THE EFFICACY OF AN INTERACTIVE BUSINESS SIMULATION GAME COMPARED TO STATIC GAMES TO TEACH STRATEGIC DECISIONS IN ENTREPRENEURSHIP AND ECONOMICS EDUCATION

by

MOULARE KESSE

(Under the Direction of Andrew Jackson and John Mativo)

ABSTRACT

Experiential learning in the curriculum of business, economics, and entrepreneurship education has been common pedagogical practice with the goal to equip students with adequate problem-solving skills. Thus, experiential learning tools such as static games are commonly used in the study of market structures to provide a visual depiction of complex mathematic formulas modeling decisions in a competitive market. Given the limitations of static games in helping students to develop extemporaneous decision-making skills in an ongoing business competition, this research study intended to inquire about an alternative game-based learning tool to enhance business strategic management and entrepreneurship education.

This research study proposed the use of an interactive business simulation game as an alternative experiential learning tool to achieve the learning objectives pursued in the curriculum of business, economics, and entrepreneurship education. The use of a business simulation game can potentially engage students while facilitating their understanding of the practical application of knowledge acquired. Hence, the focus of this study was to compare the effectiveness of an interactive business simulation game to that of a static game (traditional teaching approach) in

terms of learning engagement and knowledge acquisition. The learning process through which learning engagement and knowledge acquisition are achieved using an interactive business simulation game in entrepreneurship and economics education is elaborated through the theoretical framework of this research study.

The research findings regarding the effectiveness of an interactive business simulation game in terms of learning engagement and knowledge acquisition were quite encouraging. The high rating obtained from participants in terms of learning engagement was indicative of the effectiveness of the use of an interactive game as an instructional tool in motivating students in their learning experience. Moreover, participants' gains in knowledge suggest that the understanding of complex mathematic formulas used to model economic concepts can be facilitated through an interactive business simulation. These findings provide additional evidence for the need to scale up the development of innovative interactive learning tools to advance students' critical thinking skills in the field of entrepreneurship and economics education.

INDEX WORDS: Game theory, Experiential learning, Gamification, Learning engagement, Entrepreneurship Education, Market Structures

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by

MOULARE KESSE

BBA, Clayton State University, 2013

MBA, Clayton State University, 2016

MS, Georgia State University, 2018

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MOULARE KESSE

Major Professor:	Andrew Jackson John Mativo
Committee:	Roger Hill Shiyu Wang

Electronic Version Approved:

Ron Walcott
Vice Provost for Graduate Education and Dean of the Graduate School
The University of Georgia
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DEDICATION

First and foremost, I dedicate this dissertation to my wonderful son. Naseem, may you seize every opportunity to grow and learn, use to the fullest your gifts in this life, recognize the value of education, question everything, maintain the flame of curiosity, and pursue all your goals, hopes and dreams with unwavering perseverance, hard work, and dedication. The completion of this dissertation research is a symbolic act of passing the baton to you in pursuit of technological innovation and economic imagination as we continuously strive to improve human living conditions on earth generation after generation.

I also dedicate this work to my late father, Kesse. Like a lot of people of his generation in Africa, he didn't go to school, and yet he managed to become a skillful mason. As a professional mason, his skills in architectural design were in full display in public administration and high-rise residential buildings that he erected. He encouraged me to take my education as far as I could go in the pursuit of being all I could be. He always reminded me that self-discipline, perseverance, hard work would pave the way to greatness. The passion and creativity that went into creating this game for my dissertation research reminds me of the sense of imagination and creativity reflected in his architectural designs. I miss you immensely Dad.

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The most widely recognized model of game theory in economics was established by John Forbes Nash, for which he received a Nobel Prize in 1994. My dissertation research was to add to the work of John Nash in providing a pedagogical tool to teach business strategic decisions modeled in the game theory. I was quite fortunate to have the support of extraordinary faculty members at the University of Georgia and friends that I consider to be family. I am sincerely grateful to Drs. Andrew Jackson and John Mativo for their tireless efforts to enrich this dissertation work with all their expertise in doctoral research. They were always available to guide me through the tons of questions I had despite the time constraints that come with their professional duties. The time we spent together on this research project will remain a memorable intellectual exercise for the rest of my life. Drs. Wang and Hill certainly provided the support I needed to further enrich this research work through pertinent and constructive critiques that only great scholars can offer. In the African tradition, it takes a village to raise a child. The child in this instance was my dissertation work, and among those who supported me were Dr. Leon Prieto, Dr. Patricia Evans and her husband, Dr. Jim Evans. I was introduced to the idea of doctoral studies by Dr. Leon Prieto when I was a student in his management class. He has been a tireless mentor who has been present in every twist and turn of my doctoral journey. You all know how exhausting a doctoral program can be. I was very fortunate to have Dr. Patricia Evans and her husband, Dr. Jim Evans when I needed to get away and rest. Their retirement home in South Carolina has been a refuge where I often went to recharge and enjoy a bit of family warmth. I am so grateful for such family support.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER 1

INTRODUCTION

Rationale

The advent of mass production witnessed in the global economy throughout the 20th century was more than the use of advanced technologies in production systems. A major contributor to the increase in global production output and economic growth was an exponential increase in entrepreneurial ventures (Rideout & Gray, 2013; Martin et al., 2013). Startup enterprises turning into global firms have pushed the boundaries of market economies, which led to global economic growth. Such global economic growth fueled by entrepreneurship has inspired the need to foster entrepreneurial mindsets. Thus, national and global educational institutions have been making strategic decisions to develop entrepreneurship education programs to incubate entrepreneurship intentions and practices (Martin et al., 2013).

Entrepreneurship education programs in vocational and higher education have been about teaching and learning entrepreneurship practices. Teaching and learning in entrepreneurship education involve various pedagogical methods identified in the literature as *Supply* and *Competence* methods (Nabi et al., 2017). The *Supply method* describes a traditional teaching method in entrepreneurship education in higher education with lectures, homework, and quizzes. The *Competence method* is defined as a constructivist approach involving students' active participation in problem solving in real life situations such as case studies (Nabi et al., 2017). Students' active participation involved in the *Competence method* is also employed to facilitate students' understanding of business strategic planning leading to business growth stages of scalability and sustainability. Moreover, work-based training employed in vocational education

offers the opportunity for students to learn valuable business skills needed to manage an enterprise (Billett, 2016; Martin et al., 2013). The efficacy of various teaching methods employed in entrepreneurship education programs is determined by the impact that those teaching or training approaches have on students' learning experiences and learning outcomes (Martin et al., 2013; Nabi et al., 2017; Rideout & Gray, 2013). Included in those learning outcomes are entrepreneurial intentions, business management competency, and aspirations for entrepreneurial venture (Martin et al., 2013; Nabi et al., 2017; Rideout & Gray, 2013). Those learning outcomes are the underlying objectives of programs in entrepreneurship education in vocational and higher education.

Vocational Education and Training (VET)

VET (Vocation Education and Training) in the US is designed to incorporate school-based and work-based models in a way that students can experience holistic occupational skills development such as business management and broader academic critical thinking (Ayers, 2015). In line with a constructivist learning approach, occupational skills development and academic critical thinking were the initial goal and mission of community colleges in the United States (Ayers, 2015). Even though a constructivist approach offers enormous learning potential in terms of students' active participation in the process of problem solving, the increasing demand for low qualification occupation in the labor market derailed the goal of developing students' broader academic critical thinking (Jepsen et al., 2014). To that point, Phal (2014) observed that pedagogical practices involved in vocational training offer limited understanding of theoretical knowledge and work process knowledge. Limitations in pedagogical practices to advance occupational skills development, such as business management competency and broader

academic critical thinking in vocational education, are also found in higher education when it comes to entrepreneurship education.

Higher Education

Pedagogical practices to teach entrepreneurship in higher education have evolved over time. Practices have gone from the *Supply method,* involving lectures, homework, and quizzes, to the *Competence method,* with students' active participation in problem solving (Nabi et al., 2017). Instructional strategies including case studies, internships, and field trips are commonly employed to develop students' aptitudes in problem solving. These instructional strategies offer various forms of experiential learning where students are exposed to real life business decisions or initiatives. While business funding decisions can be learned by studying the financial records of real companies in case studies, the process of product development can be learned through internship in a real company. Moreover, field trips offer the opportunity to meet with business managers and inquire about business strategies. Thus, experiential learning contexts of case studies, internships, and field trips do certainly have the potential to achieve learning objectives in entrepreneurship education in terms of business management skills or entrepreneurial intentions. However, students' aptitudes in making extemporaneous decisions in a live business competition are yet to be fostered through an adequate instructional strategy.

The use of case studies in higher education mostly consists of exploring past business records of real business transactions, which allow students to learn from past successes or failures by analyzing data in those records (King et al., 2011). Thus, case studies might involve discussing business projections in terms of revenue, costs, and profit based on extrapolative analysis of business data. However, pedagogical practices of case studies in higher education do not involve students in settings of live business competitions where students have to make

extemporaneous decisions in response to business adversities (King et al., 2011). As such, a case study is limited in developing students' prompt and adaptive decision-making abilities in an ongoing business competition. Moreover, delays in feedback encountered in case studies are not conducive to the development of prompt and adaptive strategic management aptitudes required in a competitive business environment (Kosnik et al., 2013). Hence, students complete their programs in entrepreneurship education with less preparation in the ability to adapt managerial skills in a competitive business environment (Martin et al., 2013; Nabi et al., 2017). To address such pedagogical deficits, the call for the use of business simulation games to enhance business strategic management and entrepreneurship education in universities and colleges has intensified (Fox et al., 2018: Rideout & Gray, 2013).

Instructional Approach of Business Simulation Games

As an experiential learning approach, using a business simulation game for instruction offers students the opportunity to learn the practical application of theoretical knowledge (Strickland & Kaylor, 2016). A business simulation game further engages students in the process of knowledge and skills development. Such a process of knowledge development enhances students' critical thinking in the process of business problem solving. Thus, specialized managerial processes such as entrepreneurial learning, strategy formulation, creativity, problem-solving, and decision making can be learned through an engaging learning process in a business simulation game (Kriz, 2003). Business simulation games come in various forms including static games and interactive games.

Static Business Simulation Games

In the context of learning business decision in game theory (the study of market structures in economics), static games portray players with single strategic decisions executed

simultaneously in a way that the decisions cannot be altered once made (Warioba, et al., 2019). Game theory involves mathematical formulations to model business interactions and strategic decisions (Madani, 2010; Ozkan-Canbolat et al., 2016). Given the complexity of the mathematics, static games are used to illustrate strategic decisions to facilitate students' understanding of the underlying concepts of game theory involving strategic decisions (Dixit, 2005). Some of the commonly used static games are the prisoner's dilemma and the chicken game. The game portrays the decision outcomes of two parties driven by self-interested behavior.

For example, Webster (2014) describes the prisoner's dilemma, a scenario involving two suspects arrested by the police following a burglary. The lack of sufficient evidence to convict the suspects led to a strategy to interrogate each of them separately. Failure to get a confession from both will result in 6-month jail time for each as indicated in Table 1. A confession obtained from one of them will result in 10-year jail time for the one that refuses to confess while the one that confesses will go free. Each suspect will receive 5-year jail time if they both confess. In this illustration, the equilibrium in game theory is achieved when suspect A adopts a strategy that is the best response to the strategy adopted by suspect B, which is to confess. Similarly, suspect B adopts a strategy that is the best response to the strategy adopted by suspect A, which means confessing. Consequently, the equilibrium in game theory leads to both parties confessing with an outcome of 5-year jail time for each suspect as indicated in Table 1. In game theory, the assumption is that individuals are rational actors when they make political and economic decisions (Vesperman and Clark, 2016). Thus, individuals attempt to maximize benefits while minimizing losses when preferred outcomes are clearly identified.

Table 1
Strategic Decisions in the Prisoner's Dilemma Game

		Suspect B	
		Silent	Confess
Suspect A	Silent	6 - month jail time for suspect A 6 - month jail time for suspect B	10 - year jail time for suspect A 0 - month jail time for suspect B
	Confess	0 - month jail time for suspect A 10 - year jail time for suspect B	5 - year jail time for suspect A 5 - year jail time for suspect B

Even though static games provide simplified visual illustrations of strategic decisions, they only provide final decisions made by competing entities without explaining the process through which those decisions are made. Consequently, static games are limited in helping students to develop extemporaneous decision-making skills in an ongoing business competition.

Interactive Business Simulation Games

Besides static games, interactive games are also employed as instructional tools for business simulation. In contrast to static games, interactive games engage students in an ongoing business competition where they learn to formulate strategic decisions in a learning context of an on-going business adversity. Entrepreneurship practices involve business decision-making in a business environment that is constantly evolving. The survival of an enterprise depends on the extent to which it can generate enough sales revenue to cover its operational expenses and make profit while navigating a competitive business environment. An interactive game offers the possibility to simulate business interactions involving those survival skills, so that students can learn to make business decisions in the context of ongoing business adversity. Thus, the design

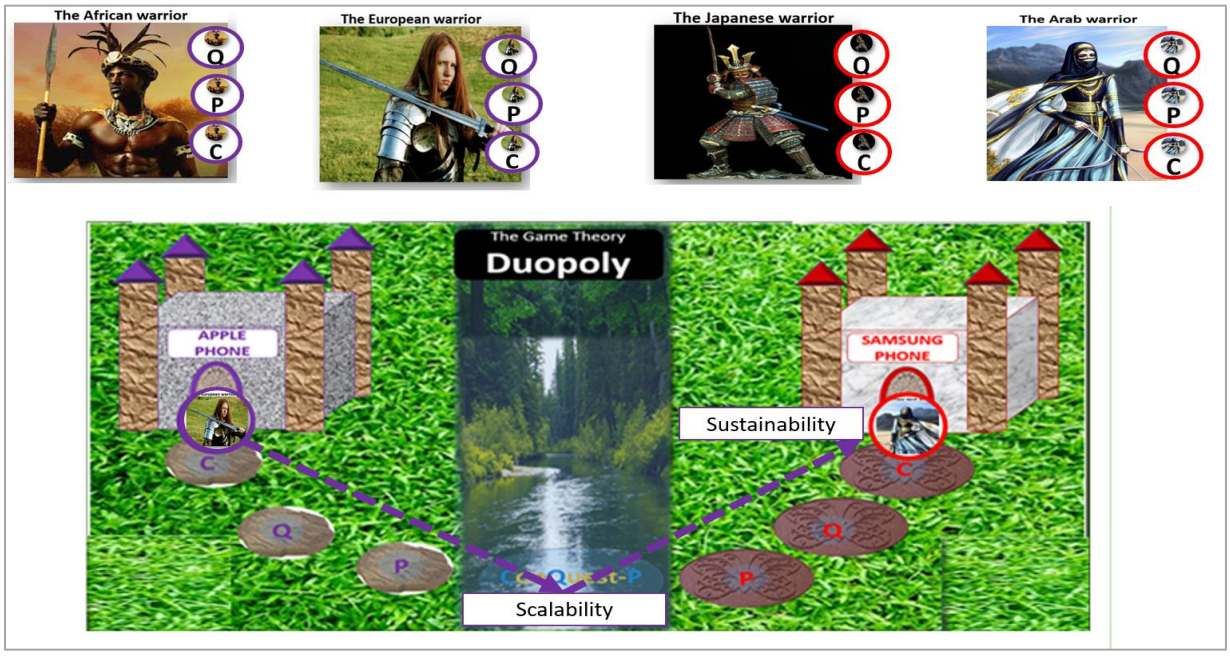
of an interactive game to teach entrepreneurship practices ought to incorporate key business concepts, such as business growth stages of scalability and sustainability. Scalability is described as the starting business growth stage where each entrepreneur is trying to develop economies of scale (lowering average total cost as output increases). Following the growth stage of scalability, sustainability is understood as the phase where the entrepreneur is trying to increase profitability, cash level and market share.

In recent decades, many interactive simulation games have been employed in teaching business strategic decisions with real-world applicability. King et al. (2011) explain that Business Strategy Game (BSG) is an interactive on-line business simulation game where teams make strategic decisions in a simulated real-world business setting. Students' decision-making in the BSG game involves the understanding of business concepts such as marketing mix, production scheduling, and financing a business. During the game, feedback and scores are immediately available and student teams can compare their performances among participants throughout the world. Interactive business simulation games in the field of education pursue various learning objectives. In the instance of the BSG game, the learning objectives consist of learning business practices in sectors of business operation such as marketing, production, and finance. The interactive game used in this study was designed and employed by the author of this dissertation research to teach business strategic decisions in previous microeconomics classes. However, the efficacy of the interactive game has not been formally explored. The learning objectives of the interactive game consist of growing a business from scalability to sustainability, and the following provides a brief description of such learning objectives, moves and countermoves leading to business growth stages of scalability and sustainability.

Learning Objectives. The learning objective in this interactive game-based lecture is to simulate decision-making processes to grow a business from scalability to sustainability in a competitive business environment. Given that business growth stages of scalability and sustainability take place over years in real life, an interactive business simulation game offers the opportunity to simulate those fiscal years and business decisions in a way that prompt and adaptive business decision-making can be fostered in a simulated setting. Thus, the abstract nature of concepts of scalability and sustainability can be visualized through the game's narrative involving a business competition between two companies: Apple and Samsung. First, scalability is achieved when a contender reaches the river as indicated in Figure 1. That means the business has attained economies of scale through unit cost reduction. Next, sustainability is achieved when a contender crosses the river, and conquers the opponent's castle. In our illustration, Apple reaches the river, crosses over and conquers Samsung's castle. That means Apple has dominance of the market.

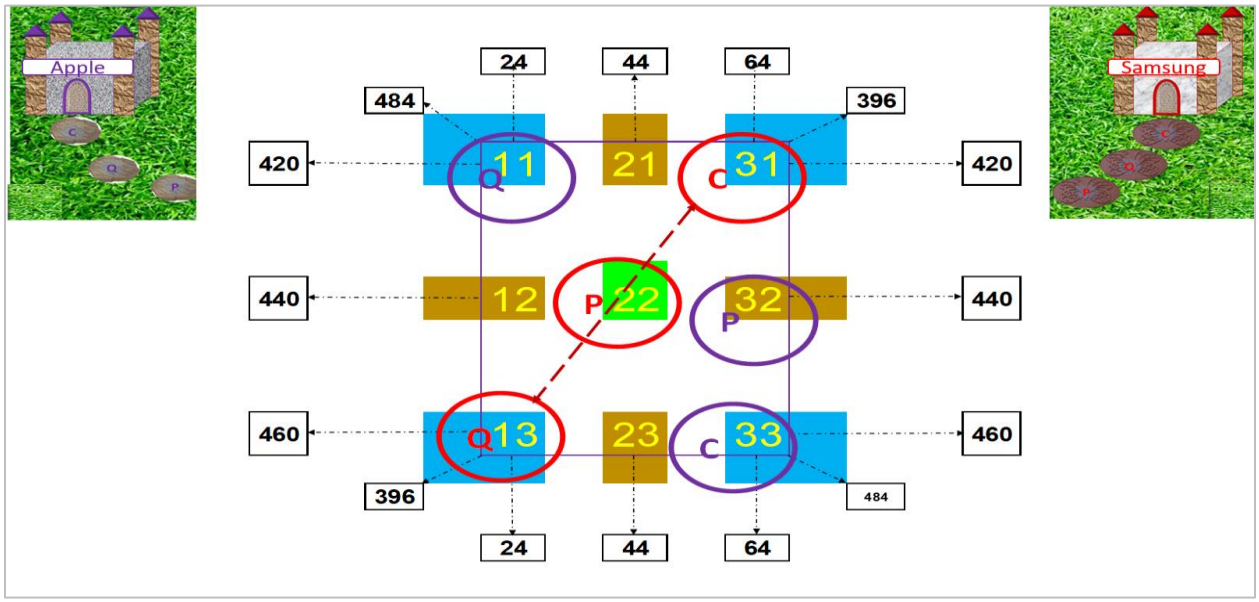
Figure 1

Learning Objectives of Growing a Business from Scalability to Sustainability



Moves and Countermoves Through Market Segments. Scalability and sustainability are achieved through moves and countermoves performed on the gameboard as depicted in Figure 2. Contenders have three pieces to place on the gameboard by taking turns. Given that moves are made sequentially, a coin toss helps determine which contender goes first. After all the pieces are placed on the gameboard, they are moved on the gameboard vertically, horizontally, or diagonally through market segments. Skipping a spot or jumping over a piece to reach an empty spot is not allowed. The depiction in Figure 2 shows that Samsung won the round because a straight line can connect its three pieces. Thus, Samsung realizes a profit of $396,000 (profit indicated on the peripheral of the gameboard are in thousand) while Apple incurs a loss. The computation of a loss is shown in Appendix B.

Figure 2
Gameboard



Note: Data are collected at the end of a simulated fiscal year (a fiscal year is one round in the game). Numbers on the peripheral of the gameboard are profit computed in thousand. Students will learn how to compute those numbers.

Achieving Scalability. In this business simulation, scalability is achieved through winning multiple rounds (each round represents a fiscal year) with $ 50, 000 cash reward for each. At the end of year one, the graph in Figure 3 shows that both companies have a cash level of negative $100,000. With the assumption that Apple wins two rounds, Apple is rewarded $50,000 for each win and the company's cash level reaches zero or breakeven at the end of year 3.

Figue 3

An Illustration of Cash Reward in the Process of Achieving Scalability

Achieving Sustainability. Prior to achieving sustainability, Apple will first achieve scalability by winning two rounds with a reward of $50,000 for each win and reach a cash level of zero or breakeven at the end of year 3 as depicted in Figure 3. After achieving scalability, Apple will achieve sustainability with three additional wins. Each win is rewarded with $50,000 and Apple ends up dominating the market with a cash level of $150,000 as indicated in Figure 4.

Figure 4

An Illustration of Cash Reward in the Process of Achieving Sustainability

Purpose Statement

The purpose of this research study was to examine the efficacy of an interactive business simulation game, in terms of students' knowledge acquisition and learning engagement in teaching business strategic decisions in entrepreneurship education. As an experiential learning approach, the use of a business simulation game has the potential to motivate and engage students while facilitating the discovery of the relationship between theory-based knowledge and practical application (Lengyel, 2020; Vlachopoulos & Makri, 2017). However, some of those business simulation games, such as static games, have limitations in explaining processes involved in business strategic decisions. This research study proposed the use of an interactive business simulation game as an instructional tool to facilitate students' understanding of decision-making processes involved in business strategic decisions. This study used a quasi-experimental research design to compare the efficacy of a static game (traditional teaching approach) with that of an interactive business simulation game on learning motivation and knowledge acquisition.

Research Questions

The following research questions were to investigate whether an interactive business simulation game is more effective than a static business simulation game traditionally employed to teach concepts of business strategic decisions in entrepreneurship education.

1. What is the difference in learning engagement between students learning business strategic decisions through an interactive game and those with a static game at a two-year college in the Southeast region of the United States of America?

2. What is the difference in knowledge acquisition between students learning business strategic decisions through an interactive game and those with a static game at a two-year college in the Southeast region of the United States of America?

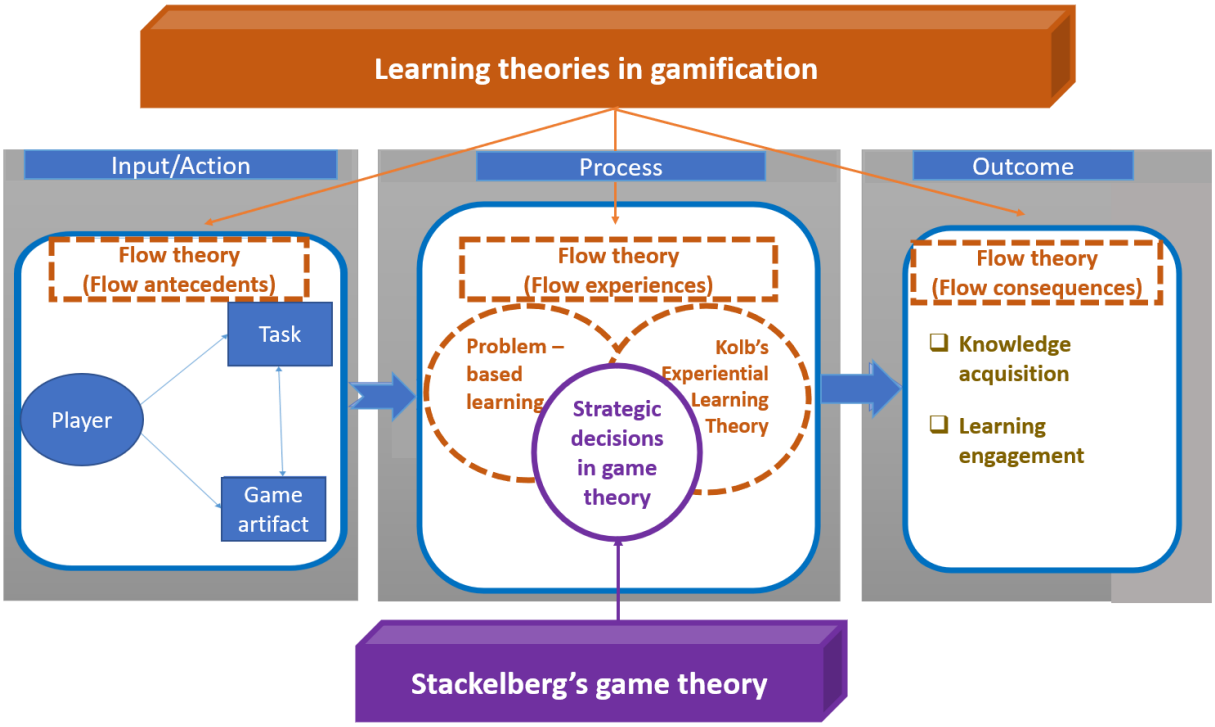
Theoretical Framework

Challenges to identify essential learning mechanics influencing knowledge acquisition and learning engagement in the design of educational games have led to the development of games with insignificant educational impact. Proulx et al. (2017) argued that the potential of games to foster motivation and learning might not manifest unless certain requirements regarding the game, the learners, and the learning objectives are met. In the proposed theoretical framework, learning theories in an interactive business simulation game facilitate the practical application of strategic decisions in game theory, which result in entrepreneurial knowledge acquisition and learning engagement as indicated in Figure 5.

The learning theories in this study are the flow theory in interactive game-based learning, problem-based learning, and Kolb's experiential learning. The process by which those learning theories in an interactive business simulation game facilitates the practical application of concepts of strategic decisions in game theory unfolds along three phases: *Input*, *process*, and *outcome*.

Figure 5

Theoretical Framework of Knowledge Acquisition and Learning Engagement in an Interactive Game



Input

A computer-based interaction between the players and the artifact of the interactive game is made possible through the game mechanics of the interactive game (Kiili, 2005). The game mechanics involve the flow antecedents where tasks are initiated through the game's artifacts. The game's artifacts are the tools employed to execute moves and countermoves to implement a strategic decision after a consensus is reached among members of a team. Following the initial phase of flow antecedents, students reach the phase of flow experience where problem-solving skills are needed to carry out strategic decisions in the process of solving business challenges by game participants.

Process

When in a state of optimal experience, the game participant is immersed in a psychological state driven solely by the activities in the interactive game (Kiili, 2005). Hence, flow experience consists of intense moments of strategic decision-making involving problem-based learning. As an experiential learning in a specific learning context, problem-based learning involves processing concepts of game theory in a more practical way. Thus, concepts of business strategic decisions mathematically formulated in game theory can be simulated through tactical moves and countermoves in the interactive game where adaptability in problem-solving requires proficiency in strategic management. In strategic management**,** the success of strategies and tactics depends on the efficacy of the strategic thinking involved in presenting a vision, analyzing internal and external information, setting reasonable objectives based on the enterprise's internal resources and market challenges, and formulating and implementing a strategy capable of harnessing opportunities in a competitive market (Kriz, 2003; Nuntamanop et al., 2013). Adaptability in problem-solving is also enhanced when team members work collaboratively.

During the developmental stages of an interactive game, team members experiment with the four experiential learning styles, which consist of Active Experimentation, Concrete Experience, Reflective Observation, and Abstract Conceptualization in Kolb's experiential learning theory (Kayes et al., 2005). These experiential learning styles enhance students' ability to reflect on their learning experiences through conversations that examine and integrate strategic decisions (Kolb & Kolb, 2009). Individual team members can learn and be motivated when various viewpoints are constructively accepted and respected. A team experiences growth when team members take time to reflect on consequences of their actions and the big picture (Kolb &

Kolb, 2009). Hence, a team is more effective in problem solving and more motivated if it follows the problem-based learning cycle, which involves identifying facts in a problem scenario, generating hypothesis, identifying knowledge deficiencies, and applying new knowledge (Hmelo-Silver, 2004).

Outcome

In the flow consequences, outcomes of entrepreneurial knowledge acquisition and learning motivation are facilitated by the learning theories in the game design. In effect, learning occurs when the evaluation of business strategic decisions during the interactive game highlights the need to correct failing problem-solving approaches while improving on successful business-decision outcomes (Nuntamanop et al., 2013). Moreover, the shared image of the team, called *executive consciousness* in Kolb's experiential learning theory, becomes a guiding light that binds the team together with the drive and the motivation to apply concepts of strategic decisions and win the competition in an interactive game (Kolb & Kolb, 2009).

Importance of Study

Pedagogical innovation in knowledge development and dissemination pursued in the curriculum of business, economics, and entrepreneurship aims at immersing students in real life experiences through experiential learning (Zapp, 2017). For instance, static games have been used to simulate business decisions in a competitive market. Despite considerable efforts made to advance students' business strategic thinking through static games, skills deficits persist when it comes to students' abilities to adapt strategic thinking in real world business environments (Fox et al., 2018).

Students can experience a challenging period of adaptability as they transition from high school to college class activities. To that point, Dyrberg and Hlmegaard (2019) assert that

students are often overwhelmed by the content of class material in their first year. For instance, economic theories are often explained through mathematical formulas. Some students struggle to discover the relationship between those theories and their practical applications. Even though instructional tools such as static games aim at providing a visual depiction of some of the mathematic formulas modeling business decisions in a competitive market, such instructional tools still fall short of providing the practical understanding of processes involved in business decisions. Thus, students experience challenges to connect theoretical knowledge to their academic aspirations, which often leads to difficulties in choosing the academic path that can fulfill their real-life aspirations. This study offered the opportunity to assess the use of an interactive business simulation game to facilitate the practical understanding of processes involved in business decisions in post-secondary learning communities.

The design of an effective interactive business simulation game, which incorporates managerial processes such as strategy formulation, creativity, problem-solving and decision making, has the potential to motivate and engage students while facilitating the discovery of the relationship between theory-based knowledge and practical application (Lengyel, 2020; Vlachopoulos & Makri, 2017). Moreover, instructors teaching entrepreneurship, economics, and business strategic management in post-secondary educational institutions can benefit from this study as they try to incorporate game-based learning as part of their instructional strategies to improve students' learning experience. Considering the importance of entrepreneurship in national and global economic growth, this study presents an opportunity for national and global educational institutions to further explore the value added of an interactive business simulation game when it comes to 21st century skills development in entrepreneurship education.

CHAPTER 2

LITERATURE REVIEW

Historical Perspectives

Entrepreneurship education begins with the understanding of entrepreneurial thinking, which is driven by the search for opportunities to fulfill needs. Moreover, entrepreneurial practices involve knowledge of the interconnectedness of economic activities and being able to initiate strategies to exploit opportunities (Jones et al., 2017; Patel & Mehta, 2017). Thus, efforts to advance entrepreneurship education since the industrial revolution of the 1700's have essentially been about the development of useful entrepreneurial knowledge. In fact, economic growth in post-World War 2 is attributed to entrepreneurship practices and education leading to innovation in technology and the organization of businesses.

Entrepreneurship Practices in the 1700's Industrial Revolution

The period of enlightenment in Europe and particularly in England in the 18th century was critical to the industrial revolution of the 1700's. The enlightenment period empowered individuals with advanced knowledge and facilitated economic decisions. Moreover, socio-economic philosophies evolved into school of thoughts along more rigorous method of reasoning in pursuit of useful and practical knowledge (Mokyr, 2005). Hence, studies of natural phenomenon and practical experimentations were advanced through educational institutions.

In Germany for instance, administrators and engineers in agricultural science, mining, and forestry were trained in numerous universities in 1740s. Community members interested in studying chemistry and other applied fields were offered the opportunity to attend classes at the University of Glasgow (Mokyr, 2005). Thus, institutional efforts of entrepreneurial knowledge development and dissemination inspired the development of new technologies through the action

of entrepreneur-inventors such as Richard Arkwright, Samuel Crompton, and James Watt (Nuvolari, 2004). In fact, difficulties encountered in earlier mining enterprises were overcome when Thomas Newcomen, in 1712, developed a steam pumping engine that could be effectively used for mining drainage. The technology was also used in agriculture and waterworks (Nuvolari, 2004). Ultimately, the ability to effectively harness the practical use of technological innovation led to the emergence of large enterprises including industrial mills, mines, and railroads.

The prospect of profit optimization motivated entrepreneurs to think of ingenious and creative ways to harness the power of technology for mass production. Inspired by the ongoing social transformation unfolding with the possibility of getting wealthier, entrepreneurs realized that the only way to increase factory output is through technological innovation and transformational change in business management (Nuvolari, 2004). The expectation was that technological innovation was to improve the structure and scale of businesses. Hence, technological innovation facilitated the establishment of large systems of production and distribution. Concurrently, the productivity of the workforce was improved through advances in managerial skills. Consequently, large scale entrepreneurial operations were initiated to respond to the increasing demand for households' products. In the course of time, entrepreneurs' ability to scale up systems of production and distribution continued beyond national borders.

Entrepreneurship Education in Post-World War 2

The global efforts of economic development in the period following World War 2 paved the way for institutions such as the World Bank to develop useful knowledge in entrepreneurship practices. The Bretton Woods Institutions known as the International Monetary Fund (IMF) and the World Bank were created in July 1944 in the United States to help rebuild the shattered post-

World War 2 economies in Western Europe and promote international economic cooperation (Stiglitz, 2000). Such efforts to rebuild ruined economies in Western Europe and motivate global entrepreneurship in post-World War 2 follow similar pattern of knowledge development and entrepreneurial practices seen in the era of the industrial revolution in the 1700's.

Useful and practical knowledge was developed in studies of entrepreneurial management and production technologies through educational and research institutions across the Western world (Ritz & Fan, 2015). As a result, entrepreneurs were equipped with advanced managerial knowledge to scale up systems of production and distribution on a global scale. Moreover, the enormity of funding needed to put in place critical economic infrastructures such as roads, telecommunications, and educational institutions had the World Bank and the IMF leading the way in financing and providing useful knowledge to advance entrepreneurship and industrialization across the globe (Abbott et al., 2010; Aubert, 2005).

Global efforts to promote entrepreneurship education and economic development were supported by global institutions with various governance policies including a *cognitive/epistemic approach*. Such governance approach consists of knowledge production and dissemination supported by educational theories deriving from local history of workforce development (Zapp, 2017). The *cognitive/epistemic* approach to build knowledge and equip the workforce with adequate skills for economic growth is a vision pursued by the World Bank in collaboration with local governments. Such knowledge development has been helpful in advancing entrepreneurship education and practices in Europe and around the world (Abbott et al., 2010; Newman et al., 2014).

A study conducted by Burchi, et al. (2021) investigated the extent to which the level of individual entrepreneurship literacy plays a role in developing and building economic potential

in Central European countries. The study was conducted by using national data and external data sources including the World Bank. The results of the study showed a positive and significant relationship between financial literacy and sustainable entrepreneurial activity. The authors argued that the evidence supports the need to increase financial education initiatives and the inclusion of topics related to economic and financial culture in workforce education.

A similar study to assess the potential of entrepreneurship training and education was conducted in Nigeria. Omeje et al. (2020) explained that the World Bank was involved in the government's plan to commit significant resources to training and empowering the youths in various entrepreneurship programs. Such programs were to increase youth employability thereby generating income for both individuals and government. According to the authors, the findings showed that the government should reduce its overdependence on oil revenue and focus more on entrepreneurship training programs for youths. They further argue that external funding partners such as the World Bank should extend their focus to the trainees' ability to own their own enterprises.

Curriculums in Traditional Entrepreneurship Education

The overwhelming consensus on the importance of entrepreneurial knowledge and practices to advance economic growth has led to a surge in national and international efforts to promote entrepreneurship education with the goal to help students acquire useful knowledge needed to conduct successful entrepreneurial ventures domestically and globally. As introduced in Chapter 1, skills of entrepreneurial practices are developed through entrepreneurship education along two distinct curriculums: vocational education and higher education.

Vocational Education

Pedagogical practices in vocational education started as practice-based educational approach known as apprenticeship to train a segment of the workforce in response to the need of specific occupational tasks in the workplace (Billett, 2011). Thus, historical apprenticeship is characterized by a self-directed cognitive effort to learn by observation or assisted by senior workers (Parey, 2016).

Apprenticeship as Early Pedagogical Practice

Apprenticeship as a pedagogical practice in early vocational education is conceptually defined as a workplace training where proficiency in occupational tasks is obtained through a learning structure involving a) practice curriculum, b) practice pedagogy, and c) learners' personal epistemologies (Billett, 2016).

First, resting on the original meaning of a pathway of experiences to guide learning, *practice curriculum* involves various stages of the process of knowledge acquisition tracked over time (Billett, 2016). Thus, the apprentice is engaged in the lived experience of working in a particular setting over time. Moreover, the curriculum is structured in a way that the occupational training is facilitated through certain activities and interactions (Parey, 2016). Second, *practice pedagogies* refer to the kind of learning cognition promoted through everyday work activities and interactions. Some of the learning methods involve experienced workers assisting novice learners. Lastly, *personal epistemologies* consist of individuals' active engagement in learning (Billett, 2016). The way learners process various occupational tasks is central to apprenticeship as a mode of learning. Learning ultimately arises through how individuals come to engage with the learning experiences. These three components of learning structure in vocational education provided the early pedagogical structure in occupational skills development. With the ultimate

goals to supply the labor market with a workforce ready to be deployed for specific occupational tasks, provisions and practices in vocational education have evolved over the years along well-structured institutions of vocational education in advanced and emerging economies (Billett, 2011).

Contemporary Provisions and Practices

The long history of workforce development in Europe, especially after the economic devastation endured during World War 2, has evolved along two pedagogical practices: workplace and school-based training. The global competition has been an important driving factor in restructuring workforce development along those two pedagogical practices to allow national companies to improve the use of capital and labor to achieve productivity growth while optimizing operational efficiency (Powell et al., 2012). While Vocation Education and Training (VET) focuses on both workplace and school-based training, the focus of High Education (HE) is school-based educational attainment. Furthermore, Powell et al. (2012) explain that US and pan-European VET models can be differentiated along the following three institutional dimensions: a) Cultural cognition, b) Normative, and c) Regulative.

First, the difference in the *Cultural cognition dimension* consists of US VET system pursuing the goal of competency development in specific tasks while the pan-European model is attempting to achieve the goal of personal development with the possibility of entrepreneurial careers. Second, the difference in *Normative dimension* consists of low school achievers and disadvantaged youth being the target in the US VET system while the pan-European model includes everyone with additional focus on disadvantaged demographic. Lastly**,** the *Regulative dimension* consists of process for regulatory revisions administered mainly by employers in the US VET system while corporatist notion with broad stakeholder participation is involved in pan-

European VET system. These three institutional dimensions, namely *Cultural cognition, Normative, and Regulative,* provide policy guides in developing contemporary US and pan-European VET models. In contrast to early apprenticeship pedagogical practice, contemporary US and pan-European VET models are designed to incorporate school-based and work-based models in a way that students can experience a holistic learning experience of occupational skills development such as business management (Ayers, 2015; Powell et al., 2012). The need to provide a holistic learning experience to students, including experiential learning and broader academic critical thinking is a goal also pursued in teaching and learning entrepreneurship in higher education.

Higher Education

Students' knowledge acquisition and their learning motivation defines the effectiveness of pedagogical approaches in entrepreneurship education. As such, experiential learning approaches are commonly employed to facilitate the understanding of practical applications of entrepreneurial concepts and theories.

Experiential Learning

To equip students with skills of entrepreneurial strategic-decision aptitudes including negotiating with investors, closing sales, managing employees, and designing products, entrepreneurship education often incorporates experiential learning practices such as a) case studies, b) field trips, and c) internship (Sommarström et al., 2017).

First, case studies offer students the opportunity to explore the application of business management concepts as they discuss business data. With students involved in data exploration process, entrepreneurship decisions and creative problem-solving uncovered in those case studies have the potential to foster learning through a constructivist approach. Such a constructivist

approach to knowledge development enhances students' critical thinking. Second, field trips foster a sense of motivation and engagement when students visit real companies and meet business executives to discuss entrepreneurial practices. Discussions about entrepreneurial practices might involve inquiries about supply and production management, distribution and customer relationship management, costs management and pricing strategies. Lastly, an internship offers the opportunity to participate in a production system where students can apply knowledge acquired in the classroom and gain hands-on experiences (Kosnik et al.,2013). Hands-on experiences in a learning context of internship might involve students conducting sales, product inventory, or customer service where they might learn to generate business reports and make decisions. Experiential learning approaches pursued through case studies, field trips, and internships in curriculums of entrepreneurship in higher education are fundamentally school-based learning with learning objectives of entrepreneurial management competency and business creation.

Instructional strategy of school-based learning in entrepreneurship education is also adopted in the REALEntrepreneurship program. Dr. Johathan Sher in North Carolina and Dr. Paul DeLargy in Georgia created the program as Rural Entrepreneurship through Action Learning (REALEntrepreneurship, n.d.). With the initial vision to teach entrepreneurship in high school through a school-based curriculum, the program is now extended to community colleges. The program's learning objectives to develop entrepreneurial management competency, and to inspire students to create businesses align with today's pedagogical practice of *Competency method* described in Chapter 1. In addition to the goal of experiential learning pursued through case studies, field trips, and internships, curriculums of entrepreneurship in higher education include broader academic knowledge to foster critical thinking.

Broader Academic Knowledge

Complex processes of strategic management must be taught in academic institutions by entrepreneurship scholars through pedagogical practices that foster students' critical thinking and enhance their understanding of those complex managerial processes in the real world (Jones et al., 2017; Kuratko, 2011). Fostering critical thinking is achieved through conceptual inquiries of strategic management, which consists of strategic planning leading to scalability and sustainability in a competitive market.

Strategic Planning. The entrepreneurial process is understood as discovering the interconnectedness of economic activities and being able to initiate strategies to exploit opportunities (Jones et al., 2017). Strategic management planning starts with the assessment of an enterprise's internal resources. Moreover, the assessment of the external business dynamic is critical to achieve scalability and sustainability of a firm (Raduan et al., 2009). Hence, the success of a strategic plan depends on presenting a vision, setting reasonable objectives based on the enterprise's internal resources and market challenges, formulating, and implementing a strategy capable of harnessing opportunities in a competitive market (Kriz, 2003; Nuntamanop et al., 2013). Ultimately, the success of strategic management planning is tested through the firm's growth stages of scalability and sustainability.

Scalability. The primary goal of a firm is to optimize its competitiveness while remaining profitable in the long run. Such a goal begins with the ability to scale up the business (Nielsen & Lund, 2015). Students learn concepts of scale and scope in economics, business management, and marketing classes. While economies of scale primarily refer to reduction in the average cost per unit associated with increasing the scale of production for a single product type, economies of scope refer to lowering the average cost through product diversification (Nielsen &

Lund, 2015). Thus, the term scalability used in the context of running a company implies the potential for economic growth within the company (Dyer & Ericksen,2006).

Achieving scalability involves a business ability to increase returns to scale from additional resources such as technology (Pedrinaci et al, 2008). Furthermore, a business can achieve scalability if flexible enough to optimize material assets, such as labor, machinery, financial capital, and other forms of resources (Nielsen & Lund, 2015). Finally, the firm's strategic approach to achieve economies of scale and economies of scope should align with the firm's vision in terms of value propositions offered to customers (Powell & Hughes,2016). In addition to resource management to achieve success in scalability, profitability is a crucial component for a business entity to achieve sustainability.

Sustainability. The theory of profit-maximizing describes a business organization's main objective to maximize long term profit by developing a sustainable competitive advantage over competitive rivals in an industry (Raduan et al., 2009). While the resource-based theory describes management of internal resources that a business possesses to achieve scalability, profit-maximizing strategies allow the business entity to sustain the competition and remain a viable company in the long-run. The need for adaptability in strategic decisions is important to sustain profitability while adjusting to changes in the marketplace (Deverell & Olsson, 2010). Strategic management emphasizes the importance of relationship between the shareholders or owners and the agents or managers to ensure the success of the business (Freeman & McVea, 2001). Studies of strategic management have led to numerous economic models attempting to incorporate strategic planning, business scalability, and sustainability, to guide business decision making. One example is Stackelberg's duopoly in game theory.

Modeling Strategic Decisions in Game Theory

Game theory consists of economic models involving mathematic formulas and graphs depicting situations in which business leaders make strategic decisions which favor their businesses and alter the condition of the market in which they operate (Madani, 2010; Ozkan-Canbolat et al., 2016). In game theory, a decision maker is referred to as a player, which can include individuals, groups, companies, and government (Webster, 2014). A payoff refers to the gains or losses in the game, which may be measured in terms of utility, profits, revenues, or market share. A strategy is the underlying rationale for a player's moves. A player's set of strategies is described as strategy profile (Webster, 2014). There are two basic types of game models in game theory: static and dynamic. While players do not know the moves of other players in a static game, the players in a dynamic game or a sequential-move game take turn.

The most widely recognized model of game theory was established by John Forbes Nash, for which he received a Nobel Prize. In 1950, Nash formulated the notion of equilibrium which bears his name (Holt & Roth, 2004). One of the assumptions of *Nash equilibrium* describes strategies of multiple players in a competitive business interaction where nobody has an incentive to unilaterally deviate from their own strategy (Holt & Roth, 2004). Another assumption of *Nash equilibrium* suggests that all players adopt a strategy that is the best response to the strategies adopted by rivals. Based on these assumptions, each contender will stick to its strategy to obtain a better payoff at equilibrium (Holt & Roth, 2004; Webster, 2014).

Assumptions of Nash equilibrium have received some criticism from scholars. Schwartz (2015) argues that rational interplay does not necessarily lead to equilibrium even when assuming complete information and common knowledge. Schwartz (2015) explains that players sometimes have other strategies that might yield better outcomes than those leading to Nash

equilibrium. Given that, Schwartz (2015) argues there can be no equilibrium if multiple opportunity pathways can lead to other outcomes, and therefore efface any possible Nash equilibrium. The possibility of Nash equilibrium being effaced is justified by the idea that players might not be fully rational to pick the strategy that might predict such equilibrium. Despite the criticism, most models of game theory have been developed based on assumptions in Nash equilibrium.

Utilizing the same assumptions in *Nash equilibrium*, equilibrium solutions based on output are highlighted in a Cournot situation, while the price equilibrium solutions are found in a Bertrand scenario (Rusescu, 2021). In their models, Cournot and Bertrand present scenarios of quantity equilibrium and price equilibrium models attained with strategic choices made simultaneously. Meanwhile, Stackelberg's model represents a perfect information, sequential game in which firms are engaged in quantity competition (Rusescu, 2021). Moreover, Stackelberg's model involving sequential strategic moves is considered dynamic, while strategic choices made simultaneously in Cournot and Bertrand describe static models.

The Mathematical Formulation of Stackelberg's Model of Game Theory

In the game scenario of Stackelberg's game theory, with two players moving sequentially, the follower chooses a certain output level; and the leader makes an output decision based on the follower's decision. Rusescu (2021) explained the mathematical formulation of Stackelberg's game theory (a sequential game).

Definitions and Notations

A general price function is shown in equation 1.

$$P(Q) = P(q_1 + q_2) \quad (1)$$

P is price and a function of Q. Also, Q is the aggregate market demand, with Q equal to q_1+q_2,

where $q_1$is the output for the leader, and q_2 is the output for the follower. In the event only two players are in the market, then it is considered as a general price function in a duopoly scenario. Coefficients a, b, and c used throughout the models represent values greater than zero where a > c, and b ∈(0,1). The notation b*Q denotes the multiplication of b and Q.

Mathematic Formulation

In Stackelberg's sequential game, the leader has the advantage of making a move after knowing the follower's move. As such, we will first determine the follower's reaction function in terms of output since Stackelberg's model represents a sequential game in which firms are engaged in an output competition.

Formulation of the Follower's Output Reaction

Let's consider $P(Q)$as a downward sloping linear demand curve scenario. The function may be written in two different forms as shown in equations 2a and 2b.

$$P(Q) = a - b * Q \quad (2a)$$

$$P(Q) = a - b * (q_1 + q_2) \quad (2b)$$

where in equation 2a, Q represents the total quantity or output in the market, and in 2b, Q is replaced by $q_1 + q_2$ because Q = $q_1 + q_2$. Let us define cost and revenue for the follower. While C_2 (q_2) represents the cost of the follower as a function of its output q_2, P*q_2 represents the revenue of the follower obtained by multiplying the consumer price (which is P) and the follower's output. We now proceed to determine the follower's reaction function in terms of revenue and then determine the follower's profit.

Follower's revenue:

$$P*q_2 = [a - b*(q_1 + q_2)] * q_2 \quad (3)$$

Follower's profit function:

$\pi_2 = P^* q_2 - C_2(q_2)$ (4)

For further simplification of the mathematic formulation, we consider that:

$C_2(q_2) = c^* q_2$ (5)

Given (3) and (5), the profit function of the follower in (4) becomes:

$\pi_2 = P^* q_2 - c^* q_2 = [a - b^*(q_1 + q_2)]^* q_2 - c^* q_2$ (6)

First order derivate expression of the follower's profit function becomes:

$$\frac{\delta \pi_2}{\delta q_2} = \frac{\delta (P * q_2)}{\delta q_2} - \frac{\delta (c * q_2)}{\delta q_2} \quad (7)$$

Setting to zero value the marginal profit expression leads to the following:

$$\frac{\delta \pi_2}{\delta q_2} = \frac{\delta (P * q_2)}{\delta q_2} - \frac{\delta (c * q_2)}{\delta q_2} = 0 \quad (8)$$

Subsequent mathematical calculation leads to finding out the follower's best reply function.

$$q_2 = \frac{a - b * q_1 - c}{2b} \quad (9)$$

Formulation of the Leader's Output Reaction

We can now determine the leader's reaction function given the follower's reaction function in (9). First, we define the leader's revenue, cost, and profit functions as follows.

Leader's revenue

$P^* q_1 = [a - b^*(q_1 + q_2)]^* q_1$ (10)

Leader's cost

$C_1(q_1) = c^* q_1$ (11)

Leader's profit function

$$\pi_1 = [a - b*(q_1 + q_2)] *q_1 - c* q_1 \quad (12)$$

Next, based on the follower's best reaction function in line (9), the leader's profit function becomes:

$$\pi_1 = \left[a - b*\left(q_1 + \frac{a-b*q_1-c}{2b}\right)\right]* q_1 - c* q_1 \quad (13)$$

After taking the first order derivative of the leader's profit in (13) and setting it to zero value, we obtain:

$$q_1^* = \frac{a-c}{2b} \quad (14)$$

The leader's output at equilibrium obtained in (14) leads to the following subsequent solutions at equilibrium in Stackelberg's game theory.

Final Equilibrium Solutions

The leader's equilibrium solutions

Output

$$q_1^* = \frac{a-c}{2b} \quad (15)$$

Profit

$$\pi_1^* = \frac{(a-c)^2}{8b} \quad (16)$$

The follower's equilibrium solutions

Output

$$q_2^* = \frac{a-c}{4b} \quad (17)$$

Profit

$$\pi_2^* = \frac{(a-c)^2}{16b} \quad (18)$$

Price paid by consumers

$$P^* = \frac{a+3c}{4} \quad (19)$$

Interpretation of Equilibrium Solutions

According to Rusescu (2021), the results of the final equilibrium solutions obtained lead to the following conclusions: the leader producing more than the follower is shown by $q_1^* > q_2^*$; $P^* >$ c confirmations that both players have the possibility of making profit; and $\pi_1^* > \pi_2^*$ indicates that the leader registers higher (double) profit, so there is a real advantage to be a leader. The leader knows that an increase of his output will force the follower to reduce his own and this decision is irreversible based on the assumptions of *Nash equilibrium*.

Using Static Games to Teach Business Strategic Decisions

The applicability of models of game theory in real life has inspired the use of static games as innovative pedagogical approaches to teach strategic decisions in a way that makes concepts of game theory less abstract. Learning has become a challenge for current students when traditional teaching methods are used in the classroom (Burke et al, 2018). Today's college-age population are known for their shorter attention spans and their attachment to smart phones (Burke et al, 2018). Thus, difficulties to engage and educate current students have led to various pedagogical tools to promote engagement and facilitate learning. Prime-time comedic TV programs and movies have been used to convey underlying economic principles and the underlying thought process (Burke et al, 2018). Business interactions modeled in game theory can be found in numerous social interactions in everyday life (Dixit, 2005). However, the

teaching of concepts of game theory appears to be abstract given that they are mostly taught with mathematic formulations. Hence, the use of games aims at facilitating the practical understanding of business interactions modeled by those mathematic formulas. In addition to the prisoner's dilemma, described in Chapter 1, the following few examples of games have been proposed by others to illustrate strategic decision making.

Microsoft Versus Netscape

The internet has become a necessity for individuals and businesses in this information age. Web browsers are the essential technological tools allowing access to information on the internet. At the early stage of web browsers' development, Microsoft enjoyed a dominant position. Meanwhile, Netscape was a relatively new company in the Operating System (OS) market (Perna & Quintas, 2004). Thus, in Stackelberg's duopoly model, Microsoft is considered the leader while Netscape is described as the follower (Rusescu, 2021). Microsoft uncovered Netscape's intention to increase competition in the Operating System market and the browser market. This situation generated a conflict of interests between both firms and led to a strong competitive attitude that was known as the "browser's war". The game theory model depicted in the "browser's war" is explained by Perna & Quintas (2004).

According to the authors, there are two essential strategic reactions considered in modeling the competition between Microsoft and Netscape: to "share" and to "compete". While the "share" strategy advocates collaboration among businesses, the "compete" strategy encourages more competition in the browser industry. The payoff used in the model are based on estimated profit from both firms' financial record and projections. In this game theory model, Microsoft's most beneficial strategy is to "share" because it is the best possible action regardless of Netscape's strategy. Similarly, the most beneficial strategy for Netscape is to "compete"

because that is the best position no matter what Microsoft's strategy is. These strategies follow assumptions of *Nash Equilibrium*, which suggest that any unilateral deviation from these actions would be worse for each firm. Perna & Quintas (2004) explain a short-term strategic position with outcomes presented in the matrix in Table 2. As described in the matrix, Microsoft and Netscape make respectively 900 million and 10 million profits when both companies adopt their most beneficial decisions. Those decisions are "share" for Microsoft and "compete" for Netscape. The matrix also shows that subsequent deviations from most beneficial decisions lead to unfavorable outcomes.

Table 2

Payoff Matrix in Stackelberg's Game Theory Involving Microsoft and Netscape

		Netscape	
		Share	*Compete*
Microsoft	Share	1 billion profit for microsoft 3 million profit Netscape	900 million profit for Microsoft 10 million profit for Netscape
	Compete	420 million profit for Microsoft 1 million loss for Netscape	170 million profit for Microsoft 1 million profit for Netscape

The Chicken Game

The idea of rational thinking in game theory is illustrated in numerous games such as the chicken game explained by Vesperman and Clark (2016). According to Vesperman and Clark (2016), the chicken game is a quick, single-round game that can be played multiple times by students in a class period. Students are informed of being on a trip to an important meeting. They are driving down a one-lane road heading toward a narrow bridge where they see another car

coming toward them and know the two cars will meet on the bridge. If they swerve off the road, they will get stuck and miss the meeting. If both cars drive onto the bridge, they will both crash and die as indicated in Table 3. Students have one minute to decide what they will do and write it down on a sheet of paper, keeping their decisions hidden from their partner. After students have written down their answer, they can reveal and discuss the rationale for the decision to drive or to swerve.

The chicken game is a visual illustration for teaching students about the nuclear arms race and mutually assured destruction (MAD) (Vesperman and Clark, 2016). The authors assert that an important element of social studies in education is teaching students how to make reasoned and rational decisions. While this rational choice theory began in economics, it has been used to evaluate the choices of politicians and the actions of states. Concepts of game theory can be abstract due to mathematic formulations involved in explaining business decisions. Thus, the use of static games aims at facilitating the understanding of concepts of game theory in a more practical way. However, the common challenge in using games for teaching social sciences is dealing with processes. Most of the educational games to illustrate business interactions or political decisions have been static games, which do not teach students processes involved in making business or political decisions.

Table 3
Strategic Decisions and Corresponding Outcomes in the Chicken Game

		Driver 2	
		Swerve	*Drive*
Driver 1	*Swerve*	Both lose	Driver 1 loses Driver 2 wins
	Drive	Driver 1 wins Driver 2 loses	Both crash and die

Shortcoming of Static Games as Game-based Learning

Defined by its formal and informal rules, a game's formal rules are often written down and made explicit, while the informal rules, including the process, are contained in the story and the social context that makes the game relatable to real life (Shubik, 2002). Thus, the understanding of processes through gamification can help answer questions raised to connect theoretical concepts and the reality these concepts are meant to represent. To facilitate the understanding of such processes involved in theoretical concepts, the current teaching of business economics uses static game models to analyze equilibrium. However, many game models such as static games fall short in dealing with these questions of process raised in economic concepts. Proulx et al. (2017) explained that the potential of games to foster motivation and learning rests on certain requirements regarding the game, the learners, and the learning context. Hence, the mechanics of an educational game ought to incorporate enough of the basic concepts and processes of business economics intended to be explored by students.

When teaching with game, the extent to which students can adequately comprehend the interplay of theoretical concepts and real-life application depends on the design and the mechanic of the game (Kiili, 2005). Static games such as those previously described to illustrate strategic interactions in game theory fall short in presenting some of the processes involved in business strategic interactions. Thus, students only learn business competitors' final decisions formulated in Nash equilibrium rather than the thought process that leads to such decisions. Hence, the instructor's ability to work with students and summarize essential processes needed to understand the flow of cognition left out in a static game is critical for students to acquire meaningful knowledge (Kiili, 2005). Even though there is enough supporting evidence that gaming simulation yield positive results in problem solving skills and learning engagement, the use of interactive game as an experiential learning approach is not often used in teaching economic subjects including entrepreneurship in many universities and colleges (Tsigaris, 2008).

The Design of an Interactive Game

The survival of an enterprise in a competitive market depends on sound business decisions leading to two important business growth stages: scalability and sustainability. The conceptual description of scalability and sustainability can be abstract, and therefore difficult to visualize in a traditional teaching approach. As such, an interactive game to simulate processes of business decisions leading to scalability and sustainability ought to incorporate three essential functional areas: *Game mechanics*, *learning mechanics*, and *assessment mechanics* (Turkay et al., 2014). Figure 6 provides an illustration of these three functional areas.

Game Mechanics

Game mechanics describe essential gameplay activities where students' behaviors are guided by well-established rules of moves and countermoves. As explained in Chapter 1, the

game's artifacts in the game design are the tools employed to execute moves and countermoves to implement a strategic decision after a consensus is reached among members of a team. Those moves and countermoves are motivated by learning objectives, which are executed through the game's learning mechanics (Turkay et al., 2014).

Learning Mechanics

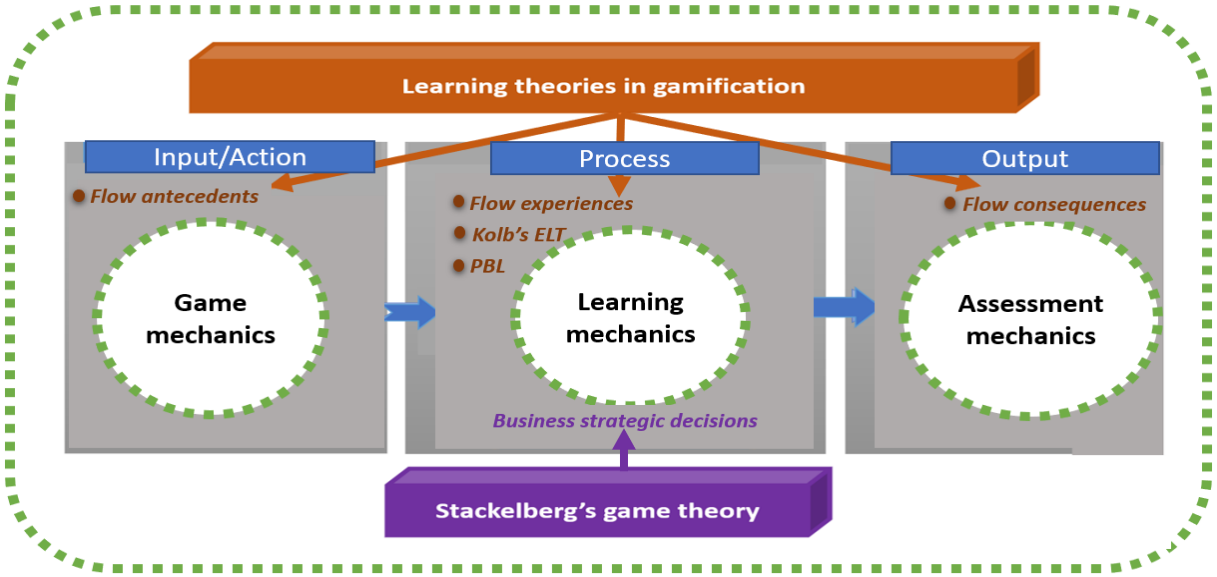
The learning mechanics of the game facilitate the execution of learning objectives, which represent the core knowledge that is to be acquired by students through the game (Turkay et al., 2014). In this study for instance, learning objectives in the design of the interactive game is to simulate decision-making processes to grow a business from scalability to sustainability in a competitive business environment. Thus, the abstract nature of concepts of scalability and sustainability can be visualized through the game's narrative involving a business competition between two companies. Furthermore, learning mechanics in the design of an interactive game ought to be supported by learning theories (Turkay et al., 2014). In this study, learning theories involved in the design of the interactive game include the *flow theory* in an interactive game-based learning, *Kolb's experiential learning* theory, and *problem-based learning*. In the end, students' learning experience is evaluated through assessment mechanics.

Assessment Mechanics

Even though assessment mechanics can be theoretical in nature, they can be operationalized into a game in a way that knowledge acquisition can be measured. The learning objectives of business decisions leading to business growth of scalability and sustainability can be assessed in an interactive game based on the conceptual understanding of scalability and sustainability. While scalability is described as the phase where each entrepreneur is trying to develop economies of scale, meaning lowering average total cost as output increases,

sustainability is understood as the phase where the entrepreneur is trying to increase profitability, cash level and market share. Based on their conceptual definitions, assessing students' understanding of scalability and sustainability can be achieved through computation tests where students will demonstrate their skills in computing cost of goods purchased, revenue and profit related to business decisions in various market segments. Moreover, the learning mechanics of the game can help students better understand the roles that computed values of cost of goods purchase, revenue, and profit play in achieving scalability and sustainability in a business competition. In summary, functional areas in the design of an interactive game such as *game mechanics*, *learning mechanics*, and *assessment mechanics* presented by Turkay et al. (2014) are essential in describing the theoretical framework of this research study as indicated in Figure 6. The following provides a description of the juxtaposition of the functional areas in the design of an interactive game and the theoretical framework of this research study presented in chapter 1.

Figure 6
Game Mechanics, Learning Mechanics, and *Assessment Mechanics* as *Functional Areas in the Design of an Interactive Game*



Note: Kolb's Experiential Learning Theory (Kolb's ELT), Problem-based Learning (PBL)

Functional Areas of the Game Design and the Theoretical Framework

The learning objective pursued in this interactive business simulation game is to engage students in making strategic decisions to grow a business from scalability to sustainability in an ongoing business competition. In Chapter 1, the proposed theoretical framework explains the process by which learning theories in an interactive business simulation game facilitates the practical application of concepts of strategic decisions in game theory. Such a process unfolds along three phases: *Input*, *process*, and *outcome.* These three phases align with the functional areas in the design of an interactive game such as *game mechanics*, *learning mechanics*, and *assessment mechanics.*

The *input* phase in the theoretical framework involves the *game mechanics* in the design of an interactive game where interactions between the players and the game's artifacts are initiated (see Figure 6). Such stage of interactions between the players and the game's artifacts is also identified as the flow antecedents in the flow theory. The *process* phase in the theoretical framework is where the *learning mechanics* in the design of the game facilitate the use of learning theories in gamification (see Figure 6). In that phase, students' intense interaction with the game's artifacts leads to flow experiences in the flow theory. During the Flow experiences, students are involved in problem-based learning as they are actively engaged in solving business challenges. Moreover, learning styles in Kolb's experiential learning theory enhance students' ability to examine and integrate each member's reflection in final strategic decisions in game theory. In the *outcome* phase of the theoretical framework, game participants reach flow consequences in the flow theory where outcome of entrepreneurial knowledge acquisition and learning engagement are measured through *assessment mechanics* in the design of the interactive game (see Figure 6). The outcome of learning engagement is reflected in team members'

motivation to apply concepts of strategic decisions and win the simulated business competition in the interactive game. In conclusion, the three phases of *input*, *process*, and *output* in the theoretical framework proposed in this research study are supported by the functional areas in the design of an interactive game such as *game mechanics*, *learning mechanics*, and *assessment mechanics* presented by Turkay et al. (2014). Furthermore, Turkay et al. (2014) assert that learning mechanics in the design of an interactive game ought to be supported by learning theories.

Learning Theories in Gamification

Among multiple definitions found in the literature, gamification is defined as a) the creation of a game to serve any non-entertainment goal or b) the transformation of an existing system into a game (Seaborn & Fels, 2015). In the context of education, the term "gamification" refers to digital game-based learning. Thus, gamification is understood as the use of the mechanics of a game and the thinking involved in a game to engage people, motivate action, promote learning, and solve problems (Seaborn & Fels, 2015). In this research study, the conceptual understanding of the term gamification, which refers to interactive game-based learning, involves three learning theories including the flow theory in game-based learning, Kolb's experiential learning in a group, and problem-based learning.

The Flow Theory

The general assumption about game-based learning as an instructional strategy is that it offers a unique opportunity to immerse students in an experiential learning process where complex entrepreneurial concepts and practices are learned through a constructivist approach of knowledge formation (Kriz, 2003). The expectation is that the active participation of students in the construction of knowledge, in a context of live competition with instantaneous feedback of

success or failure, will better equipped students with aptitude of strategic thinking needed to survive market uncertainties in today's global economy (Kriz, 2003).

The success of a game design is measured by the extent to which it generates a positive effect in players and facilitates the attainment of optimal experience (Kiili, 2005). When in a state of optimal experience, a person is in a psychological state where goal driven activities are what matters the most. A proposed model of person-artifact-task (PAT) conceptualizes the major components of a state of optimal experience. According to the model, the extent to which a person working on a computer-related activity attains optimal experience is dependent on the interplay between the person, the task, and the artifact (Kiili, 2005). Hence, the main contribution of the PAT model to the flow theory is to describe how optimal experience takes place through various stages of flow involving the task itself, and the use of artifacts by individuals.

Problem-based Learning

Bethell & Morgan (2011) explain that problem-based learning (PBL) can be understood as experiential learning in a specific learning context. PBL is a teaching approach which uses realistic, problematic scenarios. The first step is for students to identify what they know already, they then research the areas where they have identified gaps in their knowledge and finally present an informed solution. Also, Hmelo-Silver (2004) asserts that, in problem-based learning, students are exposed to complex problems that do not have a single correct answer.

Hmelo-Silver (2004) explains that the goals of problem-based learning include helping students develop a) flexible knowledge, b) effective problem-solving skills, c) self-directed-learning skills, d) effective collaboration skills, and e) intrinsic motivation. Problem-based learning follows a learning cycle which starts with a problem scenario and then facts are

identified, hypotheses are generated, knowledge deficiencies are identified, and new knowledge is applied (Hmelo-Silver, 2004). Furthermore, Jonassen (1997) identifies problem-based learning as an instructional approach to solve ill-structured problems. Understood as the kinds of problems that are encountered in everyday practice, ill-structured problems are typically emergent dilemmas. Because they are not constrained by the content domains being studied in classrooms, their solutions are not easily predictable, and they may also require the integration of several content domains (Jonassen, 1997).

Kolb's Experiential Learning Theory

Experiential learning is defined as learning through experience with learning understood to be the basic process of human adaptation (Kolb & Kolb, 2009). Thus, Kolb's experiential learning theory is considered as a holistic theory that defines learning as the major process of human adaptation applicable in the formal education classroom and other areas of real life. The holistic view of learning in Kolb's experiential learning theory involves a process of constructing knowledge along an ongoing interaction of four learning styles, which are a) active experiment in a context of concrete experiment, b) active experiment in a context of abstract conceptualization, c) reflective observation in a context of concrete experiment, d) reflective observation in a context of abstract conceptualization (Kolb & Kolb, 2009; Kayes et al., 2005). Thus, these four learning styles are part of a holistic learning mechanism by which teams can transition from lower to higher developmental stages.

Team members experiment with the four experiential learning styles and develop a decision-making process by reflecting on their experience through conversations that examine and integrate differences in members' cognitive experience (Kolb & Kolb, 2009). These three learning theories in gamification aim at fulfilling the learning objective of an interactive game

through learning mechanics. The learning objective consists of applying concepts of game theory in the process of making business decisions in a lived experience. In the end, assessment mechanics involved in the design of an interactive game help evaluate students' knowledge and learning engagement as they are actively learning concepts of strategic decisions in game theory.

Outcomes of Knowledge Acquisition and Learning Engagement

Game theory involves economic models such as Stackelberg's game theory model to illustrate interactions among competing business entities. Such interactions are understood through business decisions leading to strategic actions (Madani, 2010). Thus, economic models with mathematic formulations depict situations in which business leaders make strategic decisions which favor their businesses while altering the condition of the market in which they operate (Ozkan-Canbolat et al., 2016). Numerous static games such as the prisoner's dilemma are used to illustrate strategic decisions in business economics involving Nash equilibrium. In this research study, an interactive game-based instructional approach is proposed to illustrate the process of strategic decisions portrayed in game theory. The choice of an interactive game, instead of a static game, is to enhance knowledge acquisition and learning motivation.

Knowledge Acquisition

Today's world of globalization presents problems and situations with a high level of complexity that people, groups, and organizations are confronted with (Kriz, 2003). Interactive games in education offer the advantage of integrating knowledge of various disciplines and make complex-living contexts understandable. As such, interactive games involve dynamic models of real situations where processes, networks, and structures of specific existing systems are mimicked (Kriz, 2003). Moreover, interactive games incorporate players engaged in experiential learning involving reflective conversation and various learning styles in experiential learning

process (Kolb & Kolb, 2009). Thus, specialized managerial processes such as entrepreneurial learning, strategy formulation, creativity, problem-solving and decision making can be learned through an engaging learning process (Kriz, 2003). Moreover, the effectiveness of an interactive game-based instructional approach involves selecting the appropriate topic and defining the mode of assessment (Lengyel, 2020).

In effect, the learning mechanics of an interactive game ought to convey specific knowledge and emphasis should be placed on topic content, skills, and attitudes (Lengyel, 2020). As such, the extent to which the learning mechanics of an educational game helps develop knowledge and skills to solve problems determines the pedagogical effectiveness of a gaming simulation (Kiili, 2005; Proulx et al., 2017; Plass et al. 2015). In the context of solving challenges to grow a business from scalability to sustainability in a competitive business environment, specific entrepreneurial knowledge and skills are needed. First, the growth stage of scalability is achieved through the reduction of unit cost as output increases (Vlachos & Malindretos, 2015). Next, an enterprise's sustainability performance is realized through the stability and continuity of its supply chain network in making products or services and delivering them from suppliers to customers with higher profit (Vlachos & Malindretos, 2015). Thus, profitability is a crucial metric to assess the sustainability of an entrepreneurial venture. Hence, assessment mechanics to evaluate students' knowledge and skills to grow a company from scalability to sustainability involve computation tests. The learning objectives of business decisions leading to business growth of scalability and sustainability can be assessed in an interactive game based on computation of cost of goods sold, revenue and profit related to business decisions. Computational skills developed through the learning mechanics of the game

will help students better understand the roles that computed values of cost of goods sold, revenue, and profit play in achieving scalability and sustainability in a business competition.

Learning Engagement

As an experiential learning approach, the use of an interactive game for educational purpose has the potential to motivate and engage students while facilitating the discovery of the relationship between theory-based knowledge and practical application (Lengyel, 2020; Urquidi-Martín et al., 2019; Vlachopoulos & Makri, 2017). Learning incentives such as student freedom, different learning paths, and immediate feedback explain students' commitment in learning through an interactive game (Lengyel, 2020). Moreover, a shared goal of team success in a competitive environment presents a unique opportunity for members to be engaged in a respectful manner and be receptive to differing points of view given instantaneous feedback in a live simulation. In contrast to traditional paper test examination or a case study that takes weeks to get feedback, instantaneous feedback in a live simulation of a business competition presents the opportunity for prompt adjustment of learning styles to respond to ongoing challenges (Kolb & Kolb, 2009; Lengyel, 2020). Such initiatives of extemporaneous adaptation create a teamwork dynamic that nurtures individual and team engagement.

The interaction among the four learning modes proposed in Kolb's experiential learning theory in a group engages the learner in a process of learning cycle where action or reflection can be initiated in two possible contexts: concrete experience or abstract conceptualization (Kayes et al., 2005). Thus, the availability of four learning styles offers the learner some level of adaptability and freedom which prevents confinement in the process of constructing knowledge, and therefore leads to intrinsic motivation (Kolb & Kolb, 2009). Learning motivation includes measures of students' participation and level of interest and attitudes within specific learning

domains (Ainley, 2004). Moreover, extrinsic motivation potentially derives from a shared image of the team, called executive consciousness that enables learning and problem solving as a team attempts to respond effectively to the challenges presented (Kolb & Kolb, 2009). Hence, interviews, opinion surveys, and observation notes taken during team competitions can provide insights regarding a student's participation and engagement.

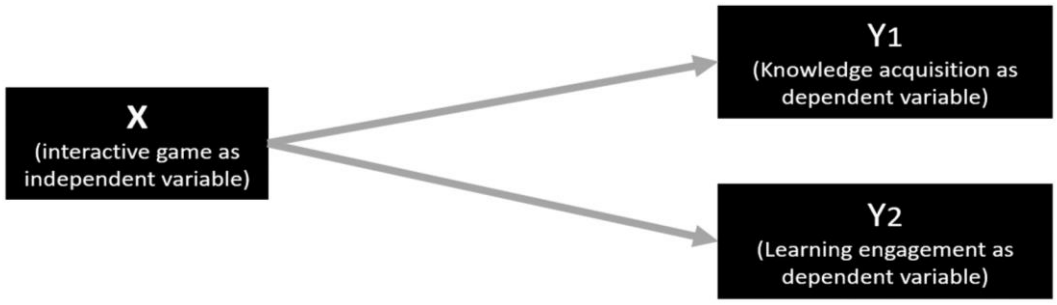
In summary, learning objectives in the design of an interactive game simulate the application of concepts of game theory involved in the process of making entrepreneurial decisions to grow a business in a competitive environment. Learning mechanics in the design of the game facilitates the execution of learning theories, which include the *flow theory, Kolb's experiential learning theory*, and *problem-based learning*. Executed through the game's learning mechanics, these learning theories unfold along stages of Input, Process, and Output. In the end, knowledge acquired by students and their learning motivation are evaluated through the game's assessment mechanics.

CHAPTER 3

METHOD

The purpose of this research study was to examine the effect of an interactive game of business simulation as an instructional approach (independent variable) in terms of knowledge acquisition (dependent variable) and learning engagement (dependent variable) as indicated by the analytical model in Figure 7. As an experiential learning approach, the use of a game-based business simulation has the potential to engage students while facilitating the discovery of the relationship between theory-based knowledge and practical application (Lengyel, 2020; Vlachopoulos & Makri, 2017). However, the current teaching of business interactions in market structures often uses static game models to analyze equilibrium. Static games such as the prisoner's dilemma used in traditional teaching to illustrate strategic interactions in game theory falls short in presenting some of the processes involved in business strategic decisions. This chapter described a causal comparative design as the method of inquiry to examine differential effects of static games in traditional teaching and interactive game of business simulation in terms of knowledge acquisition and learning engagement.

Figure 7
Analytical Model Depicting the Independent and the Dependent Variables



Research Questions

The following research questions were used to investigate whether an interactive business simulation game is more effective in terms of knowledge acquisition and learning engagement compared to that of a static game traditionally employed to teach concepts of business strategic decisions in entrepreneurship education.

1. What is the difference in learning engagement between students learning business strategic decisions through an interactive game and those with a static game at a two-year college in the Southeast region of the United State of America?
2. What is the difference in knowledge acquisition between students learning business strategic decisions through an interactive game and those with a static game at a two-year college in the Southeast region of the United State of America?

Hypothesis Tests

A two-sample t-test or a Mann-Whitney U test was employed to examine hypothesis tests related to the research questions. When data was not normally distributed, a non-parametric test called Mann-Whitney U was utilized. In the instance of a t-test, at a level of significance $\alpha = 0.05$, the critical t value was determined in accordance with the degree of freedom associated with the sample size, and in the eventuality that the t-statistic was greater than the critical value, the null hypothesis would be rejected. In the case of a Mann-Whitney U test, a p value greater than $\alpha = 0.05$ would result in a non-rejection of the null hypothesis.

Hypothesis Test Related to Research Question 1

The hypothesis test related to research question 1 was to determine if the mean value of post-lesson rating in learning engagement for the treatment group was greater than that of the control group given a level of significance $\alpha = 0.05$.

μ_1: the mean value of post-lesson rating in learning engagement for the control group

μ_2: the mean value of post-lesson rating in learning engagement for the treatment group

H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 < \mu_2$

If the t-test resulted in a rejection of the null hypothesis, that would mean the learning engagement from the treatment group was greater than that of the control group at a statistically significance level $\alpha = 0.05$. If the data was not normally distributed, a p value greater than $\alpha = 0.05$ obtained with a Mann-Whitney U test would mean that the learning engagement from the treatment group was equal to that of the control group at a statistically significance level $\alpha = 0.05$.

Hypothesis Test Related to Research Question 2

The hypothesis test related to research question 2 was to determine if the mean value of gain scores between the pre-test and the post-test for the treatment group was greater than that of the control group given a level of significance $\alpha = 0.05$.

μ'_1: the mean value of gain scores between the pre-test and the post-test for the control group

μ'_2: the mean value of gain scores between pre-test and post-test for the treatment group

H_o: $\mu'_1 = \mu'_2$
H_a: $\mu'_1 < \mu'_2$

If the t-test resulted in a rejection of the null hypothesis, that would mean the gain in knowledge by the treatment group was greater than that of the control group at a statistically significance level $\alpha = 0.05$. In the instance where the data was not normally distributed, a p value greater than $\alpha = 0.05$ obtained with a Mann-Whitney U test would mean the gain in knowledge by the treatment group was equal to that of the control group at a statistically significance level $\alpha = 0.05$.

Population and Sampling

The study was conducted at Georgia State University – Perimeter, which serves its students at five campuses: Alpharetta, Clarkston, Decatur, Dunwoody, and Newton. Perimeter's academic pathways, including business administration, communications, and criminal justice, allow students to experience online learning combined with face-to-face classroom support (Georgia State University-Perimeter College, n.d.). The College has a total enrollment of 17,383 (all undergraduate students) for the academic year 2020-2021. There are 6,624 full-time and 10,759 part-time students with a gender distribution of 36.79% male (6,395 students) and 63.21% female (10,988 students). Also, there are 24 American Indian/Native American, 3,641 White (21%), 7,691 Black/African American (44%), 1,748 Asian (10%), 2,362 Hispanic (14%), 10 Native Hawaiian or Other Pacific Islander, and 377 students with other races. Students between 18 to 25 years old account for 72% of the student population (Univstats, n.d.).

Study sampling was non-randomized because participants were self-registered students in microeconomics classes (Johnson, 2001). Such choice of non-randomized group formation was justified by the challenge to execute a random experiment with students in the school's population (Shadish et al., 2002; Reichardt, 2019). A quasi experiment offered the flexibility to conduct the experiment with participants in classes of microeconomics made of self-registered students. The choice of control group was justified by the fact that the categorical independent variable (game simulation teaching approach) cannot be manipulated (Shadish et al., 2002; Reichardt, 2019).

This research design consisted of one control group and one experiment group where one instructor administered all the interventions. To ensure group homogeneity, a t test or a Mann-Whitney U test was employed to examine baseline equivalence among the two groups in terms

of knowledge. According to Sung et al. (2019), a sample size greater than 30 is recommended to attain a significant effect size (i.e., Cohen's d > 0.8) and a statistical power greater than 0.8.

Research Design

The choice of a causal comparative design was to examine differential effects of two teaching approaches in terms of knowledge acquisition and learning engagement (Liang et al., 2012). Those two teaching approaches were an interactive game simulation and a traditional teaching using static game.

Causal Comparative Design

A causal comparative design is described as a quasi-experimental design because randomized sampling of participants is not possible (Johnson, 2001). Also, in a causal comparative design, two or more groups of participants are compared and defined by their relationship to the independent variable(s) (Liang et al., 2012). There was a control group and an experimental group. Moreover, causal comparative design includes at least one categorical independent variable (interactive game simulation teaching approach) which cannot be manipulated by the experimenter. Table 4 presents a pictorial depiction of a quasi-experiment involving nonrandom groups in a treatment and comparison conditions where X denotes the condition of treatment. While O_1 and O_2 respectively denote pretest and posttest scores (observations) in the treatment group, pretest and posttest scores (observations) in the control group are respectively denoted by O_3 and O_4.

Table 4
Pictorial Depiction of a Quasi-experiment Involving Treatment and Comparison Groups

Nonrandom (treatment group)	O_1	X	O_2
Nonrandom (control group)	O_3		O_4

Advantages and Disadvantages of a Causal Comparative Design

A quasi-experiment involves assigning units to treatment conditions in a nonrandom manner through various approaches including administrative decision, self-selected, legislative mandate, or some other nonrandom process (Shadish et al., 2002; Reichardt, 2019). In contrast, a true experiment design consists of a randomized experiment where study units are assigned to treatment conditions at random (Shadish et al., 2002; Reichardt, 2019). Such random assignment can be conducted through a coin flip, the role of a die, the numbers in a computer-generated table of random numbers, or some other random process (Shadish et al., 2002; Reichardt, 2019). A quasi-experiment in a causal comparative design was advantageous for the following reasons.

As part of the student population, dual enrollment students are faced with academic obligations in high school as well as college. They often face time constraints as they try to attend classes in both high school and college (Howley et al., 2013). A random assignment suggests that students selected to be in the experimental or control groups might have to skip their high school classes or make other arrangements to participate in the study if there is a conflict of time (Shadish et al., 2002; Reichardt, 2019). Also, traditional students being part of the student population can potentially face class disruption if they are randomly selected to participate in the research study. In contrast, having self-registered students in economics classes

selected for the research study prevented the disruption of participants' normal class routines. Also, being a quantitative research method, causal comparative design presented considerable advantages in terms of instruments of data collection and data analysis.

Even though causal comparative design approach has the potential to establish a relationship between independent variable(s) and dependent variable(s) through numeric data analysis, such research design approach comes with some limitations. Given the non-randomized sampling in the group formation, it is not possible to exclude other factors capable of impacting the dependent variables (Shadish et al., 2002; Reichardt, 2019). Therefore, control is limited, and true experimentation is not possible (Shadish et al., 2002; Reichardt, 2019). However, the formation of homogenous groups with baseline equivalent in knowledge can potentially improve control of confounding variables.

Internal and External Validities in a Causal Comparative Design

The general understanding in scholarly research is that internal validity is a precondition for external validity (Jimenez-Buedo & Miller, 2010; Reichardt, 2019; Shadish et al., 2002). The non-randomized sampling in the group formation involved in causal comparative research design poses a threat to internal validity in terms of the homogeneity of sample groups (Reichardt, 2019; Shadish et al., 2002). Efforts to mitigate sample homogeneity involved the evaluation of baseline knowledge through pretests in both the experimental and non-experimental classes. In addition to the threat posed by homogeneity of sample groups, confounding factors associated with the design of the game, experiment setting, and outcome measures could potentially be a threat to internal validity (Reichardt, 2019; Shadish et al., 2002). As part of the effort to eliminate confounding factors associated with experiment setting, lesson activities in both experimental and non-experimental classes were administered by the same instructor. Moreover, instruments

of data collection were adequately selected to ensure validity and reliability of outcome measures.

Procedure

Scheduling Lessons, Tests, and Survey

Research activities involving interactive game and traditional static game lectures took place over three weeks within the semester where lessons were delivered through in-person class sessions. Data were obtained from teaching sessions with the control group and the experiment group.

The schedule of class activities is shown in Table 5. Teaching sessions for the research began in the first week of the month of November when control and treatment groups received a pretest. Afterward, class lectures lasted one week. Opinion surveys and posttests were conducted in the third week. Opinion surveys were conducted online. Knowledge tests lasted one hour each. Lecture sessions lasted one hour and 15 minutes, which was the duration of a normal class session.

Table 5
Schedule of Class Activities Lasting Three Weeks for Each Group

	Week1	Week2	Week3
Treatment group	Pre-test	Interactive game-based lecture (One hour and 15 minutes)	--Posttest (One hour and 15minutes) --Opinion survey
Control group	Pre-test	Static game-based lecture (One hour and 15 minutes)	--Posttest (One hour and 15minutes) --Opinion survey

Class Activities in the Traditional Lecture

Students in the control group were in a non-experimental class where a lesson on monopolistic competition market was conducted through a regular lecture to provide the initial theoretical context of business competition. The lecture explained market assumptions, mathematical identities and graphical depictions, and computation of profits. The material was delivered with direct instruction and practice questions. Afterward, a static game was used to simulate entrepreneurship decision-making in an oligopoly market. The scenario in the static game presented competing entities (oligopolists) arriving at final decisions based on some rationale that students work to understand through class discussions. Given the complexity of the mathematics involved in formulating the rationale of decisions made by oligopolists in an oligopoly market, students were explained the rationale of those decisions through static game simulation. The class discussion is essentially a didactic learning approach where the instructor presents the oligopolists' final business decisions and explains the competing economic interests justifying the oligopolist's final decisions. Further understanding about oligopoly markets built on the understanding of monopolistic competition markets by contrasting the two market types. Static game-based activities lasted one hour and 15 minutes and took place over two class sessions in one week. A posttest was administered in the week following the lecture. Details of the lecture are provided in Appendix A.

Class Activities in the Interactive Game-based Learning

Students in the treatment group were in an experimental class where a lesson on monopolistic competition market is conducted through a regular lecture similar to that of the non-experimental class. In contrast to the use of static game to explain the rationale of oligopolists' final decisions in an oligopoly market, an interactive business simulation game

immersed students in the process of strategic decision-making where the decisions are made by the students themselves through moves and countermoves in a live experience. Moreover, those decisions throughout the competitions are extemporaneous decisions involving two opposing oligopolists that each team represents without any intervention from the instructor except for keeping track of the duration of the competition. Details of the lecture are provided in Appendix B.

Game Tutorial

For the interactive game-based lecture, students first received a tutorial prior to class lecture to familiarize themselves with the gameboard and the rules by which pieces were placed and moved on the gameboard. In the tutorial, students learnt about business growth stages involving scalability and sustainability in a competitive business context of oligopoly.

Game-based Lecture and Activities

Lesson activities in the game-based lecture began with a brief discussion of the game tutorial, and how a win or a loss affected the process of achieving scalability and sustainability. Next, teams with at least two students were formed to begin the game simulation of business competition. Each round of the game lasted 3 minutes, which represented one fiscal year. In each round, a competitor had 20 seconds to make a business decision and make a move on the gameboard in a sequential interaction. Following each round of the game (one fiscal year), students participated in mathematical computation and graphic depiction of cash, profit, revenue realized, cost of goods purchased (CGP), and losses. Interactive game-based activities lasted one hour and 15 minutes and took place over one week. A posttest was administered in the week following the interactive game-based lecture.

Instruments of Data Collection

In this research study, the conceptual framework presented knowledge acquisition and learning engagement as the dependent variables while the teaching method of interactive game simulation was the independent variable. The research design involved a quasi-experiment with a treatment group participating in an interactive game simulation of a competition in business decision practices and a control group participating in a static game-based lecture of business and entrepreneurship decision-making.

Instrument of Data Collection for Knowledge Acquisition

Testing procedures involved a pre-test and a post-test in both experimental and non-experimental classrooms as explained in Appendix C. Test questions were from a bank of formative assessment questions in the 18th edition of Economics Today by Miller (2008), which was the textbook used at the college where the study was conducted. Item questions were selected in a way that knowledge delivered in both experimental and non-experimental classes was adequately evaluated based on lessons' learning objectives.

Learning Objectives

Learning objectives in lessons of monopolistic competition and oligopoly markets involved discussing the key characteristics of both markets. Moreover, students learnt how to determine price, output, cost, and compute profits in a monopolistic competition market based on the characteristics of a monopolistic competition market. Also, students learnt the rationale of strategic decisions involving price, output, and profits in an oligopoly market.

Question Items

Pre-test and post-test questions were structured along two types of questions: multiple choice questions and computation questions. Multiple choice questions aimed at assessing

students' understanding of the difference between monopolistic competition and oligopoly markets based on key characteristics. Questions involving graphic determination of price, output, and cost aimed at assessing students' ability to apply key characteristics of a monopolistic competition market in computing profits. Moreover, students' understanding of business strategies in an oligopoly market were evaluated with questions presenting scenarios of business decisions driven by profits, price, or output. Multiple choice questions in pretest and posttest were selected from the same bank of questions. Computation questions in pretest and posttest were differentiated by changing numeric values needed to perform computation.

Instrument of Data Collection for Learning Engagement

The learning engagement assessment model used in this study was the ARCS model. The model was developed to identify major factors influencing students' learning engagement (Keller, 1987). Keller (1987) explained that, in ARCS model of engagement, the measurement of students' engagement related to an instructional strategy should be guided by four operational attributes such as attention, relevance, confidence, and satisfaction.

Attention

As a prerequisite to learning, attention is presented in the model as the starting point where attention-getter devices such as a dramatic statement can spark curiosity about a lesson (Keller, 1987). However, getting students' attention is just the beginning. The initial attention ought to be sustained throughout a class period; thus, the importance of the relevance of contents.

Relevance

The relevance of lesson contents is very important to sustain the initial attention. Relevancy can be created through the instructional strategy employed to deliver lesson contents.

For instance, group activities can be used to help students relate to the meaning of class materials through conversation while individual activities can inspire students to search for such meaning in their personal life experience.

Confidence

As class materials become relevant, students build a sense of confidence that academic success is attainable. Meaning, a student anticipates a good grade in a test as the confidence level grows. Moreover, the anticipation of getting a good grade can be a source of extrinsic motivation, which helps sustain a student's attention.

Satisfaction

Ultimately, a satisfactory learning experience becomes an important factor for students' intrinsic motivation. In effect, the instructional strategy employed to deliver lesson contents can foster students' intrinsic motivation and advance their academic curiosity. Hence, the level of satisfaction in terms of academic discovery can potentially lead to students feeling that they have learned something important and valuable. In the end, a high level of satisfaction can potentially be observed in students' engagement and motivation to learn. According to Keller (1987), the ARCS Model involving attention, relevance, confidence, and satisfaction produced results that supported the work of designers and teachers.

Keller (1987) explains that the ARCS was field tested in two teacher training workshops in central New York and Northeastern New York. Based on the survey responses from the participants, it was determined that the ARCS Model was successful in assessing learning engagement in these two field tests in terms of comprehensibility and utility. In their research to evaluate the efficacy of an educational game, Von Wangenheim et al. (2012) provide an operational understanding of the four attributes of learning engagement in the ARCS Model

shown in Table 6. Opinion survey questions presented in Table 7 have been developed by Von Wangenheim et al. (2012) to assess learning engagement in a game-based lecture. In this research study, survey questions used to assess students' learning engagement in static game-based and interactive game-based lectures are the same as those employed by Von Wangenheim et al. (2012). Students will respond to questions in the opinion survey based on a Likert scale with nominal values including strongly disagree, disagree, neutral, agree, and strongly agree as indicated in Appendix D.

Table 6
Description of the Four Attributes in ARCS Model

Four categories to represent learning engagement in instructional design	Description
Attention	Capturing the interest of learners; capture and maintaining attention
Relevance	Was the content important?
Confidence	Helping the learners feel that they will succeed
Satisfaction	Students feel they learned something important and valuable

Table 7
Opinion Survey Based on ARCS Model in Game-based Lecture

	Opinion statements
Attention	The variation (form, content or activities) helped me to keep attention to the game
	There was something interesting at the beginning of the game that captured my attention
	The game design is attractive
Relevance	The game content is connected to other knowledge I already had
	The way the game works suits my way of learning
	The game content is relevant to my interests

Confidence	Passing through the game, I felt confident that I was learning
	It was easy to understand the game and start using it as study material
Satisfaction	It due to my personal effort that I manage to advance in the game
	I am satisfied because I know I will have the opportunities to use in practice things I learned playing this game.

Note: This opinion survey questions are the same as those in Von Wangenheim et al. (2012)

Validity and Reliability of Instruments

Reliability and validity refer to whether the selection of instruments of data collection aligns with research questions (Tuckman & Harper, 2012). Poorly selected or improperly administered instruments present a threat to internal validity of a research study (Tuckman & Harper, 2012). In this study, exam questions were selected in a way that knowledge delivered through a static game-based lecture used in the non-experimental class and an interactive game-based lecture employed in the experimental were adequately evaluated based on learning objectives (Tuckman & Harper, 2012). Furthermore, survey questions were structured in a way that research findings about students' learning engagement were insightful in determining the effectiveness of an educational game. Measurement of Cronbach's alpha assessed questionnaire's internal consistency reliability as it relates to pretest and posttest, and the learning engagement survey. A Cronbach's alpha value equal to or greater than 0.7 is preferred because it is an indication of question items effectively measuring the construct they intend to evaluate.

Validity and Reliability of Instrument to Assess Knowledge Acquisition

To ensure validity**,** test questions selected for this research study were selected from a bank of formative assessment questions provided by the textbook used at a two-year college in the Southeast region of the United State of America. The book was the 18th edition of Economics

Today by Miller (2008). The reliability of question items aligning with the learning objectives of lessons of monopolistic competition and oligopoly markets was measured by Cronbach's alpha, which aimed at assessing questionnaire' internal consistency reliability.

Validity and Reliability of Instrument to Assess Learning Engagement

The instrument in this research is based on the ARCS model developed by Keller (1987). Keller (1987) asserts that the results of the field tests provide support for the comprehensibility and utility of the ARCS Model to assess students' learning engagement of an instructional tool. Keller (1987) further explains that comprehensibility and utility of the ARCS Model depends on the extent to which the four operational attributes including attention, relevance, confidence, and satisfaction in the ARCS Model are adequately represented by the survey questions. Failure to develop questions that effectively reflect those operational attributes based on lesson contents and the way knowledge is delivered can potentially compromise validity and reliability of the ARCS instrument. Based on the description of the four operational attributes in the ARCS Model including attention, relevance, confidence, and satisfaction presented in Table 6, opinion survey questions in this research study were well suited to investigate the difference in learning engagement between students learning business strategic decisions through an interactive game and those with a static game for the following reasons.

First, the survey questions employed in this research were the same used by Von Wangenheim et al. (2012) to assess students' learning engagement in a game-based lecture, which aligns with the game-based learning engagement inquiry pursued in this study. According to Von Wangenheim et al. (2012), the survey questions had been evaluated in terms of validity and reliability. Second, Von Wangenheim et al. (2012) explain that positive feedback obtained based on the ARCS Model to assess students' learning engagement has been instrumental in

integrating an educational game permanently in the syllabus of the course their research was about. Hence, the ARCS Model to assess students' learning engagement was adequate to investigate the extent to which an educational game sustained students' attention, made lesson content relevant, engendered confidence, and provided satisfaction. Also, in this new study, the reliability of question items in the survey were assessed with the measurement of Cronbach's alpha using SPSS. Such measurement aimed at determining the degree of reliability of question items to effectively assess attention, relevance, confidence, and satisfaction in the survey.

Statistical Tests

This research study consisted of an empirical research where statistical tests employed aimed at analyzing data to investigate whether an interactive business simulation game is more effective than a static game, in terms of knowledge acquisition and learning engagement. Statistical tests were conducted with SPSS. A two-sample t-test or a Mann-Whitney U test was employed to first assess the homogeneity of the two groups involved in the research. Afterward, hypothesis tests related to the research questions were conducted. There were couple assumptions to verify when using a t-test, and they included data being continuous or ordinal scale, normality of data distribution, adequacy of sample size, and equality of variance in standard deviation. While normality of data distribution was assessed with Shapiro-Wilks normality test, equality of variance in standard deviation was determined through a Levene's test in SPSS. When data was not normally distributed, a non-parametric test called Mann-Whitney U was utilized. Assumptions of data being continuous or ordinal scale, adequacy of sample size, and equality of variance in standard deviation were to be met as well to employ the Mann-Whitney U test.

Test to Establish Groups' Homogeneity

Establishing a baseline knowledge for both control and treatment groups helped minimize knowledge-based differences between the groups (Wright, 2006). A t-test or a Mann-Whitney U test was used to determine whether there was a significant difference between the two groups in terms of baseline knowledge (Park, 2009; Wright, 2006). In the instance of a t-test, at a level of significance $\alpha = 0.05$, the critical t value was determined in accordance with the degree of freedom associated with the sample size, and in the eventuality that the t-statistic was greater than the critical value, the null hypothesis would be rejected. In the case of a Mann-Whitney U test, a p value greater than $\alpha = 0.05$ would result in a non-rejection of the null hypothesis. The statistical result of no differences among the two sample groups in terms of baseline knowledge would pave the way to subsequent statistical analysis involving hypothesis testing.

Test to Examine Hypothesis Test Related to Learning Engagement

Responses to item questions in an opinion survey were based on a Likert scale with nominal values including *strongly disagree*, *disagree*, *neutral*, *agree*, and *strongly agree*. The nominal values were assigned discrete numeric scores where 1 corresponds to *strongly disagree*, 2 corresponds to *disagree*, 3 corresponds to *neutral*, 4 corresponds to *agree*, and 5 corresponds to *strongly agree* as indicated in Appendix D. However, a student's overall numeric score of the opinion survey was obtained by averaging the scores of the ten questions in the survey. As continuous numeric values, the obtained average scores were used to conduct a t-test, or a Mann-Whitney U provided other assumptions were met.

The hypothesis test related to research question 1 was to determine if the mean value of the rating in learning engagement for the treatment group was greater than that of the control

group given a level of significance $\alpha = 0.05$. If the t-test resulted in a rejection of the null hypothesis, that would mean the learning engagement from the treatment group was greater than that of the control group at a statistically significance level $\alpha = 0.05$. In the instance of data not being normally distributed, a Mann-Whitney U test would be employed, and a p value greater than $\alpha = 0.05$ would mean that the learning engagement from the treatment group and the control group were equal at a statistically significance level $\alpha = 0.05$.

Test to Examine Hypothesis Test Related to Knowledge Acquisition

Each students' gain score would be calculated by subtracting their pre-test score from the post-test score. The hypothesis test related to research question 2 was to determine if the mean value of gain scores between the pre-test and post- test for the treatment group was greater than that of the control group given a level of significance $\alpha = 0.05$. If the t-test resulted in a rejection of the null hypothesis, that would mean the gain in knowledge by the treatment group was greater than that of the control group at a statistically significance level $\alpha = 0.05$. If the data was not normally distributed, a Mann-Whitney U test would be employed, and a p value greater than $\alpha = 0.05$ would mean the gain in knowledge by the treatment group was equal to that of the control group at a statistically significance level $\alpha = 0.05$

In summary, the purpose of this research study was to examine the effect of an interactive game of business simulation as an instructional approach in terms of knowledge acquisition and learning engagement. The use of a causal comparative design as the method of inquiry aimed at examining differential effects of static games in traditional teaching and interactive game of business simulation in terms of knowledge acquisition and learning engagement. The study was conducted at a two-year college in the Southeast region of the United State of America with a control group and an experimental group. The next chapter involved data collection where

responses to item questions in an opinion survey were to examine learning engagement in research question 1. Data collected through pre-tests and post-tests in both experimental and non-experimental classrooms examined knowledge acquisition in research question 2.

CHAPTER 4

DATA COLLECTION AND STATISTICAL TESTS

This research study proposed the use of an interactive business simulation game as an instructional tool versus traditional static games to facilitate students' understanding of decision-making processes involved in business strategic decisions. The study used a quasi-experimental research design to compare the efficacy of an interactive business simulation game with that of static games (traditional teaching approach) in terms of learning motivation and knowledge acquisition. The first research question to compare both instructional approaches (interactive game versus static games) was to determine the difference in learning engagement while the second research question examined the difference in knowledge acquisition between students learning business strategic decisions through an interactive game and those with static games at a two-year college in the Southeast region of the United States of America.

This chapter presented data collection, statistical tests, and analysis where data collected through pre-tests and post-tests in both experimental and non-experimental classrooms aimed at examining knowledge acquisition while data obtained through responses to item questions in an opinion survey examined learning engagement. Statistical tests and data analysis were performed with SPSS. The attempt to provide answers to the two research questions first involved the examination of the reliability of instruments of measurement for knowledge acquisition and learning engagement. Next, sample groups' homogeneity was assessed, and then statistical tests related to the research questions were conducted.

Reliability of Instruments of Measurement

Reliability of the Pretest and Posttest Questionnaires for Knowledge Acquisition

Test questions selected for the pretest and the posttest in this research study were selected from a bank of formative assessment questions provided by the textbook used at the college where the study was conducted. The textbook was the 18th edition of Economics Today by Miller (2008). The reliability of item questions to effectively reflect the learning objectives of lessons of monopolistic competition and oligopoly markets was determined through Cronbach Alpha Coefficient. As explained in chapter 3, Cronbach Alpha Coefficient examined questionnaire's internal consistency with a measurement threshold of 0.7.

The measurement of Cronbach Alpha Coefficient for pretest and posttest questionnaires were conducted irrespective of a specific group because the focus of the measurement was to determine questionnaire's internal consistency which is not related to a specific group. Thus, data to measure the Cronbach Alpha Coefficient for the pretest questionnaire is found in Appendix E and involved scores of 20 test questions from 70 students (35 students in the control group and 35 students in the experimental group combined). Similarly, scores of 20 test questions in the posttest from 70 students (35 students in the control group and 35 students in the experimental group combined) are found in Appendix F. The Cronbach Alpha Coefficient of 0.71 obtained for the pretest exam questionnaire slightly exceeded the acceptable threshold of 0.7 explained in chapter 3. That suggested that the pretest exam questionnaire's internal consistency reliability was sufficient to assess students' baseline knowledge in this research study. For the posttest exam questionnaire, the Cronbach Alpha Coefficient of 0.73 obtained slightly exceeded the acceptable threshold of 0.7, which suggested that the posttest

questionnaire's internal consistency reliability was sufficient to assess students' gain in knowledge in this research study.

Reliability of the Survey Questionnaire for Learning Engagement

The survey used in this research study was based on the ARCS Model to assess students' learning engagement. The reliability of 10 item questions contained in the survey was assessed with Cronbach Alpha Coefficient. Such measurement aimed at determining the degree of reliability of 10 item questions to effectively assess attention, relevance, confidence, and satisfaction described in the ARCS Model. The post-lesson survey questionnaire data are found in Appendix G. Each row in the table presents item scores of 10 survey questions for each of the 70 students who took the post-lesson survey (35 students in the control combined with 35 students in experimental group). Like the Cronbach Alpha Coefficient measurement in the pretest and posttest item questions, data from the control and experimental groups were combined because the measurement was not related to a specific group. The Cronbach Alpha Coefficient of 0. 9 obtained exceeded the acceptable threshold of 0.7, which suggested that the survey questions' internal consistency reliability was sufficient to assess students' learning engagement in this research study.

Groups' Homogeneity Assessment

Groups' Demographic Composition

The quasi-experimental design employed in this causal comparative study involved two groups of participants assigned to treatment conditions in a nonrandom manner. To obtain reliable statistical inferences based on valid data, the two groups of participants needed to have similar characteristics such as gender, ethnicity, and age (Shadish et al., 2002; Reichardt, 2019). The study was conducted at a two-year college in the Southeast region of the United States of

America and the sample demographic in both groups was quite similar in terms of gender, ethnicity, and age range. As presented in Table 8, there were 14 females and 21 males in the control group. In the experimental group, there were 15 females and 20 males. In terms of ethnicity, both groups were largely composed of white students as shown in Table 9. In the control group, there were 15 White, 8 Blacks, 6 Hispanic, and 6 Asians while in the experiment group there were 22 White, 5 Blacks, 5 Hispanic, and 3 Asians. Students' ages ranged from 18 to 25-year-old in both groups.

Table 8
Groups' Gender Composition

	Control Group	Experimental Group
Female	14	15
Male	21	20
Total students	35	35

Table 9
Groups' Ethnicity Composition

	Control Group	Experimental Group
White	15	22
Blacks	8	5
Hispanic	6	5
Asians	6	3
Total students	35	35

Statistical Test for Groups' Baseline Knowledge

Establishing a baseline knowledge for both control and experimental groups helped minimize knowledge-based differences between the groups (Wright, 2006). The data for this statistical test is found in Appendix H. Data from each sample group (control and experimental)

was subjected to the Shapiro-Wilks Normality test to determine if the data were normally distributed. The results showed that the pretest data for the control group ($W = 0.926$, 35, $p = 0.021$) was significantly different from the standard normal distribution at $\alpha = 0.05$. However, the pretest data for the experimental group ($W = 0.962$, 35, $p = 0.260$) was not significantly different from the standard normal distribution at $\alpha = 0.05$. Given that the data for the control group did not meet the normality criteria, a non-parametric Levene's test for equal variances of the samples was performed. The test performed in SPSS showed a result of $p = 0.525$, which suggests that the within group variances of the control and experimental groups are not significantly different at a significance level of $\alpha = 0.05$.

With the criteria of equal variances and independent samples being met, a Mann-Whitney U test was conducted to determine whether there was a difference in the pretest scores between the control and experimental groups. The Mann-Whitney U test is a non-parametric test used when data are not normally distributed. The independence of samples and equal variances are required conditions for proper statistical inferences to be made. The result of the Mann-Whitney U test indicated non-significant difference between groups, [$U = 558.5$, $p = 0.523$]. In conclusion, there was no significant difference in terms of baseline knowledge between the control and the experimental groups at a significance level $\alpha = 0.05$.

Table 10

Descriptive Data for Pretest Scores to Assess Baseline Knowledge

	Observations	mean	SD
Control Group	**35**	45.28571429	17.06143127
Experimental group	**35**	42.42857143	16.90681331

Statistical Tests of Research Questions

The Statistical Tests to Examine Learning Engagement in Research Question1

Research question 1 was to determine if the learning engagement of the experimental group was greater than that of the control group and the data for this statistical test is found in Appendix H. The columns in the table present the averaged value of each student's responses to the 10 item questions of the post-lesson survey.

Data from each sample group (control and experimental) was subjected to the Shapiro-Wilks Normality test to determine if the data were normally distributed. The results showed that the post-lesson survey data for the control group ($W = 0.738$, 35, $p < 0.001$) was significantly different from the standard normal distribution at a significance level $\alpha = 0.05$. However, post-lesson survey data for the experimental group ($W = 0.979$, 35, $p = 0.724$) was not significantly different from the standard normal distribution at a significance level $\alpha = 0.05$. Given that the data from the control group did not meet the normality criteria, a non-parametric Levene's test for equal variances of the samples was performed.

The test performed in SPSS showed a result of $p = 0.078$, which was an indication that the within group variances of the control and experimental groups were not significantly different at a significance level of $\alpha = 0.05$. With the criteria of equal variances and independent samples being met, a Mann-Whitney U test was conducted to determine whether there was a significant difference in the post-lesson survey scores between the control and experimental groups. The result of the Mann-Whitney U test indicated a non-significant difference between groups, [$U = 467$, $p = 0.086$]. In conclusion, there was no significant learning engagement between the control and the experimental groups at a significance level $\alpha = 0.05$. Also, a Cohen's d value of -0.29 obtained suggested a smaller effect. The standard Cohen's d effect sizes are 0.2

(small), 0.5 (medium), and 0.8 (large) (Kraft, 2020). A d = -0.29 indicated that the control group had a rating score of 0.29 standard deviations higher than the experimental group.

Table 11
Descriptive Data for the Survey Scores to Assess Learning Engagement

	Observations	Mean	SD
Control Group	**35**	4.348571	0.764034
Experimental group	**35**	4.28	0.360392

Statistical Tests to Examine Knowledge Acquisition in Research Question 2

Research question 2 was to examine the difference in knowledge acquisition between the groups. The data for this statistical test is found in Appendix H. The columns in the table present the gain scores of each student in both the control and experimental groups.

Data from each sample group (control and experimental) was subjected to the Shapiro-Wilks Normality test to determine if the data was normally distributed. The results showed that the gain score data for the control group (W = 0.954, 35, p = 0.154) and the experimental group (W = 0.987, 35, p = 0.951) were both not significantly different from the standard normal distribution at $\alpha = 0.05$. Given that gain score data for the control and experimental groups were normally distributed, a parametric Levene's Test for Equality of Variances of the sample groups was performed in SPSS with a result of p = 0.254, which suggested that the within group variances of the control and experimental groups were not significantly different at a significance level of $\alpha = 0.05$. With criteria of independent samples, equal variances, and normal distribution met, an independent t-test was performed in SPSS. Given the directional t-test result of $t(68) = 0.529$, p = 0.599, the 35 students in the control group who took the pretest and posttest exams (M = 18.86, SD = 20.15) compared to the 35 students in the experimental group who took

the pretest and posttest exams (M = 21.29, SD = 18.24) showed no significant difference in terms of gain in knowledge at a statistically significance level $\alpha = 0.05$. Moreover, a Cohen's d value of 0.126 obtained suggested a smaller effect. A $d = 0.126$ indicated that the experimental group had a gain score of 0.126 standard deviations higher than the control group.

Table 12
Descriptive Data for Gain Scores to Assess Knowledge Acquisition

	Observations	Mean	SD
Control Group	**35**	18.85714286	20.14965
Experimental group	**35**	21.28571429	18.24437

Summary of Findings

This chapter presented data obtained through a quasi-experimental design involving control and experimental groups. The research inquiry was to explore two research questions. Question 1 was to determine if the learning engagement of the experimental group was greater than that of the control group. The result of the Mann-Whitney U test [$U = 467$, $p = 0.086$] suggested that there was no significant difference in learning engagement between the control and the experimental groups at a significance level $\alpha = 0.05$. Question 2 was to examine the difference in knowledge acquisition between the groups. The directional t-test result of $t(68) = 0.529$, $p = 0.599$ showed no significant difference between the control group (involved in the static game) and the experimental (involved in the interactive game) in terms of gain in knowledge at a statistically significance level $\alpha = 0.05$.

CHAPTER 5

DISCUSSION AND CONCLUSION

Research Purpose

Experiential learning in the curriculum of business, economics, and entrepreneurship education has been common pedagogical practice with the goal to equip students with adequate problem-solving skills (Rideout & Gray, 2013). Thus, experiential learning tools such as static games are commonly used in the study of market structures to provide a visual depiction of complex mathematic formulas that model decisions in a competitive market. Given the limitations of static games in helping students to develop extemporaneous decision-making skills in an ongoing business competition, this research study inquired about an alternative game-based learning tool to enhance business strategic management and entrepreneurship education.

This research study proposed the use of an interactive business simulation game as an alternative experiential learning tool to achieve the learning objectives pursued in the curriculum of business, economics, and entrepreneurship education (King et al., 2011). The use of a business simulation game can potentially engage students while facilitating their understanding of the practical application of knowledge acquired (Lengyel, 2020; Vlachopoulos & Makri, 2017). Hence, the focus of this study was to compare the effectiveness of an interactive business simulation game to that of a static game (traditional teaching approach) in terms of learning engagement and knowledge acquisition. The learning process through which learning engagement and knowledge acquisition are achieved using an interactive business simulation game in entrepreneurship and economics education was elaborated through the theoretical framework of this research study.

Theoretical Framework

The proposed theoretical framework explained how the learning objectives in the game theory which involves economic concepts modeling business strategic decisions are achieved. In effect, the learning objectives pursued in the interactive business simulation game in this study were to engage students in making strategic decisions to grow a business from scalability to sustainability in an ongoing business competition. Achieving such learning objectives involves learning theories incorporated in the interactive business simulation game, which include the flow theory in game-based learning, Kolb's experiential learning in a group, and problem-based learning (Bethell & Morgan, 2011; Kolb & Kolb, 2009; Kiili, 2005). These learning theories unfold along three stages: *Input, process*, and *outcome* which align with the functional areas in the design of an interactive game including *game mechanics*, *learning mechanics*, and *assessment mechanics* (Turkay et al., 2014). The functional areas in the design of an interactive game, including the assessment mechanics, provide the supporting theory in the choice of a causal comparative design as the research inquiry method.

Research Inquiry Method

The use of a causal comparative design as the method of inquiry aimed at examining differential effects of static games in traditional teaching and interactive game of business simulation in terms of learning engagement and knowledge acquisition. The causal comparative method involved a quasi-experimental research design with a control group and an experimental group. Through the quasi-experimental design, data were collected and subsequently used for statistical tests and analysis to provide answers to the following research questions:

1. What is the difference in learning engagement between students learning business strategic decisions through an interactive game and those with a static game at a two-year college in the Southeast region of the United States of America?
2. What is the difference in knowledge acquisition between students learning business strategic decisions through an interactive game and those with a static game at a two-year college in the Southeast region of the United States of America?

This last chapter of the research study includes a summary of major findings as it relates to differential effects of static games in traditional teaching and interactive game of business simulation in terms of knowledge acquisition and learning engagement. The chapter also includes a discussion of the findings, limitations of the research method, recommendations, and conclusion.

Findings

The causal comparative research method employed in this study was executed through a quasi-experimental design involving a control group and an experimental group. With the goal to assess differential effects between those two groups in terms of learning engagement and knowledge acquisition, the control group was assigned a static game-based class lecture while the experimental group was placed in an interactive game simulation class. Data collected through the quasi-experiment were used to assess the reliability of instruments of measurement, to determine groups' homogeneity, and to conduct statistical tests related to the research questions.

The Reliability of Instruments of Measurement and Groups' Homogeneity

The internal consistency for questionnaires related to pretest, posttest, and survey were found reliable with Cronbach Alpha Coefficients greater than the threshold of 0.7. The homogeneity of the control and experimental groups in terms of demographic composition and baseline knowledge needed to be established to ensure the validity of the statistical inferences in this research study. The data showed that both groups were quite similar in terms of gender and ethnicity. There were approximately the same number of male and female in both groups. In terms of ethnicity, both groups were largely composed of white students. Blacks, Spanish, and Asians were in smaller numbers. The statistical test for baseline knowledge performed with Mann-Whitney U test suggested that there was no significant difference in terms of baseline knowledge between the control and the experimental groups at a significance level $\alpha = 0.05$.

Statistical Tests Related to the Research Questions

Research questions to determine differential effects in terms of learning engagement and knowledge acquisition between static game-based learning and interactive game-based learning were formulated through hypothesis test statements. For research question 1, the null hypothesis test was to determine if the mean value of post-lesson rating in learning engagement for the treatment group was equal to that of the control group given a level of significance $\alpha = 0.05$. Meanwhile, the alternative hypothesis was to determine if the mean value of post-lesson rating in learning engagement for the treatment group was greater than that of the control group given a level of significance $\alpha = 0.05$. The statistical test to reject or not to reject the null hypothesis was performed with Mann-Whitney U. The result failed to reject the null hypothesis, which suggested that there was no difference in learning engagement between the control and the experimental groups at a significance level $\alpha = 0.05$.

For research question2, the null hypothesis test was to determine if the mean value of gain scores between the pre-test and the post-test for the treatment group was equal to that of the control group given a level of significance $\alpha = 0.05$. The alternative hypothesis was to determine if the mean value of gain scores between the pre-test and the post-test for the treatment group was greater than that of the control group given a level of significance $\alpha = 0.05$. A directional t-test result failed to reject the null hypothesis, which suggested that there was no significant difference between both groups (control and experimental) in terms of gain in knowledge at a statistically significance level $\alpha = 0.05$.

Discussion

The challenge to identify learning attributes and mechanics to incorporate in an interactive game to achieve knowledge acquisition and learning engagement had been subject of interest among educational scholars. According to Proulx et al. (2017), the potential of games to foster motivation and learning might not manifest unless certain requirements regarding the game, the learners, and the learning objectives are met. Vlachopoulos & Makri (2017) further echoed such concern about the design of an interactive game to fulfill its intended learning objectives in terms of knowledge acquisition and learning engagement. The authors explained that designers must pay attention to characteristics such as the technical challenges associated with the game design, the players involved in gaming, and the teaching modes.

In a sense, the literature tried to highlight the importance of functional areas in the design of an interactive game such as *game mechanics*, *learning mechanics*, and *assessment mechanics* presented by Turkay et al. (2014) to engender knowledge as well as learning engagement. In the course of time, concerns raised by scholars regarding the design of an interactive game to effectively fulfill the learning objectives of knowledge acquisition and learning engagement

contributed to the improvement of the design of interactive games for educational purposes. Thus, Lengyel (2020) argued that the game-based learning presented in his research article worked successfully in delivering knowledge in higher education and the number of the active students grew from semester to semester, because they had worked to incorporate the functional areas of an effective game design described by Turkay et al. (2014). The author added that gamification became more and more popular in the field of education as a result of students' engagement.

Just like previous inquiries regarding the effectiveness of an interactive game, this research study intended to explore the efficacy of an alternative pedagogical tool to enhance experiential learning in entrepreneurship and economics education. The pedagogical tool explored was an interactive business simulation game. The effectiveness of the game was measured in terms of learning engagement and knowledge acquisition.

Learning Engagement

Students in each group (control and experimental) positively reacted to game-based learning approaches with an overall mean rating score of 4.3 out of 5. Such findings support the argument that experiential learning tools are viable learning tools in terms of extrinsic motivation. Even though the study showed that an interactive game simulation drew a high level of interest from the participants in learning concepts of economics and entrepreneurship (mean rating score of 4.3 out of 5), the study failed to show that such interest was greater than that of a static game.

Even though there was no significant difference between the two experiential learning approaches in terms of learning engagement, it was interesting to note improvement made during the interactive game by participants in understanding important moves and countermoves to stay

competitive. Those moves and counter moves showed participants' adaptability to solve problems through collaborative efforts and engagement among team members (Bethell & Morgan, 2011; Hmelo-Silver, 2004). The collaborative effort to solve simulated business challenges showed that an interactive business game simulation can potentially equip students with creative skills and teamwork aptitude sought after in today's world of entrepreneurship.

Knowledge Acquisition

Students in the experimental group had an average gain score of 21 points versus an average gain score of 19 points in the control group. Even though the difference in gain score between both groups was not significant, it was encouraging to note that an interactive game could positively influence students' knowledge acquisition. Hmelo-Silver (2004) argued that team members are more effective in problem solving and more motivated when they follow the problem-based learning cycle, which involves identifying facts in a problem scenario, generating hypothesis, identifying knowledge deficiencies, and applying new knowledge. Moreover, the holistic view of learning in Kolb's experiential learning theory was greatly displayed in the interactive game simulation.

Kolb's experiential learning theory explained a process of constructing knowledge along an ongoing interaction of four learning styles, which are a) active experiment in a context of concrete experiment, b) active experiment in a context of abstract conceptualization, c) reflective observation in a context of concrete experiment, d) reflective observation in a context of abstract conceptualization (Kolb & Kolb, 2009; Kayes et al., 2005). Those four learning styles were displayed throughout the interactive game as students were immersed in intense moments of strategic decision-making (Kriz, 2003). Thus, this research showed that concepts of business strategic decisions mathematically formulated in terms of cost assessment, pricing strategy, and

profit maximization can be taught through tactical moves and countermoves in an interactive business game simulation. Students' higher scores obtained in the posttest compared to their scores in the pretest attest to the potential of an interactive game learning approach to facilitate knowledge acquisition.

In summary, the overall statistical analysis did not show a significant difference between this interactive game and a static game (traditional teaching approach). However, the evidence presented in this research in terms of learning engagement and gain in knowledge provided some encouragements. With further time and iteration, and effective integration of functional areas in game design described by Turkay et al. (2014), it is possible that the interactive game could grow its efficacy in helping students to develop extemporaneous decision-making skills in an ongoing business competition.

Limitations of the Study

Given the nature of this research study which was to compare two game-based teaching approaches, the choice of causal comparative design as the research method was adequate to establish a relationship between the independent variable (game-based teaching) and dependent variables (learning engagement and knowledge acquisition). Moreover, the use of a quasi-experimental design offered the advantage of numeric data collection and subsequent data analysis. However, given the non-randomized sampling in the group formation, it was not possible to exclude other factors capable of impacting the dependent variables (Shadish et al., 2002; Reichardt, 2019). Moreover, confounding factors associated with the design of the game, experiment setting, and outcome measures posed a possible threat to internal validity (Reichardt, 2019; Shadish et al., 2002).

Because no assessment was conducted to determine the level of students' motivation prior to the lessons in both groups, the claim of groups' homogeneity was limited in terms of baseline learning engagement. Moreover, the class schedule for the experiment group was Monday morning while the class for the control group was mid-day on Tuesday. The difference in day and time could have caused an information diffusion among students and therefore affected the results of pretest and posttest. In addition, students' enthusiasm to attend class in the morning or mid-day could have been different and might have affected students' learning engagement. Finally, data analysis to assess students' learning engagement along the specific attributes (described in chapter 3) of the ARCS Model which are *attention, relevance, confidence, and satisfaction* as opposed to students' overall learning engagement could have provided additional insights regarding students' learning engagement. For instance, further inquiry could have compared the average rating scores for the *satisfaction* attribute in the experimental group to that of the control group at a statistically significance level $\alpha = 0.05$.

Recommendations

Educational research inquiries to compare the effectiveness of various instructional tools often employ quasi-experiment design to collect data and conduct statistical analysis. Shortcomings highlighted in this quasi-experimental design can help improve settings of future educational research using causal comparative research method. Moreover, students' positive learning experience shown in this study should further encourage instructors in the field of economics and entrepreneurship education to use interactive games in the classroom.

Future Research Settings

Research setting in a quasi-experimental design is very important for data validity to assess the effectiveness of game-based instructional tools. For future research, scheduling

lessons for the control and experimental groups in the same day might increase control of some of the confounding variables capable of affecting dependent variables such as learning engagement and knowledge acquisition. Such a scheduling approach might potentially minimize the diffusion of information among students and prevent the possibility of one group having an advantage over another group. Moreover, future researchers can investigate the extent to which an increase in the duration of class sessions to 4 weeks or more may affect the outcome of knowledge acquisition in both groups.

Future Research Inquiries

The assessment of knowledge acquisition can further be segmented along two learning objectives. On one hand, knowledge assessment will involve students' understanding of the difference between monopolistic competition and oligopoly markets (multiple choice questions). On the other hand, knowledge assessment will involve graphic determination of price, output, and cost assessing students' ability to apply key characteristics of a monopolistic competition market in computing profits (computation questions). Such additional inquiry of knowledge acquisition between the control and the experimental groups presents the opportunity to investigate each group's knowledge performance along the two learning objectives described above.

Also, as explained in chapter 3, in contrast to the use of static game to explain the rationale of oligopolists' final decisions in an oligopoly market, an interactive business simulation game immersed students in the process of strategic decision-making where the decisions are made by the students themselves through moves and countermoves in a live experience. Moreover, those decisions throughout the competitions are extemporaneous decisions involving two opposing oligopolists that each team represents. Thus, additional data

collected via videos will enable the observation of a didactic learning approach (static game) where students are presented business decisions already made versus a constructivist learning approach (an interactive business simulation game) involving students' extemporaneous decision-making activities. Such observation offers the opportunity for a qualitative research approach to further investigate the difference between the instructional tool of a static game and an interactive business simulation game.

Finally, given that the interactive game used in this research was a digital interactive game involving data analytics, future causal comparative study to compare such instructional tool to that of a static game can be conducted in a technology-oriented institution. The outcome of such study in terms of knowledge acquisition and learning engagement can then be compared to this study which was conducted in a college that is not technology oriented. In addition, the findings in this research study can further encourage the use of interactive game simulation in the field of economics and entrepreneurship education.

The Development and the Use of Interactive Games

The research findings regarding the effectiveness of an interactive business simulation game were promising. Participants in this research study were found to be engaged in their learning experience in using the interactive game as an instructional tool to learn practical applications of business strategic management in entrepreneurship. Moreover, participants' gains in knowledge suggest that the understanding of complex mathematic formulas used to model economic concepts can be facilitated through an interactive business simulation. These findings provide additional evidence for the need to scale up the development of innovative interactive learning tools to advance students' critical thinking skills in the field of entrepreneurship and economics education.

According to King et al. (2011), the use of an interactive on-line business simulation game called Business Strategy Game (BSG) facilitated the understanding of business concepts such as marketing mix, production scheduling, and financing a business as teams from around the world engaged in simulated business competition. Von Wangenheim et al. (2012) explained that an educational game was permanently integrated in the syllabus of the course they researched because of the positive feedback obtained about students' learning engagement. Likewise, instructors across colleges and universities should make the efforts to incorporate innovative interactive tools in their instructional strategies as part of the quest to advance experiential learning in the field of economics and entrepreneurship education.

Conclusion

The industrial revolution which took off in the mid-1700s was arguably propelled into the post-World War 2 era by entrepreneurship initiatives at a global scale. The importance of entrepreneurship initiatives in the massive production of consumer goods and the global distribution of such goods did capture the interest of educational institutions. In effect, business models employed to advance entrepreneurial practices became subject of inquiries in business and economics research papers. A number of those research findings were adopted and incorporated in pedagogical strategies and tools along entrepreneurship and economics curriculums. Looking into the future, entrepreneurial economics will continue to play a pivotal role in the unfolding journey of globalization. As such, there is a consensus among scholars that pedagogical strategies and tools in entrepreneurship and economics education ought to be innovative to equip students with adequate critical thinking skills to address the complexity of economic issues as they enter the global workforce. Considering the pressing need for pedagogical innovation, this study intended to advance the on-going research works in exploring

innovative experiential learning tools such as interactive game simulation. The findings in this research are quite encouraging and the recommendation going forward is to intensify the development and the use of interactive game simulation in the field of entrepreneurship, economics, and business strategic management.

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APPENDIX A

Static Game-Based Lecture

Agenda of Microeconomics Studies

Course content and schedules

- **Course content**

  Lecture Topics: Economics Overview and Modeling in Economics Studies

  Chapter 1 – The Nature of Economics
  Chapter 2 – Scarcity and the World of Trade – Offs

  Lecture Topics: Demand and Supply Models

  Chapter 3 – Demand and Supply
  Chapter 28 – Labor Market
  Chapter 21 – Rents, Profits, and the Financial Environment of Business
  Chapter 9 – Demand and Supply Elasticity

  Lecture Topics: Consumer's Utility and Producer's Profit Determinations

  Chapter 20 – Consumer Choice
  Chapter 22- The Firm: Cost and Output Determination

  Lecture Topics: Market structures

  Chapter 23 - Perfect Competition
  Chapter 24 - Monopoly
  Chapter 25 – Monopolistic Competition
  Chapter 26 – Oligopoly and Strategic Behavior

Monopolistic Competition Market

Market's characteristics

Monopolistic competition market involves many firms selling products that are differentiated, and in which there is easy entry and exit. Sellers offer a differentiated product based on quality or location, and they are price setters. A seller sells more by charging less and raises its price without losing all of its customers.

Mathematic Identities for Profit Maximization and Computation Practices

The mathematic identity for profit maximization is MR = MC where MR denotes marginal revenue, and MC denotes marginal cost. Data to compute profit is obtained graphically. Students will read the values for price, quantity, and average total cost from the graph based on the identities above. P denotes price; ATC denotes average total cost; and Q denotes quantity or output. According to the graph in Figure 1 below, we obtain the following data:

- P = 70
- Q = 250
- ATC = 30

We compute total revenue, total cost, and total profit as follow:

- Total cost = Q*ACT

  = 250*30

  = 7,500

- Total revenue = Q*P

  = 250*70

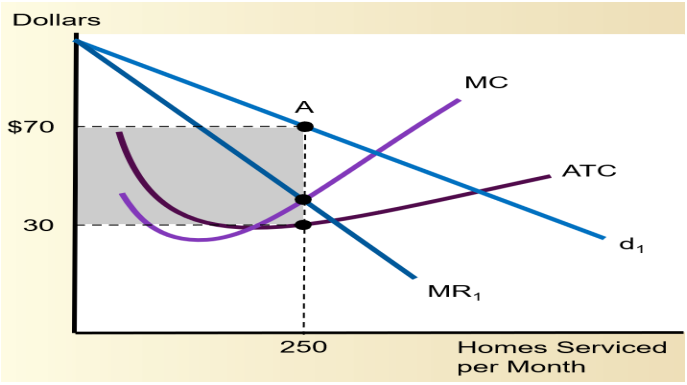
  = 17,500

- Profit = Q*(P – ATC)

  = 250*(70 – 30)

  = 10,00

Figure 1



Oligopoly Market Structure

Oligopoly market structure consists of a market dominated by a small number of strategically interacting firms. Firms anticipate how the competitors respond to a change in price or output. The game theory is used to model an oligopoly market structure.

Game Theory

The game theory is an approach to modeling the strategic interaction of oligopolists in terms of moves and countermoves. Modeling strategic interactions of oligopolists can be done through complex mathematic formulations such as Stackelberg's duopoly model involving two oligopolists. Also, static games are used to simplify the understanding of strategic decisions of oligopolists in an oligopoly market structure.

Traditional Static Game Lecture

In traditional lecture, static games are commonly used to illustrate concepts of game theory to facilitate the understanding of the underlying idea of strategic decisions involved in an oligopoly market structure. The following is an example of a static game to illustrate strategic decisions between two oligopolists: Microsoft and Netscape.

There are two essential strategic reactions considered in modeling the competition between Microsoft and Netscape: to "share" and to "compete". While the "share" strategy advocates collaboration among businesses, the "compete" strategy encourages more competition in the browser industry. The payoff used in the model are based on estimated profit from both firms' financial record and projections. In this game theory model, Microsoft's most beneficial strategy is to "share" because it is the best possible action regardless of Netscape's strategy. Similarly, the most beneficial strategy for Netscape is to "compete" because that is the best position no matter what Microsoft's strategy is. As described in the matrix, Microsoft and

Netscape make respectively 900 million and 10 million profits when both companies adopt their most beneficial decisions. Those decisions are “share” for Microsoft and “compete” for Netscape. The matrix also shows that subsequent deviations from most beneficial decisions lead to unfavorable outcomes.

Table 1

Strategic Decisions and Outcomes in an Oligopoly Market involving Microsoft and Netscape

		Netscape	
		Share	*Compete*
Microsoft	Share	1 billion profit for microsoft 3 million profit Netscape	900 million profit for Microsoft 10 million profit for Netscape
	Compete	420 million profit for Microsoft 1 million loss for Netscape	170 million profit for Microsoft 1 million profit for Netscape

APPENDIX B

Interactive Game-Based Lecture

Monopolistic Competition Market

Market's characteristics

Monopolistic competition market structure involves many firms selling products that are differentiated, and in which there is easy entry and exit. Sellers offer a differentiated product based on quality or location, and they are price setters. A seller sells more by charging less and raises its price without losing all of its customers.

Mathematic Identities for Profit Maximization and Computation Practices

The mathematic identity for profit maximization is MR = MC where MR denotes marginal revenue, and MC denotes marginal cost. Data to compute profit is obtained graphically. Students will read the values for price, quantity, and average total cost from the graph based on the identities above. P denotes price; ATC denotes average total cost; and Q denotes quantity or output. According to the graph in Figure 1 below, we obtain the following data:

- P = 70
- Q = 250
- ATC = 30

We compute total revenue, total cost, and total profit as follow:

- Total cost = Q*ACT

  = 250*30

  = 7,500

- Total revenue = Q*P

  = 250*70

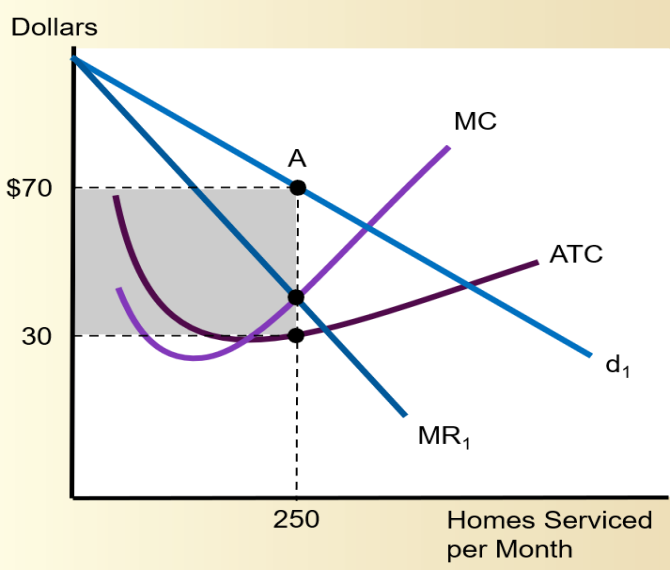
  = 17,500

- Profit = Q*(P – ATC)

  = 250*(70 – 30)

  = 10,000

Figure 1



Oligopoly Market Structure

Oligopoly market structure consists of a market dominated by a small number of strategically interacting firms. Firms anticipate how the competitors respond to a change in price or output. The game theory is used to model an oligopoly market structure.

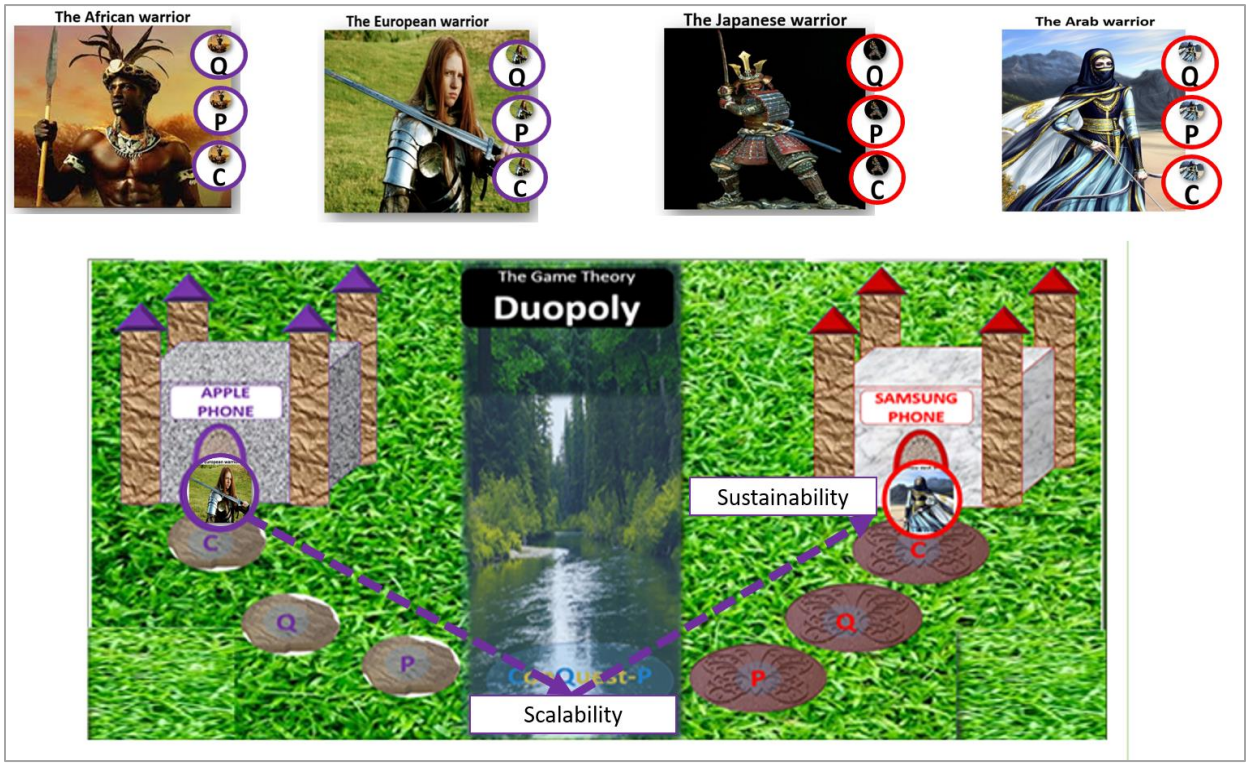
Game theory

The game theory is an approach to modeling the strategic interaction of oligopolists in terms of moves and countermoves. Modeling strategic interactions of oligopolists can be done through complex mathematic formulations such as Stackelberg's duopoly model involving two oligopolists. In this interactive game-based lecture, strategic decisions of two oligopolists are simulated where students are engaged in an ongoing business competition.

Learning objectives in the Interactive Game-Based Lecture

The learning objective in this interactive game-based lecture is to simulate decision-making processes to grow a business from scalability to sustainability in a competitive business environment. The abstract nature of concepts of scalability and sustainability can be visualized through the game's narrative involving a business competition between two companies. First, scalability is achieved when a contender reaches the river as indicated in Figure 2. Reaching the river means that the business has attained economies of scale through unit cost reduction. Next, sustainability is achieved when a contender conquers the opponent's castle. In our illustration, Apple reaches the river, crosses over and conquers Samsung's castle. That means Apple has a dominance of the market.

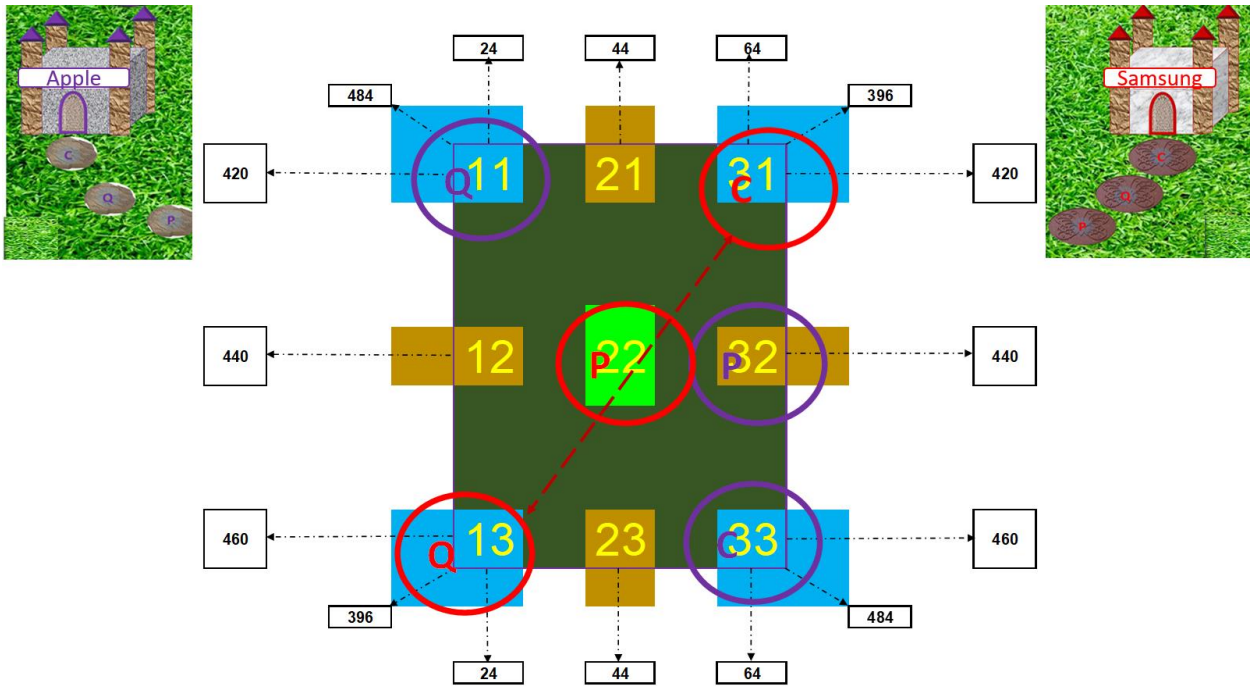
Figure 2
Learning Objective of Growing a Business from Scalability to Sustainability



Moves and countermoves in market segments

Scalability and sustainability are achieved through moves and countermoves performed on the gameboard depicted in Figure 3. Pieces on the gameboard are moved vertically, horizontally, or diagonally through market segments. Skipping a spot or jumping a piece to reach an empty spot is not allowed. The depiction in Figure 3 shows that Samsung won the round because a straight line can connect its three pieces.

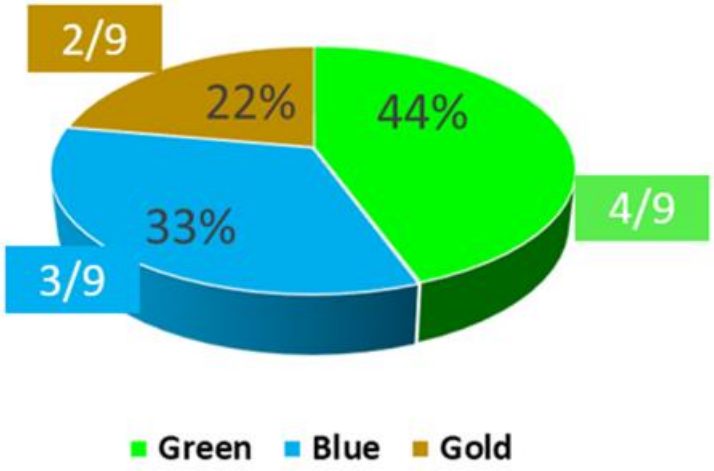
Figure 3
Gameboard



Note: Data are collected at the end of a simulated fiscal year (a fiscal year is one round in the game). Numbers on the peripheral of the gameboard are profit computed in thousand. Students will learn how to compute those numbers.

Market segments are identified as the green spot with 4 possibilities of winning, the blue spots with 3 possibilities of winning, and the gold spots with 2 possibilities of winning as shown in Figures 3 and 4. Strategic decisions involving cost(C), quantity(Q), and price(P) are formulated along those market segments. Successful strategic decisions should lead to a straight line drawn through a contender's three pieces with letters "C", "Q", and "P" as shown in Figure 3.

Figure 4
Market Segments



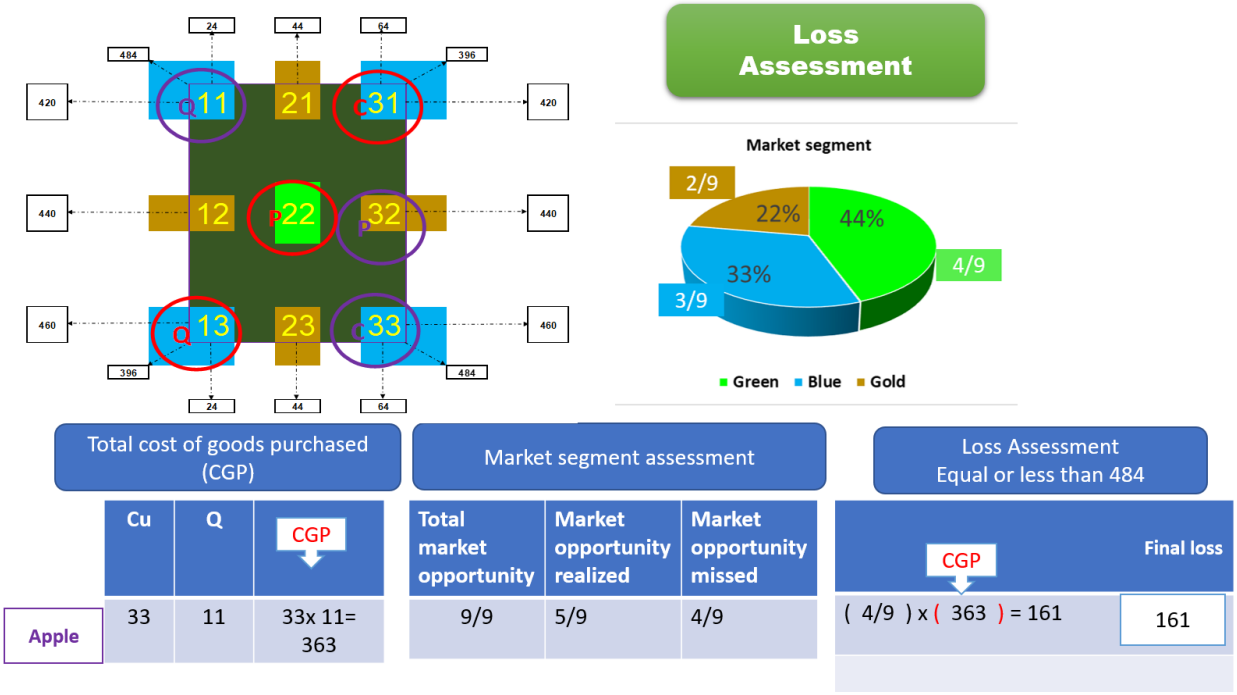
Computations

Computations of cost of goods purchased, cost of goods sold, revenue, and profit incorporated in the interactive business simulation game provide an understanding of business metrics related to business growth stages of scalability and sustainability. In Figure 3, contenders' pieces on the gameboard provide numeric values of costs, quantities, and prices to compute cost of goods purchased, costs of goods sold, revenue, and profit. Numbers on the peripheral of the gameboard are profit made when a contender wins. As indicated in Figure 3, Samsung wins with a profit of $396,000 (profit on the gameboard are in thousand).

Cost of goods purchased is computed to assess the loss of a contender in a round. As indicated in Figure 5, values of unit cost and quantity are obtained on the gameboard. When a contender loses a round, the loss is assessed by determining the portion of the cost of goods purchased that was not sold. Total market opportunity is 9 out of 9. Apple's market opportunity realized is obtained by adding market opportunity of letters "P" and "Q". These letters indicate the market segments in which the company's sales were made. The letter "P" is in the gold

market with a market opportunity of 2/9 and the letter "Q" is in the blue market with market opportunity of 3/9. Therefore, Apple's market opportunity realized is (2/9) + (3/9) = 5/9, and market opportunity missed is (9/9) – (5/9) = 4/9. As a result, Apple's loss is (4/9) *(cost of goods purchased) = (4/9) *363. The final estimated loss is equal to 161 as indicated in Figure 5.

Figure 5
The computation of losses



Graphic Depiction

Business performances leading to business growth stages of scalability and sustainability will be tracked through graphs. Students will have the opportunity to learn the use of graphs to explain business performances.

Achieving scalability: In this business simulation, scalability is achieved through multiple wins with $ 50, 000 cash reward for each. At the end of year one, the graph shows that

both companies have a cash level of negative $100,000. With the assumption that Apple wins two rounds, Apple is rewarded $50,000 for each win and the company's cash level reaches zero or breakeven at the end of year 3 as depicted in Figure 6

Figue 6
An illustration of Cash Reward in the Process of Achieving Scalability

Achieving sustainability: Sustainability is achieved through multiple wins with $50, 000 cash reward for each. With the assumption that Apple wins two rounds, Apple is rewarded $50,000 for each win and the company's cash level reaches zero or breakeven at the

end of year 3 as depicted in Figure 6. After achieving scalability, Apple will achieve sustainability with three additional wins. Each win is rewarded $50,000 and Apple ends up dominating the market with a cash level of $150,000 as indicated in Figure 7

Figure 7
An illustration of Cash Reward in the Process of Achieving Sustainability

APPENDIX C

Knowledge Assessment Instrument

Assessment procedures to examine knowledge acquisition will involve pre-test and post-test in both experimental and non-experimental classes. In this study, test questions are selected in a way that knowledge delivered in both experimental and non-experimental classes is adequately evaluated based on lessons' learning objectives. Learning objectives in lessons of monopolistic competition and oligopoly markets will involve discussing key characteristics of both markets. Moreover, students will learn to evaluate how price, output, and profit are determined in monopolistic competition and oligopoly markets based on the characteristics of each market. Also, students will learn how to apply game theory to evaluate pricing strategies, output, and profits of oligopolistic firms involved in business competition. Pre-test and post-test questions are structured along two types of questions: multiple choice questions and computation questions.

While multiple choice questions intend to assess students' understanding of the distinction of both markets based on key characteristics, computation of profits based on graphic determination of price, cost, and output will assess students' understanding of the application of key characteristics of a monopolistic competition market. Moreover, students' understanding of business strategies of game theory in an oligopoly market will be evaluated though scenarios of business decisions involving price, output, and costs. There will be a total of 20 questions composed of 8 multiple questions, and 12 questions involving some mathematic computation and numeric interpretations. Each question will receive a score ranging from 0 to 1. A student's

initial grade obtained out of 20 will then be converted to a scale of 100. Grades to measure knowledge acquisition through pre-test and post-test questions are continuous type of data provided by grade scores ranging from 0 to 100. Test questions selected for this research study are selected from a bank of questionnaires provided by the test book used at Georgia Military College. The book is the 18th edition of Economics Today by Miller (2008).

Pretest

Multiple choice questions (concepts)

Question1

Entry into a monopolistically competitive industry

A) is easy.

B) is hard.

C) requires governmental approval.

D) requires collusion.

Question 2

In an oligopolistic market, each firm

A) has a constant marginal cost.

B) faces a perfectly elastic demand function.

C) must consider the reaction of rival firms when making a pricing or output decision.

D) produces at minimum average cost in the long run.

Question 3

The distinguishing of products by brand name, color, and other attributes

A) is known as interdependence.

B) is known as product differentiation.

C) leads to many firms in the market.

D) leads to collusion.

Question 4

In which industry structure is advertising and sales promotion likely to be most important?

A) perfect competition

B) monopoly

C) monopolistic competition

D) All of these are equally reliant on effective advertising and promotion.

Question 5

Which of the following is a characteristic of oligopoly?

A) easy entry and exit

B) many firms

C) strategic dependence

D) horizontal market demand curve

Question 6

Strategic behavior and game theory are features of which market structure?

A) perfect competition

B) monopoly

C) monopolistic competition

D) oligopoly

Question 7

A market situation in which a large number of firms produce similar but not identical products is

A) a monopoly.

B) an oligopoly.

C) monopolistic competition.

D) perfect competition.

Question 8

In oligopoly, any action by one firm to change price, output, or quality causes

A) a reaction by other firms.

B) no reaction from the other firms.

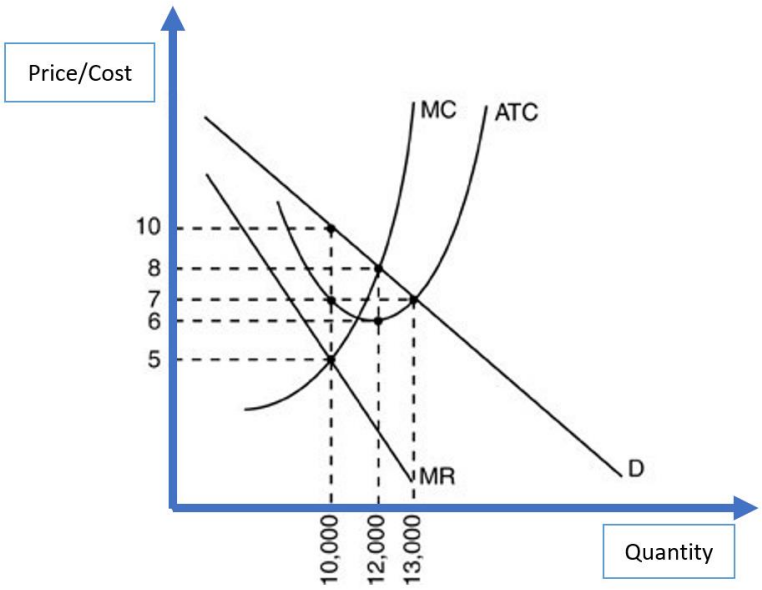
C) a profit gain for the other firms.

D) loss of market share by the acting firm.

Computations and decisions

Monopolistic Competition Market Structure

Figure 1



Question 9

Based on the information in figure 1, what is the output (quantity) at profit maximizing?

Quantity = 10,000

Question 10

Based on the information in figure 1, what is the price at profit maximizing?

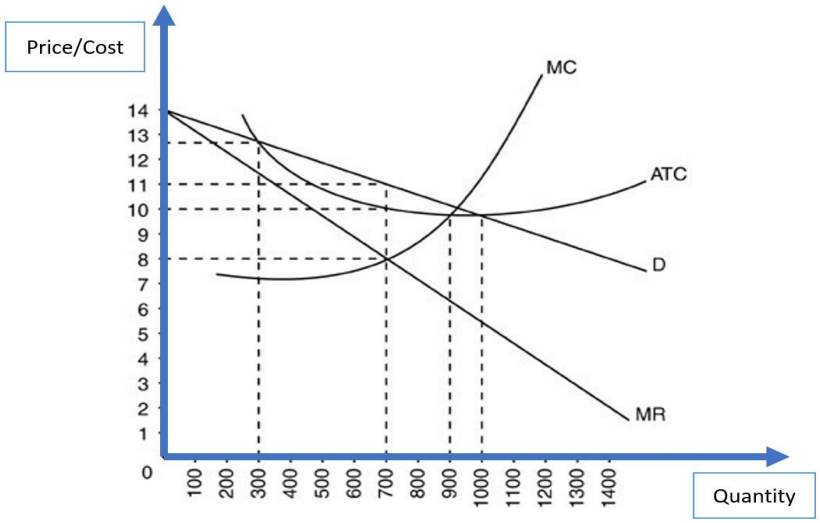
Price = 10

Question 11

Based on the information in figure 1, what is the average total cost (ATC) at profit maximizing?

ATC = 7

Figure 2



Question 12

Based on the information in figure 2, compute total revenue at profit maximizing output

Price = 11

Quantity = 700

Total Revenue = 11*700

= 7,700

Question 13

Based on the information in figure 2, compute total cost at profit maximizing output

ATC = 10

Quantity = 700

Total Cost = 10*700

= 7,000

Question 14

Based on the information in figure 2, compute total profit at profit maximizing output

Price = 11

ATC = 10

Quantity = 700

Total Profit = 700*(11-10)

= 700

Oligopoly Market

There are two companies, Excellent Coffee and Prime Coffee, operating in an oligopoly market. Prime Coffee is the follower while Excellent Coffee is considered the dominant company.

Prime Coffee's business decisions and outcomes: Prime Coffee's decisions of price, average total cost (ATC) and output generated a profit of $24,000 by making one of the following decisions.

Table 1

Decision 1	Price	31
	ATC	11
	Quantity	21,000

Decision 2	Price	13
	ATC	11
	Quantity	12,000

Question 15

Among the decisions in Table 1 above, which one Prime Coffee made to generate the profit of $24,000? (show the computation of profit below)

Decision 2

Price = 13

ATC = 11

Quantity = 12,000

Profit = 12,000*(13-11)

= 24,000

Excellent Coffee's business decisions and outcomes: As the dominant company, Excellent Coffee's decisions of price, average total cost (ATC), and output generated a profit twice that of Prime coffee.

Table 2

Decision 1	Price	13
	ATC	11
	Quantity	24,000

Decision 2	Price	33
	ATC	13
	Quantity	23,000

Question 16

Among the decisions in Table 2 above, which one Excellent Coffee made to generate a profit twice that of Prime coffee? (Show the computation of profit below)

Decision 1

Price = 13

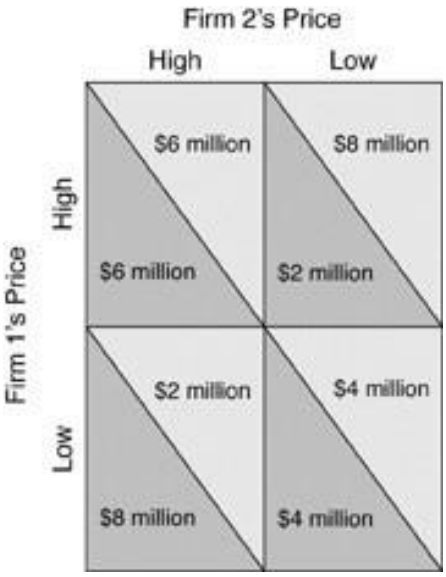
ATC = 11

Quantity = 24,000

Profit = 24,000*(13-11)

= 48,000

Figure 3



In Figure 3 above, two oligopolists are competing based on low or high prices. Profits generated for each oligopolist depend on each one's choice of high or low prices. Answers for the next three questions are to be retrieved from figure 3 above.

Question 17

Both oligopolists choose a high price. What profit does each make?

Profit = $6 million

Question 18

Both oligopolists choose a low price. What profit does each make?

Profit = $4 million

Question 19

Firm 1 chooses a high price and Firm 2 chooses a low price. What profit does Firm 1 make?

Profit = $2 million

Question 20

One Firm 1 chooses a low price and Firm 2 chooses a high price. What profit does Firm 1 make?

Profit = $8 million

Posttest

Multiple choice questions (concepts)

Question1

If a firm is an oligopolist, which is NOT true?

A) It must pay attention to other firms' prices.
B) It is one of a relatively small number of firms dominating its industry.
C) It can sell all the units it wants at the going market price.
D) It is engaged in a strategic game.

Question2

In a monopolistically competitive market, the consumer receives the benefit of

A) production at minimum average cost.
B) production where price equals marginal cost.
C) product differentiation.
D) allocative efficiency.

Question3

In a monopolistically competitive market there are

A) many firms producing an identical product.
B) many firms producing similar but not identical products.
C) many firms producing totally different products.
D) few firms producing identical products.

Question4

Managers in oligopoly firms must

A) eliminate any barriers to entry if they hope to make short-run profits.
B) advertise heavily in order to differentiate their product.
C) anticipate the reaction of rival firms.
D) establish many varieties of their products to cover the spectrum of consumer tastes.

Question5

All of the following are assumptions of monopolistic competition EXCEPT

A) many buyers and sellers.
B) homogeneous product.
C) easy entry of new firms in the long run.
D) profit-maximizing behavior.

Question6

The demand curve for the product of a monopolistic competitor is

A) downward sloping.
B) horizontal.
C) vertical.
D) unitary elastic.

Question7

An oligopoly is a market situation in which

A) there are many firms producing differentiated products.
B) there is a single firm producing several varieties of a product.
C) all the sellers act independently of the others.
D) there are very few sellers, and they recognize their strategic dependence on one another.

Question8

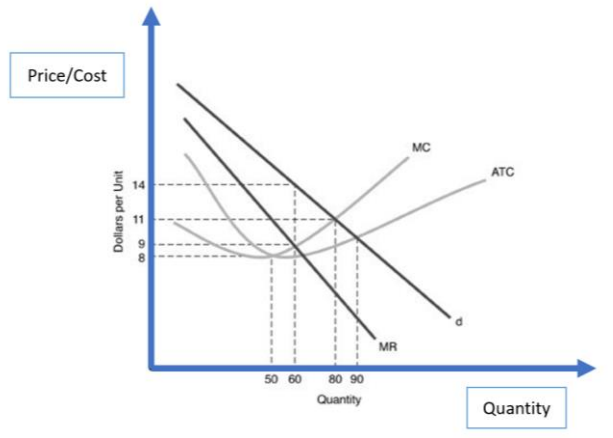
Which of the following is NOT true of an oligopoly?

A) They advertise their product.
B) The firms recognize their interdependence.
C) A few firms account for a large portion of the total output.
D) Firms are price takers.

Computations and decisions

Monopolistic Competition Market Structure

Figure 1



Question 9

Based on the information in Figure 1, what is the output (quantity) at profit maximizing?

Quantity = 60

Question 10

Based on the information in Figure 1, what is the price at profit maximizing?

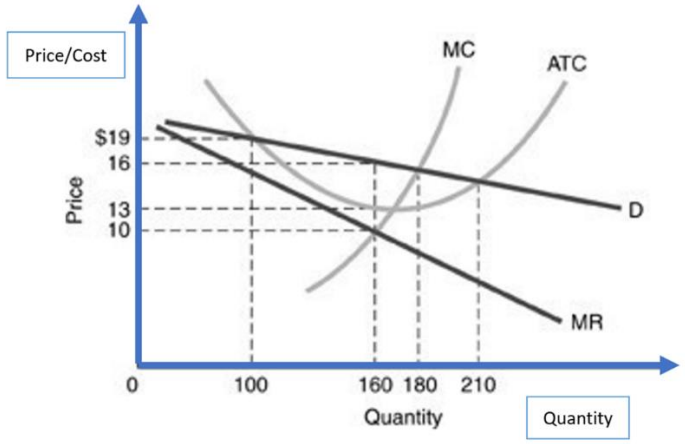
Price = 14

Question 11

Based on the information in Figure 1, what is the average total cost (ATC) at profit maximizing?

ATC = 8

Figure 2



Question 12

Based on the information in figure 2, compute total revenue at profit maximizing output

Price = 16

Quantity = 160

Total Revenue = 16*160

= 2,560

Question 13

Based on the information in figure 2, compute total cost at profit maximizing output

ATC = 13

Quantity = 160

Total Cost = 13*160

= 2,080

Question 14

Based on the information in figure 2, compute total profit at profit maximizing output

Price = 16

ATC = 13

Quantity = 160

Total Profit = 160*(16-13)

= 480

Oligopoly Market

There are two companies, Excellent Coffee and Prime Coffee, operating in an oligopoly market. Prime Coffee is the follower while Excellent Coffee is considered the dominant company.

Prime Coffee's business decisions and outcomes: Prime Coffee's decisions of price, average total cost (ATC) and output generated a profit of $420,000 by making one of the following decisions.

Table 1

Decision 1	Price	31
	ATC	11
	Quantity	21,000

Decision 2	Price	13
	ATC	11
	Quantity	12,000

Question 15

Among the decisions in table 1 above, which one Prime Coffee made to generate the profit of $420,000? (show the computation of profit below)

Decision 1

Price = 31

ATC = 11

Quantity = 21,000

Profit = 21,000*(31-11)

= 420,000

Excellent Coffee's business decisions and outcomes: As the dominant company, Excellent Coffee's decisions of price, average total cost (ATC), and output generated a profit twice that of Prime coffee.

Table 2

Decision 1	Price	13
	ATC	11
	Quantity	24,000

Decision 2	Price	33
	ATC	13
	Quantity	42,000

Question 16

Among the decisions in table 2 above, which one Excellent Coffee made to generate a profit twice that of Prime coffee? (show the computation of profit below)

Decision 2

Price = 33

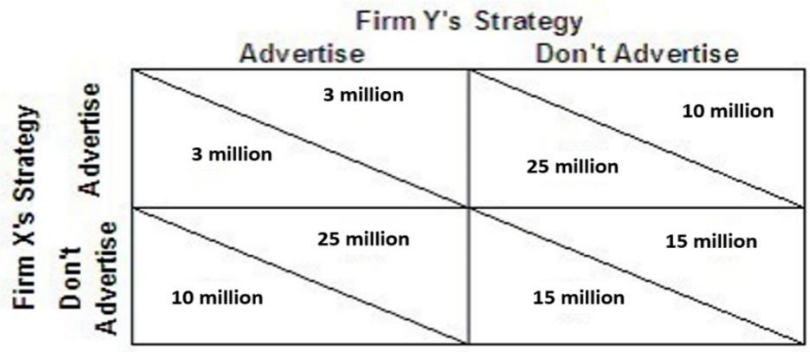
ATC = 13

Quantity = 42,000

Profit = 42,000*(33-13)

= 840,000

Figure 3



In Figure 3 above, two oligopolists are competing based on advertisement strategies. Profits generated for each oligopolist depend on each one's choice to advertise or not to advertise. Answers for the next three questions are to be retrieved from figure 3 above.

Question 17

Both oligopolists choose to advertise. What profit does each make?

Profit = $3 million

Question 18

Both oligopolists choose not to advertise. What profit does each make?

Profit = $15 million

Question 19

One Firm X chooses to advertise, and Firm Y chooses not to advertise. What profit does Firm X make?

Profit = $25 million

Question 20

One Firm X chooses not to advertise, and Firm Y chooses to advertise. What profit does Firm X make?

Profit = $10 million

APPENDIX D

Opinion Survey

Instructions: There are 10 questions in this opinion survey. Responses range from strongly disagree to strongly agree. Only mark one response to indicate your opinion for each question.

Attention

The variation (form, content or activities) helped me to keep attention to the game				
Strongly disagree Score = 1	**Disagree** Score = 2	**Maybe** Score = 3	**Agree** Score = 4	**Strongly agree** Score = 5

There was something interesting at the beginning of the game that captured my attention				
Strongly disagree Score = 1	**Disagree** Score = 2	**Maybe** Score = 3	**Agree** Score = 4	**Strongly agree** Score = 5

The game design is attractive				
Strongly disagree Score = 1	**Disagree** Score = 2	**Maybe** Score = 3	**Agree** Score = 4	**Strongly agree** Score = 5

Relevance

The game content is connected to other knowledge I already had				
Strongly disagree Score = 1	**Disagree** Score = 2	**Maybe** Score = 3	**Agree** Score = 4	**Strongly agree** Score = 5

The way the game works suits my way of learning				
Strongly disagree Score = 1	**Disagree** Score = 2	**Maybe** Score = 3	**Agree** Score = 4	**Strongly agree** Score = 5

The game content is relevant to my interests				
Strongly disagree Score = 1	**Disagree** Score = 2	**Maybe** Score = 3	**Agree** Score = 4	**Strongly agree** Score = 5

Confidence

Passing through the game, I felt confident that I was learning				
Strongly disagree Score = 1	**Disagree** Score = 2	**Maybe** Score = 3	**Agree** Score = 4	**Strongly agree** Score = 5

It was easy to understand the game and start using it as study material				
Strongly disagree Score = 1	**Disagree** Score = 2	**Maybe** Score = 3	**Agree** Score = 4	**Strongly agree** Score = 5

Satisfaction

It due to my personal effort that I manage to advance in the game				
Strongly disagree Score = 1	**Disagree** Score = 2	**Maybe** Score = 3	**Agree** Score = 4	**Strongly agree** Score = 5

I am satisfied because I know I will have the opportunities to use in practice things I learned playing this game.				
Strongly disagree Score = 1	**Disagree** Score = 2	**Maybe** Score = 3	**Agree** Score = 4	**Strongly agree** Score = 5

APPENDIX E

Cronbach Alpha Measurement for the Pretest Exam: 20 *Item Scores from 70 Students in the Control and Experimental Groups Combined*

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Student 1	0	1	1	0	1	0	1	1	1	1	0	0	0	0	0	0	1	1	1	1
Student 2	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 3	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1
Student 4	0	1	1	0	0	0	0	1	1	1	0	0	0	0	1	0	1	1	1	1
Student 5	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	1	1	1	1
Student 6	0	1	1	0	1	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1
Student 7	0	0	1	0	1	0	0	1	0	1	1	0	0	0	0	0	1	1	1	1
Student 8	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 9	0	1	1	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0	0
Student 10	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1
Student 11	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0
Student 12	0	1	1	0	1	1	0	1	0	0	1	0	0	0	0	0	1	1	1	1
Student 13	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 14	0	1	1	0	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0
Student 15	0	0	1	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0
Student 16	0	1	1	0	0	1	0	1	1	1	1	0	0	0	1	1	1	1	0	1
Student 17	0	1	1	0	0	0	0	1	1	1	0	0	0	0	1	0	1	1	1	1
Student 18	0	0	1	0	1	1	0	0	1	1	0	0	0	0	1	0	1	0	0	0
Student 19	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
Student 20	0	0	1	1	1	1	0	1	0	0	1	1	0	1	1	1	1	1	1	1
Student 21	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	2	1
Student 22	0	0	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1
Student 23	0	0	0	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Student 24	0	1	1	0	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	0
Student 25	0	1	1	0	1	0	0	1	0	0	1	0	0	0	1	1	1	0	1	1
Student 26	0	1	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	1	0	0
Student 27	0	1	1	0	0	0	0	1	1	1	0	1	1	1	1	1	1	0	0	1
Student 28	0	1	1	0	1	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0
Student 29	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1
Student 30	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Student 31	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Student 32	0	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 33	0	1	1	0	0	1	0	1	0	0	0	1	1	1	1	1	1	1	1	1
Student 34	0	1	1	0	0	0	1	0	1	1	0	0	1	0	1	1	0	0	0	0
Student 35	0	1	1	0	0	0	1	1	0	0	0	0	0	0	1	1	1	0	0	0

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Student 36	0	1	0	0	0	1	0	1	1	1	1	0	0	0	1	1	0	0	0	0
Student 37	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Student 38	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Student 39	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0
Student 40	0	1	1	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0
Student 41	1	1	1	0	1	1	1	1	1	1	1	0	0	0	1	0	1	1	1	1
Student 42	0	1	1	0	1	1	0	1	1	1	1	0	0	0	1	1	1	1	1	1
Student 43	0	1	1	0	1	1	0	1	0	0	0	0	0	0	1	1	1	1	0	0
Student 44	0	1	0	1	0	0	0	1	0	0	1	0	0	0	1	1	1	1	1	1
Student 45	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	1	1	0	0
Student 46	0	1	1	0	1	0	0	1	1	1	0	0	0	0	1	1	1	1	0	0
Student 47	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0
Student 48	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1	1	1	1
Student 49	1	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0
Student 50	0	1	0	0	0	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0
Student 51	0	1	1	1	0	1	1	1	0	0	1	0	0	0	1	1	0	0	0	0
Student 52	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0
Student 53	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
Student 54	0	1	1	1	0	0	1	1	0	0	1	0	0	0	1	1	0	0	0	1
Student 55	0	1	1	0	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1
Student 56	0	1	1	0	0	0	1	1	0	0	0	0	0	0	1	0	1	1	1	1
Student 57	1	1	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
Student 58	0	1	1	0	0	0	0	1	0	0	1	0	0	0	1	1	1	1	1	1
Student 59	0	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	1	1	1	0
Student 60	0	1	1	0	1	1	0	1	0	0	1	0	0	0	1	1	1	1	1	1
Student 61	0	1	1	0	0	0	0	1	0	1	1	0	0	0	0	0	1	0	1	0
Student 62	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1
Student 63	0	1	1	0	0	0	0	1	1	1	1	0	0	0	1	1	1	0	0	0
Student 64	0	1	1	0	1	1	0	1	0	0	1	0	0	0	0	0	1	1	1	0
Student 65	0	1	1	0	0	0	0	1	1	1	1	0	0	0	1	1	1	0	0	1
Student 66	0	1	1	0	1	0	0	1	1	1	1	0	0	0	1	1	1	1	0	0
Student 67	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0
Student 68	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Student 69	0	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Student 70	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0

APPENDIX F

Cronbach Alpha Measurement for the Posttest Exam: 20 Item Scores from 70 Students in the Control and Experimental Groups Combined

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Student 1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Student 2	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1
Student 3	1	0	0	1	0	1	1	1	0	0	0	1	1	0	1	1	1	1	1	0
Student 4	1	0	0	1	0	0	1	0	1	1	1	0	0	0	1	1	1	1	1	1
Student 5	1	1	1	0	0	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1
Student 6	1	1	0	0	1	1	0	1	0	0	0	0	0	0	1	1	1	1	1	1
Student 7	1	1	1	1	0	1	1	1	1	1	0	0	0	0	1	1	1	1	1	0
Student 8	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
Student 9	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0
Student 10	1	0	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
Student 11	0	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Student 12	0	0	1	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1
Student 13	0	1	0	1	0	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1
Student 14	1	1	1	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1
Student 15	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0
Student 16	0	1	0	1	1	1	0	1	1	1	1	1	0	1	1	0	1	1	1	1
Student 17	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
Student 18	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 19	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 20	1	1	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1
Student 21	1	1	0	0	1	1	1	1	1	0	1	0	1	0	1	1	1	1	1	1
Student 22	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
Student 23	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1
Student 24	0	1	0	0	0	1	0	1	0	0	0	1	1	1	1	1	1	1	1	1
Student 25	1	1	1	1	1	1	0	0	0	0	1	0	0	0	1	1	1	1	1	1
Student 26	0	1	1	0	1	1	0	1	0	0	0	1	1	1	1	1	1	1	1	1
Student 27	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 28	0	1	1	1	0	1	1	0	1	0	1	0	1	0	1	1	1	1	1	1
Student 29	0	0	1	1	0	1	1	0	1	0	0	0	1	1	1	1	1	1	1	1
Student 30	1	0	1	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Student 31	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0
Student 32	1	0	0	1	1	0	1	0	1	1	1	1	1	1	0	1	1	1	1	1
Student 33	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1
Student 34	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	1	1	1	1	0
Student 35	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	1	1	1	1	1

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
Student 36	1	1	1	1	0	1	1	0	1	0	1	0	1	0	1	1	1	1	1	1
Student 37	1	0	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
Student 38	0	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Student 39	0	1	1	1	1	1	1	1	1	0	1	0	0	0	1	1	1	1	1	1
Student 40	1	0	1	0	0	1	0	1	1	0	1	0	1	1	1	1	0	0	1	1
Student 41	0	0	1	0	1	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0
Student 42	1	1	1	1	1	1	0	0	1	1	1	0	0	0	1	1	1	1	1	0
Student 43	1	0	0	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
Student 44	1	0	1	1	0	0	1	1	1	0	1	0	0	0	0	0	1	1	1	1
Student 45	0	1	0	0	0	0	1	1	1	1	1	0	0	0	1	1	1	1	0	0
Student 46	1	0	0	1	0	1	1	0	1	1	1	0	0	1	1	1	1	1	1	0
Student 47	1	0	0	1	0	1	1	1	0	0	1	0	0	0	1	1	1	1	1	1
Student 48	1	0	0	0	0	1	1	1	0	0	1	0	0	0	1	1	1	1	1	1
Student 49	0	1	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1
Student 50	1	1	0	1	0	1	1	1	0	0	1	0	0	0	1	1	1	0	1	0
Student 51	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1
Student 52	1	1	1	1	0	1	1	1	1	0	1	0	1	0	1	1	1	1	1	1
Student 53	1	1	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1
Student 54	1	0	0	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
Student 55	1	0	0	1	0	1	1	1	0	1	0	1	1	1	1	1	0	1	0	0
Student 56	1	0	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1
Student 57	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Student 58	0	0	1	0	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	1
Student 59	1	0	0	0	0	1	1	0	1	0	0	0	0	0	1	1	1	0	0	0
Student 60	1	1	1	1	0	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1
Student 61	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0
Student 62	0	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Student 63	1	0	0	1	1	1	1	0	1	0	1	0	1	0	1	1	1	1	1	1
Student 64	1	0	0	1	0	1	1	1	0	0	0	0	0	0	1	1	1	1	0	0
Student 65	1	0	0	0	0	0	1	0	1	1	1	1	0	0	1	1	1	1	1	0
Student 66	0	1	1	0	0	1	0	0	0	1	1	0	1	0	1	1	0	0	1	1
Student 67	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1
Student 68	1	0	0	1	0	1	1	0	1	0	1	0	0	0	1	1	1	1	1	1
Student 69	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	1	1	1	1	1
Student 70	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1

APPENDIX G

Cronbach Alpha Measurement for the Post-lesson Survey: 10 Item Scores from 70 Students (Control and Experimental Groups combined)

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Student 1	5	5	5	3	2	4	5	3	5	5
Student 2	5	4	3	5	5	4	4	5	4	4
Student 3	5	5	4	5	5	4	4	4	4	4
Student 4	4	4	3	4	5	3	4	5	3	4
Student 5	4	4	3	4	5	3	5	2	2	4
Student 6	4	5	4	4	5	5	2	4	4	5
Student 7	5	5	4	4	4	5	4	4	4	5
Student 8	4	5	5	5	4	4	4	4	4	5
Student 9	4	3	4	4	3	4	4	4	4	4
Student 10	5	4	4	5	5	5	5	5	5	4
Student 11	5	5	5	5	5	5	5	5	5	5
Student 12	5	5	5	5	5	5	5	5	5	5
Student 13	4	5	4	5	4	5	5	4	4	5
Student 14	5	4	5	4	4	5	4	4	5	4
Student 15	4	4	3	5	4	4	5	3	4	4
Student 16	4	5	2	5	4	3	4	4	4	5
Student 17	5	4	5	4	5	4	4	4	4	4
Student 18	4	4	4	5	5	5	5	5	5	5
Student 19	4	5	4	5	4	3	5	5	5	5
Student 20	5	4	4	4	5	3	4	4	4	4
Student 21	5	4	4	5	5	5	5	5	5	5
Student 22	4	5	4	4	4	3	4	5	4	4
Student 23	5	5	5	5	4	4	4	2	5	4
Student 24	4	4	4	4	5	4	4	4	4	3
Student 25	4	4	4	4	5	4	4	5	4	3
Student 26	5	4	3	4	4	3	4	2	4	4
Student 27	5	5	5	4	5	3	5	4	5	5
Student 28	4	5	5	4	5	4	4	4	5	4
Student 29	4	3	2	4	4	3	5	4	5	5
Student 30	5	4	4	4	5	4	5	4	4	4
Student 31	4	4	5	4	4	4	4	5	3	4
Student 32	5	5	4	4	3	3	4	4	4	4
Student 33	5	5	5	5	5	4	5	5	3	4
Student 34	4	4	4	3	3	4	3	4	4	4
Student 35	5	5	5	4	5	4	5	5	5	5

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Student 36	4	5	4	5	4	4	4	3	4	4
Student 37	5	5	5	5	5	5	5	5	5	5
Student 38	1	1	1	1	1	1	1	1	1	1
Student 39	5	5	5	5	5	5	5	5	5	5
Student 40	5	5	5	4	4	4	5	5	4	5
Student 41	4	5	5	5	4	4	5	5	5	4
Student 42	4	5	4	5	5	3	4	5	4	5
Student 43	5	5	5	5	5	5	5	3	5	5
Student 44	5	5	5	5	5	5	5	5	5	5
Student 45	4	4	3	4	4	5	4	4	4	4
Student 46	2	4	4	5	3	2	5	5	1	4
Student 47	5	5	5	5	5	5	5	5	5	5
Student 48	5	5	5	5	5	5	5	5	5	5
Student 49	4	4	4	4	4	5	5	4	5	4
Student 50	5	5	4	5	5	4	5	5	5	5
Student 51	5	5	5	4	5	5	4	4	5	5
Student 52	5	5	5	5	5	5	5	5	5	5
Student 53	5	5	5	5	5	5	5	5	5	5
Student 54	5	4	4	4	4	4	4	4	5	4
Student 55	4	5	4	4	4	4	4	4	5	4
Student 56	5	5	5	5	5	5	5	5	5	5
Student 57	5	5	5	5	5	4	5	5	4	3
Student 58	5	5	5	3	5	4	5	5	5	5
Student 59	3	3	3	3	3	3	3	3	3	3
Student 60	5	4	4	4	4	4	3	5	4	4
Student 61	4	4	3	3	4	3	4	3	4	4
Student 62	5	4	4	4	5	4	5	4	4	4
Student 63	4	4	5	4	4	4	4	5	3	4
Student 64	5	5	4	4	3	3	4	4	4	4
Student 65	5	5	5	5	5	4	5	5	3	4
Student 66	4	4	4	3	3	4	3	4	4	4
Student 67	5	5	5	4	5	4	5	5	5	5
Student 68	5	5	5	4	5	4	5	5	4	5
Student 69	4	4	4	4	5	3	5	5	5	5
Student 70	5	4	4	4	5	4	4	4	5	5

APPENDIX H

Statistical Test of Baseline Knowledge: Pretest Scores in the Control and Experimental Groups

Control Group	Experimental group
70	30
25	45
50	25
40	70
85	45
50	30
40	45
55	20
45	50
55	30
45	35
45	40
35	25
35	15
35	45
40	25
85	60
50	50
25	50
85	45
50	45
60	70
15	35
40	50
35	75
50	45
35	15
50	65
60	50
45	35
35	35
25	15
20	80
40	35
30	55

Statistical Test of Learning Engagement: Averaged Scores of the Survey's Item Questions in the Control and Experimental Groups

Post- lesson Survey Averaged Scores

Control Group	Experimental group
4.1	4.2
5	4.3
1	4.4
5	3.9
4.6	3.6
4.6	4.2
4.4	4.4
4.8	4.4
5	3.8
4	4.7
3.5	5
5	5
5	4.5
4.3	4.4
4.8	4
4.7	4
5	4.3
5	4.7
4.2	4.5
4.2	4.1
5	4.8
4.6	4.1
4.7	4.3
3	4
4.1	4.1
3.6	3.7
4.3	4.6
4.1	4.4
4	3.9
4.6	4.3
3.7	4.1
4.8	4
4.7	4.6
4.4	3.7
4.4	4.8

Students' Gain Scores in the Control and Experimental Groups

CONTROL GROUP			
	Pretest	Posttest	Gain
Student 1	30	70	40
Student 2	45	80	35
Student 3	25	65	40
Student 4	70	45	-25
Student 5	45	80	35
Student 6	30	45	15
Student 7	45	85	40
Student 8	20	60	40
Student 9	50	85	35
Student 10	30	55	25
Student 11	35	25	-10
Student 12	40	40	0
Student 13	25	80	55
Student 14	15	60	45
Student 15	45	55	10
Student 16	25	60	35
Student 17	60	80	20
Student 18	50	55	5
Student 19	50	75	25
Student 20	45	40	-5
Student 21	45	50	5
Student 22	70	80	10
Student 23	35	75	40
Student 24	50	30	-20
Student 25	75	75	0
Student 26	45	60	15
Student 27	15	40	25
Student 28	65	80	15
Student 29	50	55	5
Student 30	35	75	40
Student 31	35	35	0
Student 32	15	50	35
Student 33	80	70	-10
Student 34	35	45	10
Student 35	55	85	30

EXPERIMENTAL GROUP			
	Pretest	Posttest	Gain
Student 1	70	80	10
Student 2	25	40	15
Student 3	50	55	5
Student 4	40	70	30
Student 5	85	90	5
Student 6	50	95	45
Student 7	40	90	50
Student 8	55	70	15
Student 9	45	65	20
Student 10	55	90	35
Student 11	45	75	30
Student 12	45	60	15
Student 13	35	65	30
Student 14	35	25	-10
Student 15	35	65	30
Student 16	40	65	25
Student 17	85	60	-25
Student 18	50	75	25
Student 19	25	75	50
Student 20	85	95	10
Student 21	50	85	35
Student 22	60	60	0
Student 23	15	75	60
Student 24	40	60	20
Student 25	35	30	-5
Student 26	50	80	30
Student 27	35	80	45
Student 28	50	70	20
Student 29	60	70	10
Student 30	45	60	15
Student 31	35	35	0
Student 32	25	45	20
Student 33	20	50	30
Student 34	40	55	15
Student 35	30	70	40

Statistical Test of Knowledge Acquisition: Students' Gain Scores in the Control and Experimental groups

Gain scores	
Control group	**Experimental group**
40	10
35	15
40	5
-25	30
35	5
15	45
40	50
40	15
35	20
25	35
-10	30
0	15
55	30
45	-10
10	30
35	25
20	-25
5	25
25	50
-5	10
5	35
10	0
40	60
-20	20
0	-5
15	30
25	45
15	20
5	10
40	15
0	0
35	20
-10	30
10	15
30	40