuSSI initiative and its aims for influencing school activities and the teaching and learning process. Through participatory learning, students will acquire skills and competencies for systemic and critical thinking, future vision, participation, and citizenship (Tilbury & Cooke, 2005). For example, AuSSI projects encouraged students to analyze how their schools conserve water/ resources and apply principles of diversity in their life at schools (Brett, 2016). More broadly, the AuSSI initiative is guided by an inclusive sustainable vision for Australia and its communities (Australian Government, 2009; Lewis, Baudains, & Mansfiel, 2009). It is evident in the effort to involve internal and

external stakeholders in behavior changes towards sustainability (Henderson & Tilbury, 2004; Ferreira & Davis, 2012; Lewis, Baudains, & Mansfiek, 2009).

3.4.2.3 Curriculum, Instruction, and School Management. Consistent with previous reviews, the author found that these three countries vary in their approach to curriculum, instruction, and school management (Ferreira et al., 2006; Hallinger & Nguyen, 2020; Tilbury & Wortman, 2005). ESD can be integrated into the curriculum through a particular course or throughout the curriculum (Tilbury & Wortman, 2005). ESD can be conceived as a 'subject' or as part of the life of the school, its students, and the community (Henderson & Tilbury, 2004). ESD can be taught didactically through experiential education or problem- and project-based learning (Mogensen & Schnack, 2010; Yasin & Rahman, 2011). The role of school management also varies in the extent to which school principals are expected to lead learning and model ESD or play a more passive organizing role (Mogren & Gericke, 2017b; Pepper, 2014).

By law, the USA Department of Education is not allowed to develop curriculum and requirements; and determine state education standards. Therefore, the Department can only suggest and encourage educational goals and programs through incentives such as the Green School Award (Department of Education, 2019). For example, in 2014 ESD-GRS framework was published with nine sections in three categories (i.e., educational program, organization culture, and physical place) as a guideline (Barr, Cross, & Dunbar, 2014). Besides, State governments are responsible for education and adopt federal programs to different degrees and in different ways.

As a whole school approach, the AuSSI principles are to conduct educational activities in pro-ESD holistic programs, evaluated by four measurable outcomes (environmental, economic, social, and curriculum). Schools are encouraged to incorporate ESD into school operations, teaching and learning processes, school grounds, and internal and external communities (Tilbury & Wortman, 2005). For example, AuSSI schools in Western Australia are assessed via the AuSSI-WA Review, Plan and Celebrate assessment tool. This rubric includes 12 key elements for three aspects: leadership, teaching & learning, and community (Lewis, Baudain, & Mansfield, 2009). This model recognizes school leadership as central to school planning and practices that promote engenders democratic and participatory decision-making

processes for the whole school. Regular professional development about ESD is also established for teachers, school leaders, and educational partners to operate ESD in their teaching and unify ESD-oriented competence standards for teachers (Australian Government, 2009; Kennelly, Taylor, & Serow, 2011).

In Australia, the AuSSI provides a scaffolding method to assist schools in 'planning, monitoring, curriculum development and action' (Roberts et al., 2014). The learning for sustainability approach underpins mentoring, facilitation, participative inquiry, action learning, and action research (Tilbury & Hooke, 2005). As one of three cross-curriculum priorities, sustainability has been embedded in teaching across subjects. For example, for the K-6 Science curriculum, students can learn how electricity is generated with the concerns of personal and community decisions and impacts on people's lives (Kennelly et al., 2011). Furthermore, school activities roll out through a range of initiatives, from environmental to health and well-being programs. For example, sustainable schools in AuSSI-WA are encouraged to reduce 'ecological footprint' (e.g., water, energy, purchasing, and waste) and increase 'social handprint' (e.g., cultural and social diversity; student and staff well-being; community partnerships).

AuSSI encourages schools to develop a 'sustainability culture' by providing network support as a key strategy (Davis & Ferreira, 2009). For example, this initiative provides professional development for teachers nationwide through workshops, conferences, and seminars. Those programs assure teacher development through featured practices such as 1) developing knowledge, skills, and capacity to deliver effective ESD; 2) joining practical, real-life experiences; 3) training Australian Curriculum organizing ideas; 4) networking with other practitioners (Australian Education for Sustainability Alliance, 2014). More specifically, the peer learning model is exemplified to allow teachers to network with others.

Unlike the USA and Australian models, the Sweden Sustainable School Award does not have a guiding framework. Instead, the Swedish National Agency for Education, the main coordinating body for ESD, has integrated ESD into the school system through national curricula and syllabi for preschool, school, and adult education since the mid-1990s (Pauw et al., 2015). In 2011, when Sweden underwent educational reforms, a new Education Act enlarged ESD concerns clearer in the curricula and

examination goals (Östman & Östman, 2013). As a result, ESD has appeared in national steering documents. Therefore, the national curricula work as a framework for whether the schools pursue the award.

Schools for Sustainable Development Awards are set up by combining two criteria for Educational Leadership and Teaching Approach (Östman & Östman, 2013). More specifically, school leaders are responsible for ensuring the entire structured school becomes a learning organization where each stakeholder can engage ESD effectively. The schools are also required to have clear strategies and plans for new staff about ESD and provide proper ESD in-service training to employees. Besides, schools are encouraged to share ESD expertise and experiences and cooperate with other related stakeholders (Evans, 2015; Östman & Östman, 2013).

Teaching ESD in Sweden acquires a holistic perspective for teaching content and pluralism for teaching tradition (Borg, Gericke, Höglund & Bergman, 2014; Pauw et al., 2015). The holistic approach includes all triple bottom line dimensions (environmental, social, economic) as well as their interrelationship in the interactions of time and space (Pauw et al., 2015). Otherwise, pluralism is considered a feature of ESD for the pedagogy process. More specifically, while concerning sustainability issues, pluralism brings different views and values with democratic procedures and critical perspectives (Östman & Östman, 2013). Indeed, students take an essential part in their learning process with guidance from the teacher and local community involvement (Borg et al., 2012). For the Schools for Sustainable Development Award, the Teaching Approach criteria relate to their responsibilities for planning, implementing, and evaluating ESD so that both students and educators are involved in learning actively (Evans, 2015; Östman & Östman, 2013). For example, teachers utilize learner-centered and interactive teaching strategies for students to prepare key competencies such as problem-solving and critical thinking, system thinking, participatory decision-making, and reality-based learning ability (Pauw et al., 2015). Furthermore, teachers also have to conduct an assessment for ESD measures of ESD development annually and continuously (Evans, 2015).

3.4.2.4 Distinctive Features of the Selected International Whole School Approaches to ESD. Although ESD is still a ‘marginal part’ of USA K-12 education system, the Green Ribbon School Award represents an effort by the federal

government to promote sustainability in the context of a decentralized education system. School districts and schools have the authority to select sustainability projects as well as partners and build their own way to lead the whole school toward sustainability. The Green Ribbon School Award is guided by the triple bottom line and uses a portal providing educators with sustainability materials. However, the body of ED-GRS literature lacks research on students' outcomes, comparative studies between ED-GRS school and normal school, teaching design. Moreover, as a decentralized education system, ESD implementation depends on states, local concerns, and school governances.

The Sustainable Development Award in Sweden is a practicable initiative employing the triple bottom line. A large scale and series studies are conducted to investigate the effectiveness of ESD-certified schools around Sweden regards of sustainability consciousness as a learning outcome. Even though the results are not fully significant, the whole school model seems to impact students' consciousness toward sustainability. Students are encouraged to achieve a more sustainable lifestyle when joining an ESD-certified school. The motivations and challenges which school leaders might face also are revealed. Furthermore, school leaders in Sweden strongly favor a transformative perspective, which makes ESD implementation fairly unique.

However, critics have pointed to this whole school model to ESD in Sweden. Firstly, few studies solely focus on the implementation or effects of the School for Sustainable Development Award. Secondly, with evidence, there is a small number of ESD awarded schools in Sweden, compared with other NGO-based projects in ESD (Evans, 2015). It can be explained that because of the decentralization of the educational system, participating in the awards projects depends on the focus of municipalities in Sweden. Another criticism of this type of program is the lack of some concerns of the programs, such as school operation and leadership, school change before and after receiving the title, and external and internal influencers to the school while pursuing the ESD school awards. More empirical research is needed for those issues.

The AuSSI initiative advocates the educational system to change sustainably by implementing ESD for a learning and teaching process. Collaborating with all key stakeholders, the whole school approach also keeps simultaneously engagement in addressing learning for sustainability. Furthermore, the approach's

success is an undeniable in teacher education. To the extent that it has been adopted dopted in all states and territories of Australia, the AuSSI shows characteristics of a "learning organization".

3.5 Discussion

In this final section of the review, the author synthesizes distinctive features of whole school approaches to education for sustainable development. The synthesis draws on interpretations and compares findings from research conducted in Thailand, Australia, the United States, and Sweden. This section synthesizes the results, divided into the following main aspects:

3.5.1 The Whole School Approach to Education for Sustainable Development

As a holistic and transformational education, ESD is not a one-size-fits-all approach for every country. Two main types of whole school approach to sustainability were identified. First, some initiatives reflect an 'incentives'-based approach. Several models employ an award accreditation (Sweden, USA, Thailand) to benchmark a school's progress towards sustainability. The award title provokes participants to adopt whole school ESD implementation and rewards their success. This approach's weakness could lie in the absence of top-down support and intrinsic motives, which could be crucial to the long-term institutionalization of these practices (Evans, 2015).

The second type of whole school approach is presented as a 'networked whole school participation school' (Australia). Coordinated by a national organization/committee, schools engage in a shared vision or principles (Pepper, 2014). When the school joins the network, the organization coordinators get support to access references, materials, and school activities during school operations (Ferreira & Davis, 2012). Each school later is able to develop an ESD-related plan to apply in curriculum and management.

3.5.2 Application of the Triple Bottom Line in Education

Sustainability is constructed of three main dimensions: environmental, economic, and social (Tilbury & Wortman, 2005; Wals & Kieft, 2010). First, this review found that ESD is derived from environmental education (Jickling & Sterling, 2017). Thus, all whole school models have enhanced pro-environmental curriculum, project-based learning, and environmental protection activities. For empirical results, perceptions of environmental education also noticeably have a significant impact on students and teachers (McKey, 2017; Salter, 2013; Warner & Elser, 2015). A variety of environmental activities are recorded, from in-class to extracurricular activities. Thus, this dimension of the triple bottom line plays an integral part in efforts to foster sustainability.

The economic dimension in the whole school approach could be interpreted in different ways. For example, in AuSSI (Australia), economic indicators are measured in financial savings from waste, energy, and water consumption (Gough, 2005; Lewis et al., 2009). Though, in sufficiency-based school (Thai), economic-related activities are interpreted in how to train students to handle finances in sufficient ways, such as keeping an income-expenditure balance sheet, saving energy and resources, extending food self-sufficiency by farming in school gardens (Saratun & Dharmapiya, 2020). In short, this dimension in the whole school approach often involves saving energy and resources and consuming economically and sustainably (Lewis et al., 2009; Sterrett & Imig, 2015; Warner & Elser, 2015).

As for social sustainability, the whole school approaches have extended the scope outside the school to connect with the community (Rickinson et al., 2014; Warner & Elser, 2015). As a part of the educational process, those approaches are required to link and partner with the local community (Saratun & Dharmapiya, 2020). A review of documents reveals that the range of programs that promote school connections with the community are divided into four levels, including a) field visits to the community, b) community/industry visiting, c) actively participating in projects outside, and d) equal and reciprocal partnerships. Those other social themes are well-presented, including well-being (Yiengprugsawan et al., 2010), national culture, and values (Saratun & Dharmapiya, 2020). In Thailand, the whole school approach starts with cultivating the mindset of sustainability at the beginning state. The core foundations are grounded in

knowledge and virtues, highlighting local wisdom and national cultural heritage (Choochom, 2015; Oaas, 2013; Treputtharatet et al., 2013).

3.5.3 The Role of School Management and Leadership

Although most countries have ESD-related operating organizations, the level of governance differs from country to country while coordinating ESD initiatives. In some countries, the responsibly is placed in governmental ministries or national committees (e.g., Thai), while in others models, the initiative is decentralized to NGOs, agencies, or regional level (e.g., Australian).

The common key stage to the whole school approach is school collaborative governance and shared leadership (Chusorn et al., 2017; Mc Key, 2017; Mogren & Gericke, 2017 ab; Salter, 2013; Sterrett et al., 2014). It implies that multi-stakeholders should be actively involved in all school actions, including planning and operation, teaching, and studying (Pepper, 2014; Salter, 2013). Multi stakeholders, such as management, teachers, staff, students, parents, and the community, distribute equally to decide reasonable actions and ensure school policy. School leadership also requires a vision for sustainability (Chusorn et al., 2017; Pepper, 2014). The importance of leadership education and training is noticed and taken into action in Sweden and Australia (Ferreira & Davis, 2012; Mogren & Gericke, 2017b). In the USA, this notion gets support from the effective result of "forming Green team" in Green Ribbon Schools (Sterrett & Imig, 2015). For Thailand, some proposed management models have specific SEP-based practices (Jairak et al., 2015; Treputharat et al., 2013). SEP mindset and preferable leadership practices are specified to help schools enhance sustainability (Suriyankietkaew & Hallinger, 2018; Thanomwan & Buncha, 2014).

3.5.4 Sustainability Curriculum Frameworks

ESD in the implementation process requires that sustainability be presented across the curriculum (McKeown et al., 2002). Many nations' policy statements and educational initiatives stress the commitment to integrating ESD. However, implementing ESD in school has not always been concrete and systemic. In most regions, the whole school approaches to ESD are non-mandatory initiatives. However, all these programs have included the curriculum theme, guiding the school's action to

achieve sustainability. Significantly, ESD is wholly integrated into the national curriculum in Sweden, while sustainability is one of the cross-curriculum priorities in Australia. There are criteria for an evaluation in the USA for Green Ribbon Schools, and the participating schools can set unlimited sustainability initiatives. At that time, the framework or initiatives are served as the guideline. In Thailand, although the SEP concept is also introduced and mentioned in all kinds of schools, the SEP concept is implemented profoundly and systematically in sufficiency-based schools (Saratun & Dharmapiya, 2020; Suriyankietkaew & Hallinger, 2018). Ideally, the whole educational progress is recommended to align with the sustainable development movement. As a result, the learning outcomes could be systemic at the national/state level (Pauw et al., 2015; Rickinson et al., 2014).

3.5.5 Stakeholder Awareness and Participation

The whole school approaches have raised awareness about sustainability for students (Berglund et al., 2014; Pauw et al., 2015), teachers (Australian EfS Alliance, 2014; Mc Key, 2017) or both (Tungkasamit et al., 2014). The evidence of all programs varies at different levels. Indeed, overall most of the programs succeed in increasing people's awareness level in Australia (Salter, 2013), Thailand (Yiengprusawan et al., 2010), and Sweden (Pauw et al., 2015). Even there is evidence for the impact of ESD on student's sustainability consciousness (Pauw et al., 2015) and their parent's pro-environmental behavior (Salter, 2013); however, its impact is differentiated on the triple bottom line dimensions (Berglund et al., 2014; Borg, 2017; Olsson et al., 2016). In contrast, other stakeholders (e.g., parents, students, local community, government program) could bring behavior change for teachers who do not corporate ESD in their teaching (Australia EfS Alliance, 2014). In short, whole-school approaches have yielded higher awareness and more positive perceptions about sustainability, with greater support from stakeholders in practice.

3.5.6 Resource Management and School Grounds

ESD is not merely a theoretical concept that applies to the curriculum, teaching, and learning but also emphasizes the need for schools to enhance their physical surroundings. Schools can implement various resource management practices, such as

waste management and energy conservation, to achieve this goal (Sterrett & Imig, 2015). More specifically, the school is encouraged to demonstrate sustainable development so everyone can see it. As an outdoor learning place, the school grounds make students closer to nature, enjoy outdoor play, as well as help them study sustainable living (Sterrett & Imig, 2015; Tungkasamit et al., 2014; Warner & Elser, 2015) or even self-sufficiency (Saratun & Dharmapiya, 2020). Some other distinctive figures from all models can be noticed, such as resources management (Australia), school grounds (Thailand, Australia), and zero environmental footprints (the USA).

3.5.7 Teaching and Learning Strategies/ Professional Development

Teacher professional development is a critical component of whole school approaches to sustainability to develop and improve ESD competencies. Because ESD is a driven policy initiative by UNESCO, instead of from pedagogies or educators, the problem could happen while systematically adapting a sustainable school approach in entire education sectors (Öhman & Östman, 2019). Some common barriers while implementing ESD in teaching practices include teachers' awareness, ability, and expertise (Australia EfS Alliance, 2014; Kennelly, 2012), lack of time, teaching and learning materials, and professional development and funding (Australia EfS Alliance, 2014). Therefore, ESD requires a strong commitment and deep understanding of the teacher during the learning and teaching process. Otherwise, it becomes teachers' constraints due to impractical activities (Henderson & Tilbury, 2004; Jackson et al., 2009). There are sustainability teaching projects for pre and in-service teacher education in Sweden to solve those hindrances. The mainstream sustainability model in Australia has engaged change agents across the teacher education system (Ferreira et al., 2009). Thai scholars proposed step-by-step practices for teacher development (Ariratana et al., 2013) and teaching patterns (Silanoi, 2012). Those notions highlight the need for ESD implementation in teachers' in-service training and undergraduate program standards for teacher-to-be.

Finally, after analyzing those whole school approaches, a number of characteristics that could successfully transform the whole school to sustainability are identified (Alam, 2022). These include:

- Clear vision and mission toward sustainability;

- Shared school leadership with multi- stakeholders' involvement;
- Community focus and partnership;
- Problem-based learning engagement, which engenders students required skills and competence to pursue a sustainable lifestyle;
- Integration ESD into all disciplines in the curriculum, extended with cultural and moral education;
- Continuously focus on teacher education and professional development for teachers, school leaders, and staff;
- Regular reflection and evaluation program;
- Empirical and action research that reflects ESD practices and promotes ESD-related improvement.

Figure 3.1 Features of Leading the Whole School to Education for Sustainable Development

3.6 Conclusion

This chapter analyzed key features of whole school approaches to sustainability in Thailand, the USA, the UK, and Australia and identified several implications for widening ESD across countries. The author concludes that achieving

education goals for sustainable development will be enhanced to the extent that schools fully integrate ESD into the curriculum with an interdisciplinary strategy (Kopnina, 2014, 2020).

Professional development for teachers is a tool to ensure ESD implementation at school. While teachers have a clear awareness of ESD, in reality, they struggle to pursue ESD teaching and learning. The challenge is laid in changing teachers' mindsets and behaviors. Therefore, a comprehensive professional development system is needed, aligned with teacher education and in-service teacher training.

School leaders play a pivotal role model for the whole school approach to sustainability. Thus, school administration should adopt a new leadership style in their practices to complement and support ESD. There are limits to research about school leaders' characteristics for sustainable development. Further research on those issues can be promising.

Nevertheless, this review's results provide large samples of how the whole school implements ESD in practice in four countries. To be effective, whole school approaches to ESD should consider each regional context's different sustainable development needs. The research also comes up with several typical characteristics of a successful model. Significantly, despite many similarities, the case of Thailand gives valued lessons to implement ESD, including:

- Culture plays as the fourth dimension of sustainability outcomes. While other approaches usually combine culture in a social dimension, sufficiency-based schools upgrade to a separate dimension.
- Virtues are established as a foundation. As cultural values, those virtues are rooted in the percepts of Buddhism and Sufficiency Economy Philosophy and embedded as a mindset before practicing any personal or professional activities.
- The emphasis on local wisdom aligned with scientific knowledge in the school curriculum distinguishes it from some other whole school ESD models.

Lastly, research findings on the key factors and effects of whole school approaches to ESD are preliminary and tentative and await verification through more rigorous research designs and methods. Indeed, the author recognizes the need for more experimental and action research, which can provide new ways of educating and training

sustainability content to improve quality education and extent the contribution of whole school approach to ESD in education. Because the outcomes are vague and incompletely with limit of action research and cross-cultural was recorded though the whole school approach has significant impacts on learning outcomes. Indeed, most analyzed studies are cross-sectional as they measured the effects on stakeholders simultaneously instead of studying how the results change over time. Moreover, consistent of the findings of Hallinger and Nguyen (2020), most research is primarily qualitative and descriptive quantitative research design; it has yet to be validated in terms of the effectiveness of ESD whole school approaches during the learning process or values in policy-making for ESD practical concept. As a result,-the need for more experimental studies and multi-national action research will brightly demonstrate the ESD implication at school. Each model has advantages and challenges that can learn from other countries. For instance, it requires further studies that validate the effects of the whole school approach, such as a) the route students have changed for sustainability and b) what is happening in schools during implicating whole school approaches to ESD.

CHAPTER IV
CREATING THE LEADING CHANGE FOR SUSTAINABILITY IN SCHOOLS (VIETNAM) SIMULATION: A RESEARCH AND DEVELOPMENT PROJECT

4.1 Introduction

The powerful change agents in educational institutions are leaders and teachers who cultivate the knowledge and attitudes of future citizens (Fullan, 2005; McKey, 2017; Pepper, 2014). Indeed, they play crucial roles in raising sustainability awareness and competencies among learners, as well as preparing them with the decision-making values and tools needed to foster a sustainable society. With a priority on building educators' capacities, those stakeholders must gain the necessary values, knowledge, skills, and attitudes required to support a sustainability transition in both the education system and society more broadly (Australian Education for Sustainability Alliance, 2014; Kennelly, 2012; UNESCO, 2020). There is an urgent need to improve sustainability training for educators to act as effective facilitators in education for sustainable development (ESD).

However, current programs and methods used to prepare educators to meet sustainability challenges remain limited (Wals & Benavot, 2017). In concert with technological advancements, computer simulations, online simulations and games focusing on sustainability have been proliferating in recent years (Hallinger et al., 2020). This is due in part to the perception that simulations and games are highly motivating and aligned with the developing kind of active problem-solving and higher-order thinking needed for citizens to understand and address sustainability problems (Crookall, 2013; Gatti, Ulrich, & Seele, 2019; Gosen & Washbush, 2004).

Simulations and serious games have been used extensively in Western countries as well as in some Asian countries in training for educators (Hallinger & McCary, 1990; Hallinger & Kantamara; 2001; Hallinger, Tang, & Lu, 2017). However, they have not yet been widely used in Vietnam. For example, current training programs

for educators in Vietnam continue to rely heavily on traditional lecture and discussion methods (Nguyen, 2019; Nguyen et al., 2022). Vietnamese educators tend to focus on 'communicating information' through the use of relatively passive approaches. This reduces the potential impact on developing learners' deeper understanding, actionable skills, and commitment (Farashahi & Tajeddin, 2018). These competencies are especially important in ESD, where the ability to see, understand, and act on problems systemically is paramount (Breiting, Mayer & Mogensen, 2005; Pauw et al., 2015).

Vietnam has taken tentative early moves toward implementing sustainability. The Government of Vietnam affirmed its commitment to sustainable development through Vietnam Agenda 21 in 2004 (PM & Gov Viet, 2004), and again in 2017 with the National Action Plan for the Implementation of the 2030 Sustainable Development Agenda. It has also explicitly committed to support ESD in a policy statement, the 'Vietnamese National Action Plan for ESD'. In 2017, the Ministry of Education and Training (MOET) announced Decision 2161/QD-BGDĐT which outlined national goals of sustainable development in the field of education and training for the ensuing decade. It planned the implementation of SDGs in the education and training sector by 2025, focusing on 2030. This plan states that the general goals of SD in Vietnam are to assure quality education, equitability and inclusive education; and to encourage lifelong learning for all. The specific objectives focus on equipping learners with knowledge and the ability to promote sustainability, such as sustainable lifestyle, gender equality, human rights and peace, non-violent culture, and global citizenship education. Later, in 2018 MOET approved the phased implementation of the New General Education Program, which is aligned with ESD approaches such as building competence-based curriculum, increasing experiential learning, and promoting local education (Vn Moet, 2017).

Despite these positive steps, in reality, ESD is considered as a kind of add-on subject knowledge for incorporation into the curriculum in Vietnamese schools (Nguyen, 2019). A lack of awareness of ESD continues to be a major barrier to ESD implementation in Vietnam (Do & DeMaria-Kinney, 2013). The limited research on ESD implementation in Vietnam suggests that teachers lack the positive attitudes and knowledge competencies needed to integrate ESD into educational practices (Kieu, Singer, & Gannon, 2016; Nguyen, 2018). Thus, there is a demand for tools that can be

used in training educators in Vietnam so that they can both manage their schools more sustainably and pass that sustainability knowledge to future generations of students.

Reviews of the literature have identified two key problems in the domain of simulations and games for sustainability. First, despite assertions that simulations and serious games are well-suited to teaching the holistic, systemic perspectives needed to address sustainability challenges, empirical studies that validate this assertion remain relatively few in number and weak in quality (Hallinger et al., 2020). Second, most simulations focus on specific sustainability subject domains such as energy saving, climate change, and natural resource management (Barreteau, Le Page, & Perez, 2007; Crookall, 2013; Eisenack & Reckien, 2013; Hallinger et al., 2020; Nussbaum et al., 2015). No simulations have been identified that prepare educators with the knowledge and skills needed to prepare educators and trainers for the challenges of teaching, learning, and managing for sustainability (Farashahi & Tajeddin, 2018).

This broad need also applies in Vietnam, where simulations and games are not widely used and where ESD remains at a 'primitive' stage of implementation. This is the challenge addressed in the R&D project described in this study. The project results in an educational product that can be used in educational training and development on ESD with students, educators, trainers, teachers, and principals in K-12 schooling.

The following research objectives are addressed in this project:

1. To adapt and redesign the existing English language Leading Change for Sustainability (LCS) (Business) online computer simulation into a new simulation Leading Change for Sustainability in Schools.

2. To culturally adapt and translate the resulting English language version of the Leading Change for Sustainability in Schools online computer simulation for use in the Vietnamese K-12 school context, resulting in a new version of the simulation Leading Change for Sustainability in Schools (Vietnam).

3. To evaluate the usability of the Leading Change for Sustainability in Schools (Vietnam) online computer simulation in a Vietnamese education setting.

4. To examine educator perceptions of the cultural relevance and educational content of the Leading Change for Sustainability in Schools (Vietnam) online computer simulation as perceived by users in a Vietnamese setting.

The significance of this research and development project lies in the detailed description of a research-based approach to simulation design and adaptation both in terms of institutional context (i.e., from corporate to school sector) and society (i.e., prepared explicitly for the Vietnamese cultural context). This recognizes the importance of situating knowledge in the context where it is used (Brown, Collins, & Duguid, 1989).

4.2 Overview of the Leading Change for Sustainability Simulation

The 'Leading Change to Sustainability' is a web-based simulation that addresses these leadership competencies in the context of a private sector company that is trying to become more sustainable. Learners can access the simulation anytime from anywhere via an Internet connection. This allows learners to play the simulation in virtual teams when used in concert with an online platform (e.g., over Zoom or Blackboard).

The learning objectives for the use of the simulation include the following:

1. To gain a deeper awareness of the range of sustainability challenges faced by companies and society;
2. To analyze, plan, and execute a simulated strategy for helping an organization transform for sustainability;
3. To understand key concepts related to economic, environmental, and social sustainability; and assess their implications for management practice (Hallinger, 2020).

In the simulation, as players, learners play a part as members of a Project Management Team charged with implementing a major sustainability project named 'One Future' in one company over a three-year period of time. During the simulation, players interact with 24 stakeholders located in several business units (i.e., head office and two branches). The first goal communicated to learners at the outset of the simulation is to reposition as many stakeholders as possible from off of the gameboard (i.e., left side) to the 'sustainability stage' at the end of three years. In order to accomplish this 'change', the team is going to spend an annual budget on typical organizational activities that can be used to 'move people' through the five change stages towards sustainability (see Figure 4.1). Thus, when the team has played through

the three years, it seeks to have as many stakeholders as possible in the sustainability stage, where they have accepted and are using new sustainable practices in their work.

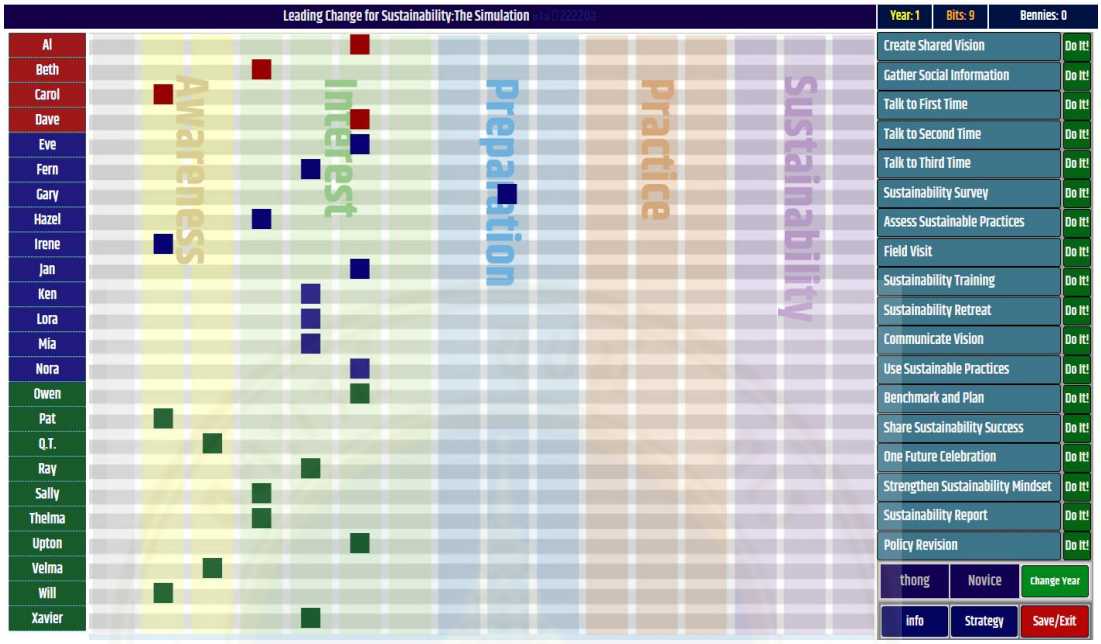

Figure 4.1 The Leading Change for Sustainability- Business Simulation Screen/Gameboard

A second goal communicated to learners in the simulation is to have a positive impact on the triple bottom-line of the company as it changes from a sole focus on maximizing shareholder value towards achieving a balanced set of economic, environmental, and social outcomes. Therefore, as people start to adopt more sustainable practices, they may gain 'Bennies' (Sustainability Benefits) for the company. This conception of Bennies is aligned with the triple bottom line of social, environmental, and economic benefits (Elkington, 1994, 2013). Consequently, learners may earn many Bennies if they can get the stakeholders in the simulation to use sustainable practices that yield improvements towards new social, environmental, and economic goals (Hallinger, 2018).

Players play this simulation within a three-year simulated timeframe. When starting each year, players receive a new budget from implementing activities designed to move the project forward (see activities on the right side of Figure 4.1). These activities each have a cost as well as an underlying purpose. Some activities can be used

to inform stakeholders and gather information about sustainability concepts and the purpose of the project (e.g., *Sustainability Survey, Assess Sustainability Practices, Talk with People, and Talk with People Again*). Other activities are used to motivate and inspire stakeholders to engage with the change (e.g., *Create Shared Vision, Communicate Vision, and Field Visit*). Some activities are used to prepare stakeholders for using new sustainable practices (e.g., Sustainability Retreat, Sustainability Training). Other practices focus on supporting the practical use of sustainable practice (e.g., *Use Sustainable Practices, Share Sustainability Success*, and *Strengthen Sustainability Mindset*). Finally, some activities are used to embed sustainability in the policy structure and corporate culture of the company (e.g., *Benchmark and Plan, Sustainability Report, Policy Revision, Theme Week Celebration*).

Players spend their *budget* on a sequence of activities and observe the results (stakeholders move, or not). Each time an activity is implemented, the costs are deducted from the team's budget, and feedback appears on the screen. The feedback tells 'what happened' (i.e., stakeholders moved, or not) as well as some information about 'why happened'. Based on the results, the players may revise their 'change strategy' and continue to select additional activities until they run out of budget for the year.

More than 600 'hidden' decision rules are embedded in the simulation, which determines the results of activities the learners select. Several theories of change were used to guide development of the simulation. The descriptions of the 24 stakeholders were informed by the diffusion of innovation theory (Rogers, 2010), which proposes that people can be grouped into one of several categories in terms of their modal responses to change (i.e., Innovators, Leaders, Majority, Laggards). The stages in the change process which feature in the simulation were derived from research on change in organizations (Hall & Hord, 2006). This research has found that successful change initiatives move through predictable stages (see Awareness, Interest, Preparation, Practice, and Sustainability stages in Figure 4.1). However, movement through these stages depends upon whether the change management strategy used by the team meets the 'concerns' stakeholders have at different stages in the change process (Hall & Hord, 2006). Understanding the concerns people typically have at different stages and linking this to action strategies are fundamental to achieving success in real change efforts, and in the simulation. Kotter's (Kotter, 1995; Kotter & Cohen, 2012)

model of leading change also informed the decision rules and conceptualization of 'change strategies' that are built into the simulation.

During and at the conclusion of the three years, players can observe the rate and patterns of changes in staff positions on the game board and the accumulation of Bennies. As players move across the game board, change is taking place. As Bennies increase, players can observe the impact of new practices on the triple bottom line. Their results are reflected and evaluated into six levels, from Apprentice to Change Master. The evaluation is measured on two main goals: 1) how many staff have achieved the Sustainability stage, and 2) how many Bennies a team/player has earned (i.e., impacted triple bottom line). When a team reaches higher levels (e.g., Expert and Master), it reflects the use of a 'stronger change strategy' based upon the theories of change embedded in the simulation.

4.3 Method

4.3.1 Research Design

Research and Development (R&D) is a research design aimed at developing products based on learning from research and practice. In education, R&D has been used to design educational products such as curriculum modules, textbooks, and simulations and games (Borg, 1987; Hallinger & Kantamara, 2001). Gall, Borg, and Gall (2003) defined educational research development as "an industry-based development model in which the research findings are used to design new products and procedures" (p. 569).

The method requires that product design systematically proceeds through a series of pre-determined project stages. These typically include sourcing information from research and practice, product design, field tests, product refinement, and further evaluation and refinement until the product meets effectiveness and quality criteria (Gall et al., 2003). R&D has been used in mathematics education (Gravemeijer, 1994), change management (Aistrup, 2010; Hallinger & Kantamara, 2001), flight attendant training (Lestari, 2017), and technology training (Martin, 2004).

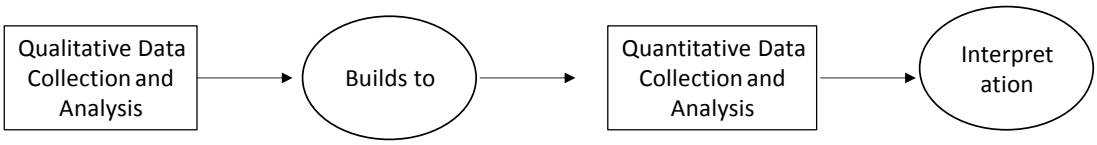

Figure 4.2 Exploratory Sequential Mixed Methods Research Design (Creswell, 2015, p. 205)

In the current project, the broad R&D approach used for product development incorporated a mixed method, quasi-experimental research design (Creswell, 2015). More specifically, an exploratory sequential methods design was used to enhance the power of the information-gathering and evaluation stages of the R&D process (see Figure 4.2). In the first phase, the researcher conducted a bibliometric review about ESD in K-12 settings and an integrative review of four models of sustainable schools. Then, qualitative data were collected through interviews with two Thai educators and video analysis of practices used in four ESD schools in Thailand. This information was used for the purpose of gaining insight into actual practices used by educators in schools that have adopted a whole school approach to education for sustainable development. Subsequently, during the evaluation phase quantitative data on learning process and outcomes are collected in order to gain insight into the efficacy of the simulation as a learning tool (see Figure 4.3).

This qualitative phase is followed by two phases of data collection and analysis. The first phase of the mixed methods research design involves several pilot tests with formative assessment of the LCS simulation's use with school leaders, teachers, and educators. Then, additional quantitative analysis using a quasi-experimental design is used to evaluate the simulation effectiveness and assess change in knowledge, attitudes, and skills of learners (Campbell & Stanley,1963, 2015). The 8-steps which guide the R&D process are shown below in Figure 4.3 and are described in this chapter.

4.3.2 Research and Development (R&D) Stages

Gall, Borg, and Gall (2003) proposed a systematic process for research and development projects whose goal is to develop research-informed products for use in schools. This process proceeds through a series of eight stages, starting with Research

and Information Collection and concluding with Dissemination and Implementation (see Figure 4.3). As suggested above, the R&D process can be implemented in conjunction with a formal research design to enhance the product's efficacy.

Stage One began with a literature review and information collection related to the planned simulation. It is started with a bibliometric review of education for sustainable development (Chapter 2). Then, to gain a comprehend picture about ESD, the whole school approach to sustainability was also reviewed through examining some initiatives around the world (Chapter 3). In addition, small-scale qualitative research was conducted to gain real sustainable practices in which schools have implemented sustainability in education. In Stage Two, a project plan was conducted. All of the details for the redesign were planned, and essential changes were investigated. Next, the author developed a preliminary version of the simulation in Stage Three.

Stage Four started with several preliminary tests with Subject Matter Experts. The author conducted three small pilot tests with different kinds of participants. This stage aims to retest redesigned functions, evaluate the usability of the new version of simulation, and examine its suitability in the Vietnamese context. This stage mainly used qualitative data collected from interviews, observations, and surveys. The analysis was then used in Stage Five, where the simulation was prepared for the final field test. The assessments and surveys for stage Six were also finally checked in this stage.

Stage Six was the main field test in which the author conducted a quasi-experiment with 32 graduate students at the Faculty of Education in a public university in Vietnam. The author also evaluated the simulation through formative and summative assessments. Both qualitative and quantitative data were collected in this stage.

Based on data collected in Stage Six, Stage Seven continued with the revision for the simulation. This variety of issues were addressed, such as correcting errors, adding supplementary materials, etc. For Stage Eight; the dissemination of the research in this project has also been disseminated in various forms of academic subjects, training courses, and conference presentations. The approach and findings from this study have been published in academic publications such as conference proceedings and journal publications.

More specifically, in the following section, each of these steps was presented respectively.

Figure 4.3 Research and Development Cycle (adapted from Dick & Carey, 1985; Gall, Borg, & Gall, 2003)

Pegden and colleagues (1995) stated that the concept of validation involves two distinct processes, namely verification and validation. Verification entails evaluating whether a simulation is functioning as expected, whereas validation involves examining whether the results derived from a simulation are consistent with those obtained from the actual system being modeled. The verification process aims to remove as many errors as possible by debugging the model. This can be accomplished through the utilization of the internal debuggers of the simulation software, analyzing output reports, evaluating step-by-step traces of a simulation run, and involving individuals who are capable of assessing the simulation (Feinstein & Cannon, 2002).

There are two different categories of validity: internal and external (Campbell & Stanley, 1963). Feinstein and Cannon (2002) suggested two forms of internal validity in a simulation. Firstly, representational validity is related to the logic and structure of the simulation itself (algorithm). Secondly, educational validity addresses the degree on how well participants comprehend and play the simulation with insight. That indicates that simulation can only acquire internal educational validity

when participants are required to discern the phenomena being modeled in the simulation. External validity reflects how the simulation model represents actual external phenomena. External validation in this refers to either the demonstration that a new simulation teaches key skills for change management for sustainability (validation as a teaching method) or that skills are needed to perform well in the LCSS-V simulation (validation as an assessment instrument).

To achieve the verification and validity, the study collected a combination of quantitative and qualitative data through many stages (see Table 4.1)

Table 4.1 Summary of Qualitative and Quantitative Research Design

Method	Stage	Location	Sample size	Research method
Qualitative	Research and Information Collection	Virtuous school project (Thailand)	2 experts	Individual Interview
			4 schools	Documentary
	Preliminary field test	Thai (virtual)	4 PhD students	After-course reflective feedback
		England (virtual)	1 professor, 2 graduate students	After-course reflective feedback
		Vietnam	5 educators	After-course reflective feedback
	Main field test	Vietnam	32 educators	Observation
			7 educators	Interview
			14 educators	After-course reflective feedback
Quantitative	Main field test	Vietnam	32 educators	Pretest and posttest for knowledge of change management for sustainability, and attitude towards sustainability
				Repeated simulation measurement for skill for change management for sustainability

During the main field test, quantitative data is collected from 32 users, who again come from the target role groups for the simulation. In this case, however, the learners consist of a convenience sample of Master's degree students who are already educators, teachers, or principals. Since this research and development project aims to provide an initial validation of the useability and effects of the new version of the

simulation, it does not seek to develop generalizable findings. Therefore, the use of a convenience sample of typical users is deemed suitable for the project's goals. Nonetheless, the sample size is sufficient to conduct statistical tests capable of assessing change in learner knowledge, attitudes, and skill.

Moreover, while the sample size is relatively small, this is not unusual in classroom experiments (Gall, Borg, & Gall, 2003). A recent review of simulation-based learning in sustainability shows that relatively small sample sizes are pretty common. They do not obstruct publication when the appropriate tests are employed (Chappin et al., 2017; Gatti et al., 2019; Rowe et al., 2017; Van Pelt et al., 2015).

This phase aimed to evaluate the effectiveness of a simulation-based learning experience in enhancing learners' knowledge, attitude, and skill related to change management for sustainability in education. The researcher developed a test instrument to measure changes in learners' knowledge and attitude towards sustainability, which was administered before and after the simulation course. The survey questions were designed to assess both cognitive outcomes, such as learners' knowledge change management for sustainability, and affective outcomes, such as their attitudes towards sustainability. The survey instrument consisted of multiple-choice questions to evaluate their knowledge of change management for sustainability and five-Likert scale questions to evaluate learners' attitudes towards sustainability.

Additionally, the simulation measurement was used to assess changes in learners' skills related to change management for sustainability. Specifically, the results of learners' performance were recorded at five points in time over the course of the learning module. The change in the number of Bennies achieved, the number of Kotter's change principles achieved, and the level of management achieved were used as indicators of learners' skill in change management for sustainability. These indicators reflect learners' progress throughout the LCSS-V simulation course [for more detail, refer to Chapter 5].

Qualitative data were collected at three stages of the R&D project. During the first stage of simulation adaptation, a small-scale qualitative study was conducted to gather information on practices used for sustainability education in Thailand's SEP-based schools. It is important to note that this study aimed to gain insights into common practices used in SEP-certified schools rather than to analyze the development of the

SEP school or identify "best practices." Therefore, the research did not aim to generate a case study description of the school but rather to inform the development of the simulation by highlighting practices used in sustainable schools. The qualitative data collection began with interviews with two SEP experts who worked as consultants with the Virtuous Schools Program in Thailand and videos of four schools applying SEP in education. Data collection involved an interview with the school principal and an analysis of video content.

During the preliminary testing stage of the project, qualitative data were collected to gain insights into the use of the simulation as a learning tool from the learners' perspective. The purpose of this stage was exploratory, and the number of participants was limited to enable the researcher to gather deeper insights and feedback to inform the simulation development and assess the suitability, validity, and reliability of the new simulation version within the Vietnamese context. The researcher also checked the simulation design to ensure that it can function correctly.

For the main field test, qualitative data were collected at a four-week course attended by 32 school teachers, educators, and leaders from Vietnam. The sample size reflected a typical class size for which the simulation could be used, enabling statistical testing of the main field test results. The participants were engaged in an online discussion forum throughout the simulation course. The researcher analyzed the contents of participants' posts to evaluate their learning process and the effectiveness of LCSS-V simulation.

After the simulation course, the investigator administered a feedback survey to evaluate the extent of the learners' improvement. The after-course feedback questionnaire containing both qualitative and quantitative questions was administered. Of the 32 participants, 14 participants (31.25%) were responded to give after-course feedback about simulation design, learning outcomes and their learning experiences, etc. Then, the researcher interviewed one focus group with four members and three individual interviews. This number was considered sufficient to reach the saturation point in the qualitative study. Additionally, these interviews provided a deeper understanding of how the simulation affected learners' knowledge, attitudes, and skills and offered insight into their learning experiences.

Overall, using a mixed-method approach for this stage provided a more comprehensive understanding of the simulation design and effectiveness, enabling the researchers to draw more robust conclusions regarding its impact on the participants. Next, the author describes each stage carefully and what have done at each stage.

4.3.3 Stage One: Research and Information Collection

Stage One began with a literature review and information collection related to the planned revision of the existing English language business simulation for use in the Vietnamese educational sector. The literature review aimed to gain a boarder and more profound knowledge about how schools integrate ESD and change to sustainability and to generate more information available for adapting the simulation.

First, to construct a knowledge base on how schools change to sustainability, a broad literature review was conducted on education for sustainable development in K-12 settings (Hallinger & Nguyen, 2020). Based on this broad review of the literature, a second review was conducted that examined the whole school approach to sustainability (Mogren, Gericke & Scherp, 2019; Nguyen & Hallinger, 2020). In this review, ESD initiatives from four countries (i.e., US, Sweden, Australia, and Thailand) were extracted that describe actual sustainability practices used in schools since Green school project generated in Vietnam leans much on environmental issues. Therefore, the author examined the Green School projects in Vietnam for the environmental aspect of sustainability.

Typically, schools react to environment/ sustainability issues in one of four ways: denial of the issues, adopt due to external pressure, integrate into the organization, or whole system redesign (Sterling & Thomas, 2006). As an ideal model, the whole school approach represents an increasingly influential theme in the ESD movement. This approach emphasizes rethinking and redesigning structures and organizations to address sustainability issues (Wals & Benavot, 2017). Emerging gradually over the last few decades, the whole school approach to sustainability seeks to reorient basic school features around sustainability goals (UNESCO, 2002). The whole school approaches have spread across continents. They have interacted beyond school grounds improvement and environmental education, connecting governance, resource allocation, stakeholder involvement, curriculum, teaching and learning process, as well as

community partnership (Tilbury & Wortman, 2005). In the whole school approach, sustainability is "lived as well as taught" (McKeown & Hopkins, 2007, p.22). Whole school approach to sustainability is also suggested for educational leaders to implement with multi-stakeholders inside and outside their institution in the global framework 'ESD for 2030' (UNESCO, 2020).

These literature reviews on sustainability in education yielded a set of principles and recommendations that were then used to guide the redesign of the LCS-Business simulation for schools. These included the following:

1. The simulation should emphasize the whole school approach to sustainability.
2. The simulation should maintain the existing focus on a triple bottom line of educational learning outcomes related to economic, social, and environmental justice. However, these would need to be 'translated' into the form and functions of an educational setting.
3. The redesigned simulation should incorporate a student-centered learning philosophy in conjunction with the efforts of schools to implement sustainability in curriculum and teaching.
4. Sustainability values should be embedded in the simulation.
5. The multi-stakeholder approach used in the business version of the LCS simulation should be maintained but adapted to stakeholders in education.
6. The organizational structure embedded in the simulation would need to be adapted to the particular educational setting of Vietnam.
7. The simulation should incorporate a systemic change dimension so that educating for sustainability moves from a project to being implemented into a system change.

To supplement the literature review, a small-scale qualitative study was conducted in order to gain deeper insights into ESD practices as well as the change process experienced by educators in schools that have adopted a whole school approach to ESD. In this phase, the lead author interviewed experts involved in Thailand's Virtuous School Project (VSP) (see questions in Appendix C). Schools involved in this project have embedded the Sufficiency Economy Philosophy (SEP) of sustainability as the basis for whole school adoption of more sustainable practices (Dharmapiya &

Saratun, 2015; United Nations Development Programme, 2007). In addition, the researcher analyzed practices used by educators in four model VSP schools for the same purpose of identifying VSP practices aimed at enhancing stakeholder's knowledge and attitudes towards economic, social, and environmental sustainability.

For preliminary small-scale qualitative research, the researcher used 'purposeful sampling' because this approach enables the researcher to identify an optimal source of subjects with unique specific knowledge related to the phenomenon being studied. In this case, the educators and schools selected work with a Virtuous School Project, which is certification Sufficiency Economy Philosophy-practiced schools. This means they have deep experience implementing desirable practices related to sustainability education. All the interviews were conducted in English and took around 30-45 minutes. Instruments used for this stage include sets of semi-structured questions. Answers for interviews were recorded. Videos contents were analyzed. The researcher later transcribed and coded all the data to analyze it with thematic topics by means of Computer Assisted Qualitative Data Analysis (CAQDAS).

Concerning the goal of small-scale research, data obtained from the interviewees and videos reinforced several themes highlighted in the literature review. These included some key factors which make some schools achieve more sustainability, e.g., inspiring other stakeholders; engaging teachers, parents, and principals; giving training about sustainability; changing students and teachers' mindsets; redesigning sustainability curriculum and activities; getting support from the community in terms of labor, traditional knowledge, money, etc.

Furthermore, the interviewees made specific comments on factors associated with schools that implemented sustainability slowly. The small-scale research also provided examples of whole school practices in SEP-based schools. These included sustainability strategies, principles, and practices that school stakeholders experienced. Those reflected honestly what happened in schools while implicating sustainability in education. From their own experiences, they gave several useful practices which schools have executed in terms of three sustainability pillars and cultural aspects. The scope and size of sustainability practices vary depending on the school type or location. Those give the author actual practices applied for redesigning

simulation. Learners learn directly from effective initiatives and use them as reference points for their own practice.

The school case videos, ranging from 10 to 15 minutes in duration, featured four model SEP-based schools from different provinces in Thailand. The case schools had been designed as "model schools' by the national organization overseeing the Virtuous Schools Program. In addition, the cases encompassed Muslim, Buddhist, and Catholic schools, as well as smaller and larger institutions. Finally, the cases included schools at the primary and secondary levels. The data were then synthesized to generate knowledge about the change process to sustainability in schools. These results were used to inform the basic decision rules that govern the movement of stakeholders on the gameboard and the generation of sustainability benefits for the schools. In addition, practical examples drawn from the interviews and analyzed videos of case schools were incorporated into the new simulation version. These included both change related obstacles encountered by schools as well as examples of actual sustainability practices that could be woven into the text of the new school simulation response cards. These data were collected systematically and stored in a form that could be used to inform the new simulation activities and response cards (see Appendix D).

Based on interviews, the author also identified eight typical obstacles schools might face while pursuing sustainability. Listed from external to internal factors mentioned by the interviewees, they were:

1. discontinue, and inconsistent policy (e.g., too many educational approaches and initiatives)
2. limited budget and resources
3. non-cooperation from parents, especially those from urban areas
4. maintaining sustainability education in a community
5. issues related to school leader: principal succession, role model, personal interest, career path, top-down pressure, mindset and behaviors, rational leadership
6. lack of teacher knowledge about sustainability
7. lack of teacher interest due to overwhelming workload
8. inappropriate teaching style for sustainability education, which requires more system thinking and critical thinking

4.3.4 Stage Two: Planning

The author recognized that the K-12 education sector has distinctive differences from the business sector. Thus, this stage began by conceptualizing the various features of the business simulation that would need adaptation for the education simulation. These included the institutional context, roles of the stakeholders, types of activities to be conducted, and the means through which sustainability can be integrated into schools. The redesign of the LCS-Business simulation involved a wide range of adaptations to the context of a school system. These included organizational goals, the institutional structure of education, position titles and description of the 24 stakeholders, problem descriptions, and activities typically undertaken to implement and integrate sustainability concepts and practices in schools.

Planning included identifying knowledge and skills to be learned, defining and sequencing simulation scenarios, distinguishing activities, and examining small-scale study feasibility. After the literature review and collection of other appropriate, relevant information in Stage One were completed, this stage analyzed and synthesized data. They offered in a 'bank' of information about the organizational and cultural context of schools, as well as propositions about the change process, key obstacles, and leadership strategies employed when leading changes to sustainability in education. Those data were synthesized into content that could be applied in next stages, such as repositioning simulation, adapting cultural and institutional settings, as well as changing rules or activities. For instance, the following in Table 4.2 is sustainability practices extracted from one SEP-based school data. Those data were woven into simulation activities or feedback cards.

Table 4.2 Example of Sustainability-Oriented Practices from School Number 1

Concepts/Practices	Scope	Themes
The school focuses on applying SEP-based knowledge and encourages pupils to maintain their moral principles; put health, working skills, and love for their work.	School	SEP model
The school should establish mutual awareness and correct understanding about SEP with all parties involved.	School	Multi-Stakeholders
The school should prepare the pupils for learning in terms of physical and mental health and fundamental learning skills.	School, Student	Whole Person Education
The teachers should assess the learning use of media and learning centers and use the assessment results in the teaching development to imbue learners with sufficiency, mindset, and habits.	Class	Teaching and Learning
There should be learning activities regarding the love for a nation.	Student	Virtue - Mindset
Parents should not over-indulge their children. They should give advice, consultation, and suggestions on what they should and should not do.	Parents	Parents Involvement
The school has activities that encourage learning of local culture and tradition, continually promote the love of Thainess, and emphasize the teaching of Thai music and dance.	School	Culture
Pupils use SEP as a main concept and practice in life, such as moral principles.	Student	Virtue Mindset
The school organizes learning activities outside the school.	School	Extra Curricular Activity
There should be an effective system for organizing field trips.	School, Community	Extra Curricular Activity
The community takes part in developing the school in all aspects of development in the school.	Community	Community
If the three parties (teachers/school personnel, parent/community, students) achieve consolidated aims, and the school can advance, the strength of sufficiency school will now take place.	School, Community, Parents, Student	Multi-Stakeholders

As a result, the aforementioned practices were carefully selected and incorporated into the simulation based on their relevance and applicability to the educational context in Vietnam. Numerous proposed functionalities were prepared. New text, responses, and decision rules were considered to accommodate the Vietnamese setting. The text was translated and rewritten to reflect the various assumptions, emphasizing the importance of sustainable change in the education sector. The author summarized instructions for players.

Fortunately, the author had access to the original MS Excel worksheets that had been used to develop the LCS-Business simulation. The Excel file included worksheets that contained all information related to the problem, people, activities, response cards, and decision rules. The author created new text columns within each worksheet next to those containing relevant business-oriented information (e.g., people roles and descriptions). Then, the author worked systematically through the information using information collected during Stage One to make revisions that reflected an education orientation. Thus, for example, the Eastern Branch Manager was replaced by a Primary School Principal, and a Marketing Staff was replaced with a second-grade teacher.

This process was followed by revising all the main components of the simulation noted above (i.e., problem, people, activities, response cards, decision rules, and gameboard vocabulary). This resulted in significant changes to the organizational structure and implications for the relationships among stakeholders, as well as to some of the actual change activities. These were described in the following section.

4.3.5 Stage Three: Developing a Preliminary Version of the Leading Change for Sustainability in Schools (Vietnam)

Redesign of the simulation required consideration of changes at two levels. These were principles underlying educating for sustainability and principles that guide successful change management in schools. In addition, the redesign would require adaptation to several dimensions of the simulation. These included the cultural and institutional context in which schools are organized and operate, the roles and characteristics of stakeholders, and activities used to implement change in an education system. Therefore, revisions to the simulation features were divided into the following

categories: (1) Reposition the simulation context; (2) Adapt cultural and institutional setting; (3) Change the roles and characteristics of the stakeholders; (4) Change and revise activities; (5) Change and adjust decision rules; (6) Change the activity feedback to learners; and (7) Programming the Leading Change for Sustainability in Schools simulation.

4.3.5.1 Reposition Simulation Context. In addition to integrating ESD themes across the curriculum, the whole school approach to sustainability recommends that an educational institution transforms into a place where pupils, students, teachers, managers, other staff, and parents should follow principles of sustainable development (UNECE, 2005, p.6). Keeping that principle, the author aimed to lead simulation players pursuing sustainability through concepts of ESD and whole school approach to sustainability with the foundation of change management theory. Therefore, the context of simulation was redesigned completely. Below are some of the sustainability-related themes embedded in the simulation. Noted that, players gain knowledges, attitudes, and skill through interaction with simulation, combining guided self-study and mini-lectures.

Table 4.3 Examples of Sustainability-Related Themes Integrated in the Simulation

Sustainability Themes	Example of applying changes to the simulation
Education for sustainable development	*Feedback cards 3M:* Ms. Minh (parent representative) says, I'm impressed with what you're trying to do. I'd like to see One Future prepare our students so they can work in the 'Green Economy' of the future. Personally, I'd like to see what innovative education for sustainability looks like. Ms.Minh moves 2 spaces.
Whole School Approach to Sustainability	*Feedback card ST7:* People learn about a 'Whole School Approach' to educating for sustainability. This involves rethinking curriculum, school operations, stakeholder participation, and school management. Gain 150 Bennies. Each participant moves 1 space, except Ms. Ích, Mr. Phát, and Mr. Will (name of stakeholders in simulation).
Sustainable Development Goals	*Feedback card ST9:* People learn about 'Sustainable Development Goals', proposed by UNESCO. The workshop also encourages people to think about how the education system could develop students with skills needed in the 21st-century economy and greater environmental and social awareness. Gain 200 Bennies. Each participant moves 2 spaces.

Table 4.3 Examples of Sustainability-Related Themes Integrated in the Simulation (cont.)

Sustainability Themes	Example of applying changes into the simulation
Sustainable Consumption	*Feedback card ST1:* Sustainable consumption is introduced at the workshop, where participants learn to create personal budgets and savings plans. Teachers discuss how this mindset and skills could be taught to students. Gain 150 Bennies. Each participant moves 1 space, except Ms. Ích, Mr. Phát, and Mr. Will (name of stakeholders in simulation).
Biodiversity	*Feedback card SP3:* These stakeholders use the garden to teach students about sustainable growing techniques, the dangers of toxic chemicals and pesticides, and the importance of maintaining biodiversity in agriculture. Participants each move 2 spaces. Gain 150 Bennies.
Climate Change	*Feedback card SS1:* A team of teachers from the school share the results of using project-based learning on the effects of climate change on flooding in Vietnam. School stakeholders in Preparation Stage or beyond move 1 space. Gain 50 Bennies for each person in Practice and 100 Bennies for each person in Sustainability.
Social Inequality	*Feedback card PR6:* The Ministry of Education accepts the Committee's proposal to integrate active citizenship, social participation, and gender equality competencies into the National Curriculum. Everyone moves 1 space. Gain 2,000 Bennies.
Culture Values and Heritage	*Feedback card SS6:* The stakeholder team shows how they have integrated learning about Vietnamese cultural values and heritage into music, dance, and social studies. Student products and performances highlight the relevance of cultural heritage even in the era of globalization and social media. Stakeholders in Preparation Stage or beyond move 1 space. Gain 50 Bennies for each person in Practice and 100 Bennies for each person in Sustainability.

Identifying similarities and differences in the process of change management in business and education was essential. The author adjusted Kotter's 8-Step Change Model (Kotter, 1995; Kotter & Cohen, 2012) to fit with the education version. For example, to achieve strategy ‘Create and communicate a shared vision of change’, players have to successfully conduct *‘Create and Shared Vision’* on year 1 and year 2 or year 3 and organize *a ‘Sustainability Retreat’*. Those condition rules are hidden for players.

Table 4.4 Hidden Condition for Strategy 'Create and Communicate a Shared Vision of Change'

Strategy	Meaning	Source	Conditions to be met
Create and communicate a shared vision of change.	An organizational change in schools must be guided by a shared vision of the educational organization that all stakeholders aim to create in the future.	Crandall et al. (1986); Doppelt (2017); Fullan (2005,2007); Hall (2006); Kotter (1995); Kotter & Cohen (2012)	Create a shared vision in Year 1 and
			Communicate Vision in Year 1 and
			Sustainability Retreat and
			Communicate Vision in Year 2 OR Year 3

If learners play successfully, there is marked on the results screen for players (see Figure 4.4). Players can evaluate their strategy through this screen and find a way to improve for the next play. They can later share and discuss how to successfully achieve the uncompleted principles with their peers.

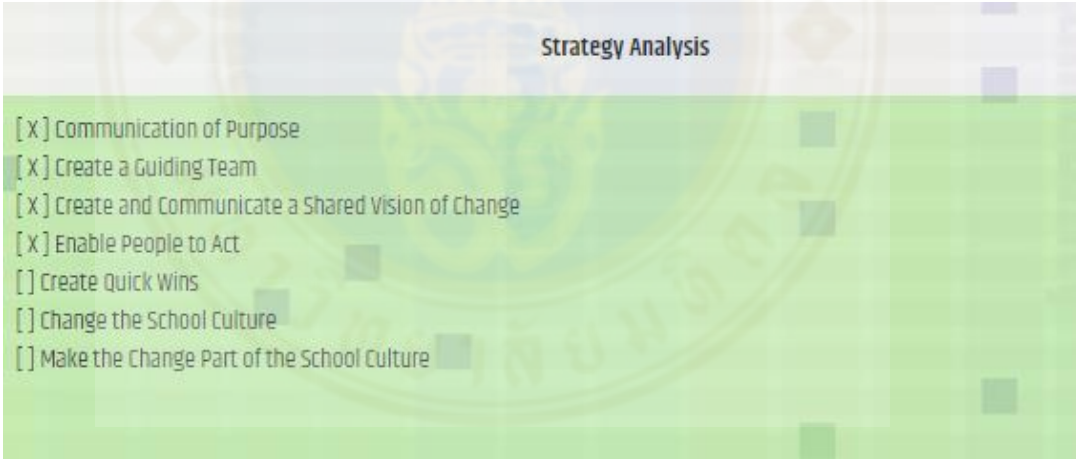

Figure 4.4 Screenplay for Strategy Analysis in English (adapted from Kotter's 8-Step Change Model)

4.3.5.2 Adapt Cultural and Institutional Setting. The researcher perceives that the redesign and translation process in this stage could be considered a process of intercultural interaction rather than a lexical transfer of meaning (Chidlow et al., 2014). Plus, as the structure of business organization are somewhat different from educational systems. A business simulation has three units: headquarters, Eastern branch, and Western branch. Therefore, in the education version, the author redesigned

three units: Department of Education, primary school, and secondary school, paralleling with that LCS-Business simulation structure

To achieve SDGs target, the goals should be localized to national and local levels as there is no one size fits all approach. ESD promotes local-level actions because the 'localization' of problem scenarios and actions is considered a critical criterion while implementing sustainability in education at the community level (UNESCO, 2020). Thus, the author accelerated cultural and institutional adaptation, so the simulation addresses global issues and local challenges in a coherent way.

The small-scale research revealed that urban schools might gain greater access to educational advancement. However, parents from those schools put an emphasis on ranking, test scores, and university admission. They might think that non-academic activities are a waste of time. Particularly, interviewee 1 expressed:

> *Implementing SEP in schools in rural areas is more accessible than in big cities because parents in rural areas respect school leaders and teachers more. So, I believe it is easier for the school personnel and administrators to explain to parents and try to convince them to go along with the idea the school proposed. However, in Bangkok or other big provinces in Thailand, with the environment, the context, and the mindset of their parents who believe in a very competitive education, I cannot see the chance can be accessible for parents to allow their children to participate in extracurricular activities. That is not in the classroom.*

This is similar to Vietnamese parents' expectations. Therefore, the author redesigned this feature in the simulation that the secondary school is in an urban area. Consequently, it faces more resistance to change and shifts toward sustainability more slowly than the primary school which is designed in suburban areas.

4.3.5.3 Redesign Roles and Characteristics of the Stakeholders. As a whole school approach to sustainability, a wide range of stakeholders are taking part in education and learning. In the simulation, the author redesigned various representatives, including educational administrators, representatives for the

Vietnamese People Committee, school leaders, trade unions, parent representatives, student affairs officers, and teachers.

All stakeholders have remodeled the job position to be adapted to the educational system in Vietnam. The author changed to the original name for Vietnamese identification (e.g., Carol to Cúc, Dave to Dương, etc.). However, some key features remained, particularly their adaptation types, such as leader, innovator, late majority, early majority, and resistor. Significantly, some key roles were modified based on the case of Vietnam. Here are some features which occurred in the Vietnamese context:

Table 4.5 Examples of Changes to the Role of Stakeholders in the Simulation

Old role	New role	Explanation	Type
Carol: Board Director	Cúc: Member of Local Political Committee - in charge of Finance	In Vietnam, as the local organ of State power, the People's Council is in charge of national defense and security, and decides on socioeconomic development plans, as well as budgets. People's Committee is the executive organization of the People's Council.	Political Structure
Dave: Board Director	Dương: Member of Local Political Committee - in charge of Education	This role is presented for outside stakeholders, but involve in education. This person is interested in education, and have voice for society about education, and make a critique if necessary.	Political Structure
Eve: Manager, Eastern Branch	Én: Primary School Principal, Head of Party Cell	School principal/ vice principal also take a role for school's political committee in Vietnam.	Political and Institutional Structure

Table 4.5 Examples of Changes to the Role of Stakeholders in the Simulation (cont.)

Old role	New role	Explanation	Type
Irene: Finance	Ích: Head of 1st -3rd Grade Teachers, Head of Trade Union	Common role in Vietnamese schools. Trade union take care of labor issues in schools.	Political System
Nora: Public Relations	Nương: Head of Ho Chi Minh Pioneers' Organization	Ho Chi Minh Pioneers' Organization is part of political system in education, especially for primary schools.	Politics in Educational System
Owen: Manager, Western Branch	Oánh: Secondary Principal, and head of Party Cell	School principal/ vice principal also take a role for school political committee in Vietnam.	Politics in Educational System
Xavier: Community Representative	Xuân: Head of HCM Communist Youth Union	Ho Chi Minh Communist Youth Union is part of political system in education, especially for secondary and high school level.	Politics in Educational System
Mia: Customer Representative	Minh: Parent Representative	Parent-teacher-school partnership is one of the key factors in education for sustainable development.	Educational System

4.3.5.4 Change and Revise Activities. A whole school approach to sustainability means a school integrates sustainability not only through curriculum, but also through school operations such as managing, planning, monitoring, and evaluating, as well as involving stakeholders and the community. As interviewee 1 mentioned:

> *That is not be done holistically. It only focused on teaching and learning. Like designing learning activities that been covered in economics, environment, and culture. You know, right? But in fact, changing the teaching styles is not enough. It has to be in school management, curriculum, relationship with all stakeholders, with parents. It cannot happen in only one part of the school.*

The basic 18 activities in simulation represented the engine that leads change to sustainability. However, different sorts of activities used to drive changes may vary from one society to another (Hallinger & Kantamara, 2001). As a result, the author checked whether the existing activities were congruent with the 'school culture' in Vietnam and whether any key sustainable activities might be missing. The cost of each activity also was revised coherently. Based on the finding of stage One, one activity (Benchmark and Plan) was eliminated, and the names, context, and descriptions were revised for four activities to reflect the education setting. And one new activity was added (Open class demonstration) as this activity is a form of teacher-led modeling activity of new professional instructions often used in Vietnamese schools. One activity expanded its effectiveness compared to one in the business version. Significantly, the 'Use Sustainable Practices' activity was tailored meticulously by integrating findings from literature review and small-scale research in Stage One. These revisions are summarized in the table below.

Table 4.6 Summary of The Revised Activities in Education Version

Action	Activity	Rationale
Create new activity	Open class demonstration	This is a typical activity in the Vietnamese educational sector.
Eliminate activity	Benchmark and Plan	This activity is tailored to the business sector and it is inappropriate for education.
Change context	Create Shared Vision Gather Social Information Talk to First Time Talk to Second Time Talk to Third Time Sustainability Survey Assess Sustainable Practices Sustainability Retreat Communicate Vision 'One Future' Festival Share Sustainability Success	Those activities were designed to adapt to educational context under the concept of education for sustainable development and whole school approach to sustainability. The activities were based on theory of change management and diffusion of change stages. They form the basic structure of the simulation.

Table 4.6 Summary of The Revised Activities in Education Version (cont.)

Action	Activity	Rationale
Change name and context	School Visit Sustainability Workshop School Support Group Revise School Report	Those useful activities are ones where players (educators) able to take what they have learnt from engaging with the sustainable activity in educational institution. They help educators in developing and learning new knowledge, working tasks, teaching and learning strategies, classroom management, technological advancement, novel innovation, etc.
Deeply integrate context	Use Sustainable Practices	These applicable practices are aimed at ESD and concept of whole school approach to sustainability, drawing on real-life practices from small-scale research and literature review. They make players not only learn theorical framework but also learn how to apply in daily work.
Extend the effectiveness	Policy Revision	The former activity in business version affects at organization only. New activity in education version expands the effectiveness in both national and regional level.

4.3.5.5 Change and Adjust Decision Rules. As discussed above, the decision rules are based on change management theories. They represent the energy in motion (i.e., movement of people in simulation). So, successful strategies reflect the underlying principles for change and are implemented through the decision rules. The literature review and small-scale research largely supported the notion that many of the change principles already incorporated in the business simulation still apply in the educational context. These included the following:

1. Obtain administrative approval before hosting activities in an organization;
2. Use different required strategies to change a diverse group of people;
3. Inform and create interest for people to prepare them and build commitment before sending them to advanced activities such as workshops; or share success.
4. Implement change with a requirement from both top-down pressure and peer support.

However, with the distinction of the educational sector, several changes to decision rules were adjusted to reflect this setting. New embedded decision rules are coherent with sequences of change strategies for sustainability. Some decision rules let players undertake an activity one time on simulation. Players must choose 'right time' to do that activity; otherwise, they will get an unsuccessful response. For example, the activity 'School visit' is able to be conducted in year 1 and 2 as people need to gain information and interest about sustainability education. However, if players conduct this activity in year 3, no successful feedback card appears as people have already get preparation to practice sustainability in teaching and learning (see Figure 4.5).

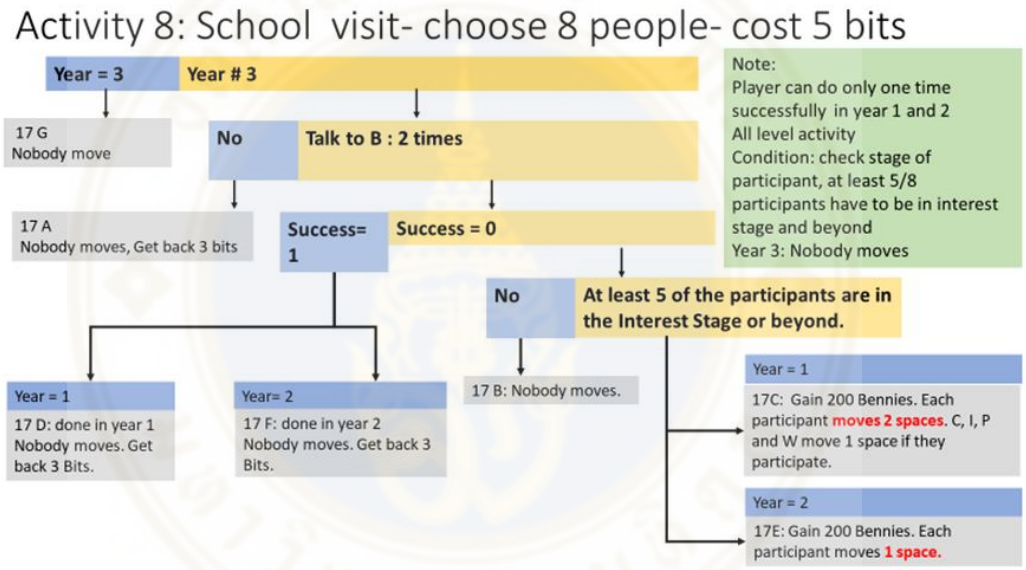

Figure 4.5 Algorithm for Activity *'School Visit'* in the LCSS-V simulation

4.3.5.6 Change the Activity Feedback to Learners. It is obvious that all the feedback cards provided in response to activities were rewritten to reflect the education sector, as well as Vietnamese culture. More than that, the author utilized contents, practices from the whole school approach to sustainability literature, and findings from small-scale research about the SEP-based school model (see Appendix D - synthesized table). This not only gives players real experiences of how school integrates sustainability in education, but they also have some preference practices to apply in the future at their institution in Vietnam. When the author rewrote the feedback cards or content, the author selected suitable and applicable practices for Vietnamese

situations and conditions. The author also wrote the text for the feedback cards that reflected distinctive features of the Vietnamese educational context. The author expected players to be able to apply that knowledge and practices directly to daily life rather than a theoretical framework.

4.3.5.7 Programming the Leading Change for Sustainability in Schools Simulation. All of the types of changes detailed in the above examples were then incorporated into the master Excel file. This Excel file was, in essence, a database of English language text that could be used in the development of the new Leading Change for Sustainability in Schools (LCSS-V) simulation for the Vietnamese context.

Once this step had been completed, additional columns were added to each worksheet, and the English text for the LCSS-V simulation was translated into Vietnamese by a native speaker. The result was an Excel file containing five worksheets: The Problem Scenario, People, Activities, Feedback Cards, and Other Vocabulary. Each worksheet contained three sets of related information describing the content of three different simulations: 1) LCS-Business simulation (English), 2) LCS-Schools (English), and 3) LCS-Schools (Vietnamese). The information in these worksheets was then used as the basis for developing preliminary versions of the LCS-Schools (English) and LCS-Schools (Vietnamese) simulations. Next, the project proceeded to the programming phase. This involved a four-step process.

In step one, a new LCS-Schools gameboard was created in English to reflect the new education context and activities (see Figure 4.6). Then all information about the Problem Scenario, People (i.e., 24 stakeholders), and Activities was copied and pasted into the program file to replace the business-related information contained in the original LCS-Business simulation program. Next, the computer code had to be reprogrammed to reflect changes to the activities that had been replaced as well as to changes in the decision rules and feedback cards.

Once these changes to the computer code had been completed, a Beta version of the new LCS-Schools (English) simulation was produced for testing. While the gameboards of the LCS-Business and LCS-Schools simulation appear quite similar, the scope of changes from the original to the school version was significant. Virtually

every piece of content-related information in the simulation was changed in the computer code.

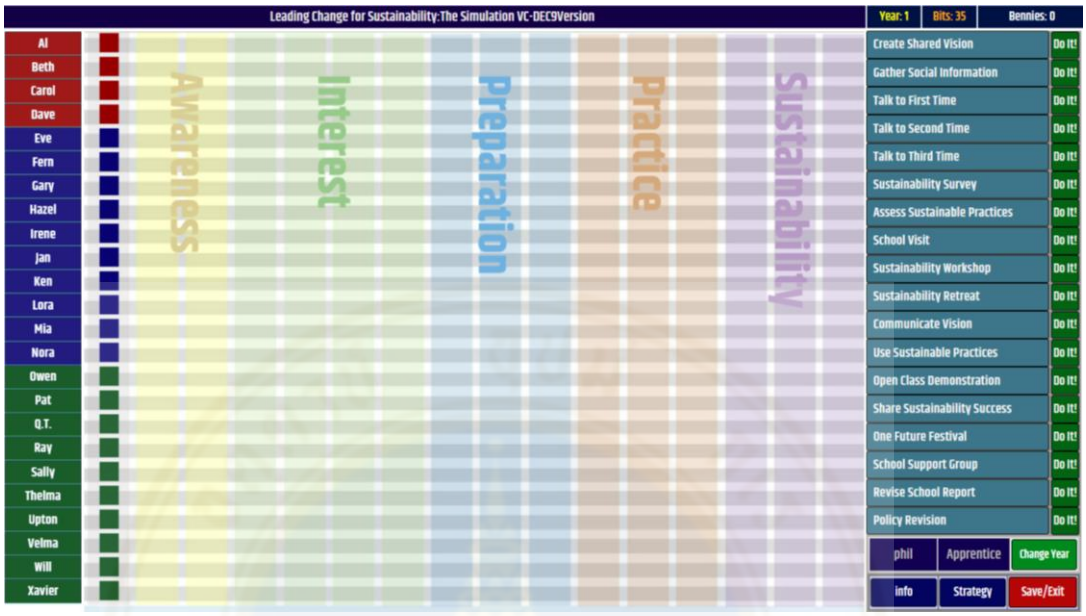

Figure 4.6 The Leading Change for Sustainability in Schools (LCSS) Simulation Gameboard (English language)

The new LCS-Schools (English) version was tested for stability, bugs, and internal coherence. Only after the simulation was played numerous times could the author not only identify bugs, but also whether the patterns of movement and feedback had face validity, or 'made sense' in terms of both the change process and sustainability content. After a stable version of the LCS-Schools (English) simulation was produced, a Vietnamese version was created using comparable data from the Excel file. Since the only difference between the LCS-Schools (English) and LCS-Schools (Vietnamese) versions was the language, the researcher was able to use the debugged code from the LCS-Schools (English) version as the basis for the Vietnamese simulation.

4.3.6 Stage Four: Preliminary Field Test

The preliminary field tests are usually carried out in limited settings with a few users (Gall, Borg, & Gall, 2003). The participants pointed for the initiative field tests were Subject Matter Experts who are a group of people who can complement the inadequate content knowledge of instructional designers and help the designer improve

the quality of multimedia teaching materials (Keppell, 2000). Therefore, in this project, the preliminary field tests were implemented in three small groups of Subject Matter Experts: one group of four Ph.D. students at College of Management, Mahidol University, who experienced LCS-Business simulation, one group of two graduate students and one professor from Faculty of Geography, Geology and Environment in a public research university in the UK, and one group of five graduate students in major Education Sciences, Faculty of Education in a public university in Vietnam.

To evaluate the verification, and face validity of the simulation, preliminary field testing is conducted with the prototype of the Leading Change for Sustainability in Schools simulation through three pilot tests. At this stage, the author focused on formative assessment to check the simulation content's stability, usability, and suitability rather than to evaluate the learning outcomes.

To begin with, the author conducted the first pilot test with four PhD students of the Sustainable Leadership program at the College of Management, Mahidol University. The four students are not only familiar with the LCS-Business version, but they also have expertise and work in the education sector. These participants come from a variety of backgrounds and races, including Myanmar, US-Singapore, Thailand, and Vietnam. First, the author gave four accounts and a brief about the LCS-Schools simulation. They had one week from 14- 23 Dec. 2021 to play with the new LCS-Schools simulation for Vietnamese context (in English language). After one week, they sent the reports to the authors [see Appendix E]. The reports checked about: 1) Ease of simulation use, 2) Clarity of simulation, and 3) Usefulness of content. Following is the summary of the playing results of Ph.D. students.

Table 4.7 Summary of Ph.D. Students' Results

Ph.D. students	Playing time	The highest score achieved (Bennies)	Number of people achieved sustainability stage (out of 24)[1]	Level of success	Number of Kotter stages achieved (out of 7)
1	20	12700	20	Change Master	7
2	7	6500	19	Expert	5
3	5	9400	20	Change Master	4
4	3	5200	10	Expert	5

[1] Although there are 24 stakeholders, the simulation design makes it nearly impossible to get more than 20 into the Sustainability stage.

These results showed that the LCS-Schools simulation works correctly as a business version. Then, the author had an open interview with these students on Zoom meeting. The interview revealed that:

- Generally, people can play simulation smoothly and achieve the highest level (i.e., move 20 stakeholders in sustainability stages, gain more than 9000 bennies, achieve all Kotter stages). However, some minor bugs occurred.
- The redesigned simulation version is somewhat challenging. Despite being difficult, it is doable.
- The simulation is suitable for Asian culture. The simulation is not tricky compared with the LCS-Business version.
- It is clear from the new simulation how sustainability is integrated into schools. The descriptions for educational context are accurate.
- Flooding response card happens so often.

Additionally, the Ph.D. students noted the following advantages and disadvantages of utilizing the simulation in comparison to the business version:

> *It seems well suited to the school context, and all changes look appropriate. I'm not sure that I see all of the nuances when implementing sustainability change in education, but it is a good starting point for learning about it. And I did feel I learned something from playing. (Ph.D. student 1)*

> *There are applications of theory and real-time feedback on decisions. For weaknesses, it takes time to get used to it, even though I've already played LCS-Business simulation before. (Ph.D. student 3)*

They also gave some suggestions to improve the simulation. The author noted those comments and used them to revise the simulation:

> *An annual progress report card would be a more straightforward way to show educators how the changes are progressing. It might be good to have an update card on the progress after each year is complete or perhaps an incident that impacts the school, similar to the business version. (Ph.D. student 1)*
>
> *Education for sustainability is a new topic in Vietnam, so it requires certain activities to introduce it. I was confused at the beginning. The simulation needs further explanations for educational terms (e.g., retreat, practices). (Ph.D. student 2)*
>
> *I think the distribution of activities among the end-of-part phase involves many more activities than at the beginning and in the middle of the part. (Ph.D. student 3)*
>
> *You should send the video before the course or integrate it into the simulation, so people can understand it more easily. (Ph.D. student 4)*

Afterward, the author corrected typing errors and bugs and paraphrased some sentence structure to make the text more accurate. Some programming has been modified, such as reducing the probability of flooding cards to the 1:9 ratio. For some challenging terms (e.g., whole school approach to sustainability, triple bottom line), the author prepared some reading materials and clips for students to understand better.

The author conducted a revised version of the pilot test by organizing a half-day virtual workshop in collaboration with a public research university in the UK. This workshop involved the participation of a professor and two graduate students from the Department of Geography, Geology, and Environment. The professor was selected as a

board member of the International Sustainable Development Research Society, bringing valuable expertise to the workshop. Additionally, the two master's students possessed knowledge and understanding of sustainability and environmental issues, making them ideal participants for the workshop. The workshop was held on February 2022. It tested and examined simulation and interactions with those without prior experience with the LCS simulation. The author also sought participants' feedback after the workshop. The participants asserted that they comprehended the simulation's background and the Vietnamese educational system:

> *Although the time is short, I am unable to recall all the activities. However, I can understand the simulation and go along with the flow of this simulation. (Participant 1)*

Finally, the author held a half-day workshop in Vietnam to check the LCSS-V whether the simulation works well in the Vietnamese language with Vietnamese people who are the target groups of the simulation. This workshop aims to perform a final pilot test of simulation in Vietnamese language and verify whether the language of texts and descriptions sounds natural. There were five master's students in major Education Sciences in the workshop. These students listened to the LCSS-V simulation introduction, practiced with simulation a few times, and provided feedback for a prepared survey. The author also observed how to keep the class dynamic while playing with simulation. One participant shared that:

> *The simulation stimulates my curiosity and makes me want to explore effective management methods to solve problems and gain a comprehensive understanding of organizations and management for different stakeholders in various situations. Learning through simulation is also closely related to real-life scenarios, helping learners easily apply them to specific situations. (Participant 3)*

As a result, the participants showed their amusement when playing the simulation. This kind of learning was relatively novel to them compared with traditional lecture-based subjects. They also gave comments on the close of the simulation context to reality. Basically, the simulation described well the Vietnamese educational system. The situation raises from the simulation is challenging but adaptable in Vietnam.

The participants were asked to provide feedback on a pre-post test to determine the comprehensibility of the test's description and its difficulty level for Vietnamese individuals. The comments received from the participants were intended to aid researchers in refining the test's content for use in the main field test. The ultimate goal was to improve the accuracy and validity of the pre-post test as a measurement tool for assessing knowledge of change management for sustainability and attitudes towards sustainability.

In conclusion, this stage assessed whether the new simulation contents, including design, project problem, scenario, organizational chart, multi-stakeholders and their descriptions, response cards, and activities, were valid in the Vietnamese school context. Many players from different backgrounds queried the face validity of the revised simulation content. The results from participants' feedback were quite positive. Therefore, the contents and new principles embedded in the new LCSS-V simulation were valid, at least for face validity. Moreover, the actual validity was tested in the main field test.

4.3.7 Stage Five: Main Field Test and Product Refinement

After analyzing the results from the preliminary tests, all data collected were compiled and analyzed. Further revisions and reprogramming were conducted. During the product revision, the author emphasized cultural adaptation, practical applications in education, and technical errors. The author rewrote some text and feedback cards in simulation to sound more natural. Text and reading material were adjusted and prepared for the intervention course. The author also revised the pre-posttest and the script, making it more straightforward. The online discussion forum for the main field test was generated with guided questions for each week; the survey feedback after course was also created in Google form. After this, the revised LCSS-V simulation was implemented in the next stage of main field testing.

4.3.8 Stage Six: Final Main Field Testing

In this session, the researcher presents the sixth stage of their study, which involved a quasi-experiment with a mixed-method design. The objectives of this stage were twofold:

1. Check the validity, suitability, and reliability of the new LCSS-V simulation;

2. Evaluate the effectiveness of simulation on learners in terms of changing learners' knowledge, attitude, and skill.

In educational research, achieving a 'representative sample' would be highly unusual since selecting participants randomly for a learning intervention would be difficult. Thus, the researcher employed the 'convenience sampling' method for mixed-method research. The main field test was conducted in collaboration with the Faculty of Education in a public university in Vietnam, where the researcher was employed as a full-time lecturer. The participants have qualified knowledge and experience working in the educational field. The primary criteria for sample selection were: 1) role group relevance, 2) availability for learning in the desired time frame, and 3) group size.

After revision, the LCSS-V simulation was ready for the main field test, with additional documents and handouts provided to learners. The programmers rectified the old version's bugs and typographical errors. The author conducted a four-week intervention learning course in Vietnam. The sessions were proposed as the teaching and learning unit for a course titled 'Effectively managing schools' for master students. These participants were 32 graduate students with a major in educational management at the Faculty of Education in a public university in Vietnam. The participants included principals, teachers, educators, NGO officers, and university staff with experience working in the education sector.

At the beginning of the intervention, the researcher introduced the LCSS-V simulation and its goals and gave the pretest about knowledge on change management for sustainability and attitude towards sustainability [see Appendix J]. All the structure and syllabus were sent to participants in the course. Then, students worked in groups and continued to play the LCSS-V simulation. At the end of the session, the instructor summarized the simulation's primary concepts and provided guidance for homework.

Participants were instructed to continue playing the simulation from home after the first session. The initial complete playthrough was used as the baseline point for simulation measurement for skill. All data pertaining to the procedure and outcomes were collected through the server, where each player was assigned a distinct username.

During the simulation intervention, the instructor also gave a mini-lecture to participants. Before and during each session, reading materials also were provided. Embedded in the simulation, the references provided various resources such as academic articles, news, videos clip, and extended websites.

During the course, the participants also joined the open forum on eLearning, where the weekly online questions were posted [see Appendix H]. These instructive questions encouraged students not only to post their answers but also to share solutions and experiences with their peers. Although the researcher typically responded to each student's post every week, most of the interactive responses came from other students. This collective problem-solving after class was critical to experimental learning for students to progress in the simulation.

In week four, the participants got the posttest for knowledge and attitude and played the LCSS-V simulation once without restarting as the final test for simulation measurement for the skill. After week four, participants were asked to complete the survey as the reflection feedback for the course [see Appendix F]. The researcher also invited four participants for focus group interviews and three for individual interviews [see Appendix G].

Although the author conducted both summative and formative evaluations, the research stage described in this chapter mainly focuses on formative assessments. The summative evaluation is discussed in Chapter 5 with more sophisticated quantitative analyses. Firstly, the identical pre-posttest measured the changes in their knowledge and attitudes towards sustainability. Besides, simulation measurements also reflect skill related to change management for sustainability while learning with simulation. Whenever participants logged in to the simulation using a class ID and password, and played the LCSS-V simulation; the researcher tracked their strategies and playing time through a portal simulation. The data from their game results was used to evaluate the skill for change management for sustainability.

The pretest-posttest results and simulation measurement for skill were analyzed using statistical tests such as Shapiro-Wilk, Paired Samples t-test, Friedman Rank Test, and One-way Repeated Measures ANOVA. The summative and part of formative evaluations for simulation effectiveness are analyzed in more detail in Chapter 5.

Qualitative data included formative assessments through observation notes, responses on an online discussion forum, semi-structured interviews, and an after-course feedback survey. They determine if the learners perceive the effectiveness of LCSS-V simulation as valid and what improvements should be made (see Table 4.8).

During the main field test, the researcher and an assistant recorded and noted how the sessions happened to observe the action and expressions of participants. They also recorded any bugs, questions, and difficulties faced by participants. The observation protocol was structured with some checklists and descriptions [see Appendix I].

After the main field test, the participants were asked to fulfill the after-course feedback. In this feedback, participants answered open-ended survey questions about the simulation design, its technical strengths and weaknesses, its ability and reliability to reflect the context of Vietnamese schools, and some suggestions to improve the simulation. The survey allowed participants to share learning experiences, comment about simulation suitability, and share ideas on the simulation.

Later, the researcher also organized one focus group interview and three individual interviews. The two-hour focus group interview included three teachers and one Youth Union officer. For individual interviews, the researcher invited one vice-principal, one art teacher, and one master's student who does not have much experience in education. The selection of interviewees aimed to diversify the opinions and participants' experiences.

The interviews were conducted in a semi-structured format. The researcher later transcribed and coded the data to analyze it with thematic topics. Interviews were beneficial for uncovering learning experiences and pursuing in-depth information about the strengths and weaknesses of simulation. Besides, participants' attitudes towards sustainability after using simulation were also explored through interviews. With their various experiences in education, the participants gave precious comments on simulation content, cultural adaptation, learning experiences, and some valued recommendations for further research.

In this chapter, the researcher uses qualitative analysis and descriptive statistics rather than inferential quantitative statistics (see Table 4.8). The narrative and content analysis was used from various sources (observation, survey, and interview). It

focused on sharing learning experiences and evaluating the simulation's validity and cultural suitability within an educational context.

Table 4.8 Summary of Analyses Used in Formative Evaluation of the Leading Change to Sustainability in Schools Simulation (Vietnam)

Evaluation	Type of assessment	Collection time	Sample	Purpose
Formative Evaluation	Online Discussion Forum	Throughout weeks 1, 2, 3	All participants	Monitor learning experiences and feedback
	Survey	After week four	14 responses	Quantitative assessment of the learning outcomes on key aspects Evaluate simulation usability, cultural suitability, and educational content Find out strengths and weaknesses with recommendations for improvement
	Observation	Throughout the sessions	Instructor and learners	Observe learners' engagement and interest Detect bugs and identify user difficulties while playing the simulation
	Open-ended interview	After course	3 participants	Evaluate learning experience and cultural suitability
	Focus group interview	After course	4 participants	Evaluate learning experience and cultural suitability

The qualitative data collected from the study were analyzed using Computer Assisted Qualitative Data Analysis (CAQDAS). Specifically, the researcher used the software MAXQDA version 20 as its technical advantage for researchers. A new project was created, which comprised rich textual material from in-depth interviews, written observations, and responses to the questions on the after-course survey. The interviews were scripted and coded from P1-P7, while open discussion forum, and feedback surveys were marked as response's students.

In this qualitative research study, the data analysis was conducted using a deductive approach, aligned with the research questions, while also incorporating a grounded approach to identify emergent themes. The researcher employed a coding scheme that encompassed predetermined categories or themes, enabling systematic analysis of the data.

To facilitate the analysis, a coding scheme was developed, consisting of several key code systems. Based on the research aims and questions, the predetermined themes within the coding scheme included "knowledge," referring to the knowledge of change management for sustainability; "attitude," which encompassed participants' sustainability mindset; "skill," addressing the proficiency in specific abilities to make a strategic plan for change management for sustainability; "simulation design," focusing on the structure and setup of the simulated environment; "simulation content," relating to the Vietnamese educational content embedded the simulation; "cultural adoption," exploring the extent to which the simulation was culturally adapted and accepted in Vietnamese context; "teaching method," examining the instructional techniques which the researcher employed during the simulation intervention; and "learning experiences," encompassing the participants' overall experiences while leaning with LCSS-V simulation.

Once the coding scheme was established, the researcher applied it to the data. Each instance of the predetermined themes was identified and systematically labeled using the assigned codes. This coding process allowed for the categorization and organization of the data, facilitating subsequent analysis.

Through a process of axial coding, the researcher used open coding to identify themes and patterns that emerged from the data. The researcher then refined and categorized a new theme as "suggestions." Finally, the researcher conducted a content analysis to summarize the results and findings of the analysis. The content analysis involved describing the key themes and patterns that revealed and emerged from the data, along with examples of quotes from the transcripts that illustrate these themes. The researcher also discussed the implications of the findings for future research or practice.

The observation’s note was analyzed and combined with other data. The notes gave the researcher participant’s attitude and reaction as well as the atmosphere

of the course, which is helpful for the future when the simulation is used as a training tool for various audiences in Stage Eight.

The after-course survey includes a short set of Likert-like questions analyzed with descriptive statistics and open-ended questions. The researcher described the mean and variability in responses. Open-ended questions were analyzed qualitatively. Responses were coded and summarized to identify the main trend in the responses of learners as well as potentially notable responses that may occur with only a few respondents.

The findings of this stage were subjected to a more comprehensive analysis, which is presented in detail in Section 4.5 Results. Moreover, the summative data derived from this analysis were further examined and analyzed in Chapter 5.

4.3.9 Stage Seven: Product Final Revision and Improvement

After completing the main field test, the data collected from the summative and formative evaluations were analyzed to make a foundation for revision and improvement LCSS-V simulation. The final revision is carried out. In this stage, the author made final adjustments to fix the bugs and refine cultural adaptations based on feedback from participants from the main field test. All of the modified descriptions and action rules were then returned to the programmer for revision. Additional documents and hand out also are prepared for future application.

4.3.10 Stage Eight: Dissemination and Implementation

The LCSS-V simulation is continued to teach master students in the education field. Besides, it should be noted that the research has also been disseminated for other training purposes. The simulation aims to use with educators and school leaders to educate them about how to implement sustainability changes in schools in the form of conference presentations. Steps have been and will be taken to disseminate the new simulation for wider use in Vietnam.

4.4 Simulation Redesign and Adaptation

The LCSS-V simulation is an online platform simulation with a user-friendly design that aims to train Vietnamese educators on managing school change to sustainable development and embed ESD in educational organizations. The learning objectives of the simulation list below:

1. To gain a deeper awareness of the range of sustainability challenges faced by schools and society;

2. To analyze, plan, and execute a simulated strategy for helping educational organizations transform for sustainability;

3. To understand key concepts related to economic, environmental, and social sustainability; and assess their implications for management practice in schools.

The LCSS-V simulation is rooted in experiential learning and a problem-based learning approach. Instead of learning solid theories, learners explore a well-tailored problem first. Only after examining the 'problem' do learners gradually perceive and explore knowledge content through many learning activities, such as mini-lecture, group discussions, and reading assignments.

4.4.1 Problem and Task

In the beginning, the instructor immediately presents learners with the challenge of change to sustainability in schools. In the simulation, the Director of Education delivers the current problem as follows:

> *As you know, the Ministry of Education has selected us as one of the pilot districts for implementing a new focus on sustainability in the education system. The pandemic has changed our lives and shown how interconnected the world has become. Health, environmental and social problems travel the world so that no country can succeed independently. This has created a new purpose for education which must become a means of educating citizens capable of living in a sustainable society and a sustainable planet.*

The learners play roles in the One Future Project team. They take responsibility for embedding ESD into schools and apply the whole school approach to sustainability in educational organizations. The director of education summarizes the task below:

> *"One Future project aims to meet aspirations embodied in Sustainable Development Goals outlined by the United Nations and increasingly accepted globally. One Future will come to define our commitment to the well-being of people, a healthy environment, and economic success for people in all of our communities. Starting today, the One Future project will become the engine to spark new investments in the development of our schools, launch actions to protect and improve the environment and enable us to protect our national and cultural heritage.*
>
> *You have been appointed members of the One Future Project team. During this 3-year assignment, you will be responsible for working with senior management to guide our transformation into an educational organization that models sustainable values and practices. This transformation should become evident in our daily routines as well as in our schools' contributions to the economic, environmental and social development of society. You will lead the pilot implementation of One Future in our units: The District Chamber Office of Education, Office of People Committee, Primary School, and Secondary School. In each of the three years, the One Future team will have a budget to spend on the project. Use the budget to fund activities to inform, engage, empower, and support stakeholders during this transformation into One Future. Use your budget wisely, think strategically, and remember that time is your most valuable resource".*

4.4.2 Simulation Screenplay

When the learners log into the simulation, the simulation screen displays the organizations, stakeholders, stage of the change process, and level of management, as in Figure 4.7 below.

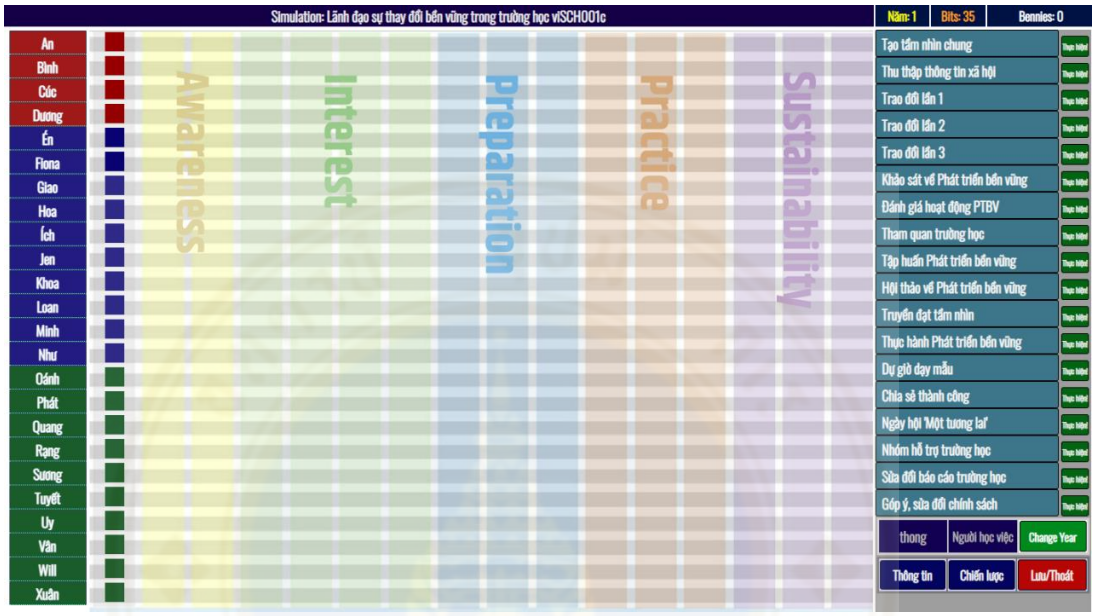

Figure 4.7 The Leading Change for Sustainability in Schools (Vietnam) Simulation Gameboard/Screen

On the left-hand side of the simulation screen are 24 stakeholders in three organization units. They are off the position of the change process as they have yet to begin the change process for sustainability. Listed across the top of the board are five stages of the change for sustainability: Awareness, Interest, Preparation, Practice, and Sustainability.

The simulation aims to 'move' those stakeholders from a state of not knowing anything about sustainability, education for sustainability, whole school approach to sustainability to being sustainability experts and applying ESD in their teaching and life. The more stakeholders are moved to the Sustainability stage; the more successful learners achieve (see Figure 4.8 below). Besides, learners also try to get as many Bennies as possible, as Bennies represent sustainability benefits in the environment, economic and societal elements.

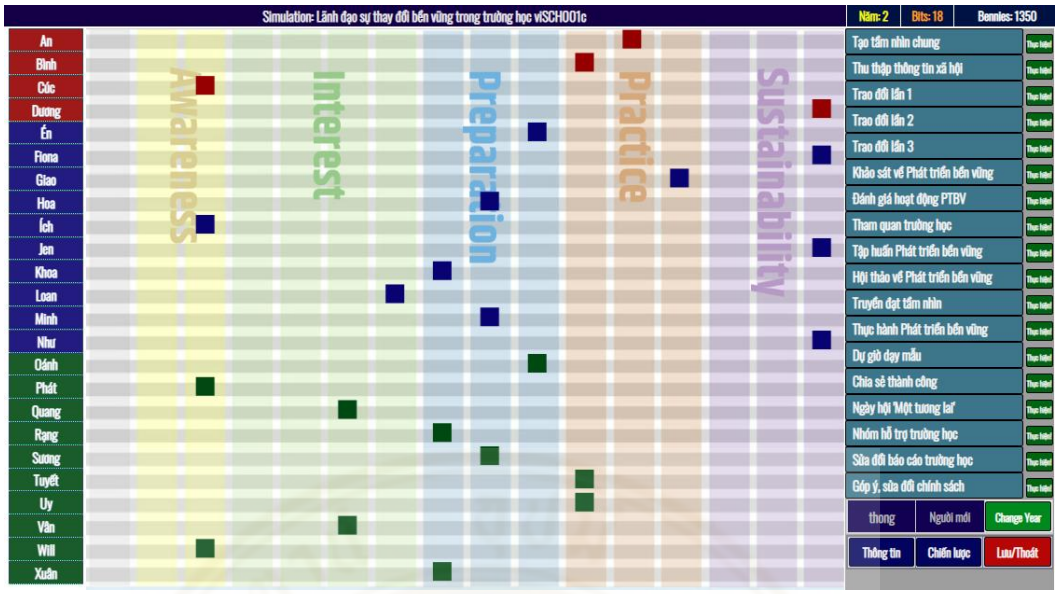

Figure 4.8 Example of the Leading Change for Sustainability in Schools (Vietnam) Simulation Gameboard/Screen During the Second Year of Play

4.4.3 Educational Organization

The chart of an educational organization is provided on the handout (see Figure 4.9). Firstly, the District Chamber Office of Education includes Mr. An (Director) and Ms. Bình (Deputy director). Next, People Committee also involves the project with two members: Mr. Dương (in charge of Education) and Ms. Cúc (in charge of finance). Then, two pilot schools joined the project with the Primary School principal, Ms.Én, and Secondary School Principal, Mr.Oánh, and stakeholders from these two schools.

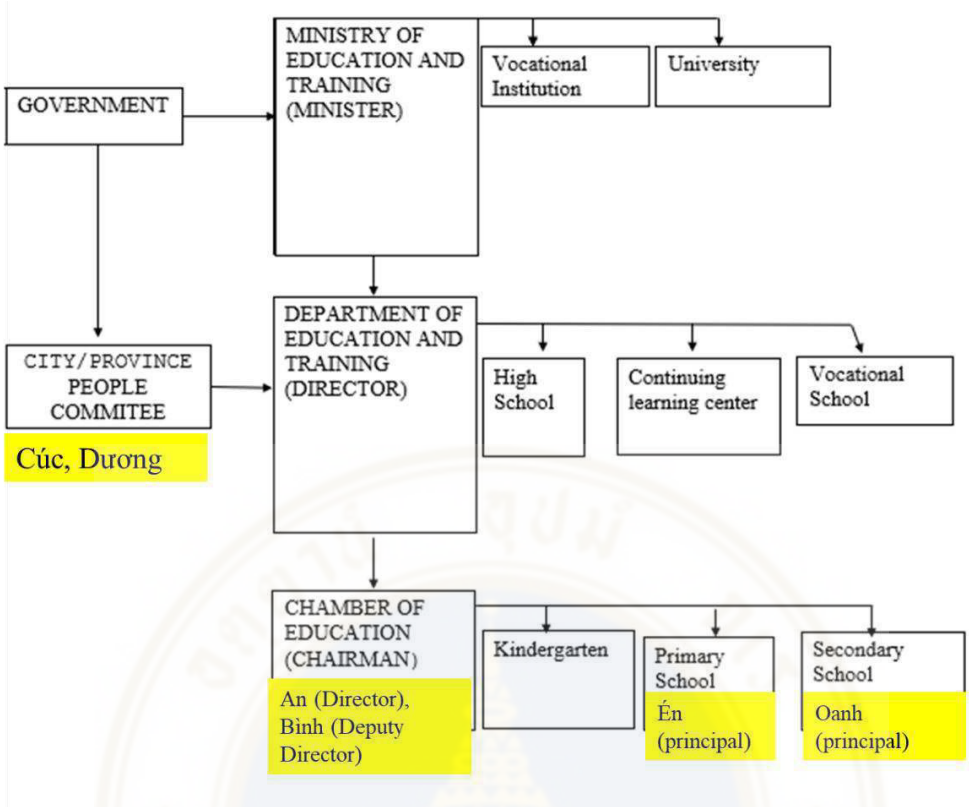

Figure 4.9 Organization Chart in LCSS-V Simulation (based on the structure of the Vietnamese educational system)

In the LCSS-V simulation, the organizational structure in schools is followed by the Vietnamese educational system. In every school, the head is the principal, who oversees all school activities. Because of political characteristics, this position also plays a role as the Party Secretary in the Communist Party Cell. The principal directly controls vice-principals and teachers in different subjects. Besides, in schools, many positions also cooperate with or under principals' control, such as trade unions, parent associations, or pioneers' organizations.

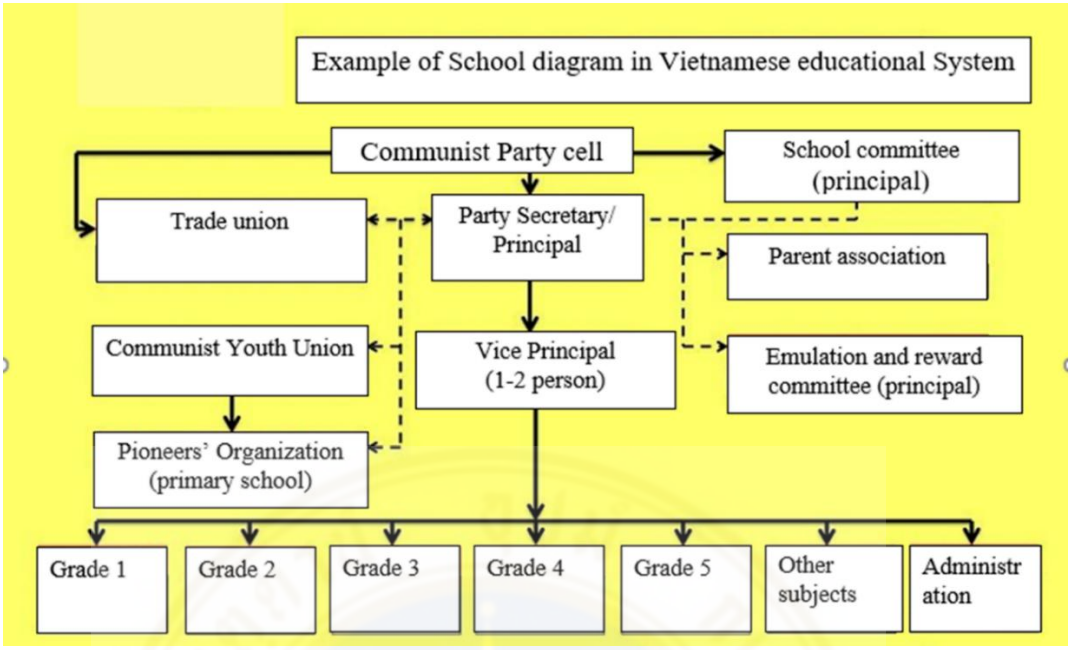

Figure 4.10 Sample Organization Chart in Vietnamese Schools

4.4.4 Stakeholders

In the LCSS-V simulation, there are 24 stakeholders who are critical in implementing ESD and the whole school approach to sustainability in schools. They represent many levels across the Chamber of Education, the People Committee, and two schools (see Figures 4.9 and 4.10). Their positions were redesigned to fit the Vietnamese educational context.

When learners appoint each stakeholder, the profile for each person is shown as the description in Table 4.9 below:

Table 4.9 Stakeholders' Role in Business and School Versions of the Simulation

People Business Role	Description	People School Role	Description
Al: Managing Director	AL has been Managing Director of the Best Company for two years and is still seeking to make his mark on the company. He has shown no previous interest in sustainability and seemed to adopt the 'One Future' project because of pressures outside of the company.	An: Director of Education	An has been Director of Education in District for 2 years. He is cautious and careful. He keeps strong connections with others. He has shown no previous interest in sustainability and adopted 'One Future' because of pressure from the Ministry of Education.
Beth: Chief Operating Officer	BETH has worked at Best Co. for one year. She was hired because of her expertise in operations and efficiency. She does not yet have strong relationships in the branches. Nobody knows where she stands on the One Future project.	Bình: Deputy Director	Bình has worked in the District Department of Education for one year. She was promoted because of her expertise in operations and administration. However, she does not yet have strong relationships with schools in the district. Nobody knows what she thinks about the One Future project.
Carol: Board Director	CAROL opposed hiring Al as Managing Director and has resisted most of his initiatives, including the One Future project. Her primary interest has always been about profit and loss on the company's balance sheet.	Cúc: Member of Political Committee - in charge of Finance	Cúc spoke out against allocating money for the One Future project and favored a different initiative to compete against other areas for school ranking.

Table 4.9 Stakeholders' Role in Business and School Versions of the Simulation (cont.)

People Business Role	Description	People School Role	Description
Dave: Board Director	DAVE is a newcomer to the Board. Although Dave supports corporate programs that contribute to the community, he did not speak up for or against One Future project when Al presented it to the Board of Directors.	Dương: Member of Political Committee - in charge of Education	Dương is an active member of the Committee who often visits schools in the District. Although he supports programs that contribute to the community, he did not take a position for or against when An presented One Future to the Committee.
Eve: Manager, Eastern Branch	EVE treats her staff with respect and receives their loyalty in return. She has strong relationships with both the community and higher management. Eve is supportive of new initiatives, but only if she thinks they will also improve branch productivity.	Én: Primary School Principal, head of Party Cell	Én treats her teachers and staff with respect and receives their loyalty in return. She has strong relationships with parents and management at the District level. Én is supportive of new initiatives, but only if she thinks they will benefit students.
Fern: Assistant Manager Eastern Branch	FERN focuses on getting the job done and keeping thing running smoothly at the Branch. She is not interested in new ideas but will go along if she must.	Fiona: Vice Principal Administration	Fiona focuses on keeping the school running smoothly. Her primary concerns are balancing the budget and maintaining efficient school operations. She is not interested in new ideas but will go along if she has no choice.
Gary: HR	GARY is an energetic young manager who strongly supports human rights and social justice. He always seeks new and innovative ways of developing people, but has been unable to get support for his ideas since arriving two years ago.	Giao: 1st Grade Teacher	Giao is an energetic young teacher who has been at the school for 2 years. He is a strong supporter of environmental education and always seeks new, innovative ways of teaching students. His enthusiasm and use of new approaches have created conflict with some older teachers.

Table 4.9 Stakeholders' Role in Business and School Versions of the Simulation (cont.)

People Business Role	Description	People School Role	Description
Hazel: Operations	HAZEL is suspicious of change and always waits to see what others think before she makes up her own mind. She often worries whether new projects will disrupt operations.	Hoa: 2nd Grade Teacher	Hoa sticks closely to the approved curriculum, and has never suggested changes for improvement. She waits to see what others think when changes are introduced but will support them if they become policy.
Irene: Finance	IRENE says, "When there's a job to be done, the old ways still work the best." She will resist anything that results in more work, even in the short term.	Ích: Head of 1st -3rd Grade Teachers, Head of Trade Union	Ích says, 'Our job as primary school teachers is to develop students who can follow instructions and master basic subjects'. She will resist anything that results in more work, even in the short term.
Jan: Sales	Bright and articulate, Jan is highly respected by her colleagues. She has been concerned about poor publicity and is looking for anything that can turn that around. Although she thinks One Future has the potential to help sales, she is also concerned if it could force a rise in prices.	Jen: Head of 4th- 5th Grade Teachers	Bright and articulate, Jen is highly respected by her colleagues. Last year she opposed the introduction of project-based learning into the 4th/5th-grade curriculum. However, she became a supporter after seeing that it could connect learning in the school with the community.
Ken: Supplier Representative	KEN's company only recently established a business relationship with Best Co. Therefore, although his company has a large contract to supply raw materials, nobody really knows much about Ken.	Khoa: 4th grade teacher	Khoa has been teaching at the school for five years. During this time, there have been quite a few parent complaints about his lack of effort. Ken is not well known by his colleagues.

Table 4.9 Stakeholders' Role in Business and School Versions of the Simulation (cont.)

People Business Role	Description	People School Role	Description
Lora: Operations	LORA is good at her job but relatively quiet. She focuses on keeping costs low and is cautious about any changes in the operations systems.	Loan: 5th Grade teacher	Loan is good at her job but relatively quiet. She also opposed the use of project-based learning in the 5th grade curriculum. After one year, she has just begun using some activities.
Mia: Customer Representative	MIA is a senior purchasing manager at Inter-Pacific Hotels, one of Best Co.'s largest international customers. She is a vocal advocate for corporate social responsibility and is proud that her hotel chain has made 'Green Living' a center-piece of their marketing strategy.	Minh: Parent Representative	Minh is a local entrepreneur who has 2 children in the Primary School. She has raised money to support a wide range of programs in the school. She is well known in the community for her efforts to raise the status of women in the society.
Nora: Public Relations	NORA has been with the company for eight years. People respect Nora for her positive attitude and thoughtful ideas. Although she is known to support corporate social responsibility, Jan is worried that Al might not follow through on his commitment to the One Future project.	Nhu: Head of Ho Chi Minh Pioneers' Organization	Như has been at the Primary School for 10 years and is respected for her positive attitude and thoughtful ideas. She is an active member of the local community who supports a large recycling program. However, she doesn't believe One Future will get the support needed to succeed.
Owen: Manager, Western Branch	Bright and ambitious, Owen runs a 'tight ship' at the Western Branch. He is careful not to offend anyone fearing that it could slow his progress to a higher position at the Best Company. Owen will follow top management's lead, but knows nothing about sustainability.	Oánh: Secondary Principal, and head of Party Cell	Bright and ambitious, Oánh runs a 'tight ship' at the secondary school. He is careful not to offend others and follows orders carefully. He does not know anything about education for sustainable development.

Table 4.9 Stakeholders' Role in Business and School Versions of the Simulation (cont.)

People Business Role	Description	People School Role	Description
Pat: Assistant Manager, Western Branch	PAT feels overworked and spends most of his time solving day-to-day problems. He is not interested in new ideas or projects because they waste his time and keep him from the practical work of the business.	Phát: Vice Principal	Phát feels overworked and spends most of his time solving school operation problems. He thinks that most new projects are a waste of time. When he first heard that One Future had been approved, he laughed and walked away.
Q.T.: Operations	Q.T.'s strong point is project management. He believes strongly in operational efficiency and only accepts new processes after they have been proven elsewhere.	Quang: Math Dept. Head	Quang is proud of the school's strong performance on math exams and contests. He is not interested in anything that will interfere with his work.
Ray: Supplier Representative	RAY's company has supplied products to the Best Co. for more than 20 years. Although his company is known for its high quality, Ray is very cost conscious and will fight any changes to his contract that impact profit margins.	Rạng: History Teacher	Rạng has taught for more than 20 years. He is upset that the younger generation of students (and teachers) lacks interest in national heritage and culture.
Sally: Marketing	SALLY has worked with the firm for over 20 years. She is suspicious of changes that may affect the company's reputation and fought against a project to rebrand the company's product lines. However, Sally will follow new policies if she is sure there is strong support from management at all levels.	Sương: Parent Representative	Sương graduated from this Secondary School and now has twin girls studying there. She is suspicious about new programs that could affect the school's ranking, but waits to see what other parents think before making up her mind.

Table 4.9 Stakeholders' Role in Business and School Versions of the Simulation (cont.)

People Business Role	Description	People School Role	Description
Thelma: Finance	The finance department has become strong under Thelma's leadership over the past five years. She is proud of the quality improvement system her staff implemented last year in the Western Branch (even though she was not initially supportive of it).	Tuyết: Science Dept. Head	Tuyết makes sure that her teachers closely follow the approved science curriculum. Although she has opposed changes to the curriculum in the past, she was successful at integrating technology in teaching in her department.
Upton: Sales	A long-term employee at Best Co., staff from other departments frequently asks Upton for his advice on different issues. Although he knows little about "sustainability', Upton has been concerned about declining market share and is looking for ways to strengthen the Best Co.'s brand.	Uy: Social Studies Dept Head, Head of Trade Union	Uy was recently recognized as a master teacher and is frequently consulted by colleagues for teaching methods. While Uy is known for his social activism, he has been quiet since a curriculum initiative he sponsored failed to get support last year.
Velma: MIS	VELMA is a competent worker who always gets her job done. She is quiet, and not well-known to a lot of other staff. She is attending a local college part-time in a Master degree program and doesn't have extra time to put into her job.	Vân: Vietnamese Literature Teacher	Vân is a quiet, competent teacher who thinks the school should be more active in broadening students' perspectives about the world. She is currently attending a Master's degree program at night and spends less time at school than in the past.

Table 4.9 Stakeholders' Role in Business and School Versions of the Simulation (cont.)

People Business Role	Description	People School Role	Description
Will: HR	WILL transferred to the Western Branch after having 'problems' at another Branch. He is often late in getting his work completed and complains a lot when asked to do anything beyond his basic job.	Will: English Teacher	Mr.Will transferred to this school after having 'problems' at another school. He is often late for school meetings and frequently complains about the teachers' heavy workload.
Xavier: Community Representative	XAVIER is a new representative of an NGO that has received funding from the Best Company's Corporate Foundation. Nobody really knows where Xavier stands on sustainability issues.	Xuân: Head of Ho Chi Minh Pioneers' Organization	Xuân joined the Secondary School last year and does not yet have strong relationships in the Youth Union or community. He is looking for opportunities that will enable students to make stronger connections with the community.

4.4.5 The Phases of Change to Sustainability

There are five phases of the change process for sustainability, including Awareness, Interest, Preparation, Practice, and Sustainability. These stages represent the normal process of people from the stage of not knowing anything about sustainability, ESD, whole school approach to sustainability to the stage of comprehending and integrating those concepts into their work and living. The number of stakeholders reflects players' success moved to the final stages.

4.4.6 Simulation Activities

There are 18 activities in the LCSS-V simulation, as described below. Learners can choose to implement and undertake the change to sustainability. Each activity costs a different budget (bits). The action's result depends on hidden conditions players have to perceive themselves. When learners choose the 'right' activity in the 'right' condition with 'right' stakeholders, the simulation piece(s) represents stakeholders moving one or more spaces. If unsuccessful, the stakeholders may stay in

the same places. For example, for 'Talk to first time', if you choose to talk to three stakeholders, those stakeholders may respond in various ways depending upon their interests, characteristics, and roles in change management to sustainability.

Some activities were redesigned to fit the new LCSS-V's simulation purpose. For example, the 'Benchmark and Plan' is not suited for an educational context, replaced by 'Open class demonstration.' It is more familiar to educators. Note that the condition and decision rule may be revised and changed even if the activity changes or does not modify the simulation education version's name.

Table 4.10 Activities in LCS-Business and LCS-School Simulation

#	Business version	Text	School Version	Text
1	**Create Shared Vision**	At a company retreat, management and staff representatives discuss what sustainability would mean in their work and personal lives. They begin to create a shared vision of what the Best Co. would look like if sustainable practices were widely adopted. Select 8 people. Cost: 6 Bits.	**Create Shared Vision**	At a District Meeting, school principals and District Dept of Education administrators discuss what education for sustainability would mean in their work and in their students' lives. They begin to create a shared vision of what the schools would look like if sustainable practices were widely adopted. Select 8 people. Cost: 6 Bits.
2	**Gather Social Information**	Information you obtain from colleagues about the informal relationships among the people with whom you're working. Cost: 1 Bit.	**Gather Social Information**	Information you obtain from colleagues about informal relationships among the people with whom you're working in the One Future project. Cost: 1 Bit.
3	**Talk to First Time**	Your first conversation with individual people to introduce sustainability issues. Choose 3 people. Cost: 2 Bits.	**Talk to First Time**	Your first conversation with individual people to introduce issues about economic, social and environmental sustainability, as well as education for sustainable development. Choose 3 people. Cost: 2 Bits.

Table 4.10 Activities in LCS-Business and LCS-School Simulation (cont.)

#	Business version	Text	School Version	Text
4	**Talk to 2nd Time**	A follow-up conversation to discuss questions about what sustainability means for people in different departments. Note: You must have talked to each of these people 1 time before you can talk to them again. Choose 3 people. Cost: 2 Bits.	**Talk to Second Time**	A follow-up conversation to discuss how sustainability issues impact our lives and answer questions about what educators can do. Note: You must have talked to each of these people 1 time before you can talk to them again. Choose 3 people. Cost: 2 Bits.
5	**Talk To 3rd Time**	A third conversation to further discuss how to make the change to more sustainable practices. Note: You must have talked to each of these people 2 times before you can talk to them again. Choose 3 people. Cost: 2 Bits.	**Talk to 3rd Time**	A 3rd conversation to discuss the progress of One Future and gain support for practical steps to make the change happen in schools. Note: You must have talked to each of these people 2 times before you can talk to them a 3rd time. Choose 3 people. Cost: 2 Bits.
6	**Sustainability Survey**	Survey staff, suppliers and customers concerning their knowledge and attitudes about sustainability in the company and society. Cost: 2 Bits.	**Sustainability Survey**	Survey teachers, staff, and parents to find out what they know about sustainability issues, and how they feel about their importance for the school and society. Cost: 2 Bits.
7	**Assess Sustainable Practices**	All departments and suppliers complete a sustainability assessment template to identify current practices related to energy conservation, use of recyclable materials, waste disposal, and equitable labor practices. Cost: 3 Bits.	**Assess Sustainable Practices**	All staff complete an assessment to evaluate the school's strengths and weaknesses, which leads to planning, operation, improvement, and application of ESD in teaching, organizing learning activities, and managing educational institutions. Cost: 3 Bits.
8	**Field Visit**	Staff visits organizations that have won sustainability awards. Select 8 people. Cost: 5 Bits.	**School Visit**	Selected stakeholders visit a school that has won sustainability awards. They have a chance to see sustainable practices in the school and classrooms, ad ask questions of the school's staff. Select 8 people. Cost: 5 Bits.

Table 4.10 Activities in LCS-Business and LCS-School Simulation (cont.)

#	Business version	Text	School Version	Text
9	**Sustainability Training**	Workshops are offered for staff on 'how to use sustainable practices' including energy conservation, recycling and reuse, and use of sustainable values in their decision-making. Choose 5 people from one Branch. Cost: 5 Bits.	**Sustainability Workshop**	Workshops are offered for teachers and staff on how to integrate sustainability issues into teaching and learning as well as school management. Choose 5 people from one School. Cost: 5 Bits.
10	**Sustainability Retreat**	Staff attend a day-long retreat that raises awareness of how sustainability challenges impact the company. The Caring for People and Planet vision is communicated and participants develop personal action plans. Cost: 5 Bits.	**Sustainability Retreat**	Teachers and staff from the project schools attend a day-long retreat that raises awareness of how sustainability challenges impact the school and society. The Caring for People and Planet vision is communicated and participants discuss what they could do at their schools. Cost: 6 Bits.
11	**Communicate Vision**	A series of meetings with staff and a social media presentation highlight how a sustainability focus can improve long-term performance and strengthen the company's contribution to society. Cost: 1 Bit.	**Communicate Vision**	A series of meetings and informal conversations that communicate how the vision of Caring for People and Planet can strengthen the school's contribution to society. Cost: 1 Bit.
12	**Use Sustainable Practices**	Staff begin using sustainable practices in their daily jobs. Select 3 people. Cost: 2 Bits.	**Use Sustainable Practices**	Teachers and staff begin using sustainable practices in their daily jobs. Select 3 people. Cost: 2 Bits.
13	**Benchmark and Plan**	Form a Committee to assess success, benchmark progress against **industry standards,** and develop a long-range plan for achieving **Sustainable Development Goals**. Form a Committee of 5 people. Cost: 5 Bits.	**Open Class Demonstration**	School staff attend a demonstration lesson taught by a senior teacher from the school. The lesson shows how environmental and social sustainability issues can be integrated into the existing curriculum. Choose a school. Cost: 3 Bits.

Table 4.10 Activities in LCS-Business and LCS-School Simulation (cont.)

#	Business version	Text	School Version	Text
14	**Share Sustainability Success**	Staff in the selected business unit contribute to a company-sponsored **sustainability social media platform** that shares and publicizes successful practices. Choose a Branch. Cost: 4 Bits.	**Share Sustainability Success**	Teachers in the selected school participate in a District Competition showing how schools use sustainable education practices. They can learn and share success in integrating sustainability in teaching. Choose a school. Cost: 4 Bits.
15	**One Future Week Celebration**	A major event showcasing successful sustainability projects undertaken at Best Co., and in partnership with the business partners and the community. Cost: 8 Bits.	**'One Future' Festival**	A District Festival is organized to showcase the benefits of environmental and social action projects started at the Schools. People attended include parents, administrators, the surrounding community as well as other schools. Cost: 8 Bits.
16	**Strengthen Sustainability Mindset**	Staff who are using new sustainability practices form a Green Action Committee. They meet weekly to share strategies, solve problems, and think of new ways to influence others. Choose 5 people from one branch. Cost: 4 Bits.	**School Support Group**	People who are using new sustainability teaching and practices form a Green Team. They meet weekly to share strategies, solve problems, and think of new ways to apply sustainable practices and inspire others. Choose 5 people from one school. Cost: 4 bits.
17	**Sustainability Report**	Data collected from all business units are combined to create a **Corporate Sustainability Report** organized around the company's sustainability goals. The Report is presented to the Board for approval. Form a Committee of 5 people. Cost: 6 Bits.	**Sustainability Report**	Data collected from all schools are combined to create a **Sustainability Report in Schools** organized around the sustainability goals. The Report is presented to the District Dep of Education. Form a Committee of 5 people. Cost: 6 Bits.
18	**Policy Revision**	Seek Board approval to revise company policies to support the change to sustainable practices. Form a committee of 5 people. Cost: 8 Bits.	**Policy Revision**	Select a group of people to consult and propose policies in order to support change to sustainability education. Form a group of 5 people. Cost: 8 Bits.

4.4.7 Feedback to Learners

The LCSS-V simulation provides instant feedback response on learning outcomes. Each time that learners conduct an activity in the simulation, they receive a response card describing what happens and the consequence of the action. For example, when learners choose "Talk to first time' with An, the director of education. The following message feedback pops up:

> *"Mr.An is busy with other projects and does not have time to talk. He says, "Please coordinate with Ms.Bình. She's responsible for overseeing this project." Al moves one space in the Awareness or Interest Stage".*

However, if learners choose "Talk to first time" with other people, different result generates reactions due to the stakeholder's situation. For example, if learners choose Ms.Cúc for the 'Talk to first time', the following response shows:

> *"Ms.Cúc says, We can't afford to waste time and money on projects that might lower our student test results. Ms.Cúc doesn't move."*

4.4.8 Strategy Record

The simulation server records activities that players have undertaken. They can access the record during playing time or they can print at the end of playing.

Figure 4.11 Example of a Strategy Record Showing the Sequence of Activities Implemented by a One Future Project Team (LCSS-V)

4.4.9 Simulation Report

At the end of each play, the assessment of success is displayed. It shows the level of management learners achieved, and the number of Kotter's change principles they reached.

Accordingly, the learners assign to one of six levels of expertise in leading change to sustainability in schools: Apprentice, Novice, Manager, Leader, Expert, or Change Master. Detailed feedback is also provided based on their achievement. Here are two examples of learners receiving the Apprentice and Change Master levels.

> *Upon completion of the LCS simulation, you have reached the Apprentice level in change management for sustainability! Achieving the Novice level means that you have yet shown meaningful progress in helping your stakeholders move through the stages of change and improving the triple bottom line of economic, social, and environmental KPIs. Your change strategy has yet to motivate stakeholders to engage in the One Future Project and support their efforts to make the change to more sustainable school practices. Since stakeholders have yet to adopt new sustainable practices, you have not gained many Bennies (i.e., triple bottom line benefits). Please review Kotter's seven strategic principles and identify on the Strategy Dashboard the principles that are lacking in your implementation plan. Begin to use more of these principles in your next LCS session….*

And here is the congratulations when learners achieve the Change Master level:

> *Congratulations on becoming a Change Master! Achieving the Change Master level means that you have been successful at both helping your stakeholders move through the stages of change and making substantial improvements on the triple bottom line of economic, social, and environmental KPIs. Your strategy has*

> *included most or all of Kotter's strategic principles that bring about successful change. These include: [..]. Once again, congratulations on demonstrating your incredible ability to successfully manage the challenge of bringing about an important change in the capacity of our schools to achieve lasting success and positively impact our stakeholders and society."*

4.5 Results

The results from the formative evaluations supported that LCSS-V simulation was successfully adapted to be culturally appropriate for the Vietnamese context for educators in K-12 settings. Most of the participants commented that the new LCSS-V simulation was interesting, innovative, inspiring, and practical for Vietnamese educators. Specifically, the significant findings reveal through those aspects.

4.5.1 Assessment of the LCSS-V Simulation Design

To rate the simulation design, students evaluated set of statements with the 5-Likert scale from 1= Very easy, 2 = Easy, 3 = Moderate, 4= Difficult, and 5 = Very difficult. Participants commented that the simulation is challenging for difficulty level (M = 3.57). And for ease of simulation usage, they did not have difficulty understanding and identifying stakeholder activities and roles (M=3.07), as well as information needed in the simulation (M=3). It implies that the display design is user-friendly and manageable. For simulation design, students felt that after the instructor's explanations, they could easily find, read, and understand the information needed.

Table 4.11 Student Ratings of Features of the Simulation

Item	N	Min	Max	Mean	SD
2.1 Simulation difficulty	14	3	5	3.57	.646
2.2 Ease of activities and stakeholder roles in the simulation	14	1	4	3.07	.917
2.3 Ease of the information needed in the simulation (i.e., on the response cards)	14	1	4	3.00	.877
Valid N (listwise)	14				

In particular, students responded that:

> *It is basically clear about the characters' introduction and layout. It is helpful for learners to find information and content. I prefer the short context. If the description of people is too long. We have to take notes that it takes time to remember all those contexts and definitions. (P6)*

> *Language is simple and easy to understand. The sentences are short. Words are natural that we talk about in everyday life. (P7)*

Another limitation of the design, the simulation may be a problem with Safari Browser due to the compatible capacity design. However, this issue was addressed and would be improved in the next revision of the simulation.

> *I used MacBook, but the font size was not suitable. So, the appearance is not clear. Others are fine. The images or design is easy to play with. (P7)*

4.5.2 Cultural Adaptation

The cultural adaptation in a new version of simulation reflects on four major parts: (a) simulation problem context, b) stakeholders' description, (b) feedback dialogue, (c) some educational activities, and (d) stakeholders' movement. These adjustments were described in the R&D cycle.

The LCSS-V simulation reflects the hierarchical organizational structure in Vietnamese schools, matching the nation's educational framework. Within each educational institution, the highest-ranking official is the principal, who assumes responsibility for the oversight of all school-related matters. Given the political context, this position also assumes the role of the Party Secretary within the Communist Party Cell. The principal is directly accountable for supervising the vice-principals and instructors across various subjects. Due to this distinctive political element, principals in educational institutions assume several positions, thereby acquiring more responsibilities than their counterparts in the Business version of the simulation. In addition, several ancillary roles are associated with or subordinate to the principal's authority, including trade unions, parent associations, and pioneers' organizations.

After playing with the LCSS-V simulation, the participants agreed that the scenario in the simulation, stakeholders' description, and response cards were reasonable and resembled key Vietnamese characteristics of reality.

> *I think that it is similar by 80%. The simulation is quite appropriate. Nearly the same activities/data are present in Vietnam. However, in real life, the issue is how deeply individuals practice them and what they imply. (P5)*

> *[about the description for stakeholders in simulation] It is similar to 100 percent Vietnamese people. When I read them, I considered that they look like Vietnamese people 100%. The simulation reflects life quite well. There are some 'laggards' who do not move. However, when there are some collective activities, they have to move simultaneously. So, if we know that 'trick', we try many collective activities. It is true with Vietnamese psychological characteristics in an educational environment. (P6)*

> *Some teachers in real life have quite similar characteristics. People who work for a long time are usually conservative or do not like to change, like Ms. Ích*

and Mr. Khoa (aka. stakeholders in simulation). (Student 19)

4.5.3 Educational Content

The after-course feedback survey and interviews were conducted to evaluate the validity of the simulation contents in the Vietnamese context. The evaluation focused on the LCSS-V simulation components, which encompass the scenario, educational, organizational system, relationships among stakeholders, stakeholder descriptions, and activities.

Students commented that the LCSS-V simulation is reasonable to reality regarding the educational content described in Vietnam. Results from both of the interviews showed that participants' opinions about simulation were quite positive. The activities provided in the simulation were typically representative of Vietnamese schools, diverse, and clearly stratified. Many participants expressed that:

The activities listed in the simulation are quite consistent. They are the activities that need to be done when you want to make a change to sustainability. (Student 22)

While playing simulation, I compared it with a school which I have known, I realized simulation is reasonable, normal. (P6)

The 18 activities listed in the simulation have many similarities with the Vietnamese education system. If you want to have a successful project, you need numerous activities to communicate to everyone what the project is. Then, they understand it and agree to do it with the school. (Student 23)

The LCSS-V simulation is a highly practical and suitable tool for Vietnamese educational institutions due to its ability to facilitate real-world application. For instance, it enables educators to conduct educational projects, establish shared visions, develop energy-saving practices, and encourage sustainable behaviors such as turning off unused appliances, recycling papers, etc.

> *Every month or quarter, all principals have a meeting together at the Department of Education. So, 'Create a shared vision' activity is possible to happen in the meetings; or head of Department of Education can implement or enact those activities. (P1)*

> *There are meetings held by the People's Committee. That is the place where the 'Create shared vision' activity can be created. Because the school principal, Dean, and experts from the university also join in these meetings. (P4)*

However, the simulation has its own limitations. As the nature of simulation-based learning, simulations are simplifications of reality. Therefore, some real-life situations may be more complicated and generate different scenarios.

> *The organizational chart in the simulation is correct with the Vietnamese education system. However, influencing and being effective in real life is difficult. (Student 06)*

> *Many simulation activities are carried out in Vietnamese education, showing that the activities are close to reality. However, in reality, some activities are performed for the sake of formality but not in accordance with their meaning. For example, when joining training sessions, teachers go there for attendance, but they do not apply it to teaching. (Student 11)*

4.5.4 Learning Experience

The LCSS-V simulation is a form of experiential learning emphasizing the interaction between learners and the problem provided in simulation through experiences and experimentation. Learners may be more likely to learn by participating in a personally meaningful activity. According to Kolb's theory, individuals gain experience either through conceptual interpretation or through feelings and emotional reactions (Kolb, 1984).

The LCSS-V simulation has impacts on participants' emotions. These emotional reactions have significant effects on cognition, motivation, and behaviors (LeBlanc & Posner, 2022). The after-course survey revealed that participants' feelings were significantly different before and after using the LCSS-V simulation. At first, many participants felt confused and curious about learning with simulation. However, after learning with LCSS-V, students felt excited because of the new active learning approach. Those feelings are pretty centralized and consistent.

Table 4.12 Description of Learners' Feelings Before and After Learning with the LCSS-V Simulation (n=14)

Feelings (before)	Count	Feelings (after)	Count
Confused	4	Excited, interested, attractive	7
Curious	3	Practical, applicable , useful	3
Quite excited	3	Effective	1
Surprised and bewildered	1		
Troublesome, frustrated	1		
Normal	1		
A bit apprehensive	1		

From his observations, the researcher noted that students tend to ask many questions with confusion in week one. Some students had real feelings of anger and resentment when the instructor did not give them a direct answer. Students later had to manage themselves to learn with simulation. They have to create a way of learning. For example, some students formed a study group. Other students chose to go to class early and practice with friends. Some students joined and shared on Online discussion forum. Eventually, they found interest in LCSS-V simulation.

In particular, these emotions engaged students in what they learned, and influenced their motivation to learn from a simulation session and their resulting behavior.

> *After learning, I find this learning method interesting because the situations given in the simulation are similar to real life. In the process of character analysis, it helps*

> *me have a way to handle the situation reasonably. I understand that depending on each person's personality, there are different ways of handling to achieve the goal they pursue. (Student 23)*
>
> *New and active learning method for learners to discover themselves after each play. (Student 06)*
>
> *In my experience, simulations have been more effective in helping me understand complex concepts compared to simply learning theories. Compared with the other constructs of knowledge we learn in other subjects simultaneously, simulation-based learning has given me a deeper understanding of the subject matter. (P2)*

Students highly evaluated the effectiveness of LCSS-V simulation. They rated on 5-Likert scale from 1 = Totally disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Totally agree. The finding revealed that learning through LCSS-V simulation has engaged the student as an active learner (M =4.14). As all students are from Educational Management major, the simulation was enacted to develop their practical managerial skills (M= 4.07).

The effectiveness of simulation encourages students to learn more about ESD (M = 4.36). Moreover, they reckoned that this simulation course is also useful for Vietnamese educators (M= 4.29). In particular, one student replied on what students learned from playing LCSS-V simulation:

> *Sustainable leadership, sustainable schools, and ESD are all interconnected. […] Education is actually needed to fill the gap left by our society's hasty development while disregarding environmental preservation. For the sake of the economy, we are destroying the source of life. Finally, we must take a step back to correct such mistakes. The simplest way to change perceptions is through education. Only people with sustainability awareness can change*

their behavior for sustainable development. (Student number 29 posted on online discussion forum week 2)

Table 4.13 Formative Assessment Using Student Perception Rating of Learning

Evaluation Questions	n	Min	Max	Mean	SD
1. Learning with the simulation engaged me actively as a learner.	14	3	5	4.14	.663
2. Learning with the simulation enabled me to develop managerial practical skills.	14	2	5	4.07	.829
3. This course makes me want to learn more about education for sustainable development.	14	3	5	4.36	.842
4. This simulation is a useful course for Vietnamese educators.	14	2	5	4.29	.914

The simulation requires students' engagement. It represents a kind of experiential learning. Learning with peers or working in a group is essential for learning with LCSS-V simulation. The researchers encourage students to collaborate with classmates and learn from others.

Moreover, the researcher noted that participants played more effectively when the number of group members was no more than four. If there were more than four, just one or two participants who directly faced the computer focus on the simulation. The others would not concentrate on simulation, so did not benefit much. Noted one more contribution of simulation-based learning: some students engaged in rather active peer interaction in the online discussion forum, in contrast to how little they spoke in face-to-face sessions.

The online discussion forum is a way for students to interact and share their experiences and effective strategies. It also reflects the patterns of participation engagement. In week one, 27 students contributed 51 posts on the online forum. These posts showed their own stories and ideas exchanged with other students. The response patterns for weeks two and three were 33 and 32, respectively. These offer the active participation of students when learning with simulation. One student recalled that:

> *My own experience is engaging in simulation, i.e., taking notes about characters and their positions. Then, I examined the activities, organized the strategy, and played many times. After each playing, I draw lessons and revise strategy (e.g., which activity should be undertaken first, how to get more bennies). Besides, I joined Connection Forum, and discussed with my classmates and instructor. I had more clues/ notifications. From that, I had my own strategy. (P3)*

Learning with simulation is time-consuming and requires students' engagement. With the instructions and material given in each session, students can operate the simulation well. In particular, students failed if they did not spend time working with simulation.

> *I did not have time to engage in simulation, so I failed many times. After each intervention, the instructor gave a guideline. Plus, classmates shared their experiences. I took notes those tips. After week 3, I played two times and reached the highest level. I thought I achieved it, so I did not spend times on simulation anymore. Till the final session, I could not reach the highest level. maybe, because I lost my temper and did not learn thoroughly. I admitted that I still did not achieve the strategy and management to sustainability. So, the final result was not so good. (P1)*

Learning with LCSS-V simulation shows many strengths compared with the traditional learning approaches students have used in the past. The participants appreciate the LCSS-V simulation for its outstanding features and combination of theories and practices. Some students expressed that:

> *The simulation is able to put the learners in a hypothetical model of practice as a manager. It gives learners a sense of authenticity and appreciation of their actions. (Student 17)*

> *Simulation allows learners to put the theories they learned into practice immediately so they can remember them longer. Playing simulation is similar to visualizing learned knowledge. Additionally, learners can verify if they have truly understood and applied the actual knowledge they have learned. Sometimes, one may understand the theory, but applying it in practice is a different story. (Student 22)*

On the other hand, participants mentioned several limitations of learning with the LCSS-V simulation: time-consuming, digital literacy requirements, some unpractical assumptions, and emotional stress after failures. The researcher recognized that those are a part of learning with simulation. Because of the large amount of information and the simulation complexity, students have to spend time playing. However, the researcher took note of those opinions to revise and improve the LCSS-V simulation.

4.5.4 Student Suggestions for Improvement

The researcher intended to gather suggestions and recommendations from participants on improving the LCSS-V simulation. This was achieved through feedback responses and interviews.

In the feedback response, nine participants expressed that they were satisfied with the current version simulation and had no further suggestions. Others suggested some activities to add to the simulation, such as rewarding stakeholders who have progressed at work and putting more pressure on laggards. One participant commented that it should provide more knowledge on economic and social outcomes since students do not have much background in these sectors, while sustainability requires multi-disciplinary issues.

One participant suggested a ‘coaching’ activity. However, the researcher later asked for other people’s opinions in the interviews. It was claimed that

> *I think coaching is quite new in Vietnam. It is not really suitable for K-12 education now. Your teaching method in the higher education level can apply somewhat coaching.*

But for young students, it is not suitable and impractical. (P4)

Agreed with this idea, the researchers do not use 'coaching' as main 18 activities. However, the content for response cards would be added in some elements, like coaching methods in the teaching and learning process.

In the interviews, participants came up with more ideas for the simulation. They suggested that simulation should extend a more student-centered approach as follows:

In some activities, you can add the object as student representatives. I work with school leaders about students. I always target students as educational products. They also interact with their parents. In the feedback cards, it is better if simulation presents more students' voice. (P2)

They also provided sustainable practices which they have applied in their work, such as:

In public schools, there is kind of festivals to share sustainability success. I have cooperated with a high school in the district. The practices are celebrating environment day, and collecting batteries and plastics. We recycle plastics and redesign products to make bio-bricks and flower pots from those plastics. Now, there is a shelf in the library made from plastic bottles. I also reused plastic banners used for school decoration. It recycles waste and raises awareness about the environment. (P1)

4.6 Discussion

This Chapter introduced the research and development process that guided the redesign and evaluation of the Leading Change for Sustainability-Business simulation for use in a Vietnamese K-12 school setting. The redesign process was described in detail, and initial research data were presented on the evaluation of the

simulation from the perspective of the learners. Research data on the learning outcomes of the new simulation are presented in Chapter 5.

4.6.1 Limitations

The results of this study should be interpreted with caution, and further research with larger sample sizes is needed to fully understand the impact of simulation-based learning on ESD in Vietnam. It should be noted as well that the simulation-based learning course used to evaluate the simulation was also the first time that the instructor had taught with the simulation. With more experience teaching with the simulation, it is likely that the instructional execution would be more effective. This limitation suggests that the results reported in this chapter may actually understate the potential effectiveness of the simulation as a learning tool.

Despite these limitations, the results of this study are promising. They have important implications for the further development of the LCSS-V simulation, as well as for sustainability education in Vietnam more broadly. The success of this R&D project highlights the potential of simulation-based learning as a tool for sustainability education, and further research in this area is needed to realize its potential. Nonetheless, the LCSS-V simulation is still in its early stages of development, and further refinements may be necessary to improve its effectiveness.

4.6.2 Interpretation of Findings

The R&D project described in this research involved eight stages, culminating in redesigning the LCS simulation specifically for Vietnamese schools. The LCSS-V simulation was evaluated by the Vietnamese educators, which showed that the simulation was effective in achieving its goals. Participants found the simulation to be engaging and practical and appreciated the combination of learning sustainability and change management theory and practice.

One of the key benefits of simulation-based learning is its ability to engage students in active learning. By combining learning theory with practical application, students are able to understand better and internalize the concepts they are learning, leading to more meaningful learning experiences. It was evident in the results of the

LCSS-V simulation, where participants commented on the intriguing and practical nature of the simulation.

Simulation-based learning also has the potential to foster emotional engagement among students. By allowing students to learn with and from each other, the simulation helps to create a more supportive and inclusive learning environment, which can lead to increased motivation and engagement. This is particularly important in the context of sustainability education, as changing attitudes towards sustainability is an important aspect of developing sustainable skills and behaviors.

Finally, this research provides valuable insights into the potential of simulation-based learning for sustainability education in Vietnam. The LCSS-V simulation provides a useful tool for educators to engage their students in learning about sustainability and developing new skills. By fostering participants' engagement, the simulation has the potential to help learners internalize the sustainability concepts and develop the attitudes and behaviors needed for a sustainable future. This study highlights the importance of further research in this area, and the potential for simulation-based learning to play a key role in sustainability education in Vietnam and beyond.

4.6.3 Implications of the Findings

This R&D project aimed to demonstrate the potential of simulation-based learning as an effective approach to engage learners in active learning and foster emotional engagement, particularly in the context of sustainability education. Integrating learning theory with a practical application can lead to more meaningful learning experiences, enabling learners to internalize sustainability concepts and develop the attitudes and behaviors necessary for a sustainable future. As such, this project underscored the potential of simulation-based learning as a valuable training tool for ESD. However, this project highlights the need to refine the LCSS-V simulation further to enhance its effectiveness.

The LCSS-V simulation provides a practical tool for educators in Vietnam to engage their students in learning about sustainability, changing mindset and developing new sustainable skills. The simulation's engaging and feasible nature was found to be effective in achieving its goals, and further research is needed to utilize a simulation in various context such as one day workshop or in hybrid mode.

As sustainability issues are global and interconnected, there is a requirement for redesigning education approach for the international context. The LCSS-V simulation can serve as a useful model for developing simulation-based learning tools that are relevant and effective for learners from diverse cultural backgrounds. In this way, a new LCSS international version can help to bridge cultural differences and promote a shared understanding of sustainability challenges and solutions, which is crucial for building a sustainable future for all.

Furthermore, this R&D project not only provides valuable insights into simulation-based learning for ESD in Vietnam but also enriches the validity of the LCS simulation in different fields and cultural contexts. The LCSS-V simulation has been specifically designed for Vietnamese schools, but the success of this project suggests that it can be adapted and implemented in other contexts. For instance, the LCSS-V simulation can be modified to suit the needs of different educational levels, from K-12 education to higher education, to foster sustainability learning across a wider audience.

The author has already sought to disseminate both the approach and findings from this study through academic publications. The findings were presented at several conferences:

1. Annual ABSEL conference (Vol. 49) Business Simulation and Experiential Learning,
2. 28th International Sustainable Development Research Society Conference Sustainable Development and Courage. Culture, Art and Human Rights,
3. 53rd annual international conference of the International Simulation and Gaming Association (ISAGA),
4. University Council for Educational Administration (USA).

In the future, the researcher will also present the simulation to the Institute for Educational Management in Vietnam. This is the main organization responsible for the preparation and training of school leaders in Vietnam.

4.7 Conclusion

In this Chapter, the author described eight stages of the Research and Development project for redesigning the Leading Change to Sustainability-Business simulation for use in the K-12 schools context in Vietnam. At the end of this R&D cycle, a working version 'Leading Change to Sustainability in Schools' simulation (Vietnam) was evaluated. The data presented in this Chapter suggest that the LCSS-V simulation provided a valuable means of introducing sustainability issues in the Vietnamese education context. The Vietnamese educators who participated in the main field test provided positive feedback on the simulation as well as constructive feedback on how it could be further refined. Most of the participants commented that the LCSS-V simulation was intriguing and practical for Vietnamese educators.

CHAPTER V
TEACHING FOR SUSTAINABILITY THROUGH SIMULATION-BASED LEARNING: EVALUATING THE EFFECTIVENESS OF THE 'LEADING CHANGE FOR SUSTAINABILITY IN SCHOOLS' (VIETNAM) SIMULATION

5.1 Introduction

The transformation to sustainable development requires complex, systemic changes at the individual, organizational, and social system levels. The traditional teaching methods emphasized in many Asian societies may lead to missed connections and interactions, which can be explored to address sustainability-related problems (Hofstein, Eilks, & Bybee, 2011; Hopkinson & James, 2010). In advancing sustainability, United Nations proposed Sustainable Development Goal (SDG) 4 as access to quality education. Education for sustainable development improves students' values, develops life skills, raises awareness of global sustainability challenges and solutions, and shapes their motivation to engage critically in their communities.

In concert with the UN's effort to achieve the SDGs, UNESCO put forward the Education for Sustainable Development (ESD) 2030 framework. The framework includes five priority action areas, one of which explicitly aims to build capacities for educators to become 'learning facilitators for education for sustainable development' (UNESCO, 2020). This priority challenges educators to employ participatory approaches to teaching and learning that are consistent with the underlying values of "educating for sustainability" (Öhman & Östman, 2019). Thus, schools and educators must seize this opportunity to empower future generations to become leaders whose mindsets and actions evidence concern for the future of society and the planet.

Scholars seeking to advance the global ESD agenda have proposed alternative learning methods that actively engage students in sustainability challenges, as opposed to simply 'learning about them'. Some of these include case study, service

learning, problem-based learning, action learning, and experiential learning (Figueiró & Raufflet, 2015). Among these diverse experiential learning approaches, educators have argued that simulation-based learning offers several strengths in the context of educating for sustainable development (Hallinger et al., 2020; Littlewood et al., 2013; Prado et al., 2020; To, 2017). Simulations are particularly suited to addressing complex problems that require interdisciplinary, holistic solutions for sustainability (Doyle & Brown, 2000; Ulrich, 1997). Moreover, simulations have the advantage of providing students with an active, engaging learning environment.

A growing number of simulations have been developed and used to educate for sustainability. However, relatively few studies have analyzed the effectiveness of simulations in teaching and learning for sustainability (Hallinger et al., 2020; Rose, Ryan, & Desha, 2015). Moreover, recent reviews have found that most empirical studies of teaching and learning for sustainability – including simulations and serious games – have used descriptive, non-experimental research (Hallinger et al., 2020; Nguyen & Hallinger, 2022; Pauw et al., 2015; Stanitsas et al., 2019). Thus, this limits the development of a knowledge base capable of identifying educational methods that achieve the stated goals for sustainability education.

This chapter focuses on three related gaps in the literature on educating for sustainable development. First, the research addresses the need for more empirical research on teaching methods that effectively address sustainability content and goals. Second, the research employed a quasi-experimental design to evaluate the efficacy of a new sustainability-related simulation for use with K-12 teachers and administrators. This responded to the need for stronger research designs when evaluating the use of new methods of teaching and learning for sustainability (Hallinger et al., 2021). Third, the research was conducted in Vietnam, where few empirical studies have been published on teaching and learning methods for sustainability (Kieu et al., 2016; Nguyen et al., 2022).

The study presents an evaluation of the Leading Change for Sustainability in Schools (Vietnamese) online computer simulation used in a graduate course module (see Chapter 4). The research questions addressed in this chapter include the following:

1. Does learning with the Leading Change for Sustainability in Schools (Vietnam) simulation have a significant effect on learners' knowledge of change management for sustainability?

2. Does learning with the Leading Change for Sustainability in Schools (Vietnam) simulation have a significant effect on learners' attitudes towards sustainability?

3. Does learning with the Leading Change for Sustainability in Schools (Vietnam) simulation have a significant effect on learners' skills in leading and managing change for sustainability?

The chapter presents the results of the main field test in the research and development cycle used in developing the Leading Change for Sustainability in Schools (LCSS-V) simulation. The main field test was conducted with a group of 32 educators studying in a Master's degree program in Vietnam. The field test employed a quasi-experimental research design to assess change in learners' knowledge, attitudes, and skills resulting from a four-week learning module centered around the LCSS-V online computer simulation. Quantitative and qualitative data were collected to assess the learning outcomes in evaluating the simulation's effectiveness.

This empirical investigation holds significant implications both in academic research and practical applications. Firstly, it presents a preliminary validation and evaluation of one of the earliest simulations specifically created to familiarize Vietnamese educators with concepts of change management for sustainability. Secondly, it contributes to the existing body of knowledge on ESD and simulation-based learning by providing empirical evidence, lacking and a point of criticism in the fields. Finally, the study sheds light on the attitudes of Vietnamese educators towards sustainability and the skills for change management for sustainability. Therefore, the findings of this study provide valuable insights into the potential of simulation-based learning in promoting ESD among Vietnamese educators.

5.2 Literature Review

5.2.1 Overview of Theories Informing the LCSS-V Simulation

As described in Chapter IV, the LCSS-V simulation is grounded in three theoretical frameworks, embedding simulation-based learning, change management, and sustainability science into the simulation's design. The literature underlying this research has been reviewed extensively in the earlier chapters presented in this dissertation. Thus, this chapter only offers a brief overview of related literature.

Simulation-based learning is an educational approach to learning rather than a specific technology. Employing a learner-centered approach, simulation-based learning is derived from constructivist learning theories (Bruner, 1996) and experiential learning theories (Dewey, 1986; Kolb, 1984; Rogers, 1969). To date, simulation-based learning shows great promise for being an active learning method applied in different educational settings (Hallinger & Wang, 2020).

The change management theories embedded in the simulation include the concerns-based adoption model (Hall & Hord, 2006), diffusion of innovations (Crandall, Eiseman, & Louis, 1986; Rogers, Medina, Rivera, & Wiley, 2005), systems thinking (Senge, 1990; Senge, Hamilton, & Kania, 2015), and strategic change leadership (Kotter, 1995, 2012). These change theories underpinning decision rules in the simulation have been described extensively in previous research (Hallinger & Kantamara, 2001; Hallinger, Lu, & Showanasai, 2010; Hallinger, Tang & Lu, 2017; Chatpinyakoop, Hallinger, & Showanasai, 2022).

The simulation also incorporates sustainability knowledge, adapting the triple bottom line (Elkington, 2013), education for sustainable development (UNESCO, 2002, 2020), the whole school approach to sustainability (Tilbury & Cooke, 2005), and the sufficiency economic philosophy bestowed by King Bhumibol Adulyadej (Wibulswasdi, Piboolsravut, & Pootrakool, 2011). The simulation employs an active method of engaging learners in learning how to apply basic sustainability concepts, education for sustainable development, and change management in an integrated fashion in K-12 schools.

Since the early 1990s, the whole school approach to sustainability has represented an increasingly influential theme in the ESD movement (Hallinger &

Nguyen, 2020; Tilbury & Wortman, 2005). It could be identified under various names such as green school, sustainable school, eco-school, and sustainable educational organization. The initial school models focused on environmental protection and environmental education. Gradually, with the emergence of the global sustainability movement, green school models expanded beyond environmental education to include social and economic education. The whole-school approach refers to implementing sustainability education across the campus, curriculum, and school's community (Tilbury & Cooke, 2005). The holistic approach appears most effective when it builds on the existing culture of the school and its surrounding communities (Bolstad et al., 2004).

A whole school approach to sustainability aims to create a culture of sustainability within the school community. UNESCO stated that the whole-school approaches to ESD seek to reorient the basic features of the school around sustainability goals (UNESCO, 2002). A sustainability culture is grounded in a specific core values (e.g., caring, environmental concern, moderation, inclusion) that are reflected in the actions and behaviors of everyone involved (Tilbury & Cooke, 2005). This approach aims to develop more environmentally conscious and responsible citizens equipped to address the sustainability challenges of the future. Research on the whole school approach to ESD has focused on students' outcomes (Eames, Barker, Wilson-Hill, & Law, 2009; Mathar, 2015), teacher perceptions (McKey, 2017), school improvement (Mogren, Gericke, & Scherp, 2019), school leadership practices (Pepper, 2014; Sterrett et al., 2014).

The UN's Sustainable Development Solutions Network (SDSN) initiated the Global School Program as a vehicle for helping educational institutions and educators worldwide pursue SDGs, especially Target 4.7. This program promotes a whole school approach by integrating sustainability in classroom activities, curricula, and school operations. In short, the whole school approach to sustainability has emerged as the dominant means through which sustainability-oriented values and practices are being implemented in schools in 2030.

5.2.2 Conceptual Framework

The logic model of the evaluation of LCSS-V simulation is based on several frameworks, such as theory-oriented evaluation for simulation-based learning (Kriz & Hense, 2006), input-process-outcome game model (Garris et al., 2002), and the simulation learning framework (Jeffries, 2005; Jeffries et al., 2015). This study's simulation model consists of three components with associated variables.

The input variables consisted of the socio-demographic characteristics of the learners and the LCSS-V simulation. The process variables include student time on task, quality of instruction, learning activities, as well as interaction among peers and instructors. The participants' individual learning outcomes represent the dependent variables, followed by experiential and problem-based learning methods.

Learning outcomes are long-lasting abilities that enable learners to adopt positive attitudes and behaviors in their daily life. In simulation-based learning, learners 'practice' the desired tasks in the context of solving a realistic challenge they might face in their lives. The transfer of knowledge and skills from the classroom to real-world experience depends on a variety of factors, including task similarity, degree of learner engagement, scaffolding of knowledge, and constructive feedback on results (Salas et al., 2009).

Researchers have created categories of learning outcomes to describe learning and performance (e.g., Bloom, 1956; Gagné, 1984; Kraiger et al., 1993). These frameworks propose cognitive (declarative knowledge, knowledge structure, and cognitive strategies), skill-based (skill compilation and automaticity), and affective (attitudes and motivation) outcomes. Based on reviews of the existing literature, scholars have frequently targeted knowledge, attitude, and practice/behavior, as measures of learning outcomes (Crick, 2008; Gericke et al., 2018; Hallinger et al., 2021; Olsson et al., 2020; Salas-Zapata et al., 2018).

Sustainability simulations have been shown to have a positive impact on affective and behavioral learning outcomes, including awareness (Chappin et al., 2017), attitude (Gatti et al., 2019; Yeung et al., 2017), interest (Nussbaum et al., 2015), and learner engagement (Rowe et al., 2017). Evaluating behavior is a challenging task that requires after-learning assessment. Since direct behavioral outcomes are difficult to

evaluate, scholars measured intended behaviors instead. However, these results are unstable (Chow et al., 2017; Yeung et al., 2017).

On the other hand, theory of planned behavior (Ajzen, 1991), many scholars concluded that knowledge and attitudes to sustainability significantly influence desirable pro-environmental/ sustainability behaviors (Chappin et al., 2017; Kollmuss & Agyeman, 2002). More specifically, it is agreed that knowledge does not solely lead to action (Jensen, 2002). Instead, schools build up students' action competence which is proposed to transfer into modified behaviors (Jensen, 2002; Mogensen & Schnack, 2010). This study aimed to measure learners' knowledge, attitude, and skill as performance and learning effectiveness with LCSS-V simulation.

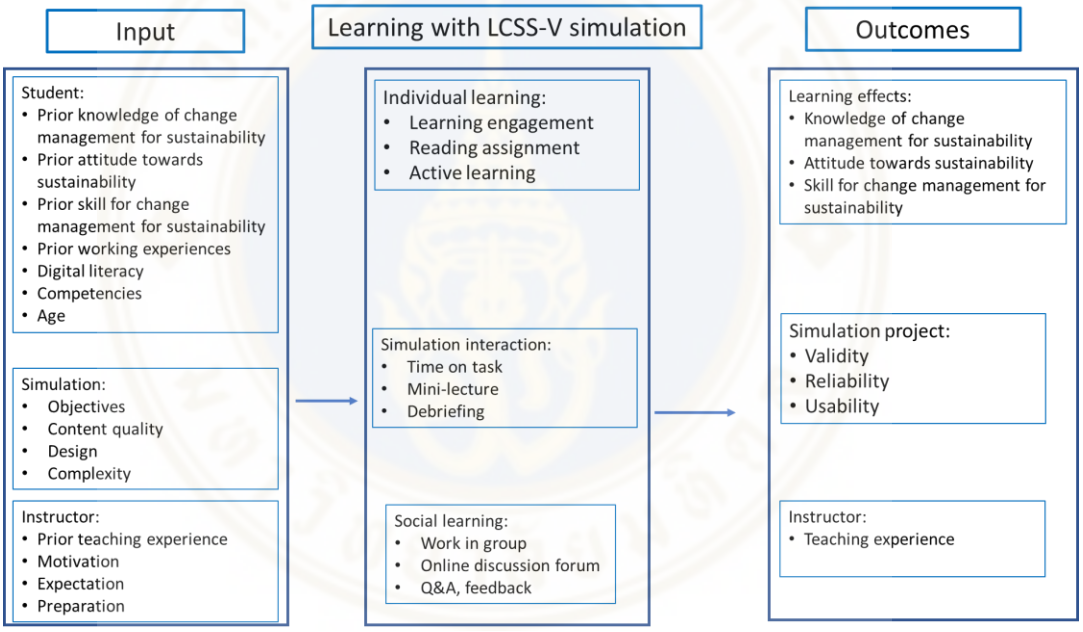

Figure 5.1 A Framework for Evaluating the Effects of the LCSS-V Simulation

5.2.3 Leading Change for Sustainability in Schools (Vietnam)

Given the extensive description provided in Chapter 4, this chapter presents only a brief summary of the LCSS-V simulation. The LCSS-V is a web-based simulation developed for Vietnamese educators, which aims to challenge learners to bring about a comprehensive change towards sustainability in schools. The goal of the simulation is to transform the traditional mode of education into an approach that

incorporates sustainability throughout the entire school system, with the support of multiple stakeholder groups.

In the simulation, players assume the role of members of the One Future Project team. They are tasked with guiding the transformation of an educational organization towards sustainable values and practices over a three-year period of time. The players work with senior management to implement the One Future project in a district education unit. Pilot implementation of the One Future project will take place in the District Office, Primary School, and Secondary School.

In each year of the simulation, players are provided with a budget to fund activities aimed at informing, engaging, empowering, and supporting 24 stakeholders throughout the transformation process via 18 activities. The system's transformation should be reflected in both the daily practices of stakeholders as well as in the impact of the educational organization on the triple bottom line of economic, social, and environmental outcomes. The simulation unfolds using a gameboard that shows five stages of the change process: awareness, interest, preparation, practice, and sustainability. As the learners succeed in formulating and executing a successful change strategy, the 24 stakeholders will gradually move through these stages of change.

The One Future project team (i.e., the learner(s) is tasked with achieving two goals. The first is to move as many of the 24 stakeholders as possible into the 'sustainability stage' on the gameboard. This means that the team's change strategy has been successful in changing the stakeholders' mindset and practices. The second is to accumulate as many 'Bennies' (i.e., triple bottom-line benefits) as possible over the course of the three-year simulation. For example, some activities such as 'Use Sustainable Practices' will not only move the participating stakeholders across the gameboard but also generate Bennies.

The simulation incorporates a form of experiential learning whereby the learners gain experience through playing the simulation, reflect on what happens (and why), reformulate their strategy, and then try out a new strategy. As discussed in the subsequent section, reflection is structured by the instructor and incorporates both instructor-to-student and student-to-student reflection activities. This experiential learning cycle (Kolb, 1984, 2014) facilitates a gradually deepening understanding of the principles that underlie successful sustainability transformation.

5.3 Method

Experimental and quasi-experimental research designs are well-suited to assessing the effects of educational interventions. Unfortunately, such designs have not been used with frequency in the ESD literature (Hallinger et al., 2021; Nguyen & Hallinger, 2020; Rose, Ryan, & Desha, 2015). Thus, scholars have recommended more frequent use of these designs in the validation of teaching and learning methods used in teaching and learning for sustainability (Den Haan & Van der Voort, 2018; Gatti et al., 2019; Hallinger et al., 2021). To address this gap, this study used a quasi-experimental research design to evaluate the effectiveness of LCSS-V simulation in promoting ESD. The study evaluated changes in learners' knowledge of change management for sustainability, attitude towards sustainability, and skills in managing change for sustainability.

5.3.1 Research Design

This research adopted a quasi-experimental design without a control group (Shadish et al., 2002). It is often difficult to conduct true experiments in education settings due to constraints in scheduling and assigning students, as well as the need to provide comparable learning experiences across classes (Gatti et al., 2019). This single-group design plays an essential role in education as it can offer preliminary insights into the viability of an intervention's promise during the development phase (Marsden & Torgerson, 2012).

Salas and colleagues (2009) conducted a review of performance measurement for simulations and proposed a set of best practices for measurement. In addition to measuring learning outcomes (e.g., post-test results), they suggested capturing the final performance on the simulation as a complementary means of measuring effects on skill performance. Thus, the evaluation should capture multiple dimensions with multiple measures at multiple analysis levels (Salas et al., 2009). Therefore, this study collected several measures over time to improve the simulation's evaluation.

This study is implemented with formative and summative assessments to evaluate the new simulation. Mixed method research designs are used when the researcher does not only need to analyze the effects of an intervention but also wishes

to explore the learning experiences and insights of the participants. The quantitative phase of this study sought to assess whether the simulation had significant effects on learners' knowledge, attitudes, and skill related to change management for sustainability.

Two different research designs were used: one for research questions one and two, and a different design for research question three. For the first two questions, the researcher used a pre/post-test design without controls (see Figure 5.2).

O_1 X O_2

Figure 5.2 Pre/Post-Test Quasi-Experimental Research Design

In Figure 5.2, X represents the simulation intervention. O_1 denoted the pre-test of knowledge and attitude measurement in week one when learners started to learn with simulation. Otherwise, O_2 referred to the post-test measurement in week four after learners played the LCSS-V simulation for the final test.

For the third research question, the researcher used a times series quasi-experimental design (Campbell & Stanley, 1966). This design collected data points multiple times in order to track changes in learner skills with the goal of linking observed changes to the intervention.

O_1 X_1 O_2 X_2 O_3 X_3 O_4 O_5

Figure 5.3 Repeated Measures Time Series Quasi-Experimental Research Design

In the time series design (see Figure 5.3), X represents the simulation intervention executed during the four weeks of the course, while O represents when data collection points. Specifically, O_1 referred to the baseline when the student played the LCSS-V simulation for the first time. Then, O_2 referred to the student's last play result at the end of the first week. Similarly, O_3 and O_4 refer to the results of the last games played by students at the end of the second and third weeks. Finally, O_5 presented the results collected in the final week (i.e., the fourth session).

The qualitative phase aimed to gain an in-depth understanding of participants' improvement and experience with simulation-based learning. For

formative evaluation, the researcher collected data from weekly responses on an online discussion forum and took in-depth interviews after finishing the course. The researcher did that to ensure the participants were not afraid that the feedback or interviews could affect their learning grades for the course.

5.3.2 Sampling and Participants

As noted above, in educational research, random sampling is often complex. It is especially the case when seeking to test the viability of an intervention that has yet to be trialed. Thus, the researcher employed the 'convenience sampling' method for this mixed-methods study.

The target group for the LCSS-V simulation consists primarily of school teachers, educators, and leaders in Vietnam. This simulation is sometimes used in workshops and sometimes in formal university settings. Given the desire to assess knowledge, skill, and attitude change beyond the surface level, it was chosen to test the simulation in a higher education course context. It would give the researcher greater control over the intervention's duration, assessment types, and data collection than, for example, testing it in a single-day workshop.

At the time of this study, the researcher worked at the Faculty of Education in a public university in Vietnam. Thus, it was decided to employ the simulation as part of an existing course in the Master in Educational Administration degree program. Using the simulation in this course, as opposed to a bachelor's degree course, ensured that the participants had gained sufficient experience as educators to offer insights to the researcher on the simulation's viability, practicality, and contextual validity. Thus, at this stage of assessing the simulation's viability, it was essential to obtain the perceptions and perspectives of experienced educators. The participants were second-year graduate students taking a course in 'Effectively Managing Schools' in the Faculty of Education.

Of the 32 participants, 11 were male, and 21 were female graduate students. They worked in various educational settings and included teachers, vice-principals, staff in universities and schools, and NGO officers. Their working experience in the education sector was varied (M = 6.63 years, SD= 5.116, Min= 01 year, Max= 20 years). There were 14 participants (43.75%) who had from one to less than five years of

experience, 11 participants (34.37%) with five to less than ten years of experience, and 7 participants (21.87%) had more than ten years of experience in education sectors.

The participants' digital capacity was assessed using a 4-point scale statement, ranging from limited to proficient in digital literacy. On average, their digital knowledge was rated moderate (M= 2.66/4). Of the total participants, 22 (68.8%) were identified as having moderate digital capacity, seven (21.9%) were classified as having advanced digital capacity, and the others rated themselves below moderation.

These participants also checked their learning and teaching experience with simulation to estimate their difficulty during sessions. Nine participants had some prior experience with learning or teaching with simulation (28.1%). In short, while all participants had prior experience using computers for general professional and personal tasks, less than a third had experience in learning with simulations. This self-assessment was undertaken to gain a sense of the extent to which prior experience with computers might inhibit their adaptation to the use of an online computer simulation as learners.

Table 5.1 Demographic Characteristics of the Participants (n=32)

	Work Experience (Year)	Digital Literacy (4-point scale)
Mean	6.63	2.66
Median	5.00	3.00
Std. Deviation	5.11	.937
Skewness	.885	.015
Kurtosis	-.038	-.888
Minimum	1	1
Maximum	20	4

The researcher conducted one focus group and three individual interviews for the qualitative data collection phase. The focus group consisted of three teachers and one Youth Union officer. The individual interviews were conducted with three participants to give diverse insights. Three participants included one vice principal of one primary school, one art teacher, and one with little experience in the education field.

For quantitative data, all 32 participants completed the pre/post-test for knowledge and attitude and simulation measurements for skill development. While participants played the LCSS-V simulation, the recorded data collected were only the participants' strategy for dealing with simulation content. No participant information was stored, nor were the participants' results used for this research only. It does not affect participants' career paths and course performance.

5.3.3 The Intervention

This study utilized a single-group quasi-experimental research design incorporating pretest-posttest and time-series variants (Campbell & Stanley, 1963). The quasi-experiment encompassed four weekly teaching sessions that took place in March-April 2022. Each class session lasted 2.5 hours for a total of 10 hours of classroom instruction. Students engaged in individual self-study with the simulation at home and participated in a weekly online Open Discussion Forum. Table 5.2 below summarizes the instructional sequence of the intervention.

Table 5.2 Summary of Instructional Activities Comprising the Intervention

Week	Classroom Activities	Homework
1	Introduce course and simulation Introduce participation to the research Pretest of knowledge and attitude Mini-lecture: Introduce to sustainability concepts, ESD Introduce the simulation Demonstrate how to play Play in student teams of three (year 1 only) Whole class debriefing	Play simulation at home Join week one Online Open Forum Reading assignments
2	Q&A Mini-lecture: Introduce whole school approach to sustainability Introduce change process stages, diffusion of innovation, and adopter types Play in student teams of three (year 1 and 2) Whole class debriefing	Play simulation at home Join week 2 Online Open Forum Reading assignments

Table 5.2 Summary of Instructional Activities Comprising the Intervention (cont.)

Week	Classroom Activities	Homework
3	Q&A Mini-lecture Introduce sustainability concepts Kotter's change model Play in student teams of three (3 year) Whole class debriefing	Play simulation at home Join week 3 Online Open Forum Reading assignments
4	Q&A Post-test for knowledge and attitude survey Individual simulation exam Whole class debriefing	Response after course feedback

In week one, the instructor (i.e., the researcher) introduced the LCSS-V simulation, the goals of the course, the simulation challenge, and the tasks. Students also were informed about the research and consent form and distributed the pretest for knowledge and attitude through Google form. Then, the instructor addressed some main concepts such as sustainability, education for sustainable development, and the whole school approach to sustainability. After the researcher instructed how to play the simulation, students played the simulation in teams for about one hour. Finally, the instructor wrapped up and debriefed some main principles of simulation and guided them to use simulation, reading materials, and an online forum. This whole class debriefing consisted of the instructor prompting participants to learn, brainstorm and analyze a strategic plan when playing the simulation.

After the first session, learners continued to play the simulation individually at home. The first complete play was recorded as the baseline for simulation measurements. Learners were recommended to play at least three times, though many people play more frequently. The process and results were collected in the server in each game with a unique username assigned to each player.

In each following session, the instructor gave a mini-lecture about theories and concepts related to the LCSS-V simulation. Students are also allowed to play in group in class. This way enabled learners to share, reflect, and learn from their peers. At the end of each session, the researcher debriefed to share individual and team questions about strategies.

At home, participants continued to play the simulation individually and joined an open discussion forum on the e-learning system. The instructor posted questions every week, so participants reflected on lessons learned and also helped them identify problems they were unable to solve. Both the instructor and peers would then respond to these calls for sharing and assistance.

In the fourth week, students took a final test for simulation measurements and a post-test about knowledge and attitude. At the end of the fourth session, the instructor debriefed the course and gave time for students to reflect on the simulation-based learning experience.

5.3.4 Data Collection Procedures

5.3.4.1 Quantitative data collection. The quantitative data collection process took place over four weeks and involved several assessments, including pre/post-tests, and simulation measurements. In week one, the researcher informed the students about the research and consent forms. Then, students completed a pre-test for change management for sustainability, and attitude towards sustainability through Google Forms. This test was identically distributed again as the post-test in week four when students finished the module.

For simulation measurements, the results from the first complete game each student played at home in the first week were counted as the baseline data points for the skill measures. A variety of data for each game a student played was recorded and saved to the server. In weeks one, two, and three, data were collected from the last game completed before the next class. In the fourth week, students took a final test where they played simulation in class once only within 30 minutes without restarting. It should be noted that the approximate time elapsed between data points one through four was five days. However, in most cases, only a single day separated data point four and five.

The results of the game played for the individual exam in week four of the class were recorded as a final record for simulation measurement. Data collected included the number of Bennies gained, the number of stakeholders in the sustainability stage, the change management level achieved, and the number of Kotter's change management principles. These indicators were used as an assessment of learner skills in applying knowledge to the simulation problem (see Figure 5.4).

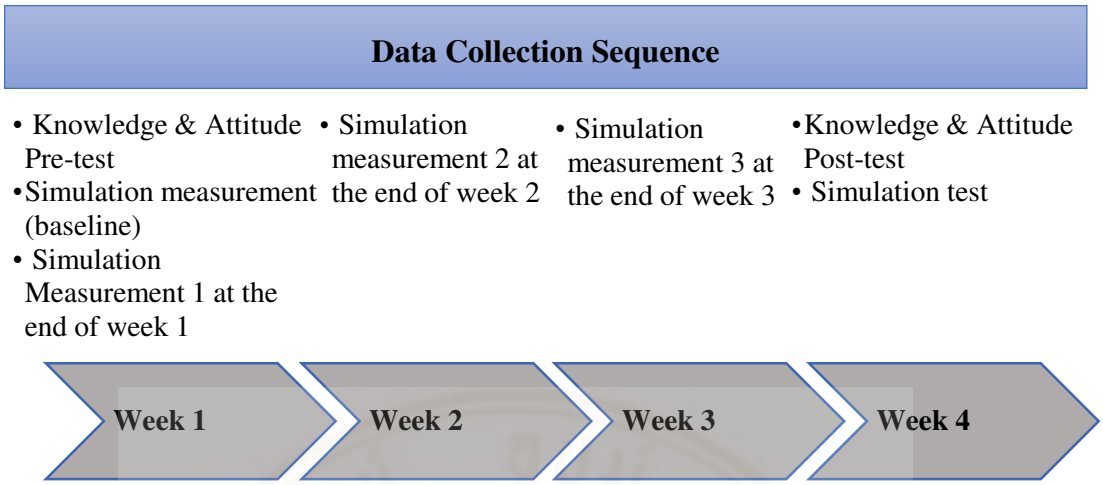

Figure 5.4 Quantitative Data Collection During the LCSS-V Simulation Course

5.3.4.2 Qualitative data collection. The qualitative data were collected in several types at different times (see Table 5.3). Some of these data were also described and analyzed in Chapter 4. The purpose of the qualitative data collected for this study was to elaborate on the quantitative findings. For example, quantitative data analyzed for research question four focused on skill development. Qualitative data were used to gain insights into the learning process experienced by students as they engaged with the simulation and began to succeed in meeting the challenge.

An Open Discussion Forum hosted on Moodle was used to collect students' responses to questions posed by the instructor. Student responses were treated as a form of qualitative data. These data were downloaded from the server for analysis at the end of the course.

After the simulation course, the researcher invited four participants for a focus group interview. The interviews aimed to explore their learning experience further and evaluate the viability of the LCSS-V simulation. Finally, the researcher conducted three individual interviews from different backgrounds after the course to gain additional insight into their learning experience and the simulation's cultural suitability. The interviews also aimed to evaluate the learning outcomes, including knowledge, attitudes, and skills achieved by the participants.

Table 5.3 Qualitative Data Collection During the LCSS-V Simulation Course

Type of Assessment	Sample Size	Collection Point(s)	Purpose
Open discussion forum post	32 participants	During course	Explore learning experience Evaluate learners' improvement
Focus group interview	4 participants	After course	Explore learning experience and cultural suitability Evaluate learning outcomes (knowledge- attitude- skill)
Individual interviews	3 participants	After course	Explore learning experience and cultural suitability Evaluate learning outcomes (knowledge- attitude- skill)

5.3.5 Data collection instruments

5.3.5.1 Knowledge Test. This study contains multiple measures used for evaluating simulation effectiveness [see Appendix J]. The test used to assess knowledge and attitude change was divided into two sections: change management for sustainability, and attitude towards sustainability.

The assessment of change management for sustainability pertains to the means by which participants integrate sustainability changes within educational institutions, specifically in schools, based on a given situation. The multiple-choice questions were framed at the analysis level of Bloom's Taxonomy level for cognitive objectives. Students were presented with a short case problem of change implementation. Short-answer questions aimed to examine participants' grasp of crucial components of change theories, including the change process, resistance to change, change adoption, and diffusion, among others. The questions were designed to describe the sustainability problems presented in the LCSS-V simulation but in a different educational context.

The case study on which the questions are based involves promotion to Director of Education Department in District X, with the mandate to facilitate the construction of sustainable schools. It requires adjusting key processes to improve student performance, explicitly moving towards education for sustainable development. The approach entails cross-disciplinary teams of teachers collaborating to evaluate existing teaching and learning methods, compare them with sustainability policies, and

redesign them accordingly. Working alongside Ms. A, the Principal of the Secondary School, the project seeks to introduce a whole school approach to sustainability, which Ms. A and some teachers are familiar with, albeit not in detail. Although Ms. A is not averse to exploring new approaches, she currently lacks an understanding of the project's scope. The test consists of 12 questions that students must answer correctly to score points [see full set of questions in Appendix J].

5.3.5.2 Attitude Measure. In addition, participants' attitudes toward sustainability were measured via a sustainability mindset scale. The assessment used the questionnaire with a five-point Likert scale, representing the least to the most positive attitude to sustainability mindset. The posttest keeps remaining for the knowledge and attitude test. The sustainability attitude test consists of 15 items using a 5- point Likert scale (i.e., total disagree =1, disagree = 2, neutral = 3, agree = 4, total agree = 5).

The Sustainability Mindset Scale incorporated statements evaluating participants' attitude towards three dimensions of sustainability [see full set of questionnaire in Appendix J]. The Sustainability Mindset Scale was adapted from the version used to evaluate the effectiveness of the LCS-Business version (Chatpinyakoop et al., 2022) and the reliability with Cronbach's Alpha was 0.671. Then, the researcher explicitly designed it for the Vietnamese context. The scale was tested in a pilot test with Vietnamese participants to ensure its face validity. Sample items include:

- My society should promote equal opportunities for males and females in school and the workplace.
- I can make changes that have a positive impact on the world around me.
- I pay attention to how much I need, not just to how much I want.

In the questionnaire, the researcher used some reversed items to help control response biases and increase the data's reliability and validity. The use of reversed items can help the researcher collect more detailed and accurate data, while minimizing respondents' random checks, identifying respondents who are not paying attention or responding in a socially desirable way, and removing them from the analysis. Among 15 items, there were six reversed items, including:

1. We cannot predict the future of climate change. Therefore, we should maximize our personal economic benefits today.

2. What I do as an individual does not have much impact on the environment.
3. My personal freedom is more important than taking actions that might help other people or the society.
4. Economic development helps everyone, so we should not limit what businesses do to gain profits.
5. The purpose of a company is to make profits, so it should not be held responsible for the labor practices of its suppliers.
6. Changing my personal consumer behavior makes no difference because companies are the main cause of environmental problems.

5.3.5.3 Skill Performance Measures. Learners' skill development was tracked over the four weeks by analyzing participants' strategy records and performance outcomes. Every time a participant played the simulation, data were captured and sent to a server, where all of the player's "moves" were stored. The collected data included the number of playing times, strategy record of activities executed, the achieved strategic principles, achieved Bennies, change management level achieved, and the number of stakeholders in the sustainability stage that they achieved at the end of three virtual years. Bennies, also known as triple bottom-line benefits, are a numerical representation of the rewards obtained by players who implement effective and appropriate strategies. The change management levels are categorized into distinct levels of management, as outlined in Figure 5.4. When the players achieve the Change Master level, it means that they have been successful at both helping stakeholders move through the stages of change and making substantial improvements on the triple bottom line of economic, social, and environmental KPIs. Therefore, the researcher collected the Change Management level achieved by each student for every game played and tracked their performance over time to gain insights into their learning trajectories.

Table 5.4 Levels of Success in the LCSS-V Simulation

Level	Level of Success	The Number of Bennies Gained in 3 years
1	Apprentice	None
2	Novice	≥ 800 Bennies
3	Manager	≥ 2000 Bennies
4	Leader	≥ 4000 Bennies
5	Expert	≥ 5000 Bennies
6	Change Master	≥ 7000 Bennies

Finally, the researcher also collected data on the ability of students to incorporate Kotter's change management principles into their change strategies (Kotter, 1995; Kotter & Cohen, 2012). Seven of Kotter's principles were tracked by the simulation for each game played by a student. Each principle was 'measured' by a set of decision sequences that were checked by the software during a game.

For example, in order to get credit for enacting the principle, 'Create and Communicate Shared Vision', the player must have met the following conditions: Created a Shared Vision AND implemented Communicate Shared Vision in Years 1 AND Year 2 or Year 3 AND conducted a Sustainability Retreat. If the student's decision sequence met these conditions, the dashboard would show a checkmark next to Communicate Shared Vision. In this way, the students could track the degree to which their strategies incorporated an important set of theoretical principles. Notably, Kotter's principles were only shared explicitly with the students in the third week. Thus, analyzing the extent to which students had incorporated these principles into their change strategies was used as a measure of knowledge synthesis.

Table 5.5 Conceptual and Operational Definition of Kotter's Stages Embedded in the LCSS-V Simulation

Principle	Concept	Research	Condition
Communicate Purpose	There must be continuous top-down, bottom-up, and multi-channel communication about the change's purposes, benefits, and impact on stakeholders and the organization.	(Kanter, 2003; Kotter 2002, 2012; Rogers, 2010)	Talk to 2X at least 9 people AND Gather Social Information AND Survey Stakeholders OR Assess Sustainable Practices.
Create a Guiding Team	Successful change requires a team of stakeholders with sufficient power, influence, motivation, and expertise to assume ownership and lead the change.	(Hall, 2006; Kanter, 2003; Kotter, 2002, 2012)	Talk to 3 social influencers AND talk to Mr.An, Ms.Én, and Mr.Oánh 2 times AND School Visit in Year 1.
Create and Communicate a Shared Vision of Change	An organizational change must be guided by a shared vision of the organization that stakeholders aim to create in the future.	(Crandall et al., 1986; Doppelt, 2017; Fullan, 2007; Hall 2006; Kanter, 2003; Kotter 2002, 2012)	Year 1: Successful Create Shared Vision AND Communicate Vision AND Sustainability Retreat; AND Communicate Vision in Year 2 OR Year 3.
Enable People to Act	Successful change involves developing new attitudes and capacities among the people responsible for implementation in the daily operation of their jobs.	(Doppelt, 2017; Fullan, 2007; Hall 2006; Kanter, 2003; Kotter 2002, 2012)	School Visit in Year 1 AND Sustainability retreat in Year 1 or Year 2 AND Sustainability Workshop at least one time in each school.
Create Quick Wins	During the change process, quick wins are needed to show that 'the change can work here' and motivate skeptics to join the change effort.	(Fullan, 2007, 2011; Kanter, 2003; Kotter, 2002, 2012)	Get at least 2 people into Sustainability Stage in Year 1OR at least 5 people in Practice stage or beyond in Year 1.
Change the School Culture	Over time, actions must be taken to reenergize stakeholders and embed the change into the culture.	(Doppelt, 2017; Fullan, 2007, 2011; Kanter, 1984, 2003; Kotter, 2002, 2012)	Use Sustainable Practice at least two times AND One Future Celebration AND Share Sustainable Success OR School Support Group.
Make the Change Part of the School Structure	Achieving sustainable change requires revisions to institutional policies that support the change in practice.	(Fullan, 2007, 2011; Kanter, 2003; Kotter, 2002, 2012)	Open Class Demonstration OR Sustainability Report AND Policy Revision.

5.3.5.4 Interviews. The researcher utilized semi-structured interviews administered to both focus group and individual participants. Prior to the interviews, a set of guideline questions was prepared to guide the process (see Table 5.6 below). The researcher used the participants' responses to formulate follow-up questions during the interviews. These guideline questions served as a framework to ensure consistency and comprehensiveness in the data collection. Below is part of a complete set of guided questions for the interview, which aim to evaluate learning outcomes in terms of knowledge, attitude, and skills (see the full set in Appendix G)

Table 5.6 Semi-structured Interview Questions

Focus of research	Questions	Probes
Knowledge	From 1 (nothing at all) to 5 (a lot), how would you rate your knowledge and skill before this workshop about: - Leading change? - Sustainability? What is the most interesting thing you have learned today about leading change? What about sustainability? If a colleague asked you to define what we mean by 'sustainability' how would you answer now?	Could you be more specific, or give an example?
Attitude and Mindset	Has the workshop changed your belief about *the importance* of enhancing sustainability in the educational system? How about in your own life?	How? Could you give an example?
Skill development	Assume that you were placed on a leadership team to improve teaching quality in your school? Can you tell me 2 change strategies that you would you apply that you might not have used before learning with the simulation?	Could you be more specific, or give an example?

5.3.5.5 Discussion Forum Reflections. Qualitative data were also collected through the weekly Open Discussion Forum hosted on eLearning Moodle. As noted earlier, the instructor posted a set of reflection questions each week to stimulate collection reflection among the students. The weekly Open Forum Discussion questions were also used as qualitative data that could offer insights into students' engagement and learning process. The questions were as follows.

Week One

1. What was the most difficult problem that you encountered so far in implementing change for sustainability in education at the New District? How did you solve it?
2. What 1 piece of advice would you like to share with others?
3. What 1 problem would you like advice on from others?

Week Two

1. What was the most surprising insight about ESD/ Sustainable school/ Whole school approach to sustainability you have gained from playing the simulation so far?
2. What 1 problem would you like advice on from others?

Week Three

1. What lesson have you learned from the simulation that you apply in your work or life? Please be specific and give an example.
2. What question(s) do you still have about managing change or sustainability?

Participants' responses in the discussion forum indicate a shift in their knowledge, attitudes, and skills, allowing them to learn from each other's experiences. The data obtained from the online discussion revealed that students were motivated to learn due to well-defined simulation objectives, ongoing feedback on their strategies, and a shared sense of working together towards a common problem. The learning process suggests that the students experienced a "community of practice" (Wenger, 2010). In this way, the participants can learn theories, interact with the instructor, improve their skills in playing the LCSS-V simulation, and share their experiences.

5.3.6 Data Analysis

This study employed a mixed-method evaluation approach to assess the effectiveness of the LCSS-V simulation. By combining both quantitative and qualitative analysis, the research aimed to yield comprehensive and factual findings pertaining to the research questions (Creswell & Clark, 2017). This approach enabled a more robust evaluation, contributing to a multifaceted assessment of the LCSS-V simulation at various levels.

For qualitative data, the researcher applied a deductive approach based on content analysis (Berg, 2001). The interview data were analyzed using Computer Assisted Qualitative Data Analysis (CAQDAS). More specifically, the software MAXQDA version 20 was used to make the qualitative data analysis more systematic. A new project was created, comprising rich textual material from in-depth interviews. The interviews were scripted and coded from P1-P7. Textual data associated with the feedback surveys were coded as student responses. Through eLearning, the researcher collected students' responses and stored them. After completing the simulation course, the researcher downloaded the data for content analysis.

The researcher used both deductive and grounded approaches to code the data based on research questions and emergent themes. A coding scheme with pre-determined categories was used, including knowledge, attitude, skill, simulation design, simulation content, cultural adoption, teaching method, and learning experiences. Axial coding was then used to identify themes, refining and categorizing them as 'suggestions'. Finally, a content analysis was conducted.

In Chapter 4, the researcher employed a range of qualitative analyses to evaluate the effectiveness of the LCSS-V simulation. These analyses were critical in providing insights into the learners' experiences, the strengths and weaknesses of the simulation, educational and cultural adaptation, and the potential improvement.

In contrast, this chapter primarily extracted data related to the themes of 'knowledge', 'attitude', and 'skill' to provide illustrative examples for the quantitative analyses. These narrative analyses were mainly used in this chapter to elaborate on the learning outcomes of learners in terms of knowledge, attitude, and skill for change management for sustainability. The researcher ensured confidentiality by coding data to protect student identification throughout the process.

The quantitative data were analyzed using SPSS Statistics version 23 and JASP software. The evaluation measures used in the study are displayed in Table 5.7.

5.3.6.1 Knowledge Test and Attitude Scale. Consistent with the quasi-experimental research design, the study utilized paired-sample t-tests to evaluate change in knowledge of change management for sustainability concepts before and after participating in the LCSS-V simulation module. Analyses were conducted separately for the two dimensions of the knowledge test (i.e., change management). Statistical

significance was determined using the 0.01 level. This analysis provided insight into the extent and importance of changes in student knowledge and attitude resulting from learning with the simulation.

The researcher utilized the Shapiro-Wilk test to ensure the normal distribution of scores on knowledge tests. The reliability of these tests was assessed using Cronbach's Alpha. Plus, Cohen's d was also calculated to determine the effect size for comparing two means. While Cohen argued against arbitrary cutoffs, scholars often classify Cohen's d for a small effect from 0.20 to less than 0.50, a moderate effect from 0.50 to less than 0.80, and a large effect if the number is from 0.80 (Cohen, 1988).

Data obtained from the sustainability attitude scale were analyzed in the same analytical sequence as for the knowledge test. The main difference was that the attitude scale was measured on a 5-point Likert scale, as opposed to the percentage of correct answers logged for the knowledge test.

5.3.6.2 Skill Performance. As noted in the research design section, the researcher employed a time series design for the purposes of analyzing change in students' skills in formulating and executing effective change strategies. More specifically, one-way Repeated Measures ANOVA was used to measure a week-by-week change in the students' Change Management Level. Specifically, the Change Management Level achieved by a student was collected and compared for five weekly data points. This analysis sought to assess the significance of the change from week to week. The assumption behind this analysis was that the presence of significant changes would provide evidence that change in student skill performance was resulting from learning with the simulation.

Mauchly's test was employed to assess the homogeneity of variance of the difference between samples, commonly referred to as sphericity (Hinton et al., 2014). If there was a p-value of less than 0.05, it indicated a violation of assumption, necessitating correction. In such cases, for the correction methods, the Greenhouse-Geisser and Huynh-Feldt tests were used prior to conducting the ANOVA.

In addition, skill measurements were also re-checked by analyzing the Friedman Rank test. The test shows differences in the median of several repeated measurements. The Friedman rank test is suitable for this case as it is distribution-free and requires no assumptions about the population distribution.

Table 5.7 Evaluation Measurements and Analysis

Variable Type	Variable	Purpose of measurement	Collecting time	Analysis
Knowledge	Change management for sustainability	Change in Knowledge	Pretest in week one and posttest in week four	Shapiro-wilk, Paired Samples t-test Cohen's d Narrative analysis
Attitude	Sustainability mindset	Change in Attitude	Pretest in week one and posttest week four	Shapiro-wilk, Paired Samples t-test Cohen's d Narrative analysis
Skill	Change of Management level	Change in Skill	Weekly	Shapiro-wilk, Sphericity test, Repeated Measures ANOVA Narrative analysis
	Kotter's change management principles	Change in Skill	Weekly	Shapiro-wilk, Sphericity test, Repeated Measures ANOVA Narrative analysis

5.3.7 Ethical Considerations

In this study, ethical standards were maintained per the university's guidelines. For all interviews, surveys, and observations, all participants were asked to provide written informed consent. The potential participants also received an explanation of the study's purpose and data collection process. The consent form explained that participation in the project was voluntary. Refusal to participate or a desire to withdraw from the study would not affect their identity, career, or grade.

Moreover, participants were informed that their involvement in this research would entail the collection of individually identifiable research data. However, it was explicitly stated that access to this personal data, including names and results, would be restricted solely to the researcher. To ensure the confidentiality of participants' identities, only identification codes were used to represent the actual data collected. This approach enabled the researcher to establish connections across different data sources while maintaining the anonymity of participants.

In the context of the online forum, participants' names were visible when they made posts due to the Elearning system's configuration. However, it is crucial to emphasize that these posts had no impact on participants' scores or the researcher's

perception of them. Throughout the study, the anonymity of participants was maintained, and their names were neither disclosed nor referenced.

When participants played the simulation, the server recorded the players' decisions and results along with the participant's ID number (e.g., gd001, gd002). No other personal data were collected when participants played the simulation.

Research data were kept confidential, consistent with Mahidol University regulations. Data were used for academic purposes only. Identifying information was stored separately from data collected for the study. Therefore, even if a third party obtained the study data, nobody would be able to determine whom the data were associated with. All personally identifiable data were stored until the completion of the study. De-identifiable data are kept indefinitely.

Personal identity was never and will not be revealed in a publication or presentation. All identifiable research data was coded (i.e., only identified with a code number, class ID) at the earliest possible stage of the research. Personal data was discarded after completing the project. This eliminated the main source of 'risk' to the participants.

This research project was reviewed for ethical approval before carrying out the study. The procedures used in the research were approved, in advance, by the Institutional Review Board (IRB) of Mahidol University, based in the Institute for Population and Social Research Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom 73170, Thailand.

5.4. Results

The following analyses were based on the 32 participants from the Master's degree class for the course "Effective Management of Schools". The presentation of results begins with descriptive statistics, followed by the results for each research question.

5.4.1 Preliminary Analysis

The scales were also tested for reliability. The knowledge of change management for sustainability, and attitude towards sustainability construct were

estimated for internal consistency with Cronbach's alpha value. The 12-item test of knowledge of change management concepts (α = 0.693) was above the minimum standard of 0.60 (Taber, 2018). The sustainability attitude scale consisting of 15 items met the desired reliability standards as well (α =0.791). Thus, the scales used for the research could be considered reliable. Next, the researcher conducted the inferential statistical analysis for each learning outcome.

The table below shows the descriptive analyses of the pretest and posttest at three levels: knowledge of change management for sustainability, and attitudes towards sustainability. Data analysis reveals an improvement in both knowledge dimensions, as well as on the sustainability attitude scale following the LCSS-V simulation intervention.

Table 5.8 Summary of the Pre-post Test Scores for Knowledge and Attitude Outcomes (n=32)

Statistic	Change Management for Sustainability Knowledge Pre-test (full marks 12 points)	Change Management for Sustainability Knowledge Post-test (full marks 12 points)	Sustainability Attitude Pre-test (5-point Likert scale)	Sustainability Attitude Post-test (5-point Likert scale)
Mean	6.22	8.13	3.74	4.05
Median	6.50	8.00	3.80	4.07
SD	2.72	1.60	.46	.37
SE Mean	.48	.28	.08	.07
Skewness	-.72	.085	-.083	-.23
Kurtosis	.14	-.626	-1.129	-.761
Min	0	5	2.87	3.26
Max	10	11	4.53	4.60

The findings from the test of change management for sustainability revealed that participants had weak knowledge of change management for sustainability at the outset of the course, with a mean score of 6.22 out of 12. However, after the simulation session, participants' knowledge of change management for sustainability showed a significant improvement (M=8.13/12, SD= 1.6) compared to their pretest scores (M= 6.22/12, SD= 2.72).

Furthermore, attitude towards sustainability was compared before and after learning with simulation LCSS-V. The range for the attitude scale was from 1 to 5. The results also showed that participants' attitudes towards sustainability significantly increased after the simulation session (M = 4.05, SD= 0.37) compared to before learning with the simulation (M = 3.74, SD = 0.46).

During the four-week simulation intervention, students had the opportunity to gradually learn about principles and theories related to change management for sustainability through a series of simulation experiences, instruction, and other supports. To better understand their improvement, the researcher analyzed the number of games played by students using the LCSS-V simulation.

Table 5.9 below shows the distribution of participants' simulation practices. The mean number of games played in weeks one and three was 6.65 and 9.91, respectively. There was a wide variation in the number of games played among the students. The researcher decided to eliminate the outliers to provide a more accurate picture of the average level of engagement among the majority of students. Two outliers were identified in the sample; one student who played the simulation 195 times during the three weeks, and another who played only four times. After removing the outliers, the average number of game sessions played during the three-week module was 24.1 times per student. During the week following the first class, students played the simulation at home an average of 6.05 times. The frequency of student play increased to an average of 7.95 times in the second week (after eliminating an outlier who played the simulation 156 times during week 2. Students played the simulation an average of 10.10 times in the third week.

The average number of playing game sessions per student was 24.1, which was high and reasonable. Using a conservative estimate of 45 minutes per session, students spent an average of 18 hours (6 hours per week) engaged in self-directed, independent learning by playing the LCSS-V simulation outside of class during the intervention. This time commitment did not include assigned readings or online discussion form responses. The high level of independent simulation practice suggests that the students were motivated and engaged in the learning activity. This engagement likely helped change students' knowledge of change management for sustainability, attitude toward sustainability, and skill in managing change for sustainability.

Table 5.9 Number of Simulation Games Played Per Student Over Three Weeks (n=32 students)

LCSS-V Class	Min Games	Max Games	Mean Games	SD	Mean after eliminating the outliers	SD after eliminating the outliers
Week 1	1	25	6.65	6.23	6.05	4.88
Week 2	1	156	14.09	31.98	7.95	8.36
Week 3	1	37	9.91	8.63	10.10	8.83
Full course	4	195	30.65	39.32	24.10	16.42

5.4.2 Knowledge of Change Management for Sustainability Concepts

Following the simulation module, participants demonstrated a significant improvement in their knowledge of change management (M=8.13/12, SD=1.6) compared to their pretest scores (M=6.22/12, SD=2.72). As shown in Table 5.10, this improvement, 1.91, 99.99%CI [-0.33, 4.14], was statistically significant, t (31) =3.81, at a confidence level of 99% ($p < 0.01$).

If 80% correct responses are used as the standard for concept mastery, on average, students were still below mastery (i.e., 67.75%) of change management for sustainability concepts (M = 8.13/12). However, the effect size measured by Cohen's d was 0.67, presenting a moderate to large effect of the simulation in terms of change in the students' level of knowledge. It suggests that the simulation intervention had a small but measurable impact on knowledge of change management for sustainability scores. It should be noted that upon reflection, the test questions might need additional refinement as several questions used double negatives, which can be difficult for Asian learners to interpret correctly.

Table 5.10 Paired Sample t-test of Differences in Knowledge of Change Management for Sustainability Concepts (n= 32)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	SD	SE	99.99% CI of the Difference				
				Lower	Upper			
Change knowledge pre-test score	6.22	2.72	.48					
Change knowledge post-test score	8.13	1.60	.28					
Change knowledge post-test score minus pre-test score	1.91	2.83	.50	-.33	4.14	3.81	31	.001

Students learned about leading and managing change for sustainability not just through the presentation of theories but also through practical application and analysis of specific situations in the LCSS-V simulation. A participant shared that:

> *This is the simulation that I find extremely difficult to play. After playing many times, I realized one principle to form a strategy to affect a specific group of stakeholders. Specifically, the leaders have a positive impact, and then we affect the remaining groups of influencers. (Student's post on Open Discussion Forum week 1)*

During the interviews, students also emphasized ways that the simulation made change management theories applicable in leading a sustainable life.

> *In psychology subject, I have learned about formal and informal relationships. But through simulation, I see more clearly the role of understanding informal relationships. It is important for leaders. (P2)*
>
> *In real life, I already have management experience. However, learning with the simulation helps me synthesize my knowledge. Up until now, I have worked at*

> *random. However, the simulation showed me how to work systematically. (P3)*

Students learned and applied knowledge of change management they experienced in real life and from LCSS-V simulation.

> *In developing a sustainable strategy for the school's activities, the school needs to plan the development of its staff through strategic phases of 5 years, ensuring the stability of the school's activities while continuously developing. Specifically, each year schools must have a plan for training and improving teachers' expertise in subjects, foreign languages, computer skills, and new pedagogy, meeting the needs of society in each phase. At the same time, it should be a plan to supplement the staff on time, ensuring succession and balancing the age of the workforce to avoid an overly ageing staff leading to stagnation and ensuring that staff has enough time to gain experience. (Student's post on Open Discussion Forum week 3)*
>
> *Through simulation, I have come to realize that, as a manager, changing the mindset of an individual or group of people is not an easy task. Managers need a clear strategy and specific plan with goals and expected results to provide a clear direction and show the value of their actions to others. Every step must take into account human resources, time, and budget. (Student's post on Open Discussion Forum week 3)*

Data extracted from the interviews also elaborated on students' developing knowledge of sustainability concepts.

> *To me, sustainability encompasses two distinct aspects: 1) knowledge of sustainable practices, and 2) the process of taking sustainable action. Even if the simulation did not explicitly focus on sustainability, we learned how to*

> *manage continuity and navigate the stages of change - from information gathering and generating interest to preparation and practice. These stages helped us plan for each step of the way. Additionally, ongoing activities, such as revising school reports, policies, and receiving group support, ensured the project's success and longevity. Thus, the project demonstrated sustainability through its continued progress and development. (P7)*

One participant shared ideas about knowledge of sustainable school and connection to reality:

> *Before learning with simulation, I did a green school project following the 'trend'. I saw the benefits and tried to perfect that project. After learning with simulation, I missed many opportunities to involve teachers and staff in creating a sustainable culture at school. I acknowledged that sustainable practices need to be demonstrated and their values communicated effectively to engage and involve others. I have not done it yet. We have to do sustainable practices and show people their values. Now just the school did. The local community still do not involve yet. I have to increase their awareness to practice sustainability. (P4)*

Some students may not be able to describe a theory precisely, but they can still interpret it in their own words.

> *While I cannot claim to understand sustainable schools completely, I do know how to build one. Rather than just talking about sustainability, starting with small activities and gradually building up to a larger, more comprehensive strategy is important. This approach helps to ensure that sustainable practices become ingrained in the school's culture and are more likely to be sustained over time. (P6)*

5.4.3 Attitude Towards Sustainability

The attitude test was comprised of 15 items presented on a five-point Likert scale, ranging from "1" (Strongly disagree) to "5" (Strongly agree). The test's score maximum score was, therefore, 5.0 points. The mean pre-test score was 3.74 points, while the average post-test score was 4.05. As shown in Table 5.11, the improvement, 0.31, 99.99% CI [-0.03, 0.66], was statistically significant with t (31) = 4.03, p <0.001. The effect size of this change in participants' attitudes towards sustainability yielded a Cohen's d statistic of 0.71, which is also considered a large effect. Thus, the four-week LCSS-V simulation positively affects participants' attitudes towards sustainability.

Table 5.11 Paired Sample t-test of Differences in Student Attitudes Towards Sustainability (n= 32)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	SD	SE	99.99% CI of the Difference				
				Lower	Upper			
Sustainability attitude pre-test score	3.74	.46	.08					
Sustainability attitude post-test score	4.05	.37	.07					
Sustainability attitude post-test score minus pre-test score	.31	.44	.08	-.03	.66	4.03	31	.000

From the interviews, the learners showed a significant change in their mindset even though they had a relatively positive attitude towards sustainability at the beginning. One student stated, "Instead of talking about 'sustainability, sustainability, and sustainability,' we must start with small activities and build up to a sequence of activities" (P6). Another observed as follows:

> *Before learning with simulation, I did a green school project, following the 'trend'. Then I saw the benefits and tried to perfect that project. After learning with simulation, I realized that I missed many things to propagate to teachers and staff to create the school culture. Like going to X primary school, students must be ABC. I have not done it yet. We must do sustainable*

> *practices and show people the school's values. Now, just the school did itself. The local community still has not been involved yet. (P5)*

On open discussion forum, one student shared that:

> *We are developing hastily and ignoring environmental protection. We are destroying our sources of life for the sake of the economy. Moreover, in the end, we have to look back to fix those mistakes. If we need to make changes, education is the quickest way to impact people's awareness. Only human beings with awareness can change behaviors for sustainable development. (Student's post on Open Discussion Forum week 3).*

5.4.4 Assumption Check for Pre/Post-test of Knowledge and Attitude

Because of the small sample size (n=32), the researcher also conducted a normality distribution test with the Shapiro-Wilk test for pre-posttest for knowledge and attitude test. In Table 5.12, the test results show that Post-test minus Pre-test results did not follow the normal distribution for knowledge of change management for sustainability (p-value 0.007) and attitude towards sustainability ($p < 0.001$).

Table 5.12 Normality Test (Shapiro-Wilk) for the Knowledge and Attitude Tests

			W	p
Change Management for Sustainability knowledge post-test	minus	Pre-test	.902	.007
Sustainability attitude post-test	minus	Pre-test	.833	< .001

Note. Significant results suggest a deviation from normality.

Thus, a robustness check was conducted for the paired sample t-test. The researcher conducted Paired Wilcoxon Signed Rank Test for knowledge of change management for sustainability and attitude toward sustainability. Table 5.13 also shows the significant differences in median knowledge and attitude among participants with the pre-posttest ($p < 0.001$). Therefore, the simulation intervention had a significant impact on the participants' knowledge and attitude.

Table 5.13 Non-Parametric Paired Sampled Test of Change in Scores on Outcome Variables (Wilcoxon Signed-Rank Test)

Measure 1		Measure 2	W	z	p	Rank-Biserial Correlation
Change Management for Sustainability Knowledge Post-test Score	minus	Pre-test	268.50	3.386	< .001	0.790
Sustainability Attitude Post-test Score	minus	Pre-test	351.50	3.904	< .001	0.860

5.4.5 Skill Performance in Leading Change for Sustainability in Schools

As discussed earlier, the assessment of change in students' skills in applying their knowledge of change management was assessed through the use of two different metrics. The first was the 'change management level' achieved by the students in their games. There are six levels that are geared to a combination of Bennies and stakeholders in the sustainability stage at the end of the three years: Apprentice, Novice, Manager, Leader, Expert, and Change Master.

The second metric consisted of the student's ability to apply seven of Kotter's change management principles. These were also shown to the student on the final game dashboard. Thus, players could see which principles (e.g., Create a Guiding Team) had been enacted through their change strategies and which were missing. Thus, the computer tracked how many of seven principles had been implemented through the student's change strategy for each game.

5.4.5.1 Analysis of Change Management Levels. This analysis examined whether there was a statistically significant improvement in participants' simulation performance from week to week during the course. Each student data set contained five records, representing longitudinal data from the baseline and four subsequent weeks.

Table 5.14 Descriptive Statistics for Change Management Levels Achieved by Learners on the Simulation

Statistic	Baseline Level	Week 1	Week 2	Week 3	Final Level Week 4
Valid n	32	32	32	32	32
Median	1.0	2.0	5.0	6.0	6.0
Mean	1.0	2.6	4.5	5.7	5.8
Std. Dev.	0.0	1.7	1.7	0.9	0.7
Min	1.0	1.0	1.0	2.0	3.0
Max	1.0	6.0	6.0	6.0	6.0

The data in Table 5.14 indicates a steady increase in the average management level throughout the four weeks. Specifically, the average level increased from Level 1 (i.e., Apprentice) at baseline to 2.6 (i.e., Novice/Manager) by the end of week one.

While most students cannot achieve mastery in a simulation after just one week, there was a case that the participant reached the Master level after playing 16 attempts. Assuming an average playing time of 45 minutes per attempt, this participant invested approximately 12 hours in getting acquainted with the simulation content and developing an appropriate strategy. Similarly, other participants commented on the online forum:

> *The biggest issue I am currently facing is finding a block of time, approximately 3 hours, to play the game with focus and continuity. I need to reason and systematize my strategic steps to achieve better results. I am beginning to develop an interest in this type of simulation game. I am determined to stay up late tonight to work on it (Student's post on Open Discussion Forum week 1).*

They progressed to an average level of 4.5 (i.e., Leader/Expert) by the end of week two and 5.7 (Expert/Change Master) at the end of week three. The measure for 'week 4' reached a peak of 5.8 (i.e., almost Change Master) out of 6.0 in the final test in week four. It should be noted that the measure taken at the end of week three was

very close in time to the final exam date in week four. Therefore, the combination of ceiling effect and limited time duration explains the smaller gain between the final two data points.

Throughout the first week of the course, students were motivated to reach the highest level. In their efforts to do so, they actively engaged with one another on the forum, sharing and soliciting strategies. By the third week, students not only continued to pursue mastery level but also took a more reflective approach to their learning. Specifically, they began to analyze their strategies more deeply, drawing connections between their learning and their professional experiences. One student shared that:

> *To change the mindset of a group, specific steps need to be taken, and careful consideration is required. Rapid and hasty changes will not bring the desired results, and all mistakes must be paid for with money and time. Previously, as a team leader with high expectations for team members, I used to actively push for a fast change process with new procedures to increase work efficiency. However, I did not realize that each person's perceiving job was different. This led to a situation where everyone just worked like a machine without truly understanding the underlying requirements. Therefore, the changes were only on the surface, and people could not proactively adjust to improve themselves, but let the process decide for them. (Student's post on Open Discussion Forum week 3)*

Table 5.15 illustrates the performance trajectories of the four students who practiced the most. While the other three students played the game between 46 and 65 times, the student who ranked first played 195 rounds in three weeks for a total of 146 hours and 15 minutes practicing the simulation. This represented an average of 48 hours and 45 minutes of weekly self-directed practice. It can be noticed that the number of games and the amount of time spent practicing are essential factors in achieving a high level of management in LCSS-V simulation. Although the first-ranked player played the LCSS-V simulation the most and spent the most time practicing, the second-ranked

player played the least number of times but reached the "Master" level sooner than the other top four students. Individual differences in practice habits and innate skill may also affect a player's ranking. These analyses contributed to explaining the factors affecting high performance in the LCSS-V simulation.

Table 5.15 Frequency of LCSS-V Simulation Played by the Top Four Students

Rank	W1	W2	W3	Total games played	Total hours practicing	Average hours practicing per week	Games played prior to the first Master	Days to reach Master level
	(times)	(times)	(times)	(times)	(hours)	(hours)	(game)	(days)
1	25	156	14	195	146.25	48.75	78	16
2	14	30	21	65	48.75	16.25	22	10
3	16	13	25	54	40.5	13.5	18	18
4	16	22	8	46	34.5	11.5	20	13

These above descriptive statistics on students' learning trajectory were complemented by inferential analysis of the Change Management Level achieved by the students that examined the statistical significance of the changes week by week. Table 5.16 presents the results of Mauchly's test of sphericity, which was used to assess whether the sphericity assumption was met in the repeated measures ANOVA. The test revealed a violation of the sphericity assumption, with a significant result of $\chi 2(9) = 58.918$, $p < 0.001$, indicating that the null hypothesis of sphericity was rejected.

Table 5.16 Mauchly's Test of Sphericity of Change Management Levels Achieved by the Students [a,b]

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon [b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Simulation intervention	0.135	58.918	9	0.000	0.606	0.661	0.250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept Within Subjects Design: Simulation intervention

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

The findings of Mauchly's test of sphericity revealed a significant violation of the assumption of homogeneity of variances between paired differences in the repeated measures ANOVA. This positive bias of the F-value renders it invalid, thereby increasing the risk of Type I error. Therefore, the researcher took The Greenhouse-Geisser correction to tackle violating the assumption of sphericity. In this case, the Greenhouse-Geisser correction was significant at the $p < 0.001$ level, using a valid critical F-value that reduces the risk of Type I error inflation. The Greenhouse-Geisser correction was applied to adjust the degrees of freedom, mean square, and p-value, thereby enhancing the validity and reliability of the repeated measures ANOVA.

Table 5.17 presents the results of a further analysis performed when the sphericity assumption was violated, and the Greenhouse-Geisser correction was applied. The result indicated a significant *F*-value of 128.738 with $p < 0.001$. These findings indicate a significant difference between the means of within-subject variables, namely the simulation played at different times.

Table 5.17 Tests of Within-subjects Effects on Change Management Levels Achieved by the Students

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Simulation (change man. level)	Sphericity Assumed	546.100	4	136.525	128.738	.000	.806
	Greenhouse-Geisser	546.100	2.424	225.323	128.738	.000	.806
Error Simulation	Sphericity Assumed	131.500	124	1.060			
	Greenhouse-Geisser	131.500	75.133	1.750			

Computed using alpha = .001

The within-subject test conducted in the previous section revealed a significant difference among data sets. The paired differences between the average simulation results at baseline and weeks one, two, three and the final test were computed and analyzed to identify which pairs of means differed. From Table 5.18 below, all paired comparisons were found to be significantly different, except for the comparison

between weeks three and the final test in week four, which were not significantly different. It can be explained by the fact that the week three data point was collected only one day before the final exam was administered in class.

Table 5.18 Pairwise Comparisons of Change Management Levels Achieved by the Students Week by Week

(I) factor1	(J) factor1	Mean Difference (I-J)	Std. Error	Sig.[a]	99.9% Confidence Interval for Difference [a]	
					Lower Bound	Upper Bound
Baseline	Week 1	-1.562***	.304	.000	-2.920	-.205
	Week 2	-3.500***	.298	.000	-4.829	-2.171
	Week 3	-4.656***	.166	.000	-5.395	-3.917
	Final test	-4.750***	.119	.000	-5.280	-4.220
Week 1	Baseline	1.563***	.304	.000	.205	2.920
	Week 2	-1.937***	.308	.000	-3.310	-.565
	Week 3	-3.094***	.319	.000	-4.515	-1.672
	Final test	-3.187***	.309	.000	-4.567	-1.808
Week 2	Baseline	3.500***	.298	.000	2.171	4.829
	Week 1	1.938***	.308	.000	.565	3.310
	Week 3	-1.156***	.254	.001	-2.291	-.021
	Final test	-1.250***	.266	.000	-2.435	-.065
Week 3	Baseline	4.656***	.166	.000	3.917	5.395
	Week 1	3.094***	.319	.000	1.672	4.515
	Week 2	1.156***	.254	.001	.021	2.291
	Final test	-.094	.113	1.000	-.599	.411
Final test	Baseline	4.750***	.119	.000	4.220	5.280
	Week 1	3.188***	.309	.000	1.808	4.567
	Week 2	1.250***	.266	.000	.065	2.435
	Week 3	.094	.113	1.000	-.411	.599

Based on estimated marginal means

***. The mean difference is significant at the .001 level.

a. Adjustment for multiple comparisons: Bonferroni.

Actually, achieving master level in LCSS-V simulation is challenging. Some students could reach the Change Master even though they played many times. It requires an ‘effective and right strategy’. One student shared:

> *Yes, I do change my strategy regularly, eliminating unnecessary steps, and organizing activities according to the changing perceptions of stakeholders. Now, I have reached the level of a master! (Student's post on Open Discussion Forum week 2).*

Participants highlighted a significant change in their perspective on strategic thinking for managers as:

> *I have experienced a significant change in my perspective on strategic thinking for managers. While 'trial and error' may be suitable for an apprentice stage, true 'change master' level involves the implementation of a long-term plan, budgeting, and a sequence of strategic actions. (P7)*
> *I am impressed with "gather social information" strategy because it is related to my current job. Every task I undertake, I need to gather social information. If I do not have that kind of information, I cannot do anything. Like in simulation, when I do not have social information, I do not remember stakeholders and their position, it is difficult to move next stages. (P6)*

The participant drew a connection between strategy and their experience with simulation, and described the enjoyment of simulation-based learning as:

> *One advantage of simulation is unlimited of playing. When I am interested, I try many different strategies. For example, the strategy is how to move all stakeholders fast, or involve people to make influences others, even negative members. I have many strategies like that. They can help me achieve the 'change master' level. It is exciting and diverse. (P7)*

5.4.5.2 Analysis of Students' Enactment of Kotter Change Principles in Their Change Strategies. The LCSS-V simulation also aims to develop strategic thinking among the students. Students were challenged to apply Kotter's change principles in their decision-making while playing the simulation to achieve this.

As noted earlier, seven principles were tracked by the software for each game played by the students. The total number of principles enacted in the student's strategy was recorded and saved for each game session at the five data collection points. A descriptive analysis was conducted, followed by an inferential analysis using a similar analytical strategy and sequence as the previous section on Change Management Levels.

During their baseline sessions, the students failed to enact even a single Kotter's change principle into their strategies (i.e., M=0.06). This began to improve by the end of the first week (i.e., 2.09) in the first week and continued to increase in subsequent weeks, reaching 3.47, 4.72, and 4.5 in weeks two, three, and the final test, respectively (see Table 5.19). It should be reemphasized that Kotter's principles were not taught explicitly until the third week. Therefore, students found their way towards these strategies during weeks one and two through a process of trial and error.

Table 5.19 Distribution of Kotter's Principles Enacted in Students' Change Strategies

Statistic	Baseline Kotter Principles (max=7)	End Week 1 Kotter Principles	End Week 2 Kotter's Principles	End Week 3 Kotter Principles	Final Exam Kotter Principles
Valid	32	32	32	32	32
Missing	0	0	0	0	0
Median	0.00	2.00	3.00	5.00	4.00
Mean	0.06	2.09	3.47	4.72	4.50
Std. Dev.	0.25	1.59	1.22	1.30	1.27
Minimum	0.00	0.00	1.00	3.00	2.00
Maximum	1.00	5.00	6.00	7.00	7.00

Note that only a single day separated Week three results from the final exam result.

As shown in Table 5.20, in the final test, almost 27 out of 32 participants (84.4%) achieved more than four principles [see Appendix L]. Three students (9.4%) got a maximum number of Kotter's change principles (7/7).

Table 5.20 Number Kotter's Principles Students Enacted in Students' Change Strategies on the Final Simulation Exam

		Count	Percent	Valid Percent	Cumulative Percent
Valid	2	2	6.3	6.3	6.3
	3	3	9.4	9.4	15.6
	4	13	40.6	40.6	56.3
	5	8	25.0	25.0	81.3
	6	3	9.4	9.4	90.6
	7	3	9.4	9.4	100.0
	Total	32	100.0	100.0	

Note: There are 7 Kotter's change principles enacted in the LCSS-V simulation

Following this descriptive analysis, Mauchly's Test of sphericity was conducted to verify if the sphericity assumption underlying the standard repeated measures ANOVA was met (see Table 5.21). The test revealed that the sphericity assumption had not been violated, as evidenced by a non-significant p-value of 0.161 ($p > 0.05$) and a chi-squared statistic of $\chi 2(9) = 13.051$. Thus, the null hypothesis was accepted.

Table 5.21 Mauchly's Test of Sphericity of the Number of Kotter Change Principles Enacted in Students' Change Strategies [a]

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon [b]	
					Greenhouse-Geisser	Lower-bound
Intervention	.642	13.051	9	.161	.829	.250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept Within Subjects Design: Simulation intervention (Kotter's change principles)

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

As shown in Table 5.22 below, the findings revealed differences in the mean of a number of Kotter's change principles achieved. These scores were statistically significant among base time, after weeks one, two, three, and the final test with $F(4,124) = 104.03$, $p = 0.000$, $\eta 2 = 0.770$.

Table 5.22 Test of Within-Subject Effects on the Number of Kotter Change Principles Enacted in Students' Change Strategies

	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Kotter change Principles Enacted (max 7)	Sphericity Assumed	475.812	4	118.953	104.030	.000	.770
	Greenhouse-Geisser Correction	475.812	3.318	143.405	104.030	.000	.770
Error	Sphericity Assumed	141.788	124	1.143			
	Greenhouse-Geisser Correction	141.788	102.857	1.378			

Table 5.23 shows significant paired differences in nearly all of the comparisons, except for week three and the final test. This finding is consistent with previous analyses that examined changes in mastery level, Bennies, and the number of stakeholders who reached the sustainability stage. It is worth noting that these results suggest that the LCSS-V simulation interventions had a positive impact on the outcome measures, with significant improvements observed across most of the time points.

Table 5.23 Pairwise Comparisons of the Number of Kotter Change Principles Enacted Week by Week

(I) factor1	(J) factor1	Mean Difference (I-J)	Std. Error	Sig.[a]	99.9% Confidence Interval for Difference [a]	
					Lower Bound	Upper Bound
Baseline	Week 1	-2.031***	.293	.000	-3.337	-.726
	Week 2	-3.406***	.224	.000	-4.405	-2.408
	Week 3	-4.656***	.236	.000	-5.709	-3.604
	Final test	-4.437***	.250	.000	-5.552	-3.323

Based on estimated marginal means

**. The mean difference is significant at the .01 level.

***. The mean difference is significant at the .001 level.

a. Adjustment for multiple comparisons: Bonferroni

Table 5.23 Pairwise Comparisons of the Number of Kotter Change Principles Enacted Week by Week (cont.)

(I) factor1	(J) factor1	Mean Difference (I-J)	Std. Error	Sig.[a]	99.9% Confidence Interval for Difference [a]	
					Lower Bound	Upper Bound
Week 1	Baseline	2.031***	.293	.000	.726	3.337
	Week 2	-1.375***	.297	.001	-2.700	-.050
	Week 3	-2.625***	.310	.000	-4.009	-1.241
	Final test	-2.406***	.323	.000	-3.849	-.964
Week 2	Baseline	3.406***	.224	.000	2.408	4.405
	Week 1	1.375***	.297	.001	.050	2.700
	Week 3	-1.250***	.215	.000	-2.211	-.289
	Final test	-1.031**	.282	.009	-2.290	.227
Week 3	Baseline	4.656***	.236	.000	3.604	5.709
	Week 1	2.625***	.310	.000	1.241	4.009
	Week 2	1.250***	.215	.000	.289	2.211
	Final test	.219	.214	1.000	-.736	1.174
Final test	Baseline	4.438***	.250	.000	3.323	5.552
	Week 1	2.406***	.323	.000	.964	3.849
	Week 2	1.031**	.282	.009	-.227	2.290
	Week 3	-.219	.214	1.000	-1.174	.736

Based on estimated marginal means

**. The mean difference is significant at the .01 level.

***. The mean difference is significant at the .001 level.

a. Adjustment for multiple comparisons: Bonferroni

Furthermore, students must understand the 7-stages of Kotter's change model to achieve the principles. The condition is underlined in the simulation. So, they must read assignments, share with peers, and reflect on themselves. Through the open online forum, students participate in the discussion and share their ideas. For example, to achieve "Create a Guiding Team," participants shared:

> *To apply the Kotter change model, we must create a guiding team who loves to carry out change and sustainable development projects. However, looking for*

> *that team is not easy in reality. What powers and tools should we give them? What do they need to set up the team? If you don't have a strategy, you will create a creative "manipulated' group with management power (Student's post on Open Discussion Forum week 3).*
>
> *In fact, I still see many managers being afraid to create pioneer groups as sometimes this group may encroach on them. To alleviate this fear, leaders must be willing to pioneer in knowledge - perception - action. Then their group will develop sustainably (Student's post on Open Discussion Forum week 3).*

Sometimes, participants expressed their confusion and shared learning experiences on how to conquer the change management model as:

> *In response to Kotter's change model, a pioneering team is needed to implement a project that moves towards sustainable change and development. However, it is difficult to find such a team in reality. It is also challenging for managers to empower staff to achieve innovation. If we do not handle things properly, it may create factions and dissent, causing negative consequences for the manager's management work. In the simulation, I have reached a relatively stable level but still have not been able to 'create a guiding team' and get 'quick win'. I don't understand why. (Student's post on Open Discussion Forum week 3).*
>
> *When I started to play simulation, I did not understand the role of top managers, aka Department of Education, Primary and Secondary school. Then I asked my classmates, and then I knew that if I wanted to make any impact, I had to influence from the top down. (P6)*

5.4.6 Assumption Check for Skill Performance

On the final simulation exam, 28 of the 32 participants achieved the highest level of success, 'Change Master'. This means they demonstrated the ability to formulate and execute an effective change strategy. Therefore, it can be said that most of the participants finally succeeded in the simulation [see Appendix K]. However, two final inferential tests were conducted to assess the effects of the simulation on skill performance.

The Kolmogorov-Smirnov and Shapiro-Wilk tests were carried out separately to test the normality assumption for each type of measurement. The data presented in Table 5.24 indicate that the results did not meet the standard of $p < 0.05$. Therefore, the data were not normally distributed. Note that the baseline of change management level test is constant, so it has been omitted.

Table 5.24 Tests of Normality for Simulation Skill Performance Results

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Baseline-Kotter Principles	.538	32	.000	.265	32	.000
Baseline Change Man. Level	.	32	.	.	32	.
w1- Kotter Principles	.242	32	.000	.871	32	.001
w1-Change Man. Level	.212	32	.001	.805	32	.000
w2- Kotter Principles	.206	32	.001	.902	32	.007
w2- Change Man. Level	.251	32	.000	.820	32	.000
w3-Kotter Principles	.178	32	.011	.903	32	.007
w3-Change Man. Level	.487	32	.000	.431	32	.000
Final- Kotter Principles	.216	32	.001	.918	32	.018
Final-Change Man. Level	.489	32	.000	.436	32	.000

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

The results in Table 5.24 suggest that the simulation measurements of skill for change management for sustainability did not follow a normal distribution (Glass, Peckham, & Sanders, 1972; Handy, 2005). This is not uncommon in educational

research, especially when the sample size is relatively small (Davidson, 1972; Greenwald, 1976; Micceri, 1989). Therefore, the researcher conducted a Friedman Rank Test for differences in medians as an additional robustness check of the repeated measures ANOVA test. Table 5.25 are still significant ($p < 0.001$), meaning the original one-way repeated measures ANOVA test results are robust.

Table 5.25 Friedman's Non-Parametric Rank Test of Normally of Simulation Skill Performance Measurements

Factor	Chi-Squared	df	p	Kendall's W
Level of change management	103.410	4	< .001	0.808
Kotter's change principles	96.976	4	< .001	0.758

The Friedman rank test was conducted to determine whether simulation measurements differed before and after learning the LCSS-V simulation course (see Table 5.25). The results indicated significant differences across the two skill measures: the level of change management ($\chi2(4) = 103.410$, $p < .001$) and Kotter's change principles enacted ($\chi2(4) = 96.976$, $p < .001$). There are differences in simulation measurements in terms of the level of management and Kotter's change principles enacted at the baseline and after weeks one, two, three, and final tests. Therefore, it can be concluded that the LCSS-V simulation enhanced students' skills in change management for sustainability.

5.5 Discussion

This Chapter has presented the results of a series of tests of the redesigned LCSS-V simulation on learners' knowledge, attitudes, and skills.

5.5.1 Limitations

Several limitations impact the interpretation of the findings presented in this chapter. The first concerns the sample size and characteristics of the participants. The sample size used in this study was admittedly small (i.e., 32), and the convenience sample did not include all of the possible stakeholder groups for whom the simulation

might be relevant. For example, most of the participants were experienced teachers. It is anticipated that the simulation could be adopted for use by Vietnam's National Center for Educational Management which is responsible for training school administrators and policymakers. These features of the research limit the generalizability of the findings and imply a need for additional studies that incorporate a larger representative sample.

Third, the researcher used a one-group pre/post-test design without a control group. As is the case in many education studies, this was not possible in the setting where the researcher was collecting data. Nonetheless, this type of design is capable of determining whether learning has taken place and was an improvement in studies that rely on student perceptions. The research did not examine the impact of the learners' characteristics on the outcomes.

Finally, the study did not control for the impact of the instructor's ability. The author of this study was the lecturer who taught the simulation-based module. Notably, this was the first time that he had taught with the simulation, a limitation which, in retrospect, certainly impacted the results. This limitation suggests two implications. First, the researcher will undertake a comparative study in which he teaches the module again to a similar group and compare the results. It is quite likely that the learning outcomes would be stronger, given the benefit of this experience.

In addition, the instructor's own experience in teaching the simulation-based module highlights the need for formal training in how to teach with the simulation. While the amount of time spent lecturing in the module is quite limited, the instructor nonetheless needs to manage the technology and provide continuous feedback to the students. This can be demanding. During the dissemination phase of the project, the instructor will produce a Vietnamese language version of a training manual for future trainers. In addition, he will offer workshops for Vietnamese instructors who wish to use the simulation in the future.

5.5.2 Interpretation of the Findings

The main objective of this quasi-experimental study was to provide a preliminary evaluation of the viability and effectiveness of LCSS-V simulation. The findings show that the LCSS-V simulation helped learners acquire a more comprehensive understanding of sustainability issues in education, as well as how they

can contribute to making sustainable change in schools. In addition, the study found that learning with the simulation strengthened student attitudes towards sustainability.

Recently, in Vietnam, ESD has begun to be integrated into curricula but only in a fragmented fashion. Teachers have misconceptions about ESD or are unaware of sustainability-related subjects (Kieu, Singer, & Gannon, 2016; Nguyen, 2018). This observation was borne out in this study which found a very low level of awareness among the teachers of sustainability issues either in general or in educational settings. Therefore, there is a need for educators to attain stronger professional competency to implement ESD. This simulation implicitly introduces educators to a whole school approach to implementing sustainability in education. This suggests that the simulation will meet a present need in Vietnam.

The LCSS-V simulation reveals a statistically significant change in participants' knowledge of change management for sustainability. Although the gain may seem small in absolute terms, the magnitude of Cohen's d indicates that the improvement was substantial due to the relatively small number of items. This outcome is likely attributed to several factors.

Firstly, a limited number of participants possessed prior knowledge of concepts related to change management for sustainability. Despite the significant improvement in participants' knowledge resulting from the four-week simulation course, there remains a need for further learning on sustainability among Vietnamese educators.

Secondly, the nature of problem-based learning provides another explanation for this. In this pedagogical approach, learners construct their knowledge through self-directed learning guided by instructors. Despite the provision of mini-lectures and reading assignments, acquiring knowledge ultimately depends on the perseverance and effort exerted by the learners. This approach aligns well with the ESD principles, where students continually construct and reconstruct their knowledge through practical experiences and their willingness to actively seek solutions.

Note that the knowledge in simulation is not only acquired through individual practices but also in a team. Participants also learned while coordinating with others in a class, or they can share on Open Discussion Forum. Feedback and experiences from other classmates are critical for obtaining optimal levels of learning

and vital for participants to learn and adapt to complex sustainable issues. It resulted in a high level of student engagement, evident from observational data on students' participation in the simulation outside of class and their responses in the weekly online learning forum.

The attitude test results through the Sustainability Mindset Scale align well with other studies, which found that while educators have limited awareness of sustainability issues, they do express a generally positive attitude towards sustainability (Borges, 2019; Mlipha & Manyatsi, 2005). In the LCSS-V simulation, educators-learners perceived increased awareness and attitude towards sustainability. They became more confident in the potential of pro-sustainability behaviors and felt urgent for immediate action. This study also helps validate Sustainability Mindset Scale in an additional context (Chatpinyakoop et al., 2022).

Stevenson (2022) stated that many social psychologists, recognizing the limitations of a sole knowledge- or information-based model in explaining the complex dynamics of behavior change, advanced more nuanced theories of planned behavior and action (Ajzen, 1985; Ajzen & Fishbein, 1988). These researchers contend that attitudes do not directly dictate behavior but instead shape behavioral intentions, which then drive actions. The attitude-behavioral intentions models developed by Ajzen and Fishbein have served as the theoretical framework for numerous studies which aimed to examine the connection between environmental attitudes and environmentally responsible behaviors (Newhouse, 1990) and evaluate the impact of environmental programs or curricula on students' attitudes and/or behavioral intentions. Therefore, the researcher believes that increased knowledge will lead to more informed behavior.

Indeed, the participants' achievement in the final test proved the skill for change management for sustainability. The repeated measure ANOVA tests in four weeks revealed significant changes in the skill. Most participants (28 out of 32) reach the novice stage to the mastery stage (i.e., the highest level) in the final test. It is not mean that the simulation is ‘easy’. As students can ‘see’ the level of their success at the end of each three- year simulation session, they are motivated to continue playing until they can succeed.

This motivation is consistent with the principles of mastery learning. Although other studies that utilized questionnaires to measure behavior when applying

knowledge-attitude-behavior (Chappin, Bijvoet, & Oei, 2017; Salas-Zapata, Ríos-Osorio, & Cardona-Arias, 2018), this study directly measured skill change through repeated measurements during the simulation intervention. Participants gained knowledge, attitude, and improved their ability to apply lessons learned from hands-on simulation practices, principles, and theories that the instructor introduced at the end of each class, such as the sustainability concept, the adopter type, the diffusion of innovation, and Kotter's change model.

5.5.3 Implications of the Findings

Serious games and simulations have garnered significant attention in the education sector, offering a valuable pedagogical approach to promoting active, experiential, problem-based learning. With sustainability simulation's growing popularity in academic and professional settings, there has been a need to critically examine learners' experiences and evaluate the learning outcomes (Ranchhod et al., 2014).

Although sustainability themes have been integrated into teacher education in Vietnam, the didactic approach still leans on passive pedagogy (i.e., lecture, Q&A) in all most all courses at one of the largest teacher education institutions in Vietnam. Active pedagogies like games, role play, and debates are rarely used (Nguyen et al., 2022). Therefore, following a learner-centered approach, the LCSS-V simulation is a prominent tool for training educators and teachers about sustainability,

Moreover, from the evaluation of LCSS-V simulation effectiveness, the use of this simulation need not be limited to courses for Vietnamese educators only. The simulation would be well suited for use in other professions that focus on change management for sustainability. Indeed, the other version of LCS simulation has been used in a different context, receiving positive results from learners (Chatpinyakoop et al., 2022).

The results from validation studies yield the potential to adapt the simulation beyond. Currently, the LCS simulation works in corporate and K-12 educational settings (Vietnam). The future version could be developed for use in educating sustainability in K-12 and higher education settings in the global version. Thus, these adapted versions

are being redesigned to reflect context, roles, and specific activities that characterize these other settings.

Based on the belief and evidence that increased knowledge might lead to more informed behavior, many environmental policies and educational programs should be integrated and embed ESD and change management for sustainability in the teaching and learning process. The responsibility for this can be started by the government and non-government organizations on a large scale or even within individual efforts.

For continued viability of the LCSS-V Simulation, the researcher should compare and disseminate the effectiveness of simulation in various learning modes (e.g., online learning or hybrid learning), as well as different duration (e.g., one-day workshop, all semester course). The target users of the simulation could expand not only to educators but undergraduate students in any particular major.

Even though the study has shown a significant and meaningful improvement in learners' knowledge of change management for sustainability, attitude towards sustainability, and skill for change management for sustainability, it is important to acknowledge that alternative learning methods, such as lectures, flipped classrooms, or case studies, may also produce similar or even better results over a similar time period. Thus, conducting comparative studies in the future would be beneficial for educators to determine the most effective teaching methods.

5.6 Conclusions

This study evaluated the effectiveness of the LCSS-V simulation as a learning tool to develop knowledge, attitude, and skills related to sustainability and change management. The study adopted a quasi-experimental pre/post-test design with 32 participants who completed a four-week course using the LCSS-V simulation. The results showed that the simulation significantly increased participants' knowledge of change management for sustainability, and skills in leading and managing change for sustainability.

Moreover, the simulation's positive impact on participants' attitudes towards sustainability highlights its potential to cultivate a sustainability mindset and awareness. In addition, the simulation encouraged sustainable practices among participants, making

it a valuable tool for undergraduate and graduate students in education programs from various disciplines, in-service teachers, and other stakeholders in the education sector. The web-based nature of the simulation also allows for integration with modern teaching and learning methods such as eLearning or hybrid learning.

The study's qualitative analysis corroborated the statistical findings, with learners expressing greater interest and enjoyment from the LCSS-V simulation than conventional teaching methods. Despite the small sample size, the study recommends expanding the research method through continuous courses and workshops to acquire a larger sample size, enabling a more diverse approach to evaluate the simulation's effectiveness and generalize its viability.

While the simulation's target audience is primarily educators, teachers, and school leaders, the study suggests that the potential audience for the LCSS-V simulation is much broader. Sustainability concepts concern every individual, independent of educational level, age, and profession, making the simulation a valuable tool for anyone who is interested in sustainability.

CHAPTER VI
CONCLUSION

6.1 Summary of Findings

Sustainability has become a critical concern for many nations. It is imperative that the next generation is equipped with the knowledge, attitudes, and skills needed to tackle the challenges of creating a more sustainable future. These challenges require educational institutions all over the world and at all levels to embed a different set of values and practices into teaching, learning, and management.

This challenge was addressed in this Ph.D. dissertation which aimed to achieve the following objectives.

1. Clarify the nature of the challenges facing K-12 schools as they seek to address the UN's sustainable development goals;
2. Survey school-based approaches to enhancing sustainability in the curriculum, instruction, school management, and operations;
3. Draw upon the current knowledge base in active learning, sustainability science, and organizational change to create a research-informed tool (i.e., the LCSS-V simulation) that can be used in training K-12 educators, specifically in the Vietnamese educational context;
4. Evaluate the efficacy of the LCSS-V simulation-based learning module and assess its potential for use in the future training of teachers and school administrators in Vietnam.
5. Contribute new knowledge to the literature on simulation-based learning and educating for sustainability.

These objectives were largely realized in the dissertation research. Chapter 2 examined the broad scope of literature on education for sustainable development (ESD) in K-12 settings worldwide. This review identified a global ESD literature that has grown rapidly over the past decade. Three findings from the literature review stood out.

First, despite its rapid growth, the ESD literature remains dominated by contributions from Western developed societies. While some findings from this literature are relevant globally, it is also true that developing societies present a different context both in terms of the nature and scope of their sustainability challenges and in the resources and policy structures needed to support the adoption of more sustainable practices. In Vietnamese schools, for example, the class size is often twice that of schools in Western developed societies. This has been identified as an obstacle to the use of active learning methods recommended by some ESD proponents (Hoa & Tuan, 2007; Tran, 2013). In addition, many Vietnamese schools lack access to advanced technologies, and teachers cannot depend upon widespread internet access in students' homes.

In addition, the cultural norms that prevail in the developing societies of Asia may also impede the adoption of more practices consistent with ESD (Kaur et al., 2016; Tyrosvoutis, 2016). For example, despite efforts aimed at change, Vietnamese schools continue to emphasize traditional, teacher-centered methods of teaching and learning (Nhat et al., 2018; Van & Thi, 2021). Thus, the adoption of active, student-centered learning methods used for ESD may conflict with prevailing cultural norms that emphasize hierarchy, rank, seniority, and rote learning (Nguyen et al., 2019; Nguyen Thanh et al., 2008; Thanh, 2010; Tyrosvoutis, 2016).

The cultural norms in developing societies may also shape responses to more sustainable management practices in schools. For example, sustainability research highlights the importance of multi-stakeholder involvement in decision-making and shared approaches to leadership. Yet, Vietnamese cultural norms continue to promote the authority of top-down, formal leaders and formalistic involvement of stakeholders (Hallinger & Truong, 2016; Truong et al., 2017). Similarly, efforts to implement sustainable purchasing and supply chain management in schools could be impeded by cultural norms that emphasize the primacy of relationships and social networks rather than efficiency or environmental justice (Claes, 2019; Truong Quang & Hara, 2018).

These "contextual" features of developing societies such as Vietnam highlight the need for research and development efforts that place sustainability problems and practices in a localized perspective. This approach was adopted in the current R&D project that sought to contextualize the change toward sustainability within

the institutional and cultural context of Vietnamese K-12 schools. Thus, this study of educating for sustainability in Vietnam addressed this need identified in the author's bibliometric review of ESD research.

The bibliometric review also identified a shift in the focus of the ESD literature over the past two decades (see also Hallinger & Chatpinyakoop, 2019; Hallinger & Nguyen, 2018; Lee, 2019). The ESD literature of the 1990s and 2000s tended to focus on environmental education (Hallinger & Nguyen, 2018; Leicht et al., 2018). However, the field has recently begun to evidence a more balanced and integrated focus on the triple bottom line of economic, social, and environmental sustainability goals (Hallinger & Nguyen, 2018). While this transition toward a balanced set of sustainability goals has already started, the field of education still needs initiatives that communicate this to prospective and practicing educators and students (Bürgener & Barth, 2018; Nolet, 2015).

Consequently, the training simulation developed and tested in this dissertation explicitly adopted the goal of enhancing the triple bottom line of sustainability indicators in K-12 school settings. Indeed, as illustrated in Chapter 4, the new LCSS-V simulation was designed to include more than 100 examples of economic, social, and environmental sustainability practices. While not all-inclusive, these represent illustrative practices that are relevant for educators interested in enhancing the sustainability of their schools and communities.

Thus, this R&D study was designed to provide both a broad and deep introduction to sustainability issues and practices in education. The simulation-based learning method adopted in this project introduces sustainability issues and practices to learners in the natural course of making school and classroom-level decisions. This training tool would, therefore, provide Vietnamese educators with access to an up-to-date and engaging model of educating for sustainability. As such, they represent a potentially useful introduction to educating for sustainability to prospective and practicing educators.

Third, the bibliometric review also identified a need to go beyond prescription and advocacy in asserting the need for more active approaches to learning for sustainability (Hallinger & Nguyen, 2020; Nguyen & Hallinger, 2020). In particular, researchers have highlighted the need for learning practices that are problem-oriented

and have the capability to both strengthen the sustainability mindset of learners and develop practical skills (Krasny & Tidball, 2017; Leicht et al., 2018; Lozano et al., 2017; Rieckmann, 2018). The literature on education for sustainable development is, unfortunately, dominated by prescription and critique with relatively few efforts at empirical validation of effective teaching and learning practices (Hallinger et al., 2020; Nguyen & Hallinger, 2020). Thus, there is an urgent need for more empirical studies that examine the efficacy of active teaching and learning strategies for sustainability (Hallinger et al., 2020; Nguyen & Hallinger, 2022).

Simulations and serious games have been identified as one type of active learning method that holds potential in the domain of educating for sustainability (Crookall et al., 2019; Den Haan & Van der Voort, 2018; Gatti et al., 2019; Hallinger et al., 2020). This is due to the ability of simulations to contextualize learning, engage learners, and enhance the transfer of learning (Gatti et al., 2019; Lu et al., 2014; Warren et al., 2016). Given this need and the potential of simulations and serious games, the current dissertation selected simulation-based learning as the active learning mode for use in the education and training of teachers and school administrators. The findings from this study suggest that teachers and administrators using the simulation would not only leave with more positive attitudes and new knowledge about ESD, but also benefit from their exposure to an unfamiliar student-centered form of pedagogy.

Chapter 3 presented an integrative research of research on "whole school approaches" to ESD implementation. The whole school implementation of ESD has increasingly replaced earlier approaches that focused on implementing an instructional unit, extra-curricular activity, or school-based project (Hallinger & Nguyen, 2020; Leicht et al., 2018; Mogren & Gericke, 2017; Ramos et al., 2015). The review of whole-school approaches to ESD implementation yielded several recommendations that characterize current efforts to implement sustainability in schools. These included the importance of developing a clear vision and mission of sustainability, shared school leadership with multi-stakeholder involvement, community focus and partnership, problem-based learning engagement in which students develop relevant skills and competence to pursue a sustainable lifestyle, inclusion of sustainability-related challenges, values, and practices throughout the curriculum, a focus on cultural and

moral education, and application of sustainability values and practices into school management and campus operations.

These findings were subsequently used to inform the development of the LCSS-V simulation. Indeed, as elaborated in Chapter 4, these sustainability findings are visible to learners as they play the LCSS-V simulation. Indeed, learners are only able to "succeed" in the simulation after they understand and are able to integrate these principles to the sustainability challenge. Thus, the LCSS-V simulation developed through this dissertation incorporated current knowledge drawn from international experience in implementing ESD using a whole school approach.

Chapter 4 described the comprehensive research and development (R&D) project that was used to adapt and create the new simulation. This R&D process was comprised of eight steps. This systematic process was used to adapt an existing business simulation (Leading Change for Sustainability-Business) and create a new simulation, LCSS-V, for use in the K-12 education sector in Vietnam. As suggested by the length of Chapter 4, this was a substantial undertaking that included:

1. undertaking a literature review,
2. carrying out a small-scale research project,
3. reconceptualizing the business simulation for a school context,
4. rewriting the problem context, descriptions of the 24 stakeholders, activities, and 175 feedback cards into English,
5. revising all of the items in step four to be consistent with the Vietnamese education structure and social-cultural norms,
6. translating all text into Vietnamese,
7. revising and reprogramming the decision rules inside the simulation,
8. testing, debugging, and continuing to adapt the simulation.

This Chapter included a detailed description of the steps used to make two key types of adaptations to the business simulation. First, the business simulation had to be adapted for a K-12 school context. Not only might educators be less interested in learning from a business simulation, but they might also find the examples of sustainability problems and practices encountered in a corporate setting less relevant to their own workplace culture, roles, and tasks. For example, while sustainability in campus operations might have many similarities to a corporate setting, the transfer of

sustainable practices from a business to curriculum and instruction in schools might be less straightforward.

The process of adapting the business simulation to a school organization required the researcher to rethink all elements of the simulation. These included the problem context, organizational structure, stakeholder roles and descriptions, and the activities used to implement change. While the structural composition of the simulation remained relevant (i.e., gameboard, goal-directed activity, change activities, budget, research-informed decision rules, stakeholders, Bennies, change stages, etc.), virtually all of the content that fits within the structure of the business simulation had to be reconsidered and revised.

Moreover, soon after the adaptation process began, it became apparent that a second type of adaptation would be required. More specifically, as the researcher began to outline the characteristics of the new K-12 education simulation, he concluded that there is no such thing as a "generic school context" (see also Kantamara, 2000; Tang, 2015). More specifically, in Vietnam, which was the target for the new simulation, both the institutional structure and cultural norms of the K-12 education system are very different from those in Thailand or the United States. For example, in Vietnam, schools not only report to the Ministry of Education and Training, but also to the political hierarchy of the Communist Party. A simulation that failed to account for this distinctive feature of the organizational context would fail to "simulate" the reality of Vietnamese schools. Omissions such as this would reduce the simulation's perceived relevance in the learners' eyes (Kantamara, 2000; Tang, 2015).

Thus, the researcher determined that the R&D process would need to include a step in which the new K-12 school simulation would be contextualized to fit Vietnamese schools' institutional structure and social-cultural norms. With this in mind, the R&D process first produced a "generic" beta version of an English language K-12 Leading Change for Sustainability in Schools (LCSS) simulation. This English language LCSS simulation was then adapted to align with the institutional structure and cultural norms of the Vietnamese K-12 education context. Only after these deeper adaptations were completed, did the researcher translate the simulation text into Vietnamese for the new LCSS-V simulation.

Chapter 4 also presented a range of quantitative and qualitative data drawn from students' perceptions of their experience in learning with the simulation. These results were largely positive, affirming the ability of the simulation to engage students and teach for practical application. This was especially significant in light of two limitations. First, only a few of the students had previous experience in learning with a computer simulation. Second, this was the first time that the instructor (i.e., the researcher) had taught using a course with the new LCSS-V simulation. In addition, numerous refinements were suggested by the students and incorporated into the final version of the simulation.

While Chapter 4 described students' perceptions of the simulation and their learning experience, the learning outcomes of the main field test of the LCSS-V simulation were reserved for a detailed description in Chapter 5. Moreover, it should be noted that the main field test results presented in Chapter 5 were designed to be more than a simple validation of the LCSS-V simulation. The main field test was also designed so that it would also contribute to the literature on simulation-based learning (Hallinger & Wang, 2020), and teaching and learning for sustainability (Hallinger & Nguyen, 2020).

Chapter 5 described a quasi-experimental study designed to assess the efficacy of the LCSS-V simulation for use with K-12 teachers and administrators in Vietnam. The study employed a quasi-experimental, mixed-method research design to assess change in learners' knowledge, attitudes, and skills resulting from a four-week learning module built around the LCSS-V simulation. While the small sample size (i.e., 32 educators) represents a significant limitation, the validation study yielded useful data on the future potential of the LCSS-V simulation. Indeed, the research design and methods used in the main field test in this study went beyond those used in other previous doctoral studies with similar goals (Kantamara, 2000; Tang, 2015).

The empirical research carried out in this dissertation yielded several findings. First, the results of the main field test indicated that this active approach to learning highly engaged the participants. Although fewer than 30% of the participants had previously used a computer simulation, they adapted quickly and were entirely engaged throughout the four-week module. The qualitative and quantitative data on

learner engagement found that while these Vietnamese educators found simulation-based learning challenging, they found it very practical and unique.

Second, the results showed that the learners began with very little knowledge about sustainability challenges and practices of change management. This is significant since the researcher would expect that experienced educators studying in a Master's degree program at a top university in Ho Chi Minh City would be among the better-informed educators in the country. While the learners did not attain a mastery level of change management for sustainability concepts, they made substantial, statistically significant improvements. This finding supports the efficacy of simulation-based learning and its use in educating for sustainability. The results also affirmed the simulation's ability to develop the learners' higher-order thinking capacities. These findings are consistent with other recently reported research on using the business version of this simulation (Chatpinyakoop, 2023; Chatpinyakoop et al., 2022).

6.2 Limitations

This dissertation project's main limitations arose from the research scope conducted to validate the LCSS-V simulation's use in training Vietnamese teachers and administrators. The main field test was conducted with a relatively small sample and in only a single location in Vietnam. Thus, the particular characteristics of the learners who participated in this study could have influenced the outcomes.

A second limitation was the researcher himself. The main field test was the first time the researcher taught a class with this simulation. Therefore, his own experience and skills in teaching with the simulation could have had a 'negative' impact on the results. In this case, however, the limitation would suggest that the simulation could yield more positive outcomes for the learners as the instructor gradually gains more experience after teaching with the LCSS-V simulation.

A third limitation lies in the setting where the validation study was conducted. The teaching was delivered as part of a four-week module within a graduate course at a university. The simulation is anticipated to be used at least as frequently in training courses and workshops offered by the Department of Education. Some adaptations in delivery would be needed in these settings. Feedback from the students

and the researcher's observations suggested that the deep learning and development of higher-order thinking follow from having multiple opportunities to play the simulation, not just once in a workshop. Therefore, future research should also examine the simulation's effectiveness when used under different conditions.

6.3 Implications

The findings from this dissertation have implications for research, policy, and practice. With respect to research, it is worth noting that research on educating for sustainability is only beginning to emerge in Vietnam. For example, the author did a Scopus search in early 2023 and was only able to locate a few empirical studies of sustainability at the K-12 level (e.g., De Prima et al., 2022; Hoang & Kato, 2016; Lee et al., 2022; Nguyen, 2019; Nguyen et al., 2012; Nguyen et al., 2022). Indeed, the lack of attention to sustainability in Vietnam's education community was aptly captured by Nguyen (2019) whose article was titled "Searching for education for sustainable development in Vietnam". This places the empirical contribution of this dissertation into perspective and highlights the timeliness of developing the LCSS-V simulation, which can potentially be at the forefront of training for educators in Vietnam.

It should also be noted that the R&D process used to develop this simulation yielded an 'intermediate product' in the form of an English language version of the LCSS simulation. This English language version was not refined but remains available for further testing and development. With only a moderate amount of effort, the English version of the LCSS simulation could be ready for evaluation and use in settings where English is the medium of instruction.

Second, the empirical study carried out for the dissertation deserves a more substantial follow-up study. The study carried out by Chatpinyakoop (2023) with the original business simulation would serve as a useful model. His study collected data that was similar to the data collected in this study but from a larger sample of students in multiple classes. This approach would enable a more valid assessment of the learning outcomes of the LCSS-V simulation.

Third, in Chapter 4, it was noted that an English language version of the LCS-B simulation was developed as an intermediate step during the process of creating

the LCSS-V. This English language version, Leading Change for Sustainability in Schools (LCSS), represents another 'product' of this dissertation. Currently, it is in a beta version that 'works' but has yet to be debugged, refined, and tested. Completing the development of that simulation was outside the scope of this dissertation. However, with a relatively small investment of time, the LCSS simulation could be ready for use in settings where English is the medium of instruction. Moreover, from a research perspective, the similarity of the LCSS and LCSS-V simulations could offer a unique opportunity for cross-cultural research on learning.

A fourth research implication of this study lies in the data collection capacity of the LCSS-V simulation. As described in Chapters 4 and 5, a wide variety of data on the learning process (e.g., student engagement, decision-making) and outcomes (e.g., attitudes, knowledge, skills) was collected via the simulation software. This is quite unusual and represents a unique opportunity to obtain compelling data that would be far more difficult to collect from a typical classroom intervention. It should be noted that this study was built explicitly upon an earlier study that built this type of data collection capacity into a simulation (Showanasai et al., 2013). This is a significant advance, and other developers and researchers who use online simulations and games are strongly encouraged to explore the development of similar capabilities for their own research.

The findings from this study also contribute to the research on simulation-based learning in general. A recent review of the literature on simulations and serious games found first that there was a trend towards the development of simulations and games in the domain of sustainability (Hallinger & Wang, 2020; Hallinger et al., 20121). However, there was a need for more simulations that focused on sustainability issues that go beyond the environment (e.g., climate change, water resources). The development of this simulation addressed that need. In addition, scholars have also noted a need for more studies that examine the learning outcomes of simulations using multiple indicators of attitude, knowledge, and skills (Hallinger & Wang, 2020; Salas et al., 2009). This study not only addressed that challenge, but also yielded a tool that can be used in future studies of simulation-based learning.

With respect to policy and practice, this dissertation also has several implications. First, the deficient level of knowledge about sustainability among the teachers who participated in this study suggests an urgent need to raise the level of

awareness of sustainability issues and ESD practices among educators in Vietnam. This finding suggests the need for government policymakers to “create a sense of urgency” within the education community in Vietnam.

The lack of awareness of local educators also highlights the potential of the LCSS-V simulation as a practical tool that can be used in the training of school teachers and administrators. The author will contact the National Institute of Education Management, which has branches in both Hanoi and Ho Chi Minh City. The simulation’s dual capability to contribute to competencies in change management and sustainability awareness would make it a useful tool in their curriculum. This government agency is responsible the preparation and development of school administrators throughout Vietnam. If the simulation could be adopted by the Institute, it could become a standard part of the training of school teachers and administrators in Vietnam.

Using the LCSS-V simulation is the potential to enhance participants' understanding and engagement with sustainability concepts. By immersing players in a virtual environment that mimics real-world educational challenges related to sustainability, simulations can provide a hands-on and experiential learning experience. It enables learners to develop a deeper understanding of complex concepts, enhances critical thinking and problem-solving skills, promotes interdisciplinary collaboration, and cultivates a sense of responsibility towards the environment, economics, and society.

Finally, while it was not a research objective of this dissertation, the researcher would like to close with an observation about the potential of using the LCSS-V simulation with Vietnamese educators. While, as noted above, numerous obstacles have been identified that can impede the use of active learning methods in Vietnamese schools, this study found that the Vietnamese teachers responded enthusiastically to the use of the LCSS-V simulation. Their own experience of learning with the simulation “opened their eyes” to the possibilities of active learning. Their own feelings about the learning experience, described in the qualitative results reported in Chapter 5, suggest that using this type of simulation-based learning in teacher training could have the unanticipated effect of reducing resistance to the use of non-traditional learning methods in Vietnamese schools.

Thus, the dissertation closes with a final research recommendation. Future research on the effects of this simulation, when used in training teachers and school administrators in Vietnam, should examine the "knock-on effects" beyond the training setting. More specifically, to what extent does the experience of learning with the simulation change educators' attitudes toward the use of active learning methods in their own classrooms and schools? Achieving success in this unexamined domain could be the most important outcome of using the simulation module in the education of educators. That, of course, would also reduce the subsequent challenges of integrating sustainability concepts and practices into the classrooms and schools of Vietnam.

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APPENDICES

Appendix A: Summary of Empirical Research Based on Sufficiency Economy Philosophy in Education

Source	Method	Sample	Key Findings
Ariratana et al. (2013)	Qual	5 small schools	Education approach focuses on brainstorming, small groups, success stories of their colleagues' experiences and positive monitoring of teacher professional development for learning organization based on SEP.
Choochom (2015)	Quant	800 under-grad students	SEP attitude mediates the relationship between friend factors and SEP living behavior. Self-immunity has a direct positive relationship with SEP living behavior. Self-immunity mediates the effects of family factors on SEP living behavior.
Chusorn et al. (2017)	Qual	P1: 5 case studies, P2: 9 experts	Administrators and stakeholders should involve in SEP-related policy. School curriculum embedded with SEP in cooperation with stakeholders. SEP implementation of plans should be based on saving, worthiness, and optimal outcomes. Environmental factor is needed for SEP instruction. Leaders and teachers play a pivotal role.
Dharmapiya & Saratun (2015)	Qual	9 VSP schools	Characteristics of SELCs are identified. Internal and external key success factors are classified.
Jairak et al. (2015)	Qual	20 CIOs, 05 IT experts, 05 SEP experts.	A formal set of SEP-based IT governance practices is developed.
Saratun & Dharmapiya (2020)	Qual	13 stake-holders in each of ten SELCs	Continuous SEP training and multi stakeholders' involvement are the key success factors for cultivating the SEP mindset. School culture serves as immunity against negative changes.
Silanoi (2012)	Qual	7 admins, 6 super-visors, 18 teachers.	A new SEP-based integrated teaching pattern is developed.

Source	Method	Sample	Key Findings
Suriyankietkaew & Hallinger (2018)	Quant	240 VSP schools	Virtues, prudence, stakeholder focus and enabling culture significantly predict enhanced ESD.
Thanomwan & Buncha (2014)	Quant	200 teachers	School organizational culture has strong relationship with sufficiency-oriented school management practices. Quality, decision making and empowerment predict well sufficiency school management.
Treputtharat et al. (2013)	Qual	32 mixed stake-holders	Key components of integrated management model are school administrators, teachers, students, administrative factors, and environmental condition. 7-step integrated management model is proposed.
Tungkasamit et al. (2014)	Mixed method	3 admins, 40 teachers, 260 parents, 260 students	Participants perceived all aspects in a high level, and have positive perceptions toward the SEP-oriented activities.
Yiengprugsawan et al. (2010)	Quant	87,134 university adult students	Life satisfaction are correlated with living standards, life achievement, future security, sense of community and personal safety. Spirituality and religion take the highest mean scores among eight domains of personal well-being.

Appendix B: Summary of A Sample of Empirical Studies from the USA, Australia, and Sweden

Source	Nation-Domain	Method	Design	Sample	Key findings
Australian EfS Alliance (2014)	Australia-Australian Curriculum, teacher education	Mixed	3 phases	5000 mixed stakeholders	The majority of teachers are either unaware of ESD or do not understand it. Most teachers think sustainability is essential and student-valued and should be integrated into the curriculum. Barriers and enablers to integrating ESD for teachers are identified.
Berglund et al. (2014)	Sweden-sustainability consciousness	Quantit-ative	Cross-section	638 K-12 students	There are significant differences in students' SC between certified ESD schools and non-certified ESD schools, but only in the economic dimension.
Borg (2017)	Sweden-global economic (in)equalities	Qualita-tive	Cross-section	53 students, aged 5-6	Children from ESD-certified schools have deeper understanding of others economic situation in comparison with those from non-ESD-certified schools.
Evans (2015)	Sweden-leader's motivations	Qualita-tive	Cross-section	Case schools,	There was a lack of leaders' intrinsic

Source	Nation-Domain	Method	Design	Sample	Key findings
				four stakeholders	motivations to sustainability. Implementation efforts are usually driven from top-down pressure in the award schools.
Ferreira & Davis (2012)	Australia-Participation of The QESSI Alliance	Quantit-ative	Cross-section	15 members of Steering Committee	While network participants were engaged and committed to participation in this network, 'old' forms of top-down engagement and relationships needed to be unlearnt.
Kennelly (2012)	Australia-Teacher education	Mixed	Two phases	107 pre-service teachers, 38 interviews, 5 case study schools	Teacher education positively affects the motivation and confidence of pre-service teachers toward ESD. Teacher education in ESD is essential for early teachers.
Lewis, Baudains, & Mansfield (2009)	Australia-Impact of AuSSI at primary school	Mixed	Longitudinal	01 case study	Compared to pre and post-AuSSI participation, the school engaged and achieved sustainability in a relatively short period at whole school level.
Mc Key (2017)	USA-Teachers' perception	Quantit-ative	Cross-section	34 awarded schools, 359 teachers	Teachers have a clear perception of ecological and democratic principles. School leaders who engage democratic

Source	Nation-Domain	Method	Design	Sample	Key findings
					principles are likely to lead their schools toward high sustainability performance.
Mogren & Gericke (2017a)	Sweden-quality criteria	Qualita-tive	Cross-section	Ten upper secondary schools	The four main principal quality criteria are identified: student-centered education; collaborative interaction and school development; cooperation with local society; and proactive leadership and continuity.
Mogren & Gericke (2017b)	Sweden-leaders' transformative perspective	Mixed	Cross-section	10 upper secondary schools	A successful transformative ESD implementation strategy should focus on school qualities that integrate internal and external ESD approaches.
Olsson et al. (2016)	Sweden-sustainability consciousness	Quantit-ative	Cross-sectio	18 ESD-certified and 18 non-certified schools, 1773 students from the K6 and K9	There was a significant difference in environmental dimension between the ESD- certified schools and the reference schools for the sixth grade. Otherwise, for the ninth grade, only social dimension was found with a significant difference.
Pauw et al. (2015)	Sweden-effectiveness of ESD	Quantit-ative	Cross-section	2413 students in K 6, 9, and	ESD can indeed impact students'

Source	Nation-Domain	Method	Design	Sample	Key findings
				12 from 51 schools	sustainability consciousness.
Pepper (2014)	Australia-Leadership for sustainability	Qualita-tive	Cross-section	Eight school leaders	Leading for sustainability in regional schools requires an understanding of change management, shared vision, and strategic action to achieve whole-of-school change
Potter (2007)	Australia-Implement ESD practices	Qualita-tive	Cross-section	01 case study	A whole-school approach is a successful ingredient for the school while pursuing ESD. Neo-humanist education and 'virtue' program are meaningful and valuable.
Rickinson, Hall, & Reid (2014)	Australia-ResourceSmart Schools (RSS) program in Victoria	Mixed	Cross-section	160 program schools	The whole school program had improved the school's sustainability activities, positive impacts in campus improvement, curriculum development, culture change, and community building.
Salter (2013)	Australia-Impact of AuSSI on upper primary students and their families	Mixed	Cross-section	02 AuSSI and 01 non-AuSSi primary schools	The whole-school approach requires visionary and shared leadership, professional learning

Source	Nation-Domain	Method	Design	Sample	Key findings
					opportunities, and student engagement. Sustainability education has a positive impact on students' knowledge and attitudes. Students can influence their parent's pro-environmental behaviors by fostering collaborative school-parent relationships.
Sterrett & Imig (2015)	USA-School strategy	Qualita-tive	Cross-section	13 stakeholders	Eight key strategies in making school turn green was identified: green team, energy savings, waste reduction, outdoor learning garden, nature trails, and outdoor classrooms, student and faculty health initiatives, curriculum alignment, and sharing the message.
Sterrett, Imig, & Moore (2014)	USA-Leaders' perception	Quantit-ative	Cross-section	75 awarded schools	Portions of disadvantaged students, scope, and location of school did not affect schools pursuing sustainability education.

Source	Nation-Domain	Method	Design	Sample	Key findings
					Principals played a leading role in pursuing sustainability.
Warner & Elser (2015)	USA-Project content	Mixed	Cross-section	59 awarded schools with 289 projects, 42 teacher interviews	Environmental/ campus activities were in favor, while community-focused activities were least interconnected. Two kinds of school which highly engaged ESD was identified.

Appendix C: Expert Interview Protocol

1. Could you briefly describe your role and experiences with the Virtuous Schools Project in Thailand?
2. Typically, what knowledge did the schools have about sustainability at the start of the project?
3. What were 5 key obstacles that all or most schools faced in making the project successful?
4. If you look back now, what elements or factors enabled schools to succeed in this initiative? Can you give some examples?
5. What factors were associated with schools that implemented slowly or hardly at all?
6. If you consider the 3 sustainability pillars, can you give a couple of examples of successful practices schools have implemented for each one?
   a. Environmental
   b. Economic
   c. Social
7. In terms of changing staff attitudes and values, what kinds of activities have proved most beneficial?
8. If I were to visit several of the model SEP schools, what are some of the things I might see that would be different from Thai schools in general? (e.g., curriculum, management, school activities, etc.)

Appendix D: Synthesis of Education For Sustainable Development Practices Based on Interviews and Videos

Synthesized Practices	**Content for New Activity's Feedback**
Do it only in one dimension, Not holistic approach. Just learning and teaching change is not enough => should be school management, curriculum, relationship with all stakeholders, with parents	A new vision of Caring for People and the Planet is adopted to signal the education department's new long-term commitment to educating for sustainability, both in classroom teaching and school management. All participants move 1 space except Ms. Cúc, Ms. Ích, Mr.Phát, and Mr. Will. Gain 200 Bennies.
Keeping accounts as an ongoing strengthening project: campaign to build habit, account training, keeping accounts, applying for an account with the school bank, assigning saving dates for each year group.	School Support Group shares ideas to show 'Caring for the People' such as applying for an account with the school Bank, helping individual keep account and getting out of debt. Participants each move 1 space and gain 250 Bennies.
Piggy bank project to encourage saving habit.	Sustainable consumption is introduced at the workshop where participants learn to create personal budgets and savings plans. Teachers discuss how this mindset and skills could be taught to students. Gain 150 Bennies. Each participant moves 1 space, except Ms. Cúc, Ms. Ích, Mr.Phát, and Mr. Will.
Workshop on planning and managing personal finance for teachers and school staff	Sustainable consumption is introduced at the Workshop where teachers and school leaders learn how to balance finance and plan ahead in spending money school operations. Gain 100 Bennies. Each participant moves 1 space, except Ms. Ích, Mr.Phát, and Mr. Will.
Media-savvy parents, media savvy team building projects: pamphlets, websites, radio broadcasts, line application for the group, parents meeting	Mr.An, Ms.Bình and the principals communicate a new vision of Caring for People and the Planet to all stakeholders in a series of face-to-face meetings and social media. Everyone moves 1 space, except Ms. Cúc, Ms. Ích, Mr.Phát, and Mr. Will. Gain 200 Bennies.
From our Hands to Sufficiency Project is extra practice for pupils: colorful toilets, growing vegetables towards sufficiency, fun science experiments, junior tour guides.	The School Support Group shares practices aimed at reducing the use of plastic to show Caring for the Planet. This leads students to share ideas on reducing the use of plastic bags and containers with vendors at the local market. Participants each move 1 space and gain 250 Bennies.

Synthesized Practices	**Content for New Activity's Feedback**
Project 3R (reduce-recycle-reuse), design environmentally friendly project *understand of limit of resources, local resources* *do planting, damn building, soil stabilizing* *go to forest, name and count tree, keep insects => biodiversity.*	These stakeholders use the garden to teach students about sustainable growing techniques, the dangers of toxic chemicals and pesticides, and the importance of maintaining biodiversity in agriculture. Participants each move 2 spaces. Gain 150 Bennies.
School carry out the Bio Way project to sustainably developed for aspects of economic sufficiency, namely husbandry, environment fishery and plants.	The School Support Group shares practices with colleagues that show Caring for the Planet by initiating a school and community garden. Participants each move 1 space and gain 250 Bennies.
The school has SEP corner/area with clear appropriate explanation for visitors.	People are glad to know that the administrators remain committed to One Future. Visitors to the District Office, pilot schools, and their websites are now greeted with the Caring for People and Planet themed mission statement. Everyone moves 1 space in the Awareness, Interest or Preparation stage.
The school organizes learning activities outside the school.	The stakeholders commit to working with local companies in a program that aims to make education more meaningful and develop 21st century job skills. Participants each move 2 spaces. Gain 150 Bennies.
Use recycle bin 3 color	These stakeholders commit to join in 'Trash hack' project to reduce food waste and rebuild the school garden to support the canteen. They propose to use three-color Recycle Bins to classify biodegradable waste, bottle, and paper. Each participant moves 2 spaces. Gain 150 Bennies.
Pupils learn to help society, family and the underprivileged.	These stakeholders commit to conduct participate in the UNESCO-sponsored 'Learning for Empathy' project. This project aims to develop student values for cultural diversity and non-violence in schools and society. Participants each move 2 spaces. Gain 150 Bennies.
Activities: talk to old people about the past, tradition, with community; field trip to community; talk to soil doctors, local wisdom	The Workshop presents how to teach a project-based learning unit on National Culture and Local Wisdom. Teachers are excited to have a creative way of increasing national pride and respect for traditions. Gain 200 Bennies. Each participant moves 2 spaces.
Urban school: believe in very competitive education, focus about ranking, performance, university	Ms.Cúc says, we can't afford to waste time and money on projects that might lower our student test results. Ms.Cúc doesn't move.

Synthesized Practices	**Content for New Activity's Feedback**
entrance, extra activities is waste of time.	
Policy: discontinue, inconsistent, so many educational approach (e.g., Buddha school, white school) => people confused, many reports	Ms.Cúc says, I heard that in other provinces, school performance ranking went down in the first year when they tried this project. So, they gave up. Honestly, I hate to see you waste effort on a project that may go nowhere. Cúc doesn't move.
Principle: Successful implementation supports the use of more engaging learning strategies.	A team of teachers from the school share the results of using project-based learning on the effects of climate change on flooding in Vietnam. School stakeholders in Preparation Stage or beyond move 1 space. Gain 50 Bennies for each person in Practice and 100 Bennies for each person in Sustainability.
Teachers change teaching style, 2-way communication -> see results own eyes -> convinced.	Ms.Nương says, I like the idea of giving more emphasis to environmental projects. But I don't know how the teachers will feel about losing classroom time for instruction in basic subjects. Ms.Nương moves 2 spaces.
Project based learning: teacher guide, students come up with solutions *QPAR technique => stimulus student learning,*	These stakeholders engage students in a 'clean river project'. This aims to raise awareness of a clean river's contribution to the community health and the economy. Participants each move 2 spaces. Gain 150 Bennies.
People of different age and gender think differently. Therefore, our opinions heard by others may be unexpected ones.	The School Support Group shows Caring for People by highlighting the need for change in policies and informal practices that reduce opportunities for female and minority group staff. Participants each move 1 space and gain 250 Bennies.
Start from the top, apply from personal life first -> have faith, do it yourself -> can explain to others wholeheartedly -> be role model	Ms.Jen says, I'd love to see our students win an environmental award with a 'Green Forest' project. I've started telling other teachers that we should give it a chance, but it's going to take time. Jen moves 2 spaces. Her friends each move 1 space, if you know who they are.
Director has to encourage teachers by the role model, convincing them, persuading them	Ms.Bình says, When I mentioned One Future to several European school administrators on my trip, I was amazed at how far they have gone in educating for sustainability. They emphasized the need for a clear picture of stakeholders' attitudes and practices. What do we know about what our people think and are doing about sustainability? Ms.Bình moves 1 space.

Synthesized Practices	**Content for New Activity's Feedback**
Directors: take teachers to other SEP learning center	You have top management support, but only a few of people are interested in going on the School Visit. The trip turns out to be a just-for-fun trip. Make sure there is enough interest among the group you select before trying another School Visit. Nobody moves.
School management: participatory style. Teachers are involved in decision making. *School leaders: open minded, open, 2 ways communicate, play important role to initiate*	Mr.Giao is excited to talk again. He says, one thing I really like about One Future is the involvement of community and parents in decision-making. But I'm not sure how the administration and other teachers may feel about that. Mr.Giao moves 1 space.
The parents help support and encouraged the school.	Ms.Minh says, our hotel group is well known for our innovative recycling and waste management practices. I'd be happy to share some with our schools if you are interested. Just let me know how I can help! Ms.Minh moves 5 spaces in Awareness or Interest stage.
The school implemented SEP in three levels of personnel: managers, teachers, and pupils. We put a great emphasis on practices in their lives.	You've done careful planning and have broad support. School principals and teachers take the initiative in planning. Parents and guests from the community join in activities. Ms.Cúc, Ms.Ích, Mr.Phát, and Mr.Will. move 1 space. Everyone else moves 2 spaces. Gain 10 Bits. Gain 50 Bennies for each person in Practice and 100 for each in Sustainability.
Encourages pupil to maintain their moral principles; put health, working skills and love for their work	The Ministry of Education accepts the Committee's proposal to integrate active citizenship, social participation, and gender equality competencies into the National Curriculum. Everyone moves 1 space. Gain 2,000 Bennies.
School collaborates with community and other organizations and develop itself to become a role model for other schools and organizations to make study visits.	The Chair agrees to let you present a proposal to include sustainability standards in the annual School Report required of all schools. With Mr. Dương's support, and the demonstrated success of the One Future project, the District Political Committee accepts your proposal. Everyone moves 1 space. Gain 1,000 Bennies.
The school has activities that encourage learning of local culture and tradition, continually promote the love of Thainess, and emphasize on teaching of Thai music and dance	These stakeholders begin to integrate activities for learning about Vietnamese values and culture through music and dance. Students are happy to learn by doing instead of listening to lectures about culture. Participants each move 2 spaces. Gain 150 Bennies.

Appendix E: Preliminary Field Test Feedback

Please choose the best answer.

1. Ease of use

How did you experience the simulation when playing?

□ Very Easy □ Easy □ Average □ Difficult □ Very Difficult

How easy was it to understand meaning of the activities and people's roles in the simulation?

□ Very Easy □ Easy □ Average □ Difficult □ Very Difficult

How easy were able to understand the information you needed to play the simulation (e.g., on the response cards)?

□ Very Easy □ Easy □ Average □ Difficult □ Very Difficult

If anything is unclear and difficult, please tell me more: .....

2. Clarity of simulation

How well do you understand concept of education for sustainability after playing simulation?

□ Totally □ party □ somewhat □ little □ not at all

How do you understand the whole school approach to sustainability after playing simulation?

□ Totally □ party □ somewhat □ little □ not at all

If anything is unclear and difficult, please tell me more: .....

3.Usefulness of content

Does the description of the problem in the simulation seem reasonable to you for a school context?

___Yes ____ No

If not, please explain why or give examples .....

.....

Do the People descriptions seem to reflect the characteristics and behave like Vietnamese school staff?

___Yes ____ No

If not, please identify the problems or give examples.....

.....

Are the Activities listed in the simulation representative (typical, commonly seen) of activities you might find appropriate in the Vietnamese education system?

__Yes ____ No

If no, please explain: .....

.....

Are any activities missing that we could use to support successful change in school?

___Yes ____ No

If no, please suggest the activities:.....

.....

What were the strengths and weaknesses of using the simulation to learn compared with the business version you have used in the past?

Strengths:

Weaknesses:

What suggestions would you make to improve the simulation as a tool for teaching educators about how to lead change for sustainability?

Please specify the errors you found

Description	**Place (or number of feedback cards)**	**Note (time and date of playing, capture screenplay)**
e.g.: workshop don't give feedback cards, people don't move even I do successfully…	E.g.: 7B	E.g.: 5pm 10 Dec

Appendix F: Main Field Test After Course Feedback

1. Rate the learning effectiveness of the simulation.

Choose the Number in Agree-Disagree Scales from 1 = Totally disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Totally agree.

1.1 Learning with the simulation engaged me actively as a learner.

1.2 Learning with the simulation enabled me to develop practical managerial skills.

1.3 This course makes me want to learn more about education for sustainable development.

1.4 This simulation is useful for Vietnamese educators.

2. Rate the simulation.

Choose the number in scales from 1 = Very easy, 2 = Easy, 3 = Moderate, 4 = Difficult, 5 = Very difficult.

2.1 Simulation difficulty.

2.2 Ease of activities and stakeholder roles in the simulation.

2.3 Ease of the information needed in the simulation (i.e., on the response cards)

Please give answer for these questions:

2.4 What were strengths of using the simulation to learn compared with the usual approaches you have used in the past?

2.5 What were weakness of using the simulation to learn compared with the usual approaches you have used in the past?

3. Feedback of learners' experiences

Please give answer for these questions:

3.1. When you first heard that you were going to learn with a computer simulation, how did you feel?

3.2. After learning with the simulation, how do you feel about this learning method?

3.3. List three words that best describe how you feel about the experience of learning through this simulation:

3.4. What three lessons did you gain from the simulation?

3.5. After receiving the instruction, can you use and operate in the simulation? Please state the difficulty you are facing.

3.6. After the initial explanation, is it easy for you to find, read, and understand the information you need in the simulation? If not, please give an example of a specific problem.

3.7. What do you think about the reasonableness of the educational content described in the simulation with reality in Vietnam? Please give reasons and examples.

3.8. Do you have any comments on the organizational chart in the simulation with the reality of the Vietnamese education system? Please explain the reason or suggest an adjustment.

3.9. Do you have any comments about the characteristics of teachers and school staff in simulation, compared with real ones in Vietnam? Please give me an example

3.10. What do you think about the 18 activities listed in the simulation? What activities can we find in the Vietnamese education system? Please give explanations or suggestions for correction

3.11. Would you recommend any missing activities that good managers in Vietnam use to support successful change in schools?

3.12. What suggestions would you make to improve simulation as a tool to teach educators how to lead sustainable change in schools?

3.13. What elements are missing in the Vietnamese education system that the simulation does not address?

Appendix G: Semi-Structured Interview Questions for After-Course Main Field Test

1. Discuss the characteristics of stakeholders.
2. Discuss logic of 18 activities
3. Ask to clarify the reflection.
4. Ask added questions.

Focus of research	Questions	Probes
Simulation design	How difficult was it to play after you took some time to play?	What problems did you face with simulation typo, display, feedback's cards, activities?
Learning experience	If you were to describe the experience of learning with this simulation to colleagues what 3 words would you use? What were strengths of using the simulation compared with the usual methods of learning used in your classes? What about weaknesses?	Can you give me any examples? How about the practicality and what you feel like you could apply?
Cultural adaptation	Did the people in the simulation seem to respond to the change like people you know in your school? Do you think that the strategies for motivating and engaging people in the change that succeeded in the simulation would also work in your schools?	If not, how were they different? Slower to change, faster to change? Which strategies seem like they would work? Which ones do you think might be less effective?
Knowledge	From 1 (nothing at all) to 5 (a lot), how would you rate your knowledge and skill before this workshop about: - Leading change?	

Focus of research	Questions	Probes
	- Sustainability? What is the most interesting thing you have learned today about leading change? What about sustainability? If a colleague asked you to define what we mean by 'sustainability' how would you answer now?	Could you be more specific, or give an example?
Attitude and Mindset	Has the workshop changed your belief about *the importance* of enhancing sustainability in the educational system? How about in your own life?	How? Could you give an example?
Skill development	Assume that you were placed on a leadership team to improve teaching quality in your school? Can you tell me two change strategies you would apply that you might not have used before learning with the simulation?	Could you be more specific, or give an example?
Recommendation	What do you suggest to improve the simulation usefulness?	

Appendix H: Questions for Online Discussion Forum

Week 1

Please provide brief but thoughtful responses to the following questions.

1. What was the most difficult problem that you encountered so far in implementing change for sustainability in education at the New District? How did you solve it?
2. What 1 piece of advice would you like to share with others?
3. What 1 problem would you like advice on from others?

Week 2

Please provide brief but thoughtful responses to the following questions.

1. What was the most surprising insight about ESD/ Sustainable school/ Whole school approach to sustainability you have gained from playing the simulation so far?
2. What 1 problem would you like advice on from others?

Week 3

Please provide brief but thoughtful responses to the following questions.

1. What lesson have you learned from the simulation that you apply in your work or life? Please be specific and give an example.
2. What question(s) do you still have about managing change or sustainability?

Appendix I: Observation Protocol (for Preliminary and Main Field Tests)

Name of Instructor:

Location:

Observer: Date of observation:

Start time: End time:

Number of participants:

Observation Categories for Notetaking

- Issues with Clarity of Instruction by the instructor and or simulation (e.g., student confusion)
- Student Engagement (e.g., bored, number of students on/off task during the workshop)
- Bugs encountered in the simulation and handouts
- Suggestions for instructional changes (sequence, clarity, additional support, handouts etc.)
- Suggestions for improving the simulation.

Note: no individual identity and personal data are recorded.

Appendix J: Pre/Post-test of Learners' Change Management for Sustainability, and Attitude Towards Sustainability

Part I: Demographic Information

User Id: Gender: Age:

Job position: Workplace: Years of experience:

1. Rate your level of computer knowledge/skills? (Choose one)
   - I can use various e-learning platforms (LMS, blackboard, Google classroom) smoothly and other software to support teaching (make videos, record)
   - I can use some popular e-learning platforms. Do not do much of installing or fixing computer- I can use software quite effectively.
   - I can use e-learning platform which provided by university and anything that I have trained and I can find and edit videos.
   - I use only necessary software for work (MS word, PowerPoint). I can teach online but only with the assistant of colleagues. I prefer traditional teaching method (lecture and assessments)
2. Have you ever used this kind of simulation before? [ ]-no [ ]-yes

Part II: Knowledge of Managing Change for Sustainability

The questions that follow are based on this short case.

You have been promoted as a Director of Education Department to District X that wishes to build more sustainable schools. This will require the school to adjust key processes as a means of students' performance as it moves to Education for sustainable development. Teachers will join cross-disciplinary teams to assess current teaching and learning processes, compare these with sustainability policies and redesign them for sustainability. You are working with Ms. A, Principal of Secondary school. Ms. A and some of her teachers are aware of 'whole school approach to sustainability' in a general way, but not in much detail. She is not opposed to examining current approaches or adopting new practices, but doesn't understand what will be involved in this project yet.

Please select the correct answers.

1. In approaching your work with the school in the first several months, what would be your goals?

    a. To get information about the people, their interests, skills, and relationships

    b. To give information to others about sustainability and inspire them to become involved

    c. To change the school culture towards sustainability

    d. To train them with the skills they need to use the new system

    e. A & B

    f. Don't know

2. From which levels of teachers and staff would expect resistance?

    a. You should expect some resistance from all levels of people.

    b. There won't be resistance since people know the project comes from Dept. of Education.

    c. Only Ms. A is likely to resist.

    d. Resistance will be highest among the lowest level of teachers and staff.

    e. Resistance will be highest among middle level managers.

    f. Don't know

3. How important is Ms. A's support in implementing the new approach at the school?

    a. Not very important

    b. Moderately important

    c. Important but not essential to success

    d. Essential to successful implementation in the school

    e. None of the above

    f. Don't know

4. Since the project was initiated at the District, what can you assume about teachers and staff attitudes?

    a. There will be enthusiastic support since the District initiated the change.

    b. There will likely be broad support, but a few people will resist.

c. Ms. A will support it since she's a principal, but people in schools will not.

d. Nobody will support this new system.

e. Support will vary among schools. (Some people would support, but people won't)

f. Don't know

5. How would you begin working with teachers and staff in the schools on the project?

a. Hold a training workshop on ESD and sustainability

b. Start by talking to Ms.A and key staff

c. Have a senior management conference for principals and vice principals to create a shared vision of sustainability

d. Select teachers and staff from the schools to visit a school won a Sustainability Award

e. Don't know

6. After about six months, you notice that several groups of teachers and staff are slow to change. They understand what ESD is and accept the need to change core processes to become more sustainable. However, they remain uncertain about how to redesign the working and teaching systems. Which strategy would you advise?

a. talk to them individually

b. give them written information about ESD in a large group meeting

c. arrange training for groups

d. get Ms. A to order them to use new sustainable practices

e. hold a celebration where teachers and staff share their success

7. Assume that you have identified Ms. L, Head Teacher as an informal leader among her colleagues. Although she is friendly, she is very quiet in meetings, and has yet to demonstrate her support for the project. What should you do?

a. wait and see what she does

b. give up, nothing will work with people like Ms. L

c. go back and talk with her again to find out why she objects to the project

d. send her to a workshop about sustainability

e. ask Ms.A to order her to participate

f. Don't know

8. A group of people identify a problem with school facilities which leads to waste and extra costs. They urge the schools to redesign procedures so that stationary costs and food waste is reduced. This is consistent with which of the following sustainability concepts?

    a. Environmental Protection

    b. Circular economy

    c. Social sustainability

    d. Sustainable consumption

    e. None of the above

    f. Don't know

9. Late in the 2nd year of implementation, teacher's interest in sustainability has started to drop. Many teachers are using new practices effectively, but some other have lost interest and gone back to using their old teaching methods. What could you do to reenergize teacher and increase momentum for change?

    a. Tell teachers who are not using the new approach, they will not receive bonuses

    b. Hold a party but only invite those who are using the new teaching methods

    c. Organize a Sustainability Week to show teachers and students improvements that have resulted from using more sustainable practices

    d. Place warning memos in the personnel files of teachers who are not cooperating

    e. A & D

    f. Don't know

10. Over a period of two years, teachers and staff increasingly adopt sustainable practices. Top management consider steps that could be taken to embed sustainability in the culture of the schools. Which activity would help to achieve this goal?

    a. Hold more training for teachers and staff

    b. Develop a team to share sustainability success

    c. Visit other schools to observe their sustainable practices

    d. Survey staff attitudes and beliefs

e. B & C

f. Don't know

11. Which of the following obstacles to sustainable change efforts is most difficult to overcome?

a. Teachers and staff lack skill to use new practices

b. Teachers and staff lack interest and motivation to sustainable change

c. Teachers and staff don’t understand what the sustainable change is for

d. Lack of budget

e. Lack of management support

f. Don't know

12. If Ms.A wishes to adopt sustainable school concept, which sustainability practice would be most relevant? *

a. Cut down school expenditures, rewards for teachers

b. Allow stakeholders involve in school activities

c. Buy more plants for school gardens

d. Find the cheaper food suppliers

e. Increase tuition fee to build bigger campus

f. Don't know

Part III: Sustainability Mindset Scale

Please indicate the extent of your agreement/disagreement with the statements by using the following scale.

#	Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	We cannot predict the future for climate change. Therefore, we should maximize our personal economic benefits today.					
2	Wealthy nations should sacrifice for the benefit of less economically developed countries.					
3	Companies have a responsibility to improve the quality of life in the communities where they do business, even when it increases their costs.					
4	My society should promote equal opportunities for males and females in school and the workplace.					
5	What I do as an individual does not have much impact on the environment.					
6	My personal freedom is more important than taking actions that might help other people or the society					
7	Changing what I buy and use in my daily life can make a positive difference for the environment.					
8	Economic development helps everyone so we should not limit what businesses do to gain profits.					
9	Companies have a responsibility to improve the quality of life in the communities where they do					

#	Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	business, even when it increases their costs.					
10	I can make changes that have a positive impact on the world around me					
11	The purpose of a company is to make profits so it should not be held responsible for the labor practices of its suppliers.					
12	I have a responsibility to make changes to my behavior for the benefit of my community and society.					
13	I pay attention to how much I need, not just to how much I want.					
14	Having a plan today can reduce future risk in the society.					
15	Changing my personal consumer behavior makes no difference because companies are the main cause of environmental problems.					

Appendix K: Result of Simulation Measurements Based on Change Management Level Achieved Through Four Weeks

The simulation shows 6 levels from lowest to highest based upon the results of the students' strategy.

Level 1 Apprentice

Level 3 Manager

Level 4 Leader

Level 5 Expert

Level 6 Change Master

Student	Baseline (Level	Week 1 Level	Week 2 Level	Week 3 Level	Final test Level
gd001	1	3	2	2	3
gd002	1	1	2	4	4
gd003	1	1	5	6	6
gd004	1	5	4	6	6
gd005	1	1	2	3	6
gd006	1	3	6	6	6
gd007	1	6	6	6	6
gd008	1	1	3	6	6
gd009	1	6	6	6	6
gd010	1	2	1	6	6
gd011	1	2	6	6	5
gd012	1	6	6	6	6
gd013	1	1	6	6	6
gd015	1	2	4	6	6
gd016	1	3	6	6	6
gd017	1	1	1	5	5
gd018	1	1	3	6	5
gd019	1	1	5	5	6
gd020	1	6	6	6	6

Student	Baseline (Level	Week 1 Level	Week 2 Level	Week 3 Level	Final test Level
gd021	1	1	4	6	6
gd022	1	3	6	6	6
gd023	1	3	5	6	6
gd024	1	3	6	6	6
gd025	1	5	6	6	6
gd026	1	1	3	6	6
gd027	1	2	6	6	6
gd028	1	1	3	6	6
gd029	1	1	5	6	6
gd030	1	2	6	6	6
gd031	1	3	6	6	6
gd032	1	3	3	6	6
gd033	1	2	5	6	6
Total: 32 students (account number gd014 withdrew at the beginning of the course)					

Appendix L: Result of Simulation Measurements Based on Number of Kotter's Change Principles Achieved Through Four Weeks.

Student	Baseline (number of Kotter's change principles achieved)	Week 1 (number of Kotter's change principles achieved)	Week 2 (number of Kotter's change principles 3achieved)	Week 3 (number of Kotter's change principles achieved)	Final test (number of Kotter's change principles achieved)
gd001	1	2	2	3	2
gd002	0	0	1	3	3
gd003	1	0	4	6	2
gd004	0	4	4	6	4
gd005	0	1	3	3	4
gd006	0	1	4	5	4
gd007	0	4	4	5	5
gd008	0	2	3	4	5
gd009	0	5	3	3	3
gd0010	0	2	2	6	6
gd0011	0	1	4	3	4

Student	Baseline (number of Kotter's change principles achieved)	Week 1 (number of Kotter's change principles achieved)	Week 2 (number of Kotter's change principles achieved)	Week 3 (number of Kotter's change principles achieved)	Final test (number of Kotter's change principles achieved)
gd012	0	5	3	5	5
gd013	0	1	4	3	3
gd015	0	2	4	6	7
gd016	0	0	4	5	5
gd017	0	1	1	4	4
gd018	0	2	3	4	4
gd019	0	1	3	3	4
gd020	0	5	6	7	7
gd021	0	1	3	4	4
gd022	0	4	4	6	5
gd023	0	5	4	4	4

Student	Baseline (number of Kotter's change principles achieved)	Week 1 (number of Kotter's change principles 5a4chieved)	Week 2 (number of Kotter's change principles 4achieved)	Week 3 (number of Kotter's change principles achieved)	Final test (number of Kotter's change principles achieved)
gd024	0	2	6	5	4
gd025	0	4	5	6	4
gd026	0	1	3	4	6
gd027	0	1	3	6	6
gd028	0	1	3	5	5
gd029	0	0	3	4	4
gd030	0	2	6	7	4
gd031	0	3	2	5	5
gd032	0	2	3	4	5
gd033	0	2	4	7	7
Total: 32 students (account number gd014 withdrew at the beginning of the course)					