The Flipped Classroom Model for an Undergraduate-Level Business Statistics Course in a Private International University in Thailand: Impacts on Student Performance, Attitudes, Perceptions, and Experiences

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Abstract

This thesis develops a Flipped Classroom Model (FCM) to teach statistics at a large private international university in Thailand. The rationale for conducting this research is two-fold. Firstly, there is a limited literature on the flipped classroom in Thai higher education (Fuchs). Secondly, there is a high student failure rate in statistics courses in general and at the university where this study occurred in particular. Using an explanatory sequential mixed methods research design, I examined and compared the impact on: students' examination performance; their attitude towards statistics; their experiences; and their perceptions of pedagogical effectiveness as a function of the traditional lecture-based model (LBM) of teaching statistics (n = 121) versus the FCM for the same statistics course (n = 95). Kolb's experiential theory was employed to construct a theoretical framework.

Collins et al.'s 13-step mixed methods methodological framework was utilized to conduct this study. During the quantitative phase of this research, I deployed the pre- and post-Survey of Attitude Toward Statistics (SATS) tool to assess the students' attitudes toward statistics learning concerning the two modes of study. In addition, I analyzed the grades of 95 FCM and 121 LBM students enrolled in seven Business Statistics courses during two consecutive trimesters in the 2021 academic year. I interviewed 19 LBM and 17 FCM students during the qualitative phase using semi-structured interviews (SSIs). Additionally, I used the College and University Classroom Environment Inventory (CUCEI) to evaluate the students' perceptions of the classroom environment concerning the two modes of instruction.

Although no statistically significant difference emerged between the two modes of instruction in terms of the attitudes and performance of the students, the quantitative results indicated that FCM students consistently outperformed LBM students, as evidenced by higher median scores, and a smaller interquartile range in all assignment categories, indicating greater score consistency, and less score variability in favor of the FCM group. Moreover, the quantitative analysis revealed a statistically significant difference in favor of the FCM group concerning the scores of homework assignments ($U[N_{FCM} = 95, N_{LBM} = 121] = 4842.00$, $z = -1.986$, $p = .047$, $\eta^2 = 0.018$ and CL = 57.59%). During the qualitative phase of the study, utilizing the CUCEI, I discovered that students enrolled in FCM sections regarded the FCM environment as being more favorable to learning than did their LBM counterparts. Furthermore, the most prevalent theme from SSIs was the positive perception toward FCM, indicating that most students viewed the FCM instructional strategy as beneficial.

The implications and significance of these findings are discussed in terms of: (1) implementation of FCM in statistics courses, (2) training educators to implement the FCM properly, and (3) monitoring the FCM classes to examine its efficacy further. The study has contributed to the FCM literature in Thailand, where FCM studies are limited in higher education settings (Fuchs). My study added to the existing literature by presenting an in-depth understanding of how students perceive and perform in flipped learning environments at a private international university in Thailand. Moreover, the practical contribution of this study is the introduction of a new teaching system in all statistics courses using Assessment and Learning in Knowledge Spaces (ALEKS) and organization of workshops to train the statistics educators on flipped teaching. In short, the results of this study contributed to a positive change within the private international university where the study occurred.

KEYWORDS: Flipped classroom model, active learning, course performance, statistics, student attitudes, student perceptions, student experiences, Survey of Attitude Toward Statistics, College and University Classroom Environment Inventory, SATS, CUCEI

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LIST OF ABBREVIATIONS

Abbreviation	Definition
AI	Artificial Intelligence
ASA	American Statistical Association
BL	Blended Learning
CA	Correspondence Analysis
CCA	Constant Comparison Analysis
CUCEI	College and University Classroom Environment Inventory
ELC	Experiential Learning Cycle
ELT	Experiential Learning Theory
FCM	Flipped Classroom Model
FV	Flipped Video
HES	Higher Education System
LBM	Lecture-Based Model
OL	Online Learning
PCA	Principal Component Analysis
PIS	Participant Information Sheet
PTIU	Private Thai International University
RQ	Research Question

SATS	Survey of Attitude Toward Statistics
SSI	Semi-Structured Interviews
STEM	Science, Technology, Engineering and Mathematics
TEFC	Technology-Enhanced Flipped Class

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CHAPTER 1: Introduction

In higher education the purpose of teaching and learning statistics is to promote a student body skilled at the analysis and interpretation of data in order to make knowledgeable decisions in their places of employment, personal lives, and as citizens in general (Burrill, 2011). In fact, in recent years, there has been an effort to include statistics even at the primary and secondary levels of education (Zieffler et al., 2018). Therefore, it is logical that universities, which are at the forefront of higher education, include statistical education in most of their curricula.

The private Thai international university (henceforth PTIU) where this research took place, offers nonmathematical curricula, such as International Hotel Management, Logistics and Supply Chain Management, Event Management, International Relations, all of which include statistical education. Hybšová and Leppink (2015) assert that "students enrolled in a non-mathematical curriculum generally do not have the mathematical background that is needed to understand mathematical formulae and relations underlying statistical concepts" (p.11). Enrolling in a statistics course is frequently a negative experience for learners in nonmathematical areas because the students find the topics challenging to comprehend or they do not understand the relevance of statistics to their fields of study (Chew & Dillon, 2014). Because of the difficulty in understanding statistical topics, new pedagogies need to be developed or existing pedagogies need to be reconsidered and refined if necessary. One such existing pedagogy is the flipped classroom model (FCM), which is a subset of the blended learning (BL) paradigm. A comprehensive discussion on BL paradigm and its relationship with flipped learning is provided in Chapter 2, the literature review.

FCM incorporates the use of Internet technology such that the learner will have an understanding of the subject matter before entering the classroom (Bergmann & Sams, 2012). FCM has been designed to increase the educator's time and the in-class interaction between the learner and the educator (Nielsen et al., 2018). Therefore, more time is allocated to the application and in-depth understanding of the topics learned before entering the classroom (Bergmann & Sams, 2012). The most basic method of flipping a class is using either flipped videos created by the instructor or videos readily available on many educational sites that the students will watch to understand the topic before coming to the class. In this model, the entire classwork versus homework schedule is reversed or flipped, hence its name. The lecturing and understanding of the concept take place outside of the classroom via the videos. According to the theory behind FCM, application, analysis and deeper understanding of the topics are achieved in the class using collaborative and active learning approaches (Prince, 2004).

Many students report high levels of anxiety when enrolled in statistics courses (Onwuegbuzie & Wilson, 2003). Onwuegbuzie (1999) suggests that at least a part of the class time should be student-centered to engage the student actively in an attempt to reduce anxiety levels. However, treatments of statistics anxiety have tended to be teacher-centered rather than student-centered (Collins & Onwuegbuzie, 2007). Because FCM is posited to be a student-centered approach (Sams & Bergmann, 2012), and a method that improves students' performance (Touchton, 2015), it is reasonable to determine whether FCM can improve their levels of performance within the context of the international university in Thailand.

1.1. A Summary of Sections to Follow

First, I have provided a concise overview of Thai higher education system to include the role of public and private universities in the country's higher education system (HES). The importance of private universities was emphasized because the current study was conducted at a PTIU. Second, the statement of the problem underlying the research is explicated. Third, I have explained the theoretical foundation using Kolb's Experiential Learning Theory (ELT) by contextualizing the study within an established framework. Fourth, I have mapped the methodological approach in this study, utilizing Collins et al.'s (2006) 13-step framework. In Chapter 1 I have focused on the first five steps of the 13-step framework, which includes the rationale for the research. Fifth, the study's limitations are detailed to clarify the scope and boundaries of the investigation. Sixth, I have explicitly addressed the study's significant limitations and acknowledged the potential constraints that might have affected the results. Seventh, the research's underlying assumptions were clarified, providing insight into the fundamental beliefs that shaped the design and interpretation of the study. Finally, I have concluded with a concise explanation of my position in relation to the current study.

1.2. A Brief Background on Thailand's Higher Education

There are currently more than 170 higher education institutions in Thailand, both public and private, that provide a wide variety of academic programs and degrees (Kew et al., 2018). In 2020, Thailand had approximately 1.7 million students enrolled in its HES according to the most recent data from the Ministry of Higher Education, Science, Research and Innovation (n.d.).

Thailand 4.0 is a reform strategy designed to transform Thailand from a middle- to a high-income nation. This strategy acknowledges the significance of encouraging innovation and employing technology within the context of education. The overarching objective is to prepare Thai students for jobs in a digital economy (Scott & Guan, 2022). This requires substantial changes to the educational system, including new curricula and methods of instruction. There is an emphasis on Science, Technology, Engineering, and Mathematics (STEM) subjects and the development of students' critical thinking, creativity, and digital literacy skills (Marín & Castaneda, 2023). In terms of higher education, this strategy encourages universities to forge closer ties with industry by promoting research and innovation to ensure that research is aligned with economic needs and that students acquire skills that increase their employability (Dhirathiti, 2023).

Thailand's HES, comprising both public and private universities, reflects the country's dedication to knowledge-driven progress and economy. Private universities accommodate the diverse needs of students, foster innovation, and contribute to expanding educational access, whereas public institutions are the cornerstones of academic tradition and the primary drivers of research (Crocco, 2018). The formation of Chulalongkorn University, one of the major public universities derived from the Royal Pages School, started a major effort to promote education in Thailand. Consequently, the number of public universities specializing in fields such as medicine, engineering, agriculture, and the arts has increased (Chaemchoy et al., 2021).

Public universities in Thailand have significantly influenced the country's intellectual and professional environment. These government-funded and government-managed institutions offer extensive science and humanities programs. Universities such as Chulalongkorn, Mahidol, and Kasetsart have received international recognition for their research and academic excellence and

contributions. They receive substantial funding from the government to support research initiatives, faculty development, and infrastructure improvements (Pongsin et al., 2023).

Given that this study took place in a PTIU, it is important to explain the role of private universities, particularly private international universities, within Thailand's HES. As of 2021, Thailand had a total of 71 universities (Chaemchoy et al., 2021). The development and expansion of private universities in Thailand have affected the country's HES. Due to private universities' diverse educational philosophies and missions, Thailand's HES has been enhanced courtesy of their diversity and innovation (Jampaklay et al., 2022).

Two factors make the role of private international universities within Thailand's HES more important. One issue that specifically affects the role of Thailand's international universities is the country's shifting demographic profile due to the increasing proportion of the population aged 60 years or older and a low fertility rate, thereby reducing the number of eligible Thai students entering the country's HES. Therefore, universities in Thailand actively recruit international students (Jampaklay et al., 2022). Many degree programs at Thai international universities are entirely taught in English, making them attractive to international students. The second issue is the Thai population's increased awareness of the importance of higher education in fostering social and economic development, which highlights the role of private universities. Private universities in Thailand expand the availability of tertiary education opportunities, serving as valuable alternatives when the capacity of the public higher education system is reached (Jampaklay et al., 2022).

In addition, private universities can develop programs in response to the shifting demands of various industries and emerging global trends. They can incorporate new fields of study more

quickly, such as technology, digital media, and entrepreneurship, into their curricula. Students who can adapt to changing circumstances acquire relevant skills, thereby increasing their employability and placing them at the forefront of evolving labor markets (Ministry of Education, Thailand, 2017). Moreover, while public universities dominate research and development in Thailand's HES, private universities also contribute by introducing innovative teaching methodologies, fostering a competitive environment, and offering a wider range of study programs, thus complementing the research-led focus of public universities.

Nevertheless, the prevalence of private universities has posed difficulties regarding quality assurance (Crocco, 2018). Therefore, the Thai government has employed strategies to screen and assess the quality of education provided by public and private universities. One such strategy includes the establishment of the Office of Higher Education Commission, the Office for National Education Standards and Quality Assessment, and the Ministry of Higher Education, Science, Research and Innovation in order to enforce rigorous quality control standards and periodic institutional assessments, thereby ensuring that higher education institutions across the country meet benchmarked educational standards. This regulatory oversight is necessary to safeguard the credibility of degrees awarded and to preserve the reputation of Thailand's HES (Crocco, 2018).

Additionally, private universities have vigorously pursued internationalization, which has resulted in establishing partnerships with foreign educational institutions, recruiting international students, and promoting intercultural dialogue (Kanjananiyot & Chaitiamwong, 2018). This approach promotes an academic environment in Thailand that is highly interconnected on a global level, fostering international collaborations and exchanges.

1.3. Statement of the Problem

Statistics education is integrated into the undergraduate- and graduate-level curricula of the PTIU in which this study took place. Although statistics education should improve learners' understanding of data in their daily lives in order to help them be ready for a variety of professions in a high-tech, data-oriented age (Rumsey, 2002), the high failure rate and the reputation for high failure in statistics courses persists (Andersson & Logofatu, 2017). This high failure rate has also been an issue at the PTIU in which the study was conducted.

As newer instructional technologies or pedagogical practices revolutionize and alter the way courses are taught in undergraduate university settings, it is necessary to review and evaluate the effect of models such as FCM on students' learning and performance, their attitude towards statistics, perception of the effectiveness of such models, and students' experiences when such models are employed specifically in statistics courses. Moreover, there has been a lack of research and data on the aforementioned pedagogical practice at the PTIU under study. Hence, it has been unclear whether FCM impacts learners' performance and attitude toward statistics at this university. Additionally, learners' perceptions of the pedagogical effectiveness of such models and their experiences were unclear. Therefore, it was desirable to determine whether there was a significantly different impact on students' performance, attitudes, perceptions, and experiences based on two different models of instruction in the university. Additionally, it was also necessary to determine whether the benefits of FCM outweigh the difficulty and the burden associated with setting up FCM properly (e.g., the time commitment for the production of videos, the training involved in teaching the instructors regarding how FCM needs to be employed and how learners need to be encouraged to do their part before coming to the class).

In order to enhance both teaching and learning, we need pragmatic information collected regarding both models of instruction based on the learners' perspectives. The aforementioned challenges suggest that administrators and instructors at the university should examine how to deliver better pedagogical practices in order to make an effective contribution to learners' achievement and accomplishment, thereby reducing student failure rates in statistics.

1.4. Theoretical Framework

1.4.1. Kolb's Experiential Learning Theory

Kolb's (2015) ELT, a constructivist learning theory, guided the overall knowledge construction process. Kolb's ELT informed this study by providing a basis for understanding the intricacies of learning, how it occurs, and how FCM can facilitate the learning process. In addition, Kolb's ELT is grounded in the learner's cognitive processes that are complemented by their metacognitive processes to achieve learning. In order to better comprehend Kolb's ELT as a framework, it is crucial to first explore and understand its conception of knowledge and learning. According to Kolb, knowledge and learning are not the same but they are intricately related. Based on Kolb's interactionist ELT epistemology, learning is an ongoing cyclical process that is rooted in the experience and transformative potential of that experience.

The cyclical experiential learning model proposed by Kolb (2015) is characterized by four iterative and cognitive learning stages, which are labelled as concrete experience, reflective observation, abstract conceptualization, and active experimentation. The first two stages of the cycle are concerned with capturing an experience, whereas the third and fourth stages are concerned with refining an experience. According to Kolb, learners can enter the learning cycle at any of the four stages. Effective learning occurs when learners complete the cycle, often more than once. Learners

will have their own preferences about which stage to join the cycle of experiential learning, according to Kolb. In this model, knowledge is created as the learner navigates through the cycles repeatedly. Hence, knowledge is the outcome of the learning process while learning involves understanding, comprehending, interpreting, and transforming experiences into knowledge.

Moreover, based on Kolb's perspective, knowledge is not a fixed and independent entity, rather it is the outcome of a continuous cycle of gaining experience, reflecting on that experience, formulating a conceptual understanding of it, and then applying the subsequent understanding to new situations and experiences. Furthermore, Kolb has posited that empirical experiences have a central role in knowledge creation and that rational thinking (e.g., reasoning and logic) is merely one component of the construction of knowledge.

In Kolb's four-stage experiential learning cycle (ELC), the learner gains a direct and tangible experience related to their learning topic (concrete experience), reflects on their experience, and identifies patterns or connections to existing knowledge (reflective observation), creates new concepts or theories based on their observations and experiences (abstract conceptualization), and finally applies new knowledge or theories in a new situation and reflects on the outcomes of their actions (active experimentation). The best practices and aims of a statistics course should be to foster the development of statistical thinking by asking appropriate questions, teaching learners how to collect data effectively, instructing them how to summarize and to interpret information and, finally, explaining to learners how to understand the limitations of statistical inferences (Garfield et al., 2000).

Kolb's (2015) ELT has provided a sound theoretical framework for designing a flipped model of a business statistics course in this study. Students can participate in a complete and ideal learning

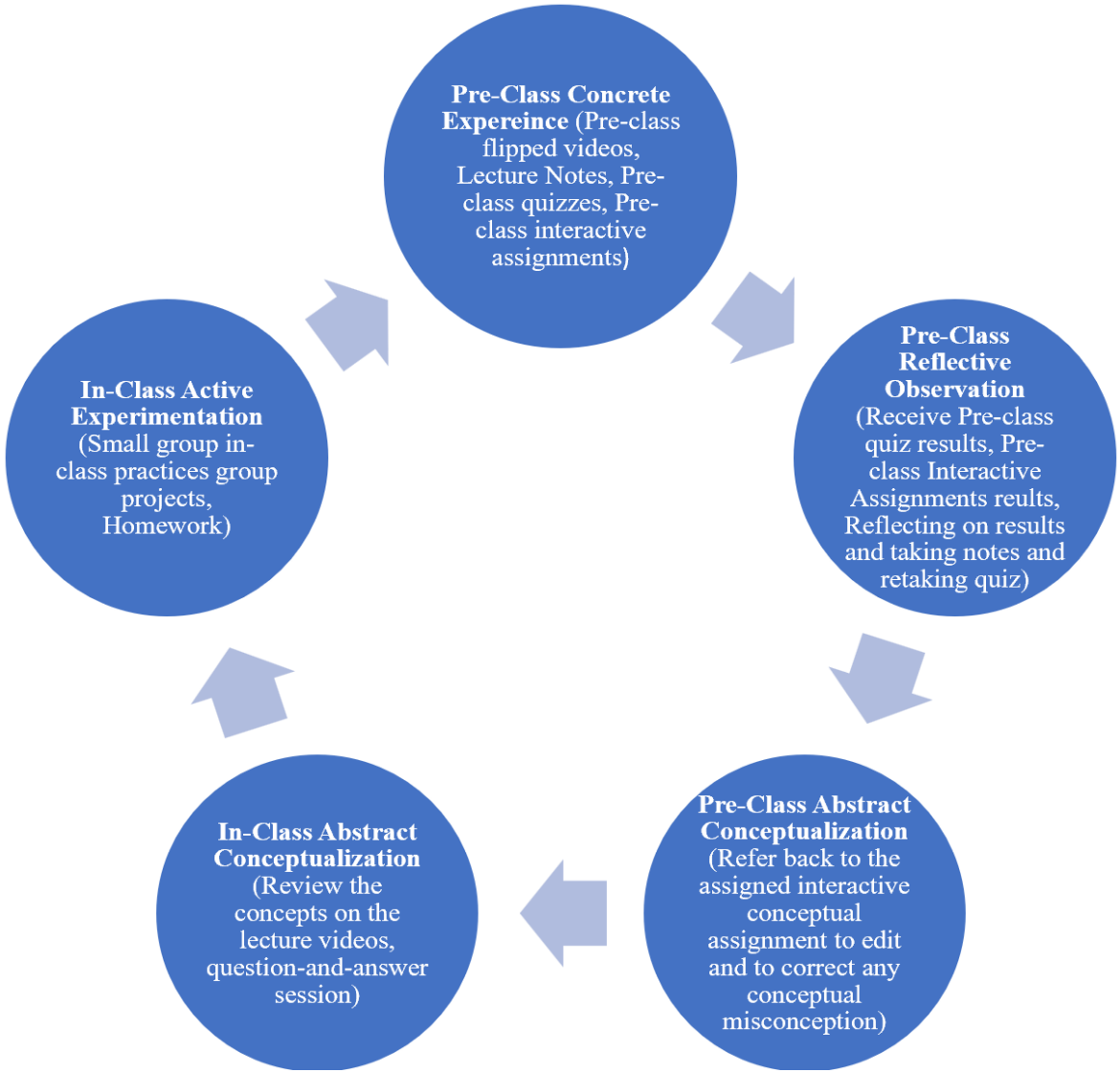
cycle, inside and outside of the classroom. During my designed study, before attending the class, students were encouraged to watch a flipped video (FV) concerning the lecture at hand while also undertaking a graded interactive conceptual assignment and a graded video quiz to reinforce the concrete experience stage. The students were then encouraged to check the result of the video quizzes and the conceptual interactive assignment to reflect on any computational or conceptual mistakes, constituting the pre-class reflective observation and abstract conceptualization stages. Moreover, the students were encouraged to check the pre-class lecture notes and write down any questions or problems in relation to understanding the concepts to present during the first 20 minutes of the class.

During the class, employing a question-and-answer session, I responded to the questions and problems posed by the learners and reviewed the main statistical concepts watched using flipped videos before coming to the class to reinforce the abstract conceptualization. The remaining time in the class was used to solve a combination of homework assignments, small group projects using real-world data, and small case studies to reinforce ELT's active experimentation stage.

Throughout the active experimentation stage, I showed and assisted the learners in downloading real-world data sets from different sites to conduct appropriate tests on the data. I introduced students to real-time data, specifically COVID-19 data, which, at the time, was the dominant issue around the globe. I intended to assist the student with real-world data, which can be chaotic and is typically dissimilar to the datasets presented in textbooks and thus aids the student in statistical reasoning. This strategy helped the students to apply the statistical concepts learned during the first three stages of the cycles beyond the textbook and its datasets. The learning process during different stages of the ELC was designed, as shown in Table A1, Appendix A. It is also important

to note that during the first 2 weeks of the academic term, I devoted a part of the FCM sections, explaining what resources were available for the learners inside and outside of the classroom and how they needed to approach the flipped learning. Figure 1 is a graphical representation of how Kolb's (2015) ELT was used to design the flow of tasks in and outside of the classroom.

Figure 1. Kolb's (2015) Theoretical Framework Informing the Study



1.5. Methodological Framework

The present study is a mixed methods research and, therefore, it is important to outline the methodological framework on which it is based. Based on Collins et al.'s (2006) framework, there are 13 steps followed, of which the first five are linear and the remainder cyclical and which inform this mixed methods research. These 13 steps can be arranged into three stages: formulation (Steps 1-5); planning (Steps 6-7); and implementation (Steps 8-13).

1.5.1. Formulation Stage.

This stage incorporates Steps 1 to 5. These steps are: determining the mixed goal(s) of the study; formulating the mixed research objective(s); determining the rationale(s) of the study and the rationale(s) for mixing quantitative and qualitative approaches; determining the purpose(s) of the study and the purpose(s) for mixing quantitative and qualitative approaches; and determining the research question(s) (Collins et al., 2006). These steps will be addressed in this chapter.

1.5.2. Planning Stage.

This stage incorporates Steps 6 and 7, which involve selecting the mixed sampling design and the mixed research design, respectively (Collins et al., 2006).

1.5.3. Implementation Stage.

This stage comprises Steps 8-13, which are collecting the quantitative and/or qualitative data; analyzing the quantitative and/or qualitative data using quantitative and/or qualitative analysis techniques; validating/legitimating the mixed research findings; interpreting the mixed research

findings; writing the final mixed research report; and reformulating the mixed research question(s) (Collins et al., 2006).

1.6. Step 1: Determine the Goal of the Study

As noted by Onwuegbuzie and Collins (2007), Newman et al.'s (2003) typology involves the following nine goals: add to the knowledge base; predict future outcomes or behaviors; measure change; have a personal, social, institutional, and/or organizational impact; understand complex phenomena; generate new ideas; test new ideas; inform constituencies; and examine the past. The goals of the present study were to have a personal, social, institutional and/or organizational impact; to add to the knowledge base; to understand complex phenomena; and to measure change.

Moreover, Brahimi and Sarirete (2015) point out that many instructors in colleges and universities are interested in using an FCM, given the spread of Internet technology. Although some researchers in Thailand have studied FCM in subjects such as English or Economics (Thaichay & Sitthitikul, 2016), currently, there are no studies on the pedagogical effectiveness of FCM in business statistics courses at any PTIU. That said, FCM as a student-centric approach in teaching (Bergmann & Sams, 2012) has the potential to improve the level of preparedness of the students prior to coming to the classroom and, in turn, to increase students' overall performance levels and satisfaction with the course (Ihm et al., 2017).

1.7. Step 2: Formulate Research Objectives

The second step of Collins et al.'s (2006) 13-step mixed methods research model is employed to identify a research objective based on a plethora of research paradigms in the field of educational research, such as post-positivism, constructivism, critical theory, participatory, pragmatism, interpretivism, post-modernism, post-structuralism, and feminism.

Although initially I intended to perform a pure quantitative analysis to compare and to contrast FCM and the lecture-based model (LBM), and their impact on students' performance, I realized that using a quantitative analysis methodology would not allow me to answer the research questions (RQs) and to understand students' experiences and perceptions. Therefore, I decided to add a qualitative component to my research study.

Mixed methods research involving a quantitative and a qualitative research component can result in a better understanding and comparison of the two aforementioned instructional pedagogies, along with answering the RQs discussed in this chapter. Therefore, I identified best with the pragmatist paradigm, which "offers an immediate and useful middle position philosophically and methodologically" (Johnson & Onwuegbuzie, 2004, p.17). In relation to answering the RQs, Johnson and Onwuegbuzie (2004) note that "taking a non-purist or compatibilist or mixed position allows researchers to mix and match design components that offer the best chance of answering their specific research questions" (p.15).

Five main research objectives were identified by Johnson and Christensen (2010). They are exploration, description, explanation, prediction, and influence. Exploration is defined as using inductive techniques to uncover a previously unknown concept, idea, or hypothesis. Description

can be referred to as the process of describing and identifying the roots and the nature of a phenomenon (Johnson & Christensen, 2010). Explanation is the process of developing or expanding theory for the purpose of making a link or a correlation among concepts, constructs, or phenomena clearer. Prediction is the use of an established model or historical data to anticipate what will happen in the future. Furthermore, influence occurs when one or more variables are controlled or affected to evaluate or establish the effect of the previously indicated manipulation (Johnson & Christensen, 2010). The objective of the quantitative part of this study was prediction, and the objective of the qualitative stage was exploration and explanation.

1.8. Step 3: Determine the Research/Mixing Rationale

The study was conducted at a PTIU with a high failure rate in statistics courses. The study was necessary and worthwhile to find a possible solution for the high failure rates in statistics courses. Regarding the efficacy of FCM, the FCM literature provided mixed results (Betihavas et al., 2016; Lo & Hew, 2017a). Therefore, it was essential to determine whether a better learning environment could be designed using FCM for this private university. In addition, the study's findings may turn out to be useful for university statistics students, educators, and administrators.

In addition, Collins et al. (2006) define participant enrichment, instrument fidelity, treatment integrity, and significance enhancement as four rationales for undertaking mixed methods research. Participant enrichment pertains to the rationale for enhancing the sample by combining quantitative and qualitative approaches (Collins et al., 2006); instrument fidelity represents the procedures followed by researchers to ensure the trustworthiness and suitability of the tools utilized in the research investigation; treatment integrity refers to the steps taken to assess the trustworthiness and dependability of interventions and treatments by mixing quantitative and

qualitative approaches; and, finally, significance enhancement refers to the maximization and expansion of the interpretations that arise from the results of the study by mixing quantitative and qualitative approaches as defined by Collins et al. (2006). Although all rationales are important for many, if not most, mixed methods research studies, in this study, significance enhancement was the main rationale used.

I intended to compile and to analyze both qualitative and quantitative data, which would allow me to obtain a richer data set to analyze and to interpret, thereby improving the significance of my findings (Onwuegbuzie & Leech, 2004). Moreover, by collecting quantitative data on students' performance and attitudes towards statistics and then selecting a sample of students from the low and high achievers for an interview, participant enrichment was supported.

1.9. Step 4: Determine Research/Mixing Purpose

Using the existing theoretical literature and analyzing and evaluating 57 empirical mixed-method research studies, Greene et al. (1989) identified five mixed methods research purposes referred to as triangulation, complementarity, development, initiation, and expansion. Triangulation is the process of evaluating and comparing the findings from both the quantitative and qualitative data, Complementarity is the process of determining whether the results yielded by one approach can enhance the results stemming from the other approaches. Development is the process of informing one approach (e.g., qualitative) using the other approach (e.g., quantitative). Initiation refers to the discovery of contradictions that can help to reframe the RQs. Finally, expansion is the process of expanding the scope of the study by using both quantitative and qualitative research approaches.

As mentioned earlier, there is a lack of research in PTIU on the topic of FCM (Fuchs, 2021). Therefore, my first purpose was to determine whether FCM is associated with increases in students' levels of performance in undergraduate business statistics courses as well as in students' attitudes toward statistics. Therefore, first, I compared the results of the students' performance and the students' attitudes toward statistics with their perceived effectiveness of FCM as a pedagogical strategy, searching for convergence or the lack of convergence (i.e., triangulation, see Greene et al., 1989). Second, I used the results from the qualitative stage to determine whether they could explain the results stemming from the quantitative stage (i.e., complementarity). Third, I expanded the scope of understanding of the effects of using FCM versus LBM in an undergraduate business statistics course by using quantitative and qualitative approaches in different stages of the study (i.e., expansion).

To put it simply, and in order to address the issues noted in Section 1.3 the "Statement of the Problem", the purpose of the study was to evaluate the effect of flipped instruction in a PTUI on both students' examination performance and their attitude towards statistics. In addition, I was interested in examining students' experiences and their perceptions of pedagogical effectiveness as a function of the traditional lecture-based model of teaching statistics and the FCM model of the same statistics course.

1.10. Step 5: Determine Research Questions

Plano Clark and Badiee's (2010) typology classifies nine research questions. In the current thesis, I used combination research questions to classify my RQs (Plano Clark & Badiee, 2010). Plano Clark and Badiee define combination research questions as one or more mixed methods question

which includes separate quantitative and qualitative RQs. The present research was designed to address the mixed methods combination research question with three sub-questions:

Mixed Methods research question (RQ)

The following mixed methods research question and its quantitative and qualitative sub-questions were addressed:

1. What is the difference in learning experiences between the undergraduate college students from a Thai International University enrolled in a traditional lecture-based model of teaching statistics and undergraduate college students from a Thai International University enrolled in a flipped model of the same statistics course? (Mixed Methods Research Question)

    i. What is the difference in statistics course attainment through assessment of assignments between undergraduate college students from a Thai International University enrolled in a traditional lecture-based model of teaching statistics and undergraduate college students from a Thai International University enrolled in a flipped model of the same statistics course? (Quantitative research sub-question)

    ii. What is the difference in attitudes towards statistics between undergraduate college students from a Thai International University enrolled in a traditional lecture-based model of teaching statistics and undergraduate college students from a Thai International University enrolled in a flipped model of the same statistics course? (Quantitative research sub-question)

iii. What is the difference in perceptions about the pedagogical effectiveness between undergraduate college students from a Thai International University enrolled in a traditional lecture-based model of teaching statistics and undergraduate college students from a Thai International University enrolled in a flipped model of the same statistics course? (Qualitative research sub-question)

Research Hypotheses

The quantitative research questions lend themselves to the following two research hypotheses:

Hypothesis 1. Students enrolled in the FCM sections of a statistics course have higher levels of course attainment through assessment of assignments than do students enrolled in the LBM sections of the same statistics course.

Hypothesis 2. Students enrolled in the FCM sections of a statistics course have more positive attitudes toward statistics and statistics courses than do students enrolled in the LBM sections of the same statistics course.

1.11. Educational Significance of the Study

Given the growing popularity of FCM (Brahimi & Sarirete, 2015), it was very relevant to research this topic in order to determine whether it yielded a positive result on student performance at the PTIU in which the study took place, given that the research to date has shown mixed results (Betihavas et al., 2016; Lo & Hew, 2017a). In terms of the high failure rate of students enrolled in statistics courses in the university where this study was conducted, as an instructor-researcher

conducting this research the significance of the study was based on its exploration of the effectiveness of FCM in improving student performance in statistics courses at a PTIU. The purpose of this study was multifaceted. It examines an important pedagogical approach, building upon previous research. The intention was to explore the causes behind high failure rates, with a view to uncovering insights that could potentially enhance educational outcomes. Ultimately, the findings are intended to inform administrative decision making and to shape educational practices.

Moreover, the study addressed the increasing popularity of FCM in education, highlighting its relevance as a contemporary pedagogical approach. In addition, the study was significant because it builds on and contributes to the existing body of knowledge on FCM and aims to provide additional insights and potentially to offer clarity on the impact of FCM on student performance in a specific educational context (i.e., PTIU). As just mentioned, the study took place at a PTIU with a high failure rate among students enrolled in statistics courses, which was the rationale behind conducting this study. By investigating the potential benefits of FCM in improving student performance, the study aims to address an important challenge (i.e., high failure rates) faced by the university. The study's findings also were expected to offer valuable insights into statistics education at the institution where the study occurred. These insights could inform instructional practices and possibly change how statistics courses are taught and learned. This can potentially enhance the quality of education and improve student outcomes.

In addition, the study's findings might influence not only teaching and learning methods but also the policies of the university administration, hence it could affect the quality of education. Equally important, by investigating the impact of FCM in the context of statistics teaching and learning, the study potentially contributes to the broader field of statistics education and pedagogy.

1.12. Delimitations

The present study was conducted at only one PTIU. In addition, this study included only the business statistics courses taught. Therefore, the findings are limited to students who were enrolled at this particular PTIU and relate to the discipline of statistics. The focus of the study was specifically on the comparison of two different instructional pedagogies, that is FCM versus LBM.

1.13. Limitations

The study had several limitations. The limitations are as follows: the fact that it was conducted during the COVID-19 pandemic, which means that the study was conducted using an online flipped format rather than a face-to-face flipped format as originally intended; the study only included students from a single private university; the study might have been affected by selection bias due to convenience sampling; the study only included a specific demographic group; the study did not consider the time and resource constraints of the learners; the study has limited generalizability due to the relatively small sample size; the study had a short duration; and, finally, the researcher also was the instructor, which could have resulted in instructor bias.

1.14. Assumptions

The assumptions of the current study were that the students studying online would exert themselves in learning statistics as much as those students in face-to-face classes, and responses to the interview questions would be honest and accurate by the participants. Had these two assumptions not been met, the quantitative and qualitative data would likely have lacked validity and credibility. To mitigate these potential threats, I employed several strategies. Firstly, to ensure online students engage as thoroughly as those in face-to-face classes, I implemented additional

monitoring tools, such as monitoring the time spent on online tasks or the frequency of participation in forum discussions. For the second assumption, regarding the honesty and accuracy of responses, I constantly reminded the interviewees of the importance and anonymity of the research to participants. I assured respondents that their identities would not be linked to their responses, which can often encourage honesty. In addition, I included cross-checking or validation questions in the interviews to help identify inconsistencies in responses, further enhancing credibility and validity.

1.15. Researcher Positionality

An insider researcher conducts research within a group or culture, of which they are a part (Chavez, 2008; Holmes, 2020). Being an insider researcher involves walking a fine line between familiarity and objectivity because the values and principles we hold shape the research questions we formulate, our interpretations, and the policy recommendations that we propose (Gamage et al., 2021). However, with careful practice, I was able to capitalize on my unique position while minimizing potential disadvantages. As an insider researcher, my positionality within the group of my students meant that I approached the research subject from a place of pre-existing knowledge, experience, and relationships. This gave me easier access to the culture being studied, the ability to ask deeper, more meaningful questions, garner more honest responses, and produce richer descriptions and understanding of the culture (Chavez, 2008; Holmes, 2020). However, being an insider researcher also introduced potential disadvantages, such as inherent bias, limitation to raise sensitive issues, and lack of external perspective. Respondents also may withhold sensitive information due to the continuity of the relationship (Chavez, 2008; Holmes, 2020).

To mitigate these disadvantages in my research, I employed reflexivity and consistently analyzed and considered my beliefs, biases, and preconceptions and how they may be influencing my research. Additionally, I used a mixed methodology that helped me to balance biases. For example, I used qualitative data to provide context and depth, while using quantitative data for a broad, objective overview. Moreover, I involved my doctoral advisors to critique my work to distance myself from the research and incorporate an external perspective. In addition, I was transparent and clearly stated my positionality and background in my research, helping others understand my insider position and consider it when interpreting results. Furthermore, I used member checking to allow my students to review my interview transcriptions and my interpretation of their responses.

Based on prior research, active learning is the most engaging and efficient method for instructing subjects such as statistics (Benková et al., 2022; Corbo & Sasaki, 2021). Involving students in hands-on activities that are directly applicable to real-world situations is preferable to relying solely on lectures, which makes the information they learn more applicable to the real world. As evidenced by prior research studies (Carlson & Winquist, 2011; Theobald et al., 2020), implementing real-world practical exercises can facilitate an in-depth understanding of abstract statistical ideas. This is accomplished by grounding the concepts in comprehensible and tangible contexts. This approach encourages students to think critically and fosters a deeper, more nuanced understanding of difficult topics. In addition, it helps students cultivate a sense of curiosity and inquiry that extends beyond the classroom.

Although active learning is valuable and grounded in its merits, suspending this idea when comparing the effectiveness of FCM versus LBM learning methods was essential for maintaining the integrity of my research and arriving at unbiased conclusions. One example of suspending this

belief was the implementation of objective measures such as employing similar tests and assignments and basing conclusions on quantifiable outcomes by using sound statistical analysis of the data collected to objectively compare the two different learning methods. By approaching the research with an open mind and implementing a rigorous methodology, I contribute to a more comprehensive understanding of the FCM versus LBM comparison as an instructional strategy. I set aside my personal preferences and biases to ensure an unbiased research analysis using Collins et al.'s (2006) framework as outlined in Section 1.5. This involved critically evaluating the methodologies, sample sizes, and validity of tests and surveys that examined active and passive learning. Doing so ensured that my conclusions were based on rigorous evidence rather than personal inclinations (Cousin, 2009).

1.16. Structure of the Remaining Chapters

Steps 1-5 of the methodological framework are covered in Chapter 1. Chapter 2 provides a review of the relevant research literature on FCM, particularly in relation to Thailand and as it pertains to the FCM movement and its pros and cons. Steps 6-8 are included in Chapter 3. Moreover, Chapter 3 also describes in detail the methodology of this study. Step 9 is covered in Chapter 4, along with data analysis and interpretation. Steps 10-13 are covered in Chapter 5. In addition, Chapter 5 summarizes the thesis and concludes with a discussion of its implications and recommendations.

CHAPTER 2: Literature Review

2.1. Summary of the Sections to Follow

In the sections that follow I have provided an explanation of how the literature review was conducted. I have discussed the reasons for including and excluding certain studies or articles, the databases consulted, and the time range considered. Moreover, I have described a flipped classroom model (FCM), its theoretical foundations, and how it fits into the broader context of blended learning (BL). Next, I have delved into the history and evolution of the FCM movement, including who the primary actors were, when it began, and significant milestones. In addition, I have examined various studies conducted on the FCM, focusing on the benefits and challenges associated with this approach. In addition, I have focused on the most recent research and literature, both in general and specific to Thailand, providing readers with the most up-to-date insights and developments on flipped classroom practices in that context. Next, I have positioned the flipped classroom model in terms of the latest progress in statistics education, discussing innovative teaching methods, student engagement, and learning outcomes. In the closing section, I have identified the areas that current the literature has not explored sufficiently and suggest potential directions and opportunities for future research.

2.2. Literature Review Methodology

In this section, I outline the process for conducting a literature review on flipped learning in higher education. First, the literature review aimed to explore studies and research on the implementation and effectiveness of flipped learning in higher education settings. To ensure relevant studies were

included while excluding irrelevant ones, I conducted a thorough search using Google Scholar and ScienceDirect. Searching Google Scholar resulted in finding journal articles across a variety of relevant sites such as *Computers & Education*, *Educational Technology Research and Development*, *British Journal of Educational Technology*, *Education and Information Technologies*, and more. The search encompassed articles on flipped and blended learning regardless of location, time-range, and course type. However, I excluded the literature that was not specifically focused on higher education settings. Second, I narrowed it down to articles addressing flipped learning in statistics classes. Third, in order to enhance the rigor and scope of the literature review, I searched for meta-analyses conducted between 2020-2023 that focused on flipped learning in higher education settings. These meta-analyses offer a synthesis of existing research on the topic. Finally, I searched for flipped learning articles, specifically in Thailand's higher education system (HES).

2.3. The Concept of a Flipped Classroom Within the Wider Blended Learning Paradigm

The instructor's job is changing from a presenter of knowledge to a designer of learning experiences that enhance active student participation (Klochko et al., 2020). This shift is influenced by the evidence that thoughtful instructional design makes students' construction of knowledge and expertise more effective, practical, and interesting, as well as reflecting an increased recognition that learning experiences should be dynamic in order to increase student engagement (Johnson & Johnson, 2018).

Because FCM can be positioned within the wider BL paradigm, it is essential to succinctly introduce and define BL along with its perceived advantages and disadvantages. Although there is no universally accepted definition of BL as Buhl-Wiggers et al. (2023) note, BL generally refers

to a pedagogical approach combining online and face-to-face instructions to provide a comprehensive learning experience (Buhl-Wiggers et al., 2023; Grønlien et al., 2021; Mueller & Wulf, 2022). In addition, BL supports the constructivist epistemology of the learner's active knowledge construction by allowing the learner the opportunity to take control of the learning process (Mueller & Wulf, 2022).

In blended learning, online materials do not replace face-to-face instruction, rather the two modes are complementary. BL combines online and in-person instruction to create an enriched learning environment for the learner (Buhl-Wiggers et al., 2023). Two of the advantages of the BL environment are posited to be the flexible format of the course along with student-to-student and student-teacher interaction (Adam et al., 2023). However, the BL environment might be better suited for learners with a degree of self-regulation and self-direction as far as learning is concerned (Grønlien et al., 2021). This means that students who are not able to take control of their learning process by planning small steps that assist them in learning a given concept, monitoring the learning process, and reflecting on their own learning might be at a disadvantage within this learning environment (Grønlien et al., 2021).

BL also is posited as an umbrella term that includes various forms of learning, one of which is FCM (Adarkwah & Huang, 2023; Arpaci & Basol, 2020; El Sadik & Al Abdulmonem, 2021; Erbil, 2020). A study by Fisher et al. (2021) examined the relationship between BL and FCM with respect to student engagement, performance, and satisfaction. They found that "it is the flipped learning that mediates the effects of blended learning on performance" (p. 13). In this viewpoint, FCM is the mediator variable or the vehicle through which BL, as an independent variable, will affect student performance as a dependent variable. In the context stated, FCM being the mediator

variable means that it is FCM itself that primarily drives the impact of blended learning on student performance. Here, BL can be seen as the broader, independent learning model that combines various techniques including FCM. When the two are compared, FCM appears to be the "vehicle" or intermediary through which BL significantly affects the dependent variable (i.e., student performance). Thus, any changes in student performance can be attributed to FCM, revealing its potentially crucial role in the effectiveness of BL.

Within the BL paradigm, FCM is a model whose focus "is specifically on changing the instructional design to support pedagogical aims of more active and student-centered learning by shifting presentation of content online whereby in-class time can be spent on interactive learning activities" (Buhl-Wiggers et al., 2023, p.153). The FCM model can be traced back to ancient times (e.g., the Socratic dialogue approach), whereby learners were encouraged to think independently before engaging in intellectual conversations and debates (Bates et al., 2017). In recent history, the flipped learning model is primarily rooted in pedagogical practices employed by literature educators, who require learners to read a book before coming to the class and to discuss the concepts during class time (Bergmann & Sams, 2012). However, the term "flipped learning" was popularized in the early 2000s when two chemistry teachers in Colorado, Jonathan Bergmann and Aaron Sams, utilized technological advances to produce lecture videos for learners who failed to attend the lecture presentations during class time (Bates et al., 2017).

FCM is characterized as an instructional method that promises that students are actively involved in their learning (Santos & Serpa, 2020). Al-Samarraie and Saeed (2018) have noted that the importance placed on policies in the field of education have centered on facilitating access to the most current method of two-way communication, which is seen as evidence that learning develops

over time, intending to enhance students' learning and self-direction. Students are expected to engage with course content regularly without instructor aid in a university context (Baragash & Al-Samarraie 2018a, 2018b), and the flipped or inverted classroom is a strategy utilized in this situation. The primary purpose of this approach is to move the information, typically delivered in a lecture-based model (LBM) of instruction, outside of the classroom for students to engage with and prepare. Consequently, FCM frees up classroom time for active learning activities, such as practical application (Lindeiner-Stráský et al., 2022).

Prust et al. (2015) suggest that, in a flipped classroom, students must take responsibility for their education and be accountable for the choices made inside and outside a classroom. Throughout the learning process, students' reflections and communications are aided by the knowledge gained at each phase. Outside of the class in a flipped model, the students are required to study and review the content provided by the instructor to gain the immediate knowledge needed to participate during the actual class. During the class, following a review of the main topics reviewed and learned outside of the class, the students are given more in-depth content specific to their subject to engage, wherein the instructor is used as a facilitator (Staddon, 2022). After the finalization of the class, students are given more content and activities to help them consolidate their information from the former stage. Many prior studies have been driven by the outcomes of these stages of learning to confirm the viability of FCM in various educational settings (Bishop & Verleger, 2013; Goedhart et al., 2019; Maneeratana et al., 2016; McLean & Attardi, 2018; Lawter & Garnjost, 2023; Santos & Serpa, 2020; Staddon, 2022; Strelan et al., 2020). This is due to the widespread view that the flipped classroom paradigm provides students with significant learning opportunities as Yilmaz and Baydas (2017) note, allowing them to solve complex problems within their domain of studies by connecting all pre-and-post class knowledge.

Furthermore, in 2012, an online educational community called Flipped Learning Network (FLN) was launched. This network was designed to guide educators on appropriate strategies for implementing a flipped classroom. The Flipped Learning Network is a non-profit online association that has become an important center for teachers interested in the flipped method. Currently, instructors worldwide may contribute or download material and learn about the best FCM practices in their respective fields. The current resources provided by this network equip educators with, firstly, optimal strategies for a flipped classroom setting, secondly, forums for in-depth discourses and debates relating to pedagogy, and thirdly, practical guidelines for the application and incorporation of technology (Brewer & Movahedazarhouligh, 2018).

Moreover, an increasing amount of empirical research has been conducted annually to investigate the implications of this innovative educational approach, referred to as the "Flipped Classroom Model", on influencing student academic performance (Zou et al., 2022). A simple search in Scopus demonstrates the annual increase in the number of studies conducted on the flipped classroom model as of this writing, which is November 2023. In fact, the search reveals a geometric mean of 0.246, which indicates a 24.6% increase in the number of FCM studies conducted annually from 2014 to 2022 (2023 is still in progress at the time of writing).

Students participating in the lecture-based courses continually encounter a multitude of information and educational objectives. However, due to the constraints of classroom time, active learning might not be extensively emphasized or facilitated. As highlighted by Adams et al. (2016), active learning can be cultivated in lecture-based structures through homework assignments. However, students frequently face challenges with assignments due to the absence of immediate instructor guidance. Jensen et al. (2015) propose that the efficacy of the FCM rests primarily in its

promotion of active learning. Based on multiple studies (Moussaoui & Moubtassime, 2022; Reinoso et al., 2021; Zhang & Niu, 2022), this model is an apt approach that liberates classroom time, thereby fostering active learning via in-class collaborative problem-solving. Implementing FCM involves the relocation of lectures to online platforms, thereby encouraging students to digest the material prior to class. This strategy reserves class time for active learning initiatives, such as group discussions, cooperative problem-solving, and case studies (Jensen et al., 2015).

Despite several studies favoring FCM, the difference is nominal (Adams et al., 2016; Cheng et al., 2019; Li & Li, 2022). Some authors suggest that learners in a fully flipped model outperform learners in a partially flipped one (Triantafyllou & Timcenko, 2014; Vidic & Clark, 2016). The significance of researching partial versus fully flipped learning models lies in understanding how the extent of "flipping" impacts student performance. If learners in fully flipped models consistently outperform those in partially flipped ones, it suggests that there could be an optimal level of flipping that enhances academic outcomes. This research could lead to the refinement of teaching techniques and the better integration of flipped learning in curriculum design. Furthermore, Burgoyne and Eaton (2018) claim that FCM is particularly suited to courses such as psychology and statistics. In contrast, subjects like introductory courses, wherein student interest in the subject matter is still emerging, are less conducive to FCM (Hamdan et al., 2013). The definition of FCM, agreed upon by researchers, includes two key elements: interactive group activities within the classroom and individual computer-based learning outside of the classroom (Barrios et al., 2022; Bishop & Verleger, 2013; Goedhart et al., 2019; Lapitan Jr. et al., 2023; Lawter & Garnjost, 2023; Lo & Hew, 2017b; Maycock et al., 2018; Staddon, 2022). Song et al. (2017) argue that the debate regarding FCM implementation remains unresolved. As such, numerous studies are being conducted regarding full versus partial FCM, the duration of active

learning within the classroom, and the nature of the lecture format when transferred outside the classroom, among other issues.

2.4. Recent Studies on the Flipped Classroom Model

Unlike a traditional lecture-based method of learning, "flipped or inverted learning" refers to a particular teaching and learning strategy within the wider blended learning paradigm, in which the lower order thinking skills of Bloom's Taxonomy (i.e., remembering and understanding) are moved into the learner's personal space, such as home, usually in the form of lecture videos, which are the most prominent method of moving the lecture outside of a classroom (Ahmed & Indurkhya, 2020; Klochko et al., 2020; Zain & Sailin, 2020). Consequently, the higher order thinking skills (i.e., applying, analyzing, evaluating, and creating) are conducted in a classroom (either online or face-to-face). In this model, most of the class time is allocated for active learning using different learning procedures such as in-class practices, small in-class group projects, class discussions, question-and-answer sessions, and problem-solving within collaborative groups, which, in turn, creates a better learning environment using active learning methods, resulting in fewer distractions to learning (Staddon, 2022).

Moreover, it has been suggested that FCM can foster an environment that encourages teamwork and enhances critical thinking skills (Sun & Xie, 2020). This instructional approach promotes active, collaborative learning throughout the class by facilitating group discussions and problem-solving exercises. As students collaboratively address intricate problems, these activities subsequently foster prospects for collaboration. Students are also obligated to assess information, implement concepts, and integrate ideas due to this active learning approach. FCM, therefore,

facilitates the development of students' critical thinking skills through their complete immersion in these intellectually stimulating activities.

In addition, this model allows students to become independent learners and actively supports integrating emerging technologies (Barrios et al., 2022). Furthermore, the role of the instructor shifts to that of a facilitator or guide, a change that fosters increased student participation (Barrios et al., 2022). In addition, FCM is a promising method for helping underachieving students enhance their academic performance based on several studies conducted on the effects of FCM on underachieving students (Lo & Hew, 2017b; Youssef & Al-Shahrani, 2021). Equally important, and also based on multiple studies (Lapitan et al., 2023; Rodriguez-Paz et al., 2020; Zheng et al., 2020), learners view collaborative activities within this model favorably, contributing to its efficacy. Lastly, FCM has been found to bolster student engagement and to increase digital literacy as evidenced by multiple studies previously conducted (Aslan, 2021; Fisher et al., 2021; Gómez-García et al., 2020; Yanuarto, 2021; Zain & Sailin, 2020).

In addition, a study conducted by Luo and Wang (2023) revealed that early course start times (e.g., 8 a.m.) at a university can have a negative effect on midterm and final examination scores, as well as influencing learners' self-confidence and enjoyment of the learning process. The same study showed that flipped learning could be a possible solution to the negative influence of early course start time by increasing the academic performance of the learner. Nonetheless, no effect sizes were produced in the study. This finding could impact how universities schedule their classes and construct student timetables. In addition, the research conducted by Luo and Wang (2023) highlights the need for further exploration of flipped learning as a potential solution to counteract the adverse effects of early start times on academic performance. This introduces a critical

discourse on how innovative teaching techniques, such as FCM, can be pivotal in mitigating inherent challenges in educational setups, ultimately leading to enhanced academic performance and positive learning experiences.

However, the latest FCM studies also show mixed results when contrasting the outcome of FCM comparing to LBM (Chen et al., 2017; El Sadik & Al Abdulmonem, 2021; Setren et al., 2021; Wittmann & Wulf, 2023). As an example, a recent quasi-experimental study on flipped versus lecture-based learning by Ruzafa-Martínez et al. (2023) has shown that, although the flipped section under study had higher attitude and performance scores in comparison to the lecture-based section, these higher scores were not statistically significant. Therefore, to understand better the results of flipped versus lecture-based pedagogical models across different spectrums, it is crucial to review many of the recent meta-analyses and systematic reviews of flipped learning.

A meta-analysis conducted by Strelan et al. (2020) at all levels of education included 174 studies conducted at the higher education, 21 at the secondary, and three at the primary levels of education respectively. This analysis revealed that FCM was advantageous regardless of the discipline with a moderate positive effect (i.e., $g = .5$) on learners' achievement, which has a meaningful practical significance. Strelan et al. (2020) also found that the components required in order for FCM to be a beneficial instructional strategy include the inclusion of structured active learning and problem-solving techniques because a "flipped approach provides for the most productive use of their face-to-face time with students" (p. 2). This means that competence or a lack of in the implementation of active learning and problem-solving techniques can result in changing the relationship (e.g., making the relationship more positive or more negative) between the independent variable, FCM, and the dependent variable, namely the learners' performance (Cevikbas & Kaiser, 2023).

Similarly, Strelan et al. (2020) also concluded that the benefit of FCM is not in learners' ability to use technology to access pre-class material such as recorded videos, but rather in how the facilitator implements active learning and problem-solving during class time.

A more recent comprehensive meta-analysis conducted by Bredow et al. (2021) on the effects of FCM versus LBM focused on four domains, namely, learners' academic achievement, intrapersonal skills (i.e., self-regulation, self-awareness, motivation), interpersonal skills (i.e., collaboration and communication with others in a group), and satisfaction-related outcomes in higher education. Academic achievement only captures one dimension of the overall learning experience, therefore researching domains other than academic achievement is significant because it provides a more holistic approach to understanding the impact of different teaching methodologies on students**.** Bredow et al.'s (2021) meta-analysis has shown a positive gain in favor of FCM instructional pedagogy regarding student achievement, interpersonal and intrapersonal skills, and satisfaction. Of equal importance, the aforementioned meta-analysis showed that educational context has a moderating effect on FCM outcome. This finding showed that the context in which FCM is applied – such as course type or course location – can increase or decrease the strength of the relationship and thereby account for more of the variability in FCM outcome measures.

Another meta-analysis conducted by Tutal and Yazar (2021) focused on academic performance, content retention, and attitude towards the course in which FCM was implemented, which included all levels of education, with 177 studies on academic performance, 9 studies on learning retention, and 17 studies on attitude toward the course. This analysis also revealed a positive moderate effect size in favor of the effectiveness of FCM in academic performance (g = 0.764) and retention (g =

0.601) but a weak positive effect size regarding the attitude toward the course (g = 0.406). The findings also showed that FCM can be implemented better in smaller class sizes in all domains of study and has been applied more effectively in primary schools. This study is significant because it highlights the effectiveness of FCM in improving academic performance and content retention across all education levels and indicates that certain factors, such as smaller class sizes and primary schools, optimize its impact. The moderate positive effect sizes on academic performance and learning retention indicate FCM's direct impact on enhancing student understanding and information retention. The weak positive effect size for the attitude toward the course may hint at other factors influencing students' perceptions about the subject, not necessarily connected to the teaching method. It opens a new avenue for research into what other elements play a role in influencing attitudes toward a course. The fact that FCM has been more effectively applied in primary schools suggests it may better suit the educational needs of younger learners, facilitating their active engagement and enthusiasm for learning. This piece of information could be valuable for educators and curriculum designers in operating and evaluating the effectiveness of their teaching methods.

The most recent meta-analysis by Lawter and Garnjost (2023) is comprised of 38 studies of both quantitative and non-quantitative business courses focused on knowledge acquisition and student satisfaction. The result of this meta-analysis revealed that there was a larger positive effect, in both quantitative and non-quantitative courses, regarding the acquisition of knowledge in courses that implemented a flipped approach in comparison to a lecture-based one. Interestingly, the effect in non-quantitative courses regarding knowledge acquisition was higher but not statistically significant. Moreover, this analysis by Lawter and Garnjost has revealed that student satisfaction in quantitative business courses is higher, albeit not statistically significantly higher. Lawter and

Garnjost recommend not using FCM as a universal format, but rather considering the balance between student satisfaction and knowledge acquisition in order to design learning environments. The significance of this meta-analysis lies in its findings, which provide evidence that flipped learning can enhance knowledge acquisition in both quantitative and non-quantitative courses. Moreover, their recommendation is not to use FCM as a universal format but to consider the balance between student satisfaction and knowledge acquisition, which underscores the importance of course and student-specific considerations in instructional design. This contributes to an understanding that education methods should be tailored to the unique demands of specific courses and student populations for maximum effectiveness.

Another recent meta-analysis by Borokhovski et al. (2023), largely at the higher education level, has compared online learning (OL), blended learning and flipped learning with lecture-based learning. This meta-analysis was conducted on pre- and in-service teachers at the higher education level, focusing on achievement outcomes with 77 studies, attitudinal outcomes with 21 studies, and self-efficacy outcomes with 22 studies included. All the studies included had at least one treatment and one control group as well as sufficient information to compute effect sizes. This recent meta-analysis showed a relatively moderate effect size ($g = 0.44$) in favor of a combination of OL, FCM, and BL compared to the lecture-based model. However, the most important finding was that a combination of BL and FCM improved performance compared to purely OL. This combination (BL/FCM) revealed statistically significant positive results in all three outcome measures, namely, performance, attitude, and self-efficacy. This study is important as it provides empirical evidence that integrating synchronous and asynchronous learning models can optimize educational outcomes. Hence, enhancements in all these dimensions (i.e., achievement, attitudinal, and self-efficacy outcomes) indicate a more holistic educational advantage. This suggests that a

blend of FCM and BL is more effective in fostering comprehensive academic development. This information can be helpful for educators when choosing instructional methodologies.

The recent meta-analyses above reveal that, regardless of the course type, level of education, or location, outcome measures – such as performance or satisfaction – are higher for FCM/BL learning than for lecture-based models. Although most articles and meta-analyses show higher scores in outcome measures, many individual studies reveal no statistically significant result when comparing FCM to LBM. This difference in results might be attributable to the variability in implementing active learning methods within a flipped learning model, as Rawas et al. (2021) suggest. This information is noteworthy because it highlights the consistently positive impact of FCM/BL across different course types, levels of education, and locations in comparison to LBM, while at the same time underlining the inconsistent results found in individual studies, suggesting that the application and impact of FCM can vary significantly based on the specific methods of active learning employed within the model. Therefore, while FCM/BL generally appears to be more beneficial, understanding the optimal ways to apply active learning within a flipped model is crucial for realizing its full potential. This insight can guide future research and instructional design in education.

2.5. Recent Studies on FCM and Statistics Education

Statistics learning, like numerous other educational domains, necessitates the application of cognitive capabilities inclusive of critical thinking and problem-solving skills (Manik, 2020). A meta-analysis by Freeman et al. (2014) examined students' academic achievement in LBM versus FCM classes in undergraduate STEM (science, technology, engineering, and mathematics) fields. This meta-analysis revealed improved academic achievement in favor of FCM sections concerning

academic achievement with a practical significance. The practical significance stems from the fact that 158 of the 225 studies examined by Freeman et al. included examination score data. In addition, Freeman et al. discovered that the overall mean effect size for performance on identical or equivalent examinations, concept inventories, and other assessments had a weighted standardized mean difference of 0.47 (n = 158, z = 9.781, p < .001), which means that the performance of learners increased by approximately one half a standard deviation when active learning was utilized versus lecturing. The rationale for reporting practical significance rather than statistical significance is that, according to Onwuegbuzie and Daniel (2005), "statistical significance" and its variants should be used when interpreting p values, whereas "practical significance" should be used when interpreting effect sizes. Due to the reported effect size being very close to 0.5, we can conclude that there is a medium effect size and, consequently, a practical significance in favor of active learning models of instruction compared to lecture-based models.

Employing a control group and a treatment group, Wang et al. (2020) conducted a study in a 16-week flipped medical university-level statistics class. The study focused on the learners' academic performance, self-regulated learning ability, and interest in learning. The study results showed that the learners' interest in learning (d = 0.58) and academic performance (d = 0.48) was statistically significantly higher in the FCM section, with no statistically significant difference in self-regulated learning (d = 0.08). Hence, Wang et al. (2020) posited that, generally speaking, the FCM is more effective than LBM in their study. However, it should be noted that the sample size of this study is small and, therefore, the results cannot be generalized to other settings.

Holm et al. (2022) have evaluated the efficacy of FCM in a university-level statistics course. The results of this study revealed no statistically significant difference concerning academic

performance defined by examination grades. Nevertheless, the study showed that the FCM was perceived more favorably by the learners ($p = 0.008$). The authors note that a sample size of 21 for both the treatment and control groups was calculated based on a power of 0.8 and a 0.05 level of significance. However, using Faul et al.'s (2007) free G*Power 3 software program computes a minimum sample size of 64 for each group. Therefore, the sample size for this study also is too small to generalize the results.

A more recent study was conducted by Liao and Wu (2023) and involving a flipped statistics course, in which clickstream data analytics were used to determine the learning profile of the students and their behavior in learning the pre-class lecture material in the form of lecture videos. Clickstream data is information collected from the learner, which shows their profile and behaviour while watching the videos. It utilizes metrics, such as the length of time the video was watched, the standard deviation of times, the number and the length of pauses while watching the lecture videos, and how many times the video was rewound or forwarded. This study is unique because most FCM studies focus on implementing FCM active learning techniques during class time. However, the researchers in this study sought to discover the learners' profile during their pre-class work. The researchers argued that educators, as the experts and guides in the classroom, must address the motivational issues of learners regarding why one should learn the material and create an environment in which their learning motivation increases. This study also was limited by a small sample size of 47; therefore, the results might only apply to the environment in which this study was conducted.

A meta-analysis conducted by Farmus et al. (2020) focused on the FCM research on statistics courses at an undergraduate level. This meta-analysis included only the studies conducted on

statistics courses, in which the students were not mathematics or statistics majors (see Cilli-Turner, 2015; Gundlach et al., 2015; Heuett, 2017; Khan & Watson, 2018; Maldonado & Morales, 2018; Nielsen et al., 2018; Reyneke et al., 2018; Shinaberger, 2017; Wilson, 2013). The studies included were either experimental or quasi-experimental with a control and treatment group design and focused on final examination grades to measure learners' academic performance. The studies chosen had sample sizes between 20 to 1,466 for the FCM sections and between 20 to 1485 for the LBM sections. The result of this meta-analysis revealed a nearly moderate effect size ($g = 0.43$) in favor of the FCM statistics classes. The meta-analysis of Farmus et al. (2020) also determined that the weekly in-class quizzes acted as a moderating factor, meaning that the studies with weekly in-class quizzes had a higher positive outcome regarding learners' academic performance. The meta-analysis by Farmus et al. (2020) is significant because it reveals the beneficial effect of the flipped classroom model on the academic performance of students in undergraduate statistics courses, specifically those who are not mathematics or statistics majors. This suggests that the FCM approach can aid understanding and performance in complex content areas for non-specialists. Crucially, the findings also reveal that adding weekly in-class quizzes facilitates better outcomes in these FCM settings. This suggests that these quizzes could be a critical moderating factor in ramping up the benefits of FCM.

Concerning statistics education, Cobb (2015) proposed a rethink of the undergraduate statistics curriculum, listing five imperatives. The imperatives used as a guideline were to flatten prerequisites (i.e., creating a more flexible pre-requisite course structure and introducing topics as needed to solve problems), seek depth (i.e., focusing on statistical concepts and ideas rather than fixating on mathematical formulas), exploit context (i.e., using real-world data to teach concepts), embrace computation (i.e., exploring data using computational techniques and algorithms

borrowed from computer science rather than relying heavily on mathematics), and teach through research (i.e., motivating students to learn by encouraging them to ask questions important to their lives while helping them to learn by using data to answer those questions).

Given that digital literacy in this increasingly digital century is a valuable skill to develop (Marín & Castaneda, 2023), it is critical to approach statistics education as one of a number of methods that can foster a citizen's digital literacy. Numerous statistics educators and articles, such as Di Leo and Sardanelli (2020), Erhardt and Lim (2020), Reyneke et al. (2021), Schwartz et al. (2018) and Schwartz et al. (2016), refer to the American Statistical Association (ASA) and its reported guidelines in statistics education. There are six guidelines stated in the Guidelines for Assessment and Instruction in Statistics Education (GAISE College Report), which are to "teach statistical thinking, focus on conceptual understanding, integrate real data with a context and purpose, foster active learning, use technology to explore concepts and analyze data, and use assessments to improve and evaluate student learning" (Carver et al., 2016, p.3).

In recent years, there has been an increasing amount of literature on statistics education and the standards to uphold in teaching statistical concepts**,** as evidenced by a simple search in Scopus showing an annual increase of 19.2% for such articles from 2019-2023. Reviewing the latest published literature, such as Elder and Crain-Dorough (2021) and Erhardt and Lim (2020) reveals many recommendations that align with the ASA guidelines while underlining developments that further complement its recommendations. Much of the available literature in statistics education deals with articulating queries, collecting data, analysing data, and interpreting the results, however, Weiland and Williams (2023) have argued for the fundamental role of culturally relevant data and pedagogy in statistics education to motivate students to learn the concepts. In addition,

Raman et al. (2023) have observe**d** that because real-world data is abundant and easily accessible, incorporating ethics in statistics education is more critical than in previous decades in order to educate learners on issues such as data privacy or preventing the presentation of fake data. Raman et al. (2023) have noted that "the ease of posting fake data have arisen since the early 2000s because of the growth of the Internet and social media" (p.324).

Tackett (2023) recommends "Regularly engaging with complex and relevant real-world data and applications, Developing the skills and computational proficiency for a reproducible data analysis workflow, and Developing important nontechnical skills, specifically written communication and teamwork" (p.116) to teach undergraduate statistics courses especially when regression analysis is involved. In addition, Wang and Cai (2023) suggest developing in-class activities based on active learning principles to motivate students better to learn statistics. Similarly, Davidson (2023) suggests using investigative projects and project-based learning to allow learners to apply the learned concepts to encourage them further to engage in the learning process. These recommendations are significant as they provide educators with a roadmap for designing courses in a way that could maximize student learning and engagement. They also highlight the role of a variety of teaching strategies in statistics education, underscoring the multifaceted nature of effective instruction.

Moreover, van Borkulo et al. (2023) advocate using spreadsheets to promote problem-solving skills such as computational thinking in statistics education. Furthermore, Curley and Downey (2023) propose employing an alternative grading system (e.g., allowing students to take tests or assignments multiple times) to help learners acquire ways of learning different concepts. Curley and Downey also posit that learners' text anxieties could be reduced through an alternative grading

system in order to help create a better learning environment. The significance of these studies lies in addressing two major themes in improving statistics education: developing problem-solving skills and creating a supportive learning environment. In particular, allowing learners to take tests or assignments multiple times provides a means to optimize learners' acquisition of different concepts while reduce test anxieties, thereby creating a more conducive and less stressful learning environment.

The newest article on the most recent trends in statistics education is by Burrill and Pfannkuch (2023). Based on specific criteria, they selected an expert group of statisticians from 15 countries and consulted these experts about emerging trends in statistics education. Their qualitative analysis of the responses showed these trends to be data science (i.e., the ability to collect big data using technology and the use of modelling to predict trends), "visibilizing" statistical concepts (i.e., using technology to perform data visualization to grasp concepts), social statistics (i.e., the critical evaluation and communication of results and arguments based on the evidence), and new learning contexts (exploring alternative methods of data and data collection such as qualitative data).

Perhaps the most exciting and up-to-date recommendation concerning statistics education has been offered by Ellis and Slade (2023) regarding using ChatGPT or artificial intelligence in statistics education. Although Ellis and Slade (2023) acknowledge the danger of plagiarism using ChatGPT, they suggest that educators can demonstrate to learners the ethical use of ChatGPT along with deploying it to develop course content such as lecture notes for the class and to create new material such as in-class activities and examinations.

Although a few of the aforementioned articles briefly note the role of pedagogy in statistics education, none specifically advocates the use of a specific pedagogy. FCM, as a subset of BL, is

one particular model that has the potential to address many, if not most, of the emerging trends and developments in statistics education. Because FCM frees up classroom time (Lindeiner-Stráský et al., 2022) and makes better use of face-to-face class time (Strelan et al., 2020), all the aforementioned active learning strategies mentioned in this section by different researchers can be implemented easily to create an environment conducive to learning.

2.6. Latest Literature on the Flipped Classroom Model in Thailand's Higher Education Setting

Fuchs (2021a) is one of the few academics reviewing FCM studies in Thailand. Fuchs has reported that, according to Kew et al. (2018), Thailand has approximately 170 governmental and private higher education institutions with more than 4,000 curricula, in which various government-owned colleges receive government funding for research. In Thailand, there are many non-profit public universities, such as the Rajabhat Universities, which formerly functioned as educator training colleges (Fuchs, 2021). Rajabhat Universities primarily operate in different provinces of Thailand. Moreover, Thai universities do not rank well internationally (Fuchs, 2021), although they are well-regarded for developing outstanding science and engineering graduates (Watson, 2018).

The institutions of higher education in Thailand are modelled after the three-tiered system of universities in the Western hemisphere (e.g., undergraduate, graduate, and postgraduate degrees) (Fuchs, 2021) with 4-year degrees at the undergraduate level. Thailand has gradually shifted toward private higher education, continuing the pattern of higher education reform in the 1990s allowing a sharp increase in the number of private higher education institutions and programs, such as the institution in which this study took place (Fuchs, 2021). Concurrently, the number of

private higher education programs and private universities in Thailand has increased dramatically (Yousapronpaiboon, 2014).

Thai students often complain about overwhelming schoolwork, while educators struggle to engage disinterested learners due to time constraints and the complexity of instruction (Fuchs, 2021). Santikarn and Wichadee (2018) have posited that the flipped classroom method could address the abovementioned concerns by engaging students in active learning. This paradigm categorizes learning in various environments (i.e., pre-class and post-class). Fuchs (2021a) observed that although there is limited literature on FCM in Thai higher education, the studies undertaken showed favorable benefits relating to student performance and perspectives, as evidenced by positive results from FCM studies conducted on Thailand's HES (Maneeratana et al., 2016; Pattanaphanchai, 2019; Santikarn & Wichadee, 2018; Srisuwan & Panjaburee, 2020).

Utilizing flipped learning, Srisuwan and Panjaburee (2020) have deployed both traditional and tailored ubiquitous educational approaches to enhance the digital competence of undergraduate students at a Thai higher education institution. The FCM approach statistically significantly increased students' digital competence and course attainment in this study. Moreover, Turan and Göktaş (2018) used an introductory computer course to study how the FCM affects students' motivation. During the initial class meeting, students were trained to utilize a standard lecture-based technique. Another class meeting was held for a different group involving the same material using a flipped approach which included flipped videos. The findings revealed that the learners using the flipped approach had more motivation to learn (Fuchs, 2021). These two FCM studies in Thailand are significant because they demonstrate the advantages of flipped learning in enhancing students' digital competence and motivation in different contexts. This suggests that the FCM

might be used effectively to improve digital literacy, an increasingly crucial skill in today's technology-driven academic and professional environments. These findings underscore the potential of the FCM model to facilitate practical learning experiences in terms of both skill acquisition and learner motivation.

In addition, academic performance in many engineering disciplines improved while student withdrawals were reduced when students in the Mechanical Engineering Department used flipped learning models (Maneeratana et al., 2016). Flipped classrooms, particularly in the Mechanical Engineering Department, improved course management and student academic performance. In another experiment in Thailand, Pattanaphanchai (2019) undertook a comparative research study to assess the influence of the FCM approach. It was discovered that the flipped learning technique produced better outcomes among Thai students regarding student assessment and meeting the course's learning objectives. These findings reinforce the effectiveness of the FCM in improving students' academic success across different contexts, thereby offering empirical support for the FCM approach in terms of enhancing students' performance. Together, these studies strengthen the case for implementing the FCM in different fields and diverse cultural contexts, highlighting its versatility and effectiveness in achieving various educational goals.

Suebsom (2020) conducted a study on blended learning, in which flipped learning and collaborative work alongside social media was utilized. The study involved the use of a pre-test/post-test one-sample design, without a control group. Suebsom found that the students' academic performance and thinking skills increased because of using blended learning in conjunction with flipped learning. The author also found that using BL/FCM encouraged the learners to learn more about using technology as a tool and helped them display more confidence

in their learning ability. However, the researcher did not provide a *p* value or an effect size to place the results into an appropriate statistical perspective. This study provides important evidence regarding the effectiveness of blended and flipped learning models in enhancing students' academic performance and thinking skills. Crucially, it emphasizes the added value of integrating technology and collaborative work through social media. This could lead to increased technological literacy and boost learners' confidence in their learning ability.

Fuchs (2021b) has stated that there have been very few studies in Thailand concerning a technology-enhanced FCM (TEFC). He conducted a qualitative research study to determine the perceptions of students employing TEFC to support their graduate studies. Fuchs's study revealed that the learners' overall perception of FCM was positive. The TEFC model was a practical and useful model to deploy, particularly during pandemics or emergencies when online education takes precedence.

Phurikultong and Kantathanawat (2022) have conducted a study to determine and to develop the most effective format for teaching and learning analytical thinking skills. Analytical thinking skills are defined as correctly researching, finding pertinent information, and properly analysing the information using critical thinking skills during the entire process. The researchers concluded that using a flipped classroom format in conjunction with inquiry-based learning and digital storytelling is the best format for educators to teach and for students to learn analytical thinking skills. However, it is essential to note that the study did not have a control group. It was a one-group experimental design with pre- and post-testing, which showed the post-test result to be statistically significantly higher than the pre-test. Due to the lack of a control group, one might conclude that perhaps the same result could have happened if a lecture-based method had been

used in conjunction with inquiry-based learning and digital storytelling. Moreover, a *p* value of zero had been recorded without using any measure of effect size.

In attempting to research and design the best teaching and learning format to improve Thai student-teachers' academic achievement and problem-solving skills in a bachelor's degree education program, Nantha et al. (2022) designed a quasi-experimental study with a three-group design format. The first group, a control group, used the traditional lecture-based method, whereas the second group was an FCM treatment group, whereas the third was a problem-based learning group. The study revealed that the student-teachers enrolled in the FCM section had statistically significantly higher academic achievement and problem-solving scores than did the other two groups. The sample size was 90 in total and almost equally divided between the three groups. This study is noteworthy for two reasons. Firstly, it demonstrates the effectiveness of FCM in improving student-teachers' academic achievement and problem-solving skills compared to LBM. Secondly, the study's three-group design, including a control and two different intervention methods, provides a better understanding of the comparative effectiveness of these teaching strategies.

Khasanah and Anggoro (2022) conducted a study of a university-level English course in Thailand to investigate the efficacy of flipped learning, particularly concerning pronunciation and to examine learners' perceptions concerning FCM. The study used a pre-test/post-test design with no control group. A questionnaire with 22 items was used to extract four aspects of the design: the learners' perception of the pre-class component, in-class components, the perception of stressing the word pronunciation, and the learners' perception of the FCM instructional strategy. Khasanah and Anggoro discovered that, overall, the FCM model was effective because the post-test average scores were statistically significantly higher than were the pre-test average scores ($p < 0.001$, $d =$

1.4). Moreover, according to Khasanah and Anggoro, the questionnaire responses were positively high, which represented a positive perception of the four aforementioned aspects. The sample size of this study was 59. This study is important because it provides evidence of the efficacy of FCM in a specific application, namely improving pronunciation in a university-level English course. In addition, it coupled objective performance measures (pre-test and post-test scores) with subjective measures (learner perception) to provide a more comprehensive view of FCM's effectiveness.

Another FCM study by Daungcharone et al. (2023) researching a university-level system analysis and design course focused on learning style preference (i.e., prefer to learn in a group or a self-learner) as an independent variable and motivation as a dependent variable. Using questionnaires to record students' scores regarding motivation, Daungcharone et al. also found that in a flipped classroom model with collaborative group work, the students who prefer to learn in groups have a higher motivation in terms of intrinsic, self-efficacy, and self-determination motivation respectively. This study also was a one-group design with a sample size of 115 learners. This study is significant as it explores the role of learning style preference in the efficacy of the FCM, providing insights into how different students may respond to such pedagogical models based on their preferred learning style.

2.7. Synthesizing the Latest literature on FCM

The new literature on FCM at higher education levels, in Thailand, and in relation to statistics courses respectively as well as their meta-analysis have generally revealed positive reviews and results concerning the efficacy of FCM and learners' attitude toward FCM (Khasanah & Anggoro, 2022; Farmus et al., 2020; Suebsom, 2020). In addition, FCM's impact on learners' academic

performance, engagement and motivation while using a FCM/BL approach were generally positive, regardless of the discipline in which it was employed (Rawas et al., 2021).

Alas, as mentioned earlier, many of the studies suffer from small sample sizes and/or do not report *p* values or effect sizes. Moreover, many studies in Thailand (Khasanah & Anggoro, 2022; Phurikultong & Kantathanawat, 2022; Suebsom, 2020), did not involve the use of a control group, which might make the positive conclusions regarding FCM subject to multiple threats to internal validity (e.g., maturation, statistical regression to the mean). In addition, overreliance on published articles might be a serious threat in stating a generalized conclusion that FCM is more efficient than is LBM due to publication bias, which is defined as only publishing articles that show positive results and not publishing articles with negative results It is possible that the effectiveness of FCM might be overestimated if studies that demonstrate significant improvements in student learning are published more often than those that show no difference or negative impacts. This could lead to the widespread adoption of FCM based on an inaccurately positive perception of its benefits by researchers and educators (Afonso et al., 2023; Marks-Anglin & Chen, 2020; Page et al., 2022; Van Aert et al., 2019).

The studies mentioned in previous sections present the results of recent studies exploring the use of FCM in university-level courses in general, and statistics courses in particular. The literature highlights research from Wang et al. (2020), Holm et al. (2022), and the study from Liao and Wu (2023), with the goal of assessing the efficacy of FCM. The latter involves switching traditional teaching practices, wherein students consume instructional content outside the classroom and class time is dedicated to active learning tasks. The potential advantage of FCM is its promotion of student engagement and active learning, crucial elements in understanding complex topics in

statistics education. Critically, Wang et al. (2020) have shown increased interest in learning and improved academic performance, implying that FCM can stimulate interest and enhance understanding of a topic often perceived as challenging. However, no impact was noted in relation to self-regulated learning. Conversely, Holm et al. (2022) have observed that, despite the lack of statistically significant improvement in examination scores, students held a positive perception of FCM, which could foster a positive learning environment, crucial for the long-term understanding and application of statistical concepts. Significant across these studies is a limitation regarding small sample sizes. Holm et al.'s (2022) sample size (21 per group) stands as a stark example of this, compared to the calculated ideal sample size of 64 per group. Limited sample sizes generate concerns about the precision of effect sizes (i.e., the magnitude of differences between groups) and, consequently, the external validity of these studies. Overall, although these studies present FCM's potential benefits in improving engagement and learning outcomes in statistics education, their insights should be interpreted cautiously due to the limitations regarding sample size and/or small effect sizes.

2.8. Gaps in the Literature

From the literature presented (e.g., Barrios et al., 2022; Bishop & Verleger, 2013; Goedhart et al., 2019; Lapitan Jr et al., 2023; Lawter & Garnjost, 2023; Lo & Hew, 2017b; Maycock et al., 2018; Staddon, 2022; Strelan et al., 2020; Wittmann & Wulf, 2023), it can be concluded that students' attitudes towards the flipped classroom approach and learner achievement have been mixed (Lo & Hew, 2017a). In addition, the literature review on the FCM in Thailand is inconclusive regarding the usefulness of this instructional technique. Moreover, my research on FCM differs from that of

other researchers because I conducted my research at a large private Thai international university (PTIU), a type of higher education institution in which such a study has never been undertaken.

Moreover, because of the "limited amount of relevant research in Thai higher education related to the flipped classroom" (Fuchs, 2021, p. 129) as well as the lack of evidence of a mixed methods research design that specifically examines the use of the flipped paradigm in statistics courses in any PTIU, there was a need to fill a gap in terms of Thailand's body of FCM-related knowledge of undergraduate statistics courses. Furthermore, no books or meta-analyses on FCM, particularly in Thailand, have been published. Moreover, there is only one recent article by Ratanothayanon (2018) comparing two groups of learners in only one section of a business statistics course, comprised of 20 students per group, which showed no statistically significant difference between the performance of the flipped group and the non-flipped group ($t = .505$, $p > .05$). Given that the sample size was only 40 students and all students were in the same class, my study with a much larger sample size employing control and treatment groups could perhaps contribute further to the FCM literature in Thailand.

As more educational institutions of higher education favor, emphasize, and support the application of student-centered instructional methodologies (Omar, 2022), it is becoming more important to investigate the impact of FCM in at least one PTIU. Examining the impact of FCM versus LBM in teaching different sections of the same undergraduate statistics course would be both informative and useful. Thus, there is sufficient reason to rigorously design and conduct a comprehensive research study that includes both quantitative and qualitative approaches to determine whether there is a difference in the performance, attitude, and perception of learners by comparing a much larger sample of business statistics students using two different modes of

instruction (FCM vs. LBM) in many different sections of the same statistics course over the course of two semesters.

CHAPTER 3: Methodology

3.1. A Summary of the Sections to Follow

In the "Research Context" in Section 3.2 a brief overview of the environment where the data were collected is provided along with a detailed Ethics Consideration in Section 3.2.3 to discuss the ethical considerations within the context of this study. Next, I have discussed the methodology employed in the current study. Because Steps 1-5, which are called the formulation stage, were discussed in the previous chapters, I began by discussing Step 6 (selecting the mixed sampling design) of the 13 steps and then continue with Step 7 (selecting the mixed research design), Step 8 (collecting data), and Step 9 (Data Analysis), as well as the instrumentation used in the coming sections. The steps above are discussed within the context of the quantitative, qualitative, and mixed component of the current study. This chapter ends with a summary of the study's methodology.

3.2. Research Context

3.2.1. Background Information and Locational Context

The research was conducted at a private Thai international university (PTIU) with a student population of 2,500. Most of the students are Thai and Chinese. Each term there are three to four sections of business statistics offered. Business statistics is a core course at the university. Typically, the maximum capacity of 40 students is reached in each section. This private university offers curricula that include statistics education. However, there is only one single basic mathematics course serving as a sole pre-requisite before proceeding with statistical coursework.

I had initially intended to conduct the study in a face-to-face setting. However, due to unforeseen circumstances brought about by the COVID-19 pandemic, the classes were unexpectedly transitioned to an online format. Therefore, I had to design and to collect data in an online flipped classroom model (FCM) and an online lecture-based model (LBM) environment.

3.2.2. Theoretical Context

Using Kolb's (2015) experiential learning theory (ELT), I designed the Concrete Experience, Reflective Observation, and Abstract Conceptualization, and Active Experimentation phases for pre-class and in-class activities by creating instructional flipped videos (FVs) for every learning objective. I personally created and designed the FVs using Panopto, video editing software for educational institutions, and then deployed this on the Blackboard Learning Management System. The FVs were approximately 10 minutes long. I aimed to help the learners to engage in these three phases independently by watching the FV lectures. I also posted some review items that were essential for learning new information, such as specific notes or videos to show them how to solve McGraw-Hill problem sets, how to compute and to understand concepts such as *p* values that the students found problematic, and/or how to navigate the McGraw Hill platform. Hence, the learners could recall their previously learned statistical skills by pausing and revisiting the material as needed. Moreover, I used the FVs to show learners new skills and information and their practical applications. To learn at their own pace, students were able to replay the instructional videos (Clark, 2015). For each FV, I created an online follow-up video quiz as a graded assignment to check the given learner's understanding of the material to which they were exposed in the FVs. The graded video quizzes gave the learners a chance to apply their newly learned material.

Blackboard LMS and the Connect McGraw-Hill system were utilized to arrange and to distribute pre-class learning resources in the present research. The FVs were posted to Blackboard. Quizzes for the FVs were published and made available on the Blackboard LMS. However, the graded quizzes were produced utilizing the McGraw-Hill Connect system. By examining the performance statistics of the video quizzes on the McGraw-Hill system I was additionally able to evaluate how well the learners had mastered their subject matter. Based on information obtained through the McGraw-Hill system, I was able to clarify any misunderstandings during the class or even change their lesson plan in response to a given student's progress. More crucially, the performance statistics on the student's online assignments were available to me. During the class, I used this information to discuss the underlying learning objectives of the problematic questions.

The interactive assignment was one of the assignments created to help the students with their conceptual understanding of the topics, which were primarily used to promote comprehension. I could use the information from the performance statistics of interactive assignments to inform myself about the topics that I must include in the upcoming class discussion. In summary, the FVs, graded quizzes, lecture notes, and the interactive assignments constituted the pre-class concrete experience phase of Kolb's (2015) ELT.

Once the students had received the results of the graded pre-class quizzes and interactive assignments, they had the motivation to redo the quizzes to increase their scores. The subsequent quiz questions would be different, albeit covering the same objectives. By reflecting on the correct solutions to the incorrectly solved quiz questions and retaking the graded quizzes, the students experienced the pre-class reflective observation phase of the learning process. Next, the students experienced the pre-class abstract conceptualization phase of Kolb's (2015) learning cycle by

referring to the graded interactive assignments, which included conceptual questions and correcting any conceptual misunderstandings. I also encouraged the students to take notes regarding the conceptual or computational problems that they might have encountered.

Next, I implemented the in-class abstract conceptualization phase of Kolb's (2015) ELT by preparing the students for class at the start of the period by emphasizing the key concepts from the FVs and a questions-and-answer session, which lasted between 20 and 30 minutes. This initial activation was particularly crucial for the underachievers (Lo & Hew, 2017a), who were a subset of the qualitative sample, because they might have needed further direction. I also provided essential group work to review what they had learned previously or to let the students examine the quiz questions or the concepts that most of them struggled to answer.

Moreover, after the conclusion of the question-and-answer session, the remainder of the class time was allocated for in-class practice questions, small projects using real-world data, and solving homework assignments in randomly assigned groups, constituting the in-class active experimentation phase of Kolb's (2015) ELT. Nevertheless, the underachievers found it challenging to perform these assignments independently. In order to help underachievers in particular, I employed instructor-led problem-solving and collaborative groups to work through the more difficult tasks together in pairs or groups. Group discussions can increase students' comprehension and support them in applying new knowledge to real-world circumstances, as Warter-Perez and Dong (2012) discovered in their flipped classroom. In order to support the students' learning, I joined and exited the breakout groups (Blackboard's terminology for student groups) when necessary. Briefly, the entire classwork was designed based on the foundational premise of Kolb's ELT, which rests on the idea that learning is a process and the process begins

with students repeatedly engaging and traversing through the four phases of Kolb's (2015) experiential learning cycle (ELC) both inside and outside the classroom boundaries in order to construct knowledge.

In addition to FVs, in-class student-to-student support and cooperation are critical components of FCM that might increase academic attainment (Bishop & Verleger, 2013). Students' knowledge is not static to be merely transferred from teacher to student. Instead, it is developed through a cycle of collaborative group work and students assisting each other with the learning process (Hatano, 1993, Lo & Hew, 2017a). Additionally, Clark (2015) found in an FCM study that more accessible class time can create an environment where students can engage in a variety of active learning strategies and tasks. Consequently, I provided a variety of learning problems that are suitable for group activities, including questions requiring more advanced investigation, questions requiring complex or difficult knowledge, and questions with multiple acceptable answers.

Additionally, I employed McGraw-Hill Connect's built-in performance statistics to collect students' real-time, in-class responses. If the responses to in-class practice questions or homework assignments were satisfactory, then I could introduce more advanced topics and examples. I could also use the same built-in performance statistics feature of the McGraw-Hill Connect system to check the performance of students in pre-class work. In addition, by analyzing student-specific statistics, I was even able to determine which students in particular needed special assistance.

3.2.3. Ethical Considerations

Before conducting the study, I received approval from the local university's Institutional Review Board, and student participation was entirely voluntary. In researching the topic of FCM, I foresaw

no harm. This is attributed to several factors: the ongoing efforts by the statistics department to incorporate FCM across all statistics courses; my lack of vested interest in the study's outcome; no pre-existing assumption favoring FCM as a superior pedagogical approach for teaching statistics within the university context; the consideration that traditional LBM could potentially be shown to be more beneficial; and an absence of intent to give preferential treatment to the FCM group. Consequently, the thesis topic matches seamlessly with the practical task that the department needed to perform. All ethical procedures, as prescribed by the University of Liverpool and the local university where the study occurred, were strictly adhered to per the guidelines established during the ethical approval process.

Because the study involved human subjects (learners) who were under my guidance and in my classes, it was necessary to take precautions to ensure that I did not know the students who agreed or refused to participate in the quantitative component of the study. Obtaining ethical approval is critical for any study involving human subjects. In this study, rooted in real-life virtual classrooms, I paid meticulous attention to ethical aspects. Patton (2014) emphasizes that the legitimacy and trustworthiness of a research study is largely contingent upon the researcher's ethical conduct. Rigorously, I complied with the process of securing a comprehensive ethical endorsement from the Thai Private University's Research Ethics Committee and the University of Liverpool’s Committee on Research Ethics.

Furthermore, in instances where maintaining participant anonymity was not practical, as occurred during the interviews, pseudonyms were employed to safeguard the identities of those interviewed (Lahman et al., 2023). All participants were duly informed via a Participant Information Sheet (PIS) of the voluntary nature of their involvement and their option to withdraw themselves from

the research proceedings at any point in time during the study. Additionally, contact details of my doctoral supervisors were displayed on the PIS forms, providing participants with an immediate point of contact in the event of encountering any potential issues.

Prior to initiating the research, I deemed it appropriate to inform a fellow colleague about the study's parameters. Following this disclosure, I requested he contacts potential student participants and disclose study-related details using the PIS form. I further entrusted this colleague with the responsibility of disseminating the PIS and the consent forms to make the students aware of what the research is about and what their role in the research is (Cousin, 2009). The students who decided to participate in the study were required to indicate their consent by providing an electronic signature on the allocated forms.

Due to the COVID-19 issue, the entire process took place online because all of the classes were online. All of my students were enrolled in a mock class created for them by the IT department on the Blackboard learning management system, of which I was not a member. As a result, the colleague had no trouble disseminating material (e.g., PIS and the consent forms) and obtaining consent from those who volunteered without my knowledge of the participants. I also handed the colleague a pre-test, post-test, and a pre-and post-Survey of attitude toward statistics (SATS) to upload to the mock Blackboard class and to administer to the students who consented at the appropriate time. The consented students took a pre-test in Week 2 and a post-test in Week 11. In addition, in Weeks 3 and 11, students took the pre-and post-SATS. After I completed the submission of the final grades by the deadline on Week 13 and the verification of the grade submission by the colleague, I was provided the names of the students who consented to participate

in the quantitative component of the mixed methods research study along with their pre-and post-test scores and completed pre- and post-SATS.

Following the quantitative analysis of the performance of the students who consented, based on their extremely low or high final class averages, I invited them to participate in the qualitative component of the study by sending them an individual email. The rationale for inviting only the students with the highest and the lowest performance was to fulfil the maximum variation sampling scheme chosen for the qualitative component of the research within the nested sampling design used to select a subset of students who had previously consented to the quantitative part.

Due to the COVID-19 situation, using email, I presented new consent forms constructed for the qualitative component of the study to only the students who had responded positively and had agreed to participate. The consent forms were signed. I administered the Classroom and College and University Classroom Environment Inventory (CUCEI) and interviewed the consenting students (see Figures B7, Appendix B, and C1, Appendix C).

I did not know the names of any of the students who consented until the final grades had been submitted, consistent with the procedure described earlier. The identities of all participants were methodically protected, with each participant's personal data, including audio recordings, being securely stored. As per established research protocol (Anderson et al., 2023), this information will be retained for five years after completing the research, upon the expiration of which all the data will be destroyed. As an educator and researcher, I was acutely conscious of the potential power dynamics that could emerge when undertaking research involving my students. To mitigate these dynamics and to ensure an equitable and respectful research environment, I adhered to several

principles: commitment to transparency; confidentiality; reflexivity; and clear role demarcation (Yadav, 2023).

I ensured complete transparency (Amundsen & Msoroka, 2021) regarding the purpose and methodologies of the research. I thoroughly clarified the voluntary nature of students' participation, emphasizing their right to withdraw at any moment without any repercussions for their academic standing. I anonymized all collected data to mitigate potential biases and maintain stringent confidentiality (Yadav, 2023), all in order to provide a safe space for open discourse. Furthermore, during the qualitative phase, when I knew the names of the participants, I employed participant feedback and reflexivity to balance the power dynamics throughout the research process. This institutes a researcher-participant collaboration rather than a hierarchical relationship. Moreover, it was pivotal that I maintained an ongoing operational distinction between my roles as educator and researcher. By doing so, I continuously worked towards minimizing the potential threats of power dynamics in my research. Lastly, the students had the email address of both of my doctoral advisors and were instructed to use these contacts if they felt any pressure. As a result, any ethical issues stemming from my dual role as an instructor were virtually eliminated or, at least, greatly reduced (see Figure B1, Appendix B).

3.2.4. Positionality as an Instructor and Researcher

As a researcher, my personal aspects (e.g., a researcher's individual values, beliefs, and experiences), temporal aspects (e.g., the timeframe within which the research was conducted), and spatial aspects (e.g., geographical, or physical location where the research took place) would deeply impact my understanding of my own research and research methods (Cousin, 2009).

In another article, “Positioning positionality: The reflexive turn”, Cousin (2010) discusses the concept of positionality in research. One of the main points of this article is that the researcher is not disconnected or removed from the research. My values and ideas will affect my research. However, this does not mean that I was not mindful or thoughtful in conducting the research. I had to be a reflexive researcher at all times during the research, asking myself difficult questions such as “Is there a power relationship with my students?” and “How can I ensure that this power relationship does not affect my study negatively?”. The idea of researcher reflexivity, which is defined as the process of self-reflection about one’s biases (Cousin, 2010), is one way of answering these questions. Cousin suggests a fluid, negotiated understanding of positionality, meaning researchers should constantly re-evaluate their perspectives and acknowledge the subjective nature of their positions.

Cousin views researcher reflexivity as being ‘grey’, reflecting that researcher positionality is not unequivocally right or wrong, good or bad. It is subject to personal experiences, interpretations, and perspectives, which should be reflected upon and challenged during the research process. Thus, research is inherently reflexive, as researchers contemplate their own influence on the research process and outcomes. Considering these personal, temporal, and spatial aspects offered depth and context to my research and assisted me in the interpretation and understanding of the findings.

Because I started my doctoral journey in 2016, I had to complete two and a half years of coursework. Having an engineering background, I was very fascinated with topics such as “The Nature of Learning”, “Construction of Knowledge”, and “Epistemology and Ontology”. In most engineering schools – at least when I started my higher education in the late 1970s – there was not

even one course about the nature of learning, subjectivity in research, or the influence of personal values in research. I was taught to be objective and only consider hard, cold facts.

I recall that in one of my first few modules in my doctoral program, I suggested a predictive analysis to find a solution to a problem presented during the class by the professor. It was quite interesting to realize that the professor was labelling predictive analysis – a method that is used extensively in statistical analysis – as a "positivist" idea. Soon, I was introduced to the paradigm wars, and I did not think that looking down on a certain research method or methodology was helpful. The words of Cousin (2009) suggesting not to "get overly involved with paradigm wars" (p.3) reflected my view of this situation because conducting research is often complex, thereby requiring a mix of methodologies and paradigms, real-world problems often do not fall strictly within a single paradigm, and overemphasis on paradigm allegiance can interfere with collaboration between researchers from different backgrounds. In fact, Cousin (2009) suggests that if one is a qualitatively oriented researcher, one should consider reading Using everyday numbers effectively in research by Stephen Gorard (2006) to get some respect and understanding for quantitative research. Equally, she also suggests that a quantitatively oriented researcher might consider reading The art of case study research by Robert Stake (1995) to gain respect for the rigorous methods and methodologies used in qualitative research.

In light of the abovementioned argument, as I studied and read more articles, I identified with the pragmatism-of-the-middle philosophy (Johnson & Onwuegbuzie, 2004) because I respect both quantitative and qualitative approaches to answering research questions (RQs). I believe that both quantitative and qualitative paradigms have their own merits and cannot simply be disregarded by labels such as "positivist" used in a negative sense or as being "not objective enough". Although I

could have conducted purely quantitative or qualitative research, mixed methods research helped me to gain more insight into my study. In fact, to mitigate the power relationship as an instructor-researcher, my primary doctoral supervisor and I, with the approval of my secondary supervisor, chose sequential explanatory mixed methods research, in which the quantitative phase of the investigation comes first (Creswell & Creswell, 2018; Ivankova et al., 2006; Toyon, 2021). In this situation, the instructor/researcher does not know who is or is not participating in the study, as mentioned under "Ethical Consideration" Section 3.2.3. The qualitative phase, including interviews, was conducted after the grades had been submitted, the grade submissions had been verified, and there was no power relationship in place. Had I chosen an exploratory sequential mixed methods research, I would have had to know the students first because the qualitative phase would have been first.

Regarding the temporal aspect of research, this study took place during the COVID-19 pandemic, when the classes moved abruptly online without any training for online teaching. Had the research been conducted face-to-face, the results might have been different, because this is one of the limitations of this research mentioned before. For example, face-to-face classes offer an element of social interaction and emotional connection (Achterhof et al., 2022) that might not be present in online classes and that factor alone could have caused a difference in the research results.

In terms of the spatial aspect of the research, it took place in a single PTIU, where the typical culture is speculated to present as shy, and the students are often very reluctant to respond to the instructors' questions (Deveney, 2005). This shyness as a face-saving measure could influence Thai students in classrooms. Using active learning methods of instruction, such as small project-based learning assignments in groups and in-class practicals, mitigated the negative effects of

shyness within the classes. Besides, having the courses online, inadvertently mitigated the negative effects of this typical Thai cultural characteristic, as mentioned by many students during the interviews, which might cause Thai students to appear passive.

3.3. Methodology

The methodology employed in this study will be discussed in detail in the following sections. As noted in Chapter 1, this research employs a mixed-methods research design encompassing the 13 steps that were conceptualized by Collins et al. (2006) as follows:

> step 1: determining the goal of the study; step 2: formulating the research objective(s); step 3: determining the research/mixing rationale(s); step 4: determining the research/mixing purpose(s); step 5: determining the research question(s); step 6: selecting the sampling design; step 7: selecting the mixed-methods research design; step 8: collecting the data; step 9: analyzing the data; step 10: validating/legitimating the data and data interpretations; step 11: interpreting the data; step 12: writing the final report; step 13: reformulating the research question(s). (pp.69-70)

3.4. Steps 6 and 7: Mixed Sampling Design and Selecting the Mixed Methods Research Design

Steps 6 and 7 are referred to as the planning stage, and they are intertwined because the sample design influences the mixed methods research design and vice versa (Collins et al., 2006). The choice of the sampling design is crucial because it influences the validity of the inferences that

researchers can draw from a given study's findings (Collins et al., 2006). According to the typology outlined by Onwuegbuzie and Collins (2007), mixed methods sampling designs can be classified in eight ways, as shown in Table 1.

Table 1. Typology of Mixed Methods Sampling Designs

Time Orientation of the Components	Sample Relationships	Naming Convention
Sequential design		
	Identical: Indicates that exactly the same participants are involved in both the qualitative and quantitative phases of the study	Sequential Identical Sampling Design
	Parallel: Denotes that the samples for the qualitative and quantitative components of the research are different but are drawn from the same population of interest.	Sequential Parallel Sampling Design
	Nested: Reveals that the participants selected for one phase of the study represent a subset of those sample members selected for the other component of the research.	Sequential Nested Sampling Design
	Multilevel involves the use of two or more sets of samples that are extracted from different levels of the population of interest.	Sequential Multilevel Sampling Design
Concurrent design		
	Identical: The same description as in the	Concurrent Identical Sampling Design

Time Orientation of the Components	Sample Relationships	Naming Convention
	Sequential Design section above.	
	Parallel: The same description as in the Sequential Design section.	Concurrent Parallel Sampling Design
	Nested: The same description as in the Sequential Design section.	Concurrent Nested Sampling Design
	Multilevel: The same description as in the Sequential Design section.	Concurrent Multilevel Sampling Design

Adapted from Onwuegbuzie and Collins (2007, p.294; see also Figure C2, Appendix C)

Combining the naming convention of Onwuegbuzie and Collins (2007) with that of Creswell and Creswell (2018), I used an explanatory sequential mixed methods research design based on a sequential nested sampling design. Creswell and Plano Clark (2017) define an explanatory sequential design as the process of collecting quantitative data first, followed by the collection of qualitative data to help explain or to expound on the quantitative results. I justified using the aforementioned design in my research, firstly, because despite the fact that the quantitative data and conclusions provide a basic understanding of the research topic, additional analysis, particularly the acquisition of qualitative data, is necessary to clarify, broaden, or expound in order to achieve deeper understanding and, secondly, to achieve data richness by interpreting students' class performance and attitudes toward statistics based on the mode of instruction via subsequent

semi-structured interviews (SSIs) (see Figure B8, Appendix B) and, finally, to anonymize the participants' identities during the quantitative component of the research.

I did not know the names of the students who volunteered until after I had submitted the final grades. However, after the grades were delivered to the university administration, I needed to know the volunteers' identities to analyze their grades and classify them into high- and low-performance groups. Subsequently, I submitted an email request to the high-performing students and the low-performing students asking for interview volunteers. Therefore, explanatory sequential mixed methods supported this situation, in which the first sample of volunteers for the quantitative analysis remained anonymous, and the subsequent qualitative component's volunteers were chosen from the high- and low-performing students.

Onwuegbuzie and Leech (2007a) identified 24 sampling schemes and categorized them into two groups, one group including five random sampling procedures and a second group including 19 non-random sampling procedures. Purposive, non-random sampling procedures were deployed in this research to examine the academic performance of the student volunteers as measured by five assignment categories, namely, pre-test and post-test grades; five comprehensive quiz grades; in-class practice grades; homework grades; and final class averages.

3.4.1. Quantitative Component Setting and Participants

Based on their academic prerequisites and advisor recommendations, students are enrolled in business statistics. However, because the student population is approximately 2,500 in total and the gender and ethnic composition of this population are known, using the Chi-square goodness of fit test, each class was checked and determined to be a good representative of the population with

regard to gender and ethnicity. All sections of business statistics were included in the research. Based on the curriculum, approximately 1,365 students are required to enroll in the business statistics course. A power analysis, based on Faul et al.'s (2007) free G*Power 3 software program, indicates that at least 64 participants are needed in each group (i.e., 64 experimental group members and 64 control group members) to detect a moderate difference (i.e., effect size of d = 0.5) using a two-tailed test with 0.80 power at a 5% level of statistical significance. Therefore, a sample size of at least 128 was needed. During the first term of data collection, two classes were set as the control group using the LBM, yielding 69 students, and two classes were set as the treatment group, yielding 68 students. Due to the class sizes, two terms were allocated to data collection to achieve the required sample size. The demographics of all students were accessible via the university's registration system. Before enrolling in the class, these students did not have prior knowledge of the difference in the teaching methods between the control and treatment groups.

During a two-trimester period, a total of 223 students participated in the quantitative component of the research. However, three students were eliminated for not taking a pre-test (n = 1 LBM, n = 2 FCM), and four students were eliminated for not taking a post-test (n = 3 LBM, n = 1 FCM). Therefore, a total of 216 students' grades were analyzed (n = 121 LBM, n = 95 FCM). Table 2 is a breakdown of the quantitative sample by the mode of instruction and gender.

Table 2. Quantitative Sample Size by Gender and the Mode of Instruction

Sample size	Men	Women	Total
LBM	62	59	121
FCM	45	50	95
Total	107	109	216

n = 216.

The sampling scheme for the quantitative component of the study was a purposive sampling scheme—specifically, convenience sampling (*n* = 121 LBM, *n* = 95 FCM). I requested information from the registration office on the proportions of students by gender and nationality in order to conduct a Chi-square goodness of fit test to assess if my sample is representative of the population. Next, I performed a Chi-square goodness of fit test to determine whether the proportion of students by nationality was equal between the sample taken and the entire population of undergraduate students. The proportions did not differ by nationality, χ^2 (2, N = 216) = 4.54, p = .103. In addition, I also performed a Chi-square goodness of fit test to determine whether the proportion of students by gender was equal between the sample taken and the entire population of undergraduate students. The proportions did not differ by gender χ^2 (1, N = 216) = .20, p = .651. Hence, the quantitative sample was representative of the population by both nationality and gender.

In order to control for gender and nationality between the control groups (i.e., LBM sections) and the treatment groups (i.e., FCM sections), I performed a Chi-square goodness of fit test to

determine whether the proportion of students by nationality and gender was equal between the groups. The proportions did not differ by gender, χ^2 (1, N = 216) = .319, p = .572 or by nationality (i.e., proportion of Thais χ^2 (1, N = 139) = 2.597, p = .107, proportion of Chinese χ^2 (1, N = 37) = .243, p = .622, and proportion of other nationalities χ^2 (1, N = 40) = .400, p = .27)).

Moreover, the treatment and control groups did not differ statistically significantly by GPA (i.e., proportion of students with GPA ≥ 3 χ^2 (1, N = 43) = .209, p = .647, proportion of students with 2 ≤ GPA < 3 χ^2 (1, N = 99) = 1.707, p = .191, and proportion of students with GPA ≤ 2 χ^2 (1, N = 74) = 1.351, p = .245)).

3.4.2. Qualitative Component Setting and Participants

For the qualitative portion of this study, I used a nested sampling design based on maximum variation sampling scheme from high-performance and low-performance FCM and LBM groups (n = 19 LBM, n = 17 FCM). According to Onwuegbuzie and Leech (2007a), nested sampling designs are most commonly used to choose critical participants from a broad group of study participants, resulting in a significant share of the researcher's data. The maximum variation sampling scheme is used to obtain the broadest range of views investigated in the study (Collins, Onwuegbuzie, & Jiao, 2007). Table 3 details the breakdown of the qualitative sample by mode of instruction and performance level.

Table 3. Qualitative Sample Size by the Level of Performance and the Mode of Instruction

Mode of instruction	High Performance	Low Performance	Total
LBM	11	8	19
FCM	9	8	17
Total	20	16	36

n = 36.

Next, I further classified the 36 interviews of the qualitative sample, including by gender and performance (see Table A2, Appendix A). Moreover, Table A3, Appendix A details the pseudonyms used along with the level of performance and the interviewees' mode of instruction.

3.5. Step 8: Data Collection

Step 8 is one of the steps in the implementation stage, along with Step 9 (data analysis), Step 10 (validating/legitimating the data and data interpretations), and Step 11 (interpreting the data). In the mixed methods research process, these steps are interactive and cyclical. The mixed methods researcher must be aware of the emergent link between quantitative and qualitative data throughout all four processes. After data from at least one phase has been acquired, the information is either evaluated or validated (Collins et al., 2006). Furthermore, Table 4 provides a timeline for administering the data collection instruments.

Table 4. Data Collection Timeline

Instruments Used for Data Collection	Mixed Methods Research Phase and Time
1. Pre-test	1. Quantitative Phase / Week 2.
2. Pre-Survey of Attitude Toward Statistics	2. Quantitative Phase/Week 2
3. Homework assignments, comprehensive quizzes, in-class practices, and interactive assignments	3. Quantitative Phase/Weeks 1 to 12
4. Post-test	4. Quantitative Phase/Week 11
5. Post-Survey of Attitude Toward Statistics	5. Quantitative Phase/Week 11
6. College and University Classroom Environment Inventory	6. Qualitative Phase/Weeks 15 and 16 after the submission of final grades
7. Interviews	7. Qualitative Phase/Weeks 15 and 16 after the submission of final grades

3.5.1. Mixed Methods Research Design

This study used an explanatory sequential design. The rationale for this approach was to provide data richness by interpreting students' class performance and attitudes toward statistics, based on the mode of instruction and via subsequent SSIs. Creswell and Creswell (2018) define an explanatory sequential design as one that involves a process with the following two phases of data collection: firstly, quantitative data collection in the initial phase, and secondly, qualitative data collection during the second phase based on the analysis of the quantitative data during the first phase. The results and interpretation of the quantitative data in the first phase informed the

secondary qualitative phase of this study such that a purposefully selected sample of participants was asked to undergo interviews and to complete a climate survey to explain the initial quantitative results better. Figure B8, Appendix B provides a framework for questioning; however, based on the participants' replies, I asked additional questions.

3.5.2. Quantitative component

The quantitative aspect of the study involved the application of a Likert-type pre-and post-SATS to the students who consented, all in order to have a baseline for their initial attitudes toward statistics at the beginning of the class and to compare it to their final attitudes in relation to statistics. The quantitative component of this thesis also addressed student achievement and attitudes using a nonequivalent groups quasi-experimental design model. The control groups were the LBM sections already in place while the treatment groups were the newly designed FCM sections. Priority was given to developing content for the flipped classroom model, such as online material and the best ways of evaluating the learner. In the already established traditional statistics sections, learners received lectures during classroom time and reviewed homework and prior assessments.

In the newly designed flipped sections, students were instructed to view short videos and other interactive material to learn the lecture. Students completed their homework assignments in class under the supervision of the instructor. The emphasis of the class time in these flipped sections was on the application of the material to achieve deeper learning through collaborative group work and active learning, instructor-led training, and using case studies and problem sets (see Figures B2, B3, and B4, Appendix B). Students from all sections then took five comprehensive quizzes, with the fifth quiz acting as a final examination. A statistics test and SATS (Schau, Stevens,

Dauphinee, & Del Vecchio, 1995) also were administered as a pre-survey and post-survey to the treatment and control groups at the beginning of the term and as a post-test and post-survey at the end of the term to determine whether there is a statistically significant difference in student learning and attitude between the two modes of instruction (see Figures B5 and B6 in Appendix B and Figure C4, Appendix C). Data on the five aforementioned assignment categories then were analyzed in order to compare and contrast student performance in the treatment and control groups. Based on the results, I then examined the effectiveness of the FCM in order to answer the first two quantitative sub-questions.

3.5.3. Qualitative component

Because the qualitative component of the thesis was informed by the quantitative component, first, the high-performance and the low-performance learners were identified using quantitative analysis. Second, a purposeful sample of students based on maximum variation sampling scheme from the high- and low-performance learners were selected to obtain their perceptions of the pedagogical effectiveness and their learning experiences during the two modes of instruction. Third, the qualitative part of the study involved administering the CUCEI developed by Fraser and Treagust (1986) as well as conducting SSIs with the academically high and low performers who were purposefully selected from the initial group of students who consented to the quantitative part (see Figures B7 and B8, Appendix B).

Data collection during the qualitative phase was accomplished by using open-ended items in surveys and interviews that could facilitate respondents to articulate their experiences and perceptions in detail, using their own words (Vogt, 2008). Vogt has noted that these kinds of open-ended items in surveys or interviews, which can extract people's perceptions and experiences, are

qualitative in nature and, therefore, can be analyzed using qualitative approaches. Therefore, a case study that includes climate surveys and interviews was used to extract the learners' perceptions and experiences for the two modes of instruction in order to analyze the data collected and to answer the third qualitative research sub-questions.

3.5.4. Procedures

The research was conducted using seven sections of a business statistics course (STA 201) at a large PTIU with a diverse student population. The business statistics course (i.e., STA 201) is the second statistics course in the curriculum. Before enrolling in STA 201, students must pass the first statistics course satisfactorily. Therefore, STA 201 is an intermediate-level course, with most students in their second or third year of university. The course textbook used was a McGraw-Hill eBook. STA 201 is taught in a computer laboratory using Microsoft Excel software for data analysis. However, due to the COVID-19 situation, all classes were taught online. The quizzes and tests are self-graded by the McGraw-Hill system, thereby reducing instructor bias on grading (i.e., scoring) the FCM versus LBM tests. The STA 201 course objectives include performing a one- and two-sample hypothesis test of means and proportions; understanding and applying analysis of variance; understanding and applying correlation and linear regression; performing multiple regression analysis; and, finally, being able to perform nonparametric tests using Chi-square, Wilcoxon signed-rank, and Kruskal-Wallis tests respectively. Peterson (2016) suggests that in order to ensure that the FCM and LBM classes are as equivalent as possible, the same instructor needs to design the in-class and outside classwork such that the in-class work is directly related to the work undertaken outside of the class. Hence, I personally designed the work for all flipped classes. The LBM classes had already been designed and implemented by me. I flipped three

sections of this course to be as close as possible to the LBM classes. All relevant demographic data was collected to ensure that both the control and treatment groups were as comparable as possible.

I taught all seven sections of the statistics course while the same material – such as lecture notes, homework assignments, comprehensive tests, and in-class practices – were assigned to both FCM and LBM sections. The identical pre-test/post-test was designed and given to both LBM and FCM sections for comparison purposes. Homework assignments for the traditional LBM sections along with more in-depth practice problems were used as in-class practices for FCM sections. The lecture and lecture notes for the LBM sections were in the form of online videos for the FCM sections. Both traditional sections and fully flipped sections represent two 120-minute classes per week. In the sections that were fully flipped, a review of the video lectures was provided during the first 40 minutes of class time. The last 80 minutes were spent on active learning, which includes working on McGraw-Hill problem sets and case studies. The lecture was provided on the university's classroom management system called Blackboard (Spivey & Mcmillan, 2013) in the form of videos created by the instructor to explain each section of the required material precisely as explained in the LBM classrooms. The students in the FCM sections were encouraged to watch the videos before the class, to take notes, and to take a small, graded quiz based on each section video watched.

For the four sections using LBM, all lectures were provided during the first 80 minutes of class time. The last 40 minutes were spent on active learning to solve a few McGraw-Hill problem sets. The problem sets were similar to the FCM sections. Most of the problem sets that were given in the FCM sections were assigned as homework in the LBM sections. The students in all sections were evaluated based on five comprehensive quizzes, homework assignments, and in-class

practicals. Both FCM and LBM sections covered the same learning objectives and identical assessments to ensure objectivity in measuring performance. The grades on the pre-test/post-test, five comprehensive quizzes, the practicals, homework assignments, and the final class averages were used to compare the control and treatment groups. The main difference between the two models was allocating more time to active learning in FCM sections because of the time freed by watching the FVs. Moreover, via the university's registration system, all student demographic data was collected to ensure that both treatment and control groups were as identical as possible.

3.6. Step 9: Data Analyses

Onwuegbuzie and Teddlie (2003) have described using a combination of quantitative and qualitative data analysis approaches. I used the framework of Onwuegbuzie and Teddlie to analyze the data. In addition, Onwuegbuzie and Teddlie (2003) identified the following seven phases of mixed research analysis: data reduction, data display, data transformation, data correlation, data consolidation, data comparison, and data integration. In my thesis, I utilized six of the aforementioned seven phases: data reduction; data display; data transformation; data consolidation; data comparison; and data integration.

The data reduction phase involved cleaning, organizing, and compressing the collected data to a manageable size for analysis. Moreover, data reduction involved simplifying quantitative and qualitative data in a mixed methods research study. I organized the information into a manageable size for the quantitative data, which, in this case, was the students' grades for the FCM and LBM sections. Summarizing the grades using statistical parameters such as mean, median, mode, standard deviation, and interquartile ranges for each group helped to reduce these data. Because the data was not normally distributed, I used median, interquartile ranges, and means ranks to

represent the data. For the qualitative data, the reduction process involved transcribing the interviews and coding them for themes, thus creating categorical data. The reduced data from the quantitative and qualitative phases formed the basis for the next data analysis phase.

The data display phase involved creating a visual representation of the quantitative and qualitative data. I created box-and-whisker plots for the quantitative data to display each group's scores' median, quartiles, and potential outliers. Regarding the qualitative data, students' positive and negative perceptions of FCM and LBM as identified from the interviews were displayed using bar charts. By visually displaying the quantitative and qualitative data, I presented the data more understandably, thereby allowing for easier comparison between the two groups.

The data transformation in the qualitative phase involved categorizing the numerical grades into "high performance," "average performance," and "poor performance" to recruit the qualitative sample. The data transformation of the qualitative phase involved assigning a score of "1" to a qualitative attribute expressed by students (e.g., positive attitude toward FCM) if present and a "0" if the attribute was not present. Using this process, a quantitative matrix of codes versus the learners was constructed and analyzed further using principal component analysis (PCA).

The data consolidation phase of the framework involved combining various data sets to form a complete picture of the situation at hand. The quantitative data was presented in various forms such as median and interquartile range. The qualitative data stemmed from the interviews. In the data consolidation phase, I aligned key codes from the qualitative data (e.g., Positive Perceptions Toward FCM) with corresponding patterns in the quantitative data (e.g., poor performance vs. high performance).

Data comparison in a mixed methods research study, featuring students' grades of the FCM and LBM sections, involved drawing inferences based on the relationships between the quantitative and qualitative data. I compared the two groups' median grades, distributions, or pass rates for quantitative data. In terms of the qualitative component, I compared themes or patterns that emerged from the data. I also compared the prevalence rate of different themes between the students from the two groups. My ultimate goal was to integrate and to compare these data types better to understand students' different perceptions in both groups.

3.6.1. Quantitative Data Analyses

After data collection during the first phase, the normality of the data collected was checked and it was found that they did not follow a normal distribution. Therefore, in order to test both Hypothesis 1 and Hypothesis 2, nonparametric methods/tests – namely, the Kruskal-Wallis, Mann-Whitney U, and Wilcoxon Signed Rank tests respectively – were used to test these hypotheses (Lind, Marchal, & Wathen, 2017). When a statistically significant difference was found, the effect sizes also were computed and reported as detailed in Chapter 4, "Presentation and Data Analysis". Leech and Onwuegbuzie (2002) noted that researchers who employ nonparametric tests generally do not report effect sizes or incorrectly report parametric effect sizes such as Cohen's *d*. However, because violations of normality and heterogeneity of variances affect measures of effect size within the *d* family (Onwuegbuzie & Levin, 2003), they may not be appropriate for data with a non-normal distribution.

As Leech and Onwuegbuzie (2002) stated, "Reporting effect sizes is no less important for statistically significant nonparametric findings than it is for statistically significant parametric results" (p.15). In addition, according to Richardson (2011), two specific metrics known as *eta*

squared (η^2) and *partial eta squared* were initially developed for quantifying effect sizes in factorial designs, but they now have a wide range of additional applications. Richardson (2011) added that *eta squared* (η^2) is utilized more frequently than any other effect size estimate in educational studies, thereby being of particular importance. Moreover, Leech and Onwuegbuzie (2002) name Common Language (CL) effect size as one of the five effect sizes that can be used in nonparametric statistics. Ruscio (2008) posits that CL is resistant to the violation of the assumption of normality, as is the case in this analysis.

Therefore, whenever during the data analysis I obtained a statistically significant result, I reported the η^2 and CL and for better understanding and comprehension, I converted them to Cohen's (1988) *d* using the calculator of Lenhard and Lenhard (2016). It is important to note that in a nonparametric statistical test, Cohen's *d* is not utilized because the assumption of normality is not met. The transformation to Cohen's *d* is done only for a better understanding of the effect size.

As indicated in Chapter 1, the entire study was guided by a mixed methods RQ comprising two quantitative sub-questions (i.e., Sub-questions i, and ii) and one qualitative sub-question (i.e., Sub-question iii) as well as two quantitative hypotheses. To answer the combination mixed methods research question, it is essential to respond to its sub-questions.

To address the quantitative Sub-question i, and subsequently Hypothesis 1, the overall numeric grades on pre-test and post-test, five comprehensive quizzes, in-class practices, homework assignments, and final class averages during Terms 1 and 2 of academic year 2021 were collected and separated into one of two independent groups (i.e., FCM and LBM section). To determine the difference in performance between FCM and LBM sections, all the collected grades were placed into an Excel file, converted to an SPSS file, separated according to the respective groups, and

utilized in a series of nonparametric independent samples tests such as Mann-Whitney *U* test and Kruskal-Wallis test during the quantitative analysis phase, because the data collected were not normally distributed.

To address the quantitative Sub-question ii, and subsequently Hypothesis 2, the results of pre- and post-SATS given to both FCM and LBM sections were downloaded into an Excel file and uploaded in SPSS 28.0.1.1 software for quantitative analysis (IBM Corp, 2021), then checked for validity, and then analyzed.

3.6.2. Qualitative data analysis

I used thematic analysis – specifically constant comparison analysis (CCA) – to analyze the qualitative data collected. Leech and Onwuegbuzie (2007) consider CCA to be one of the most widely used qualitative data analysis approaches. Moreover, Glaser (1965) indicated that the principal purpose of CCA is the generation of themes based on participants' responses. The instruments used to collect data during the second phase of the research (i.e., the qualitative phase) were SSIs and the CUCEI climate surveys. Four steps make up the constant comparative methodology: "(1) comparing incidents applicable to each category, (2) integrating categories and their properties, (3) delimiting the theory, and (4) writing the theory" (Glaser & Strauss, 1967, p.105). To produce a meaningful narrative from the responses received, Glaser and Strauss (1967) suggest a coding scheme using three stages, which are open coding (i.e., assigning labels after arranging the raw data into meaningful groups); axial coding (i.e., related categories are formed by grouping codes); and selective coding (i.e., combining the codes into a meaningful narrative). Based on the aforementioned coding process and also by using NVivo 12 (QSR International, 2018) as a tool, I was able to find a meaningful narrative by organizing raw data into meaningful

groups and then assigning them labels, producing categories by grouping codes, and, finally, connecting the codes into a meaningful narrative.

The qualitative sub-question was used to explain the result of the quantitative component. Utilizing Glaser's (1965) CCA and Berelson's (1952) classical content analysis, I proceeded to analyze data from interviews of all FCM and LBM sections of business statistics students selected from the quantitative component of the study based on maximum variation sampling to address the qualitative Sub-question iii. I utilized Glaser's (1965) CCA to label pieces of data with descriptive codes by cycling through coding and recoding and then grouping the codes into meaningful themes to generate a narrative to saturation (Flick, 1998; Lincoln & Guba, 1985; Morse, 1995). The frequencies of the themes retrieved via the CCA were determined after the topics had been identified using a classical content analysis.

3.6.3. Mixed data analysis phase

I used nine phases of sequential mixed analysis to assess the data, as described in this section (SMA; Onwuegbuzie & Teddlie, 2003; Tashakkori & Teddlie, 1998). Due to the non-normality of the data, the quantitative data were evaluated using a series of nonparametric tests for independent samples, such as the Mann-Whitney *U* test and the Kruskal Wallis test. Next, I explored the qualitative data using a CCA. The qualitative data was then subjected to quantitative analysis.

The qualitative data were quantified when suitable (Tashakkori & Teddlie, 1998). For the most prevalent and emergent codes, crosstab analysis in NVivo 12 was used to compute the frequencies representing the number of times the students had expressed any positive or negative feelings towards the two modes of instruction. This process resulted in an inter-respondent matrix of codes

versus the learners classified by the mode of instruction. I computed each theme's prevalence rate by determining the frequency at which each theme occurred in the inter-respondent matrix. These frequencies were employed as effect sizes used in qualitative research (Onwuegbuzie & Teddlie, 2003). Moreover, a correspondence analysis (CA) was conducted on the inter-respondent matrix graphically to determine or observe the relationship between the students and the themes. Next, a PCA was conducted to extract meta-themes including two or more themes, thereby assisting to explain the overall emergent themes and narratives.

Next, the nine stages of data analysis (i.e., quantitative, qualitative, and mixed analysis) are discussed in detail. By discussing the details of the nine stages, I describe in full the methods and tests that I employed to analyze quantitative and qualitative data. These are the stages that allowed the ultimate blending of data (i.e., data integration) to assess the results shown in Chapter 4 and the interpretation presented in Chapter 5.

Stage 1: Descriptive Analysis. In the first stage, using SPSS 28, I examined the shape of data for the five aforementioned categories of assignment. Next, an inferential analysis was performed to compare overall learners' quantitative performance across the two groups (i.e., FCM and LBM sections of the same business statistics course). Specifically, due to non-normality of data, nonparametric independent samples tests (i.e., the Mann-Whitney *U* test and Kruskal-Wallis tests) were used to examine the difference in performance and the difference in attitude toward statistics between business statistics courses using FCM and business statistics courses using LBM in terms of overall numeric course grades. (Sub-question i).

Stage 2: Quantitative Survey Analysis (SATS). In order to address the quantitative Sub-question ii along with Hypothesis 2, I proceeded to analyze the findings of the pre- and post-SATS developed by Schau et al. (1995) and given to both the FCM and LBM sections. Specifically, 70 of the 95 students who participated in the FCM section took the pre-SATS, whereas 83 took the post-SATS. Further, 101 of the 121 participants in the LBM sections took the pre-SATS, whereas 110 took the post-SATS. Although there were students who took the post-SATS without taking the pre-SATS, I decided not to disregard these learners because I considered their post-SATS result as a distinct voice in this study. Hence, I treated the pre-SATS and post-SATS samples as independent samples and compared them using independent sample tests.

SATS consists of 36 items (worded both positively and negatively) that comprise six subscales to examine attitudes about statistics as shown in Table 5. These subscales are Affect, Cognitive Competence, Value, Difficulty, Interest, and Effort. On a typical 7-point Likert scale to include SATS-36, 1 equates to "strongly disagree," 4 to "neither disagree nor agree," and 7 to "strongly agree."

Table 5. SATS Subscales and their Intended Construct Measure

Survey subscales	Number of items	Subscales definitions and the intended idea to measure
Affect	6	Positive or negative sentiments regarding statistics held by the learners (Schau, 2003)
Cognitive Competence	6	Learners' attitudes about intellectual knowledge and abilities applied to statistics, (i.e., their mental capacity to grasp statistics) (Schau, 2003)
Value	9	Learners' perspectives of the expediency, importance, and significance of statistics in their personal and professional lives (Schau, 2003)

Difficulty	7	The perspectives of learners about the difficulty of statistics as a subject matter (Schau, 2003)
Interest	4	Learner's individual degree and level of interest in statistics (Schau, 2003)
Effort	4	The amount of work a learner devotes to learning and understanding statistics (Schau, 2003)

Stage 3: Exploratory Analysis 1. Using NVivo 12 Pro as a coding tool, the third step consisted of conducting a qualitative analysis to assess the positive and negative perceptions/experiences of FCM or LBM instructional strategies from the SSIs on the part of the learners. The exploratory analysis was conducted to determine whether the results would agree, disagree, or neither agree nor disagree with the quantitative results of the previous two stages. Using open coding, axial coding, and selective coding, the three steps of CCA (Glaser, 1965; Glaser & Strauss), I developed and assigned various codes to the student interviews. My interpretation of the student data led me to these coding decisions (Carley, 1993). Through numerous iterations of coding, I generated more codes, then I created themes based on those codes. After identifying the themes, a traditional content analysis was conducted to assess the frequency of the themes derived using CCA. To validate the data interpretations, a peer debriefing was undertaken (Onwuegbuzie et al., 2008). The peer debriefer for my research project was my primary thesis advisor. In addition, I permitted a colleague to evaluate the audit trail to confirm that my interpretations of the data created by SSIs were legitimate and objective (Sub-question iii).

Stage 4: Explanatory Analysis 2. Using Matrix Coding in NVivo 12, the frequency of each positive and negative perception/experience theme identified via CCA of student SSIs was determined. By computing the frequency of each theme using matrix coding, prevalence rates for each positive and negative student perception/experience theme were determined (Sub-question iii).

Stage 5: Climate Survey Analysis (CUCEI). The purpose of this survey was to evaluate the atmosphere of classrooms of a relatively small size appropriate for higher education. CUCEI is an instrument that measures students' or instructors' impressions of seven psychosocial aspects of the current or desired classroom environment. The CUCEI is a typical 4-point, Likert-format scale, with 1 equating to "strongly disagree," and 4 equating to "strongly agree." Overall, higher subscale scores indicated a more favorable view of the classroom with respect to that particular subscale. For example, a higher "Personalization" average score on the FCM CUCEI versus the LBM CUCEI suggested that the FCM students had a more favorable view about the student-teacher engagement in the FCM classrooms. Table 6 defines the seven aforementioned CUCEI subscales.

Table 6. CUCEI subscales and their intended construct measure

Survey subscales	Number of items	Subscales definitions and the intended idea to measure
Personalization	7	Placement of a strong emphasis on opportunities for individual students to engage with the teacher, as well as a care for the personal well-being of the students (Fraser & Treagust, 1986)
Involvement	7	The degree to which students participate both actively and attentively in activities and discussions in the classroom (Fraser & Treagust, 1986)
Student Cohesiveness	7	The degree to which learners know, assist, and get along with one another (Fraser & Treagust, 1986)

Satisfaction	7	The degree of class enjoyment (Fraser & Treagust, 1986)
Task Orientation	7	The extent to which activities in the classroom are presented in a manner that is both comprehensible and well-organized (Fraser & Treagust, 1986)
Innovation	7	The degree to which the teacher arranges innovative and unconventional classroom activities, instructional strategies, and assignments (Fraser & Treagust, 1986)
Individualization	7	How much students are allowed to make decisions and choose their own activities, and how they are treated differently based on their ability, interest, and rate of work (Fraser & Treagust, 1986)

Stage 6: Crosstab Analysis. In order to avoid a simplistic and biased reporting of themes (Bazeley, 2009), I performed a crosstab analysis after extracting themes from the SSIs using CCA. Performing a crosstab analysis ensured that I reported all the major themes and codes, not simply those that supported my RQs.

Stage 7: Correspondence Analysis 1. After conducting a crosstab analysis in NVivo 12 Pro, I exported the data from NVivo 12 Pro to SPSS 28 to conduct a CA. My major objective in conducting the CA was to evaluate whether the correspondence plot revealed anything unexpected or unique (i.e., students vs. themes). In the first CA, I utilized only the students' perceptions of the two modes of instruction. I did not make use of themes such as "ways to improve the classroom environment." I was mainly concerned about the students' perceptions of FCM and LBM.

Stage 8: Principal Component Analysis. Prior to Stage 8, I conducted an analysis by quantitizing (i.e., translating qualitative data to a numerical form) the themes discovered using a CCA of the students' SSIs (Tashakkori & Teddlie, 1998). Sandelowski (2001) noted that quantizing the qualitative themes might lead to a more detailed description of qualitative data and consequently a more insightful interpretation. Thus, I was able to define the hierarchy of the developing themes (Onwuegbuzie & Teddlie, 2003). To determine the prevalence rate of each theme, I calculated percentages by assigning a score of "1" if an answer included an attribute associated with a particular code a score of "0" if it did not. Using this process, an inter-respondent matrix of codes versus the learners was constructed. Using this matrix, I computed the prevalence rate of each codes and conducted a PCA to ascertain the underlying makeup of the meta-themes (Onwuegbuzie, 2003a; Onwuegbuzie & Teddlie, 2003). To be specific, I utilized Kaiser's (1958) "eigenvalue greater than one" rule and a "scree" graphical test in SPSS 28 to assess the number of

themes that can be retained after applying orthogonal rotation. My primary objective for conducting a PCA was to construct meta-themes (Onwuegbuzie, 2003a), which would contain one or more of the emergent themes.

Stage 9: Correspondence Analysis 2. After conducting the PCA, I loaded 19 factors (i.e., themes) under five components (i.e., meta-themes) which, according to the output of SPSS 28, accounted for 71.93% of the total variation. Three objectives guided my second correspondence analysis: Initially, I utilized the perception themes regarding the two modes of teaching during the first correspondence analysis to examine the differences between the two modes as perceived by students enrolled in the two modes (i.e., FCM vs. LBM perception). Second, applying a correspondence analysis on 100 or more themes would result in a very clogged-up correspondence graph, which is not easy to read. Third, applying a CA to 19 themes under five meta-themes, although challenging and difficult to read, is manageable. I was able to read and to find new qualitative insights from the second correspondence graph.

3.7. Linking Kolb's ELT to a Mixed Methods Research Methodology

Kolb's (2015) ELT can link to a mixed methods research methodology combining qualitative and quantitative research methods given its integral focus on experience, reflection, conceptualization, and experimentation. However, it is important to note that ELT and its sequence of stages are not strictly linear but rather a holistic approach to learning and can vary depending on the study's design and purpose.

In the quantitative phase, I designed the flipped course so that the students would repeatedly cycle through all stages of ELT and, nonetheless, largely engage in Kolb's abstract conceptualization

and active experimentation stages of ELT during the class time. During this abstract conceptualization phase, the students used their understanding of the concepts introduced during the pre- and in-class concrete experience and reflective observation to identify underlying patterns, trends, and relationships from the concepts to which they were exposed. This aligns with the abstract conceptualization stage because the construction of theories and predictions often happens at this point. Then, during the active experimentation stage, students would apply these theoretical concepts practically, implement them in a controlled setting, and elicit data for further examination.

During the qualitative phase, primarily gathering personal accounts, I employed surveys and interviews to gain insight from students' perspectives. The qualitative phase formed the environment for the direct encounters (e.g., interviews) and indirect encounters (e.g., CUCEI) with the phenomenon being studied (i.e., students being studied under two different pedagogies), giving depth to the findings derived from the quantitative data. Thus, Kolb's (2015) ELT learning cycle integrated the depth and contextuality of the qualitative research and the statistical power of the quantitative research, thereby making it suitable for framing a mixed methodology.

3.8. Summary

To analyze the quantitative and qualitative data collected, a mixed research design was employed. This study's research implementation process is depicted in Figure 2. As illustrated in this figure, the quantitative phase of the study was conducted by collecting pre-test and post-test grades, five comprehensive quiz grades, in-class practice grades, homework grades, final class averages, and SATS scores to collect information about the learners' performance. The quantitative data then

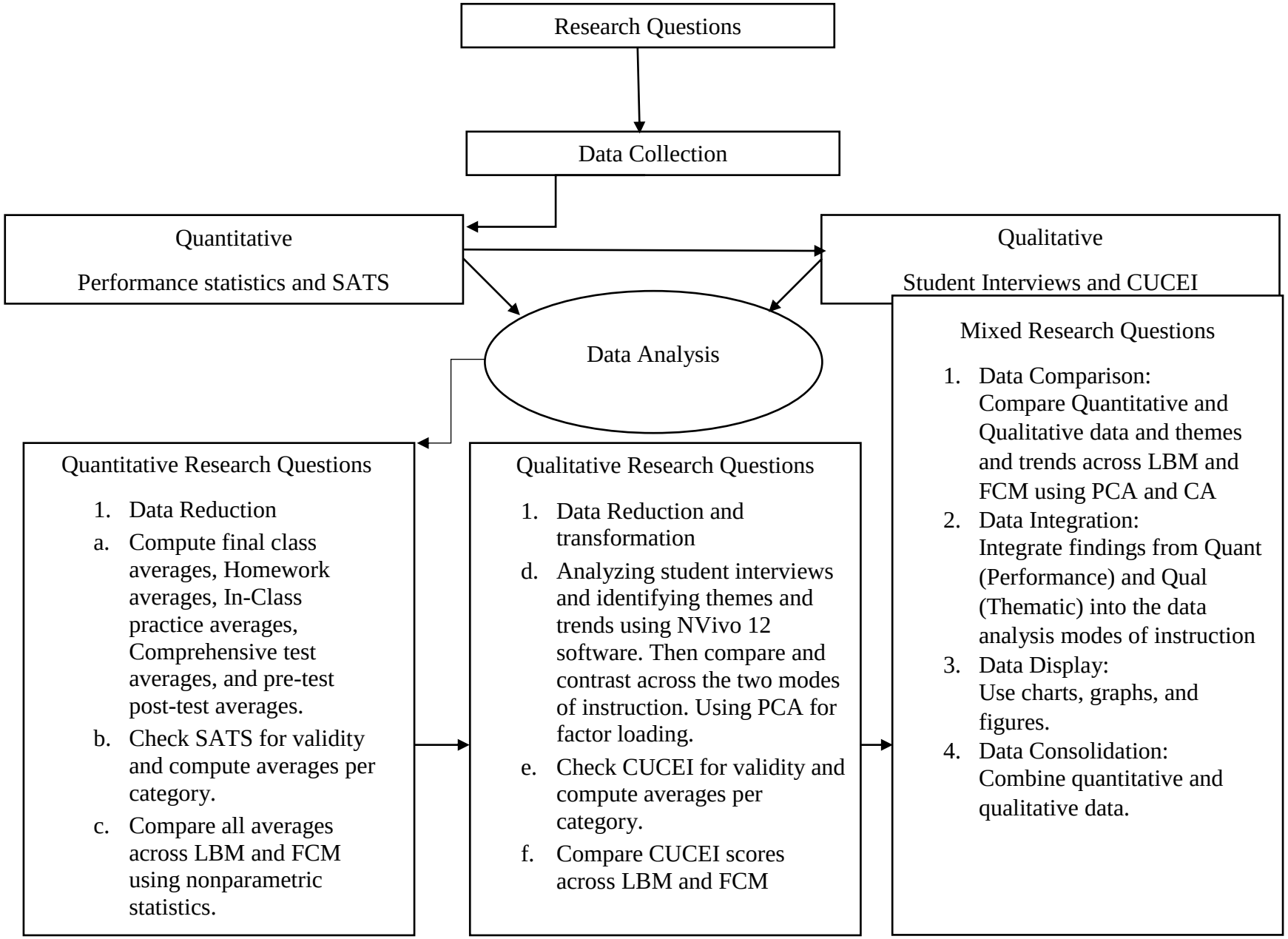
were analyzed using SPSS 28 to determine the performance averages for each pair of assignment mentioned earlier, which then were compared and contrasted across all sections of LBM and FCM.

After assessing normality, nonparametric statistics were utilized to analyze the quantitative RQs. To determine whether the averages of the LBM and FCM sections are different for each pair of assignments, a Kruskal-Wallis test was conducted, followed by a Mann-Whitney *U* test if the Kruskal-Wallis test yielded a statistically significant result when comparing every pair of performance statistic.

Sequentially, as shown in Figure 2, this is a *QUAN* ⟶ *qual* study, in which the qualitative data were analyzed as a small subset of the quantitative sample and data. Qualitative instruments, such as SSIs and CUCEI, contributed to the quantitative phase of the research by providing contextual information and more in-depth insights into the collected data. The qualitative data assisted me in identifying themes and patterns and extended better explanations for the quantitative results. Combining qualitative and quantitative data led to a more thorough examination of the RQs, a more robust set of suggestions in general, and specific recommendations to lower student failure rates in statistics courses at the institution where the study was conducted.

Using the software NVivo 12, the qualitative research questions were analyzed to identify themes and trends. Moreover, a PCA was used for identifying loading themes (factors) and for identifying themes at a higher level of abstraction (i.e., meta-themes). In addition, a CA was used to study the correspondence plot to gain a better insight into the quantitative data. I conducted a mixed analysis of quantitative and qualitative data to answer the mixed research questions. As a result, the steps of data reduction, data display, data transformation, data consolidation, data comparison, and data integration were utilized in the process of mixed analysis.

Figure 2. Mixed Methods Research Design Flow



CHAPTER 4: Presentation and Analysis of Data

4.1. Summary of the Sections to Follow

The objective of this mixed methods research study was two-fold. First, using survey of attitude toward statistics (SATS), this study compared the differences in students' attitudes toward statistics between the flipped classroom model (FCM) and lecture-based model (LBM) sections, as well as their quantitative performance as measured by assignment grades. Second, using college and university classroom environment inventory (CUCEI) and semi-structured interviews (SSIs), this study expanded the breadth and scope of the effects of employing the FCM strategy in a business statistics environment (i.e., expansion). Consequently, this chapter presents Step 9 (i.e., data analysis) of Collins et al.'s (2006) 13 steps for the mixed methods, quantitative, and qualitative research questions (RQs) and the two hypotheses that, as stated previously in Chapter 1, guided this study. Finally, I summarize the chapter and present the contributions of this study in detail.

4.2. Quantitative Analysis and Results of Grades and All Survey Instruments

I proceeded to examine the difference in the mean scores of the five assignment categories of students who enrolled in FCM sections versus LBM sections. Therefore, the very first test that I conducted was the test of normality for all data and then a test of normality for the LBM and FCM data separately. The test of normality for all data showed the shape of all collected data to be non-normal.

Examining the skewness, kurtosis, and standard errors (Cramer & Howitt, 2004; Doane & Seward, 2011), as well as visually inspecting their histogram, normal Q-Q plots, and box plots, and

performing a Shapiro-Wilk's test (p = .012) (Razali & Wah, 2011; Shapiro & Wilk, 1965) verified that the sample data (i.e., dependent variables such as final class averages, comprehensive exam averages, homework averages, practical averages, and the difference between the pre-and posttests scores) were not approximately normally distributed, as shown in Table A6, Appendix A. The p values less than 0.001 indicate that the null hypothesis that the data are normally distributed had to be rejected; hence, the non-normal distribution of the collected data was established. Next, I proceeded to test the normality of data for each mode of instruction (i.e., FCM and LBM) as shown in Tables A7 and A8, Appendix A). The test on normality verified that the LBM sample data and the FCM sample data were not approximately normally distributed.

Next, I conducted a nonparametric Levene's test of homogeneity of variance as an assumption of using nonparametric tests, specifically Mann-Whitney U tests. The rationale behind undertaking a nonparametric Levene's test of homogeneity of variance was to validate the underlying assumption of nonparametric tests, which is that different data groups must have the same distribution type (Nordstokke & Zumbo, 2010). The homogeneity of variances in the samples ($p > 0.05$) (Nordstokke & Zumbo, 2010; Nordstokke et al., 2011) was confirmed for all variables, which means that the study was not restricted to utilizing the Mean Ranks. The medians of the distributions could also be used to compare the distributions (Karadimitriou et al., 2018).

4.2.1. Comparison of Grade Performance Between FCM and LBM

After conducting the test of normality of data and the nonparametric Levene's test of homogeneity of variance, I proceeded to test the difference between the two groups with respect to the five assignment categories regarding both modes of instruction with the following results. All mean scores in the FCM classes were higher than in the LBM classes. However, the FCM homework

average was the only variable that was statistically significantly higher than was the homework average in LBM classes (U[NFCM = 95, NLBM = 121] = 4842.00, z = -1.986, p = .047, with η^2 = 0.018 and CL = 57.59%). In addition, all median scores in all assignment categories also were higher and the interquartile ranges were lower for the FCM groups as shown in Table 7.

Table 7. FCM Versus LBM performance by Medians and Interquartile Ranges (IQR)

Assignments		Practicals	Homework	Comprehensive Exams	Pre- and Post-test differences	Final Class average
Median	LBM	85.79	89.61	67.78	47.04	75.52
	FCM	88.20	93.53	69.30	48.75	77.49
IQR	LBM	23.34	23.41	17.75	33.26	15.77
	FCM	22.00	21.04	14.90	31.35	16.61

Note: Obtained using SPSS 28. n = 216.

4.2.2. Survey of Attitude Toward Statistics.

Prior to the end of the academic semester, all students who provided informed consent completed the pre-SATS during the second week of the term and the post-SATS during the 11th week of the term. Questions with negative wording were reverse-coded (Dauphinee et al., 1997). Each student's mean score on each subscale was calculated (Schau, 2003). If a student did not respond to a question on the pre-SATS or post-SATS for a specific subscale, his/her responses for that component were discarded. The allowable score range for each component is between 1 and 7. Using a 7-point reply scale, higher scores indicate a more positive attitude.

4.2.3. SATS Subscale Score Reliability Tests

All pre- and post-SATS surveys for FCM and LBM sections were examined for the score reliability of the subscales. Subscale scores on the SATS are derived by reversing the responses to negatively

worded items so that all items point in the same direction (1 becomes 7, 2 becomes 6, etc.), summing the item responses within each component, and dividing by the number of items within each component to obtain an average. The potential score range for each factor is between 1 and 7. Using a seven-point answer scale, higher scores indicate more favorable and positive sentiments/attitudes.

Using SPSS 28, Cronbach's analysis was conducted on the "affect" subscale. It was found that the subscale's alpha level was .87, which indicates that the subscale has an adequate level of inter-item reliability. Table A9, Appendix A shows each subscale with their respective Cronbach's Alpha for all pre- and post-surveys for both the FCM and LBM sections. Scores pertaining to all subscales in all pre- and post-SATS yielded adequate reliability, apart from the "difficulty" subscale. Therefore, the difficulty subscale was eliminated from subsequent analyses.

4.2.4. SATS Score Validity Test

Using SPSS 28 in both the LBM and FCM sections, I assessed the validity of the scores of the pre- and post-surveys of attitude toward statistics utilizing the Pearson Product Moment Correlation Test. The test was used to evaluate the relationship between the individual items and the total score of the survey. The results showed a statistically significant correlation between the variables with correlation coefficients ranging from .70 to .85, which indicated that the results were statistically significant. This suggested that the individual items were a good predictor of the total score and that the scores generated by the scale were valid.

4.2.5. FCM Pre- and Post-SATS Analysis.

Eliminating the difficulty scale due to a low Cronbach's alpha and using nonparametric tests to analyze the ordinal data (Kuzon et al., 1996), I conducted a series of Mann-Whitney *U* tests to compare the difference in attitudes between the pre- and post-SATS survey for the FCM sections. The Mann-Whitney *U* test indicated that the differences between the mean ranks of all pre- and post-SATS subscales of the FCM sections were not statistically significant, indicating that the FCM mode of instruction has not affected the learners' attitudes toward statistics in a positive or a negative way. The Mann-Whitney test, indicated that the difference in "affect" subscale between the pre- and post-SATS surveys of the FCM sections was not statistically significant, $U(N_{preFCM} = 70, N_{postFCM} = 83) = 2712.500$, z = -0.706, $p = .480$. All other computations are presented in Table A10, Appendix A.

4.2.6. LBM Pre- and Post-SATS Analysis

Next, I conducted a Mann-Whitney *U* test to compare the difference in attitudes between the pre- and post-SATS survey for the LBM sections. The Mann-Whitney test indicated that the differences between the mean ranks of the four subscales of the pre- and post-SATS for the LBM sections (i.e., affect, cognitive competence, interest, and value) were not statistically significant. However, the Mean Rank Scores of the "effort" subscale in pre-SATS (114.58) were higher than those of post-SATS "effort" subscale (98.12). The Mann-Whitney test indicated this difference was statistically significant: $U(N_{preLBM} = 101, N_{postLBM} = 110) = 4688.00$, z = -1.978, $p = .048$, $\eta^2 = 0.019$. All other computations are presented in Table A11, Appendix A.

4.2.7. Testing the SATS Differences Between FCM and LBM

Next, using SPSS 28 and eliminating the difficulty scale due to its low reliability score, I conducted a series of Mann-Whitney *U* tests between all the pre- and post-SATS subscales of the LBM sections and the FCM sections to compare the difference in attitude toward statistics between the two modes of instruction. There was only one scale (i.e., interest scale), which showed to be statistically significant in favor of the LBM sections noted as $U(N_{FCM} = 83, N_{LBM} = 110) = 3797.50$, $z = -2.003$, $p = .034$, $\eta^2 = 0.021$.

4.2.8. CUCEI Subscale Score Reliability Tests

This survey was administered to 36 students during the qualitative phase of the study. However, the survey is analyzed quantitatively, and the results are presented in the qualitative phase. Both CUCEI surveys for FCM and LBM sections were examined for the score reliability of subscales. Cronbach's analysis was conducted on all seven subscales of the CUCEI survey for both FCM and LBM sections. It was found that all subscales' alpha levels for both FCM and LBM sections were equal to or higher than 0.70, which indicates sufficient reliability for all subscales in both modes of instruction (see Table A12, Appendix A).

4.2.9. CUCEI Score Validity Test

I examined the CUCEI scale used in the qualitative phase of the study using Pearson Product Moment Correlation tests via SPSS 28. All items correlated statistically significantly with the total score with correlation coefficients ranging from .70 to .85, which indicated that the results were statistically significant, the individual items were a good predictor of the total score, and that the

scores generated by the scale were valid. The score validity demonstrated that the findings accurately reflected the views of the participants regarding the classroom climate.

4.2.10. CUCEI Analysis

Due to the ordinal nature of the Likert-format Scale data, the first test that I conducted was a nonparametric Kruskal-Wallis test, to compare the differences in class climates based on the perspective of the LBM versus the FCM students (see Table A4, Appendix A). In terms of the scope of my research, it is crucial to highlight that CUCEI was administered to a qualitative subset of 36 participants. Consequently, the discussions related to these results will be situated within the qualitative phase of my study. A Kruskal-Wallis H test revealed a statistically significant difference between all subscales of the CUCEI survey measuring the classroom climate in favor of FCM section as shown in Table A4, Appendix A. Moreover, as shown in Table A5, Appendix A, the median of all FCM subscales was higher than that for the LBM sections. The higher medians are indicative that the FCM students perceived the classroom climate to be more conducive for learning.

4.3. Summary of Quantitative Results

Homework grades were the only category that showed a statistically significant difference in favor of the FCM sections reported as $U(N_{FCM} = 95, N_{LBM} = 121) = 4842.00$, z = -1.986, $p = .047$, with $\eta^2 = 0.018$ and CL = 57.59% as measures of effect sizes. Moreover, as previously shown in Table 7, all median scores also were higher for the FCM classes (recall that I used Levene's test of homogeneity of variances, which ensures that I could use the medians to compare distributions).

The learners' academic performance, as measured by median scores across all categories of assignments, exhibits important distinctions between those enrolled in FCM classes and those in LBM classes. In each category of assignments, learners in the FCM environment consistently recorded higher median scores than did their LBM counterparts. This serves to highlight the comparative effectiveness of the FCM teaching approach in fostering better academic achievement.

Moreover, it is noteworthy that in all assignment categories, the interquartile range observed amongst FCM learners was smaller than that found in the LBM group. The interquartile range, a statistical measure that denotes the dispersion or spread of the middle 50% of scores, being smaller suggests greater consistency and less variability in the performance of FCM students. A smaller interquartile range would suggest that FCM students are performing better on average given higher medians while demonstrating a concentrated higher performance across assignments, indicating the Flipped Classroom Model's reliability and consistency.

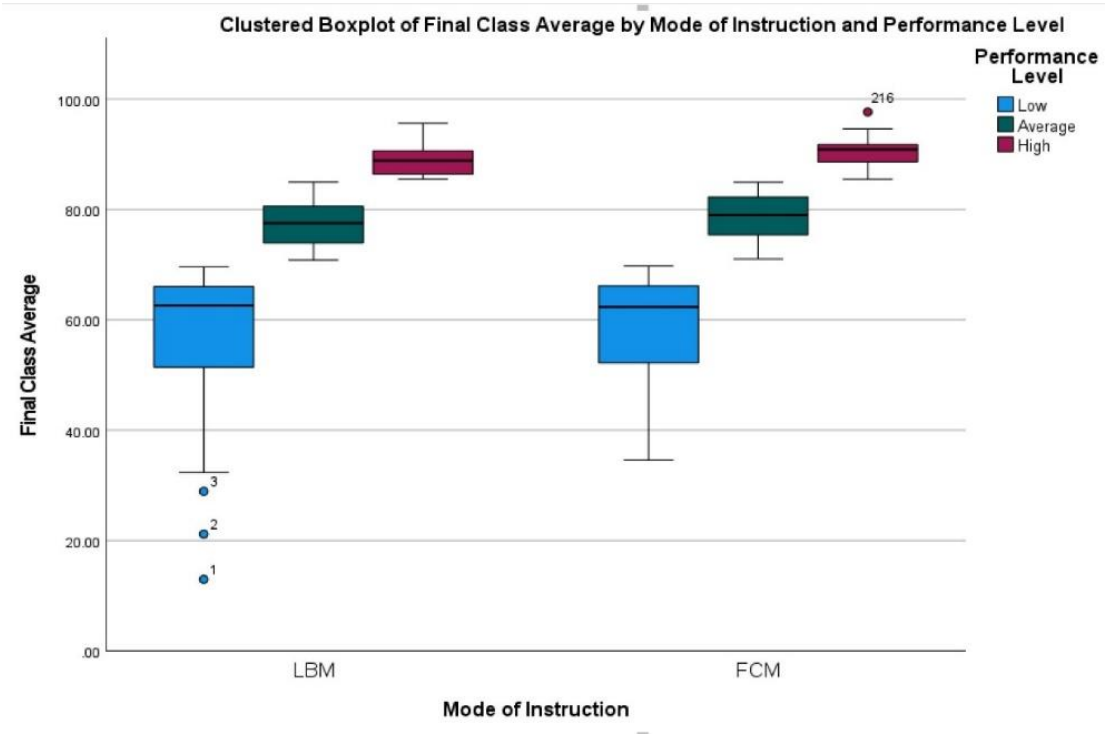
Furthermore, due to the statistical significance of the differences in homework assignment grades, I computed the effect size using the calculator of Lenhard and Lenhard (2016), which is $\eta^2 = 0.018$ and CL = 57.59%; and then using the same calculator, I converted the number to a Cohen's *d* of 0.27 for better comprehension and interpretation. The aforementioned effect size was small, indicating that there is a very small practical significance for the difference in homework grade averages between the two modes of instruction. It is possible that the difference in homework grade averages in favor of the learners enrolled in the FCM sections is because I assisted the learners in the FCM sections to solve their homework assignments in class, whereas the learners enrolled in the LBM sections solved their homework assignments at home without my supervision.

This could account for the statistical significance of the difference, albeit it is not practically significant.

Analysis of SATS did not reveal a statistically significant difference, either positive or negative, in relation to the learners' attitudes toward statistics before and after the start of the course within each section (i.e., LBM or FCM) or a statistically significant difference between the two modes of instruction.

Further, a crosstab analysis of the mode of instruction by the performance level showed a Cramer's V of .75, which is indicative of a very strong association between the mode of instruction (i.e., FCM and LBM) with the students' quantitative performance level (i.e., low-, average-, high-performing students). Based on this strong association, I concluded that the higher performing students were better able to take advantage of the FCM. Given that FCM students performed better on all assignments than their LBM counterparts as evidenced by a smaller interquartile range and a higher median score, indicating less score variability and consistently higher performance, I concluded that the FCM method of teaching had contributed to better performance. In addition, Figure 3 is a box plot of final class averages by the mode of instruction and the performance, which supports the aforementioned argument.

Figure 3. Mode of Instruction Versus the Performance Level



4.4. Qualitative Analysis and Results of Interviews and College and University Classroom Inventory

After the finalization and submission of the final grades, I received the name of the students who had participated during the quantitative stage. I asked for student volunteers based on the maximum variation sampling scheme (i.e., low or high performance during the quantitative phase), and 36 students (n = 19 LBM, n = 17 FCM) volunteered for the qualitative phase of the study.

I asked the volunteers to fill out a climate survey called the College and University Classroom Environment Inventory (CUCEI) developed by Fraser and Treagust (1986). Then, I analyzed the

CUCEIs and compared the result between the two modes of instruction. The quantitative analysis of CUCEI was undertaken during the quantitative phase of the study. Each CUCEI subscale measuring the classroom environment demonstrated a statistically significant difference favoring FCM sections. Further substantiating this, it was previously discerned that the median values for all FCM subscales exceeded those of the LBM sections (see Table A5, Appendix A). Such a pattern reveals that students perceive the environment created by the flipped instructional strategy with greater favor, as echoed by the higher median values.

4.4.1. Semi-Structured Interview Analysis and Discussion

In order to discover the students' perceptions pertaining to the effect of the FCM versus LBM instructional strategies on their course performance and to explain the quantitative results of the previous sections, I conducted SSIs with 17 FCM and 19 LBM participants. As stated previously in Section 3.4.2, based on a nested sampling design and using a maximum variation sampling scheme, all students with high and low performance during the quantitative stage were identified. To recruit these participants, due to the online nature of all sections because of the COVID-19 situation, I initiated contact via email with the low and high performers. A total of 17 students from the FCM sections and 19 students from the LBM sections returned my email and agreed to be interviewed. Also, I emailed the consent form to the students who agreed to participate in the interview. All students who agreed to participate in the study electronically signed and returned the consent form prior to their interview.

Each student participant was tasked with conducting an interview via Blackboard Collaborate. Although each student signed the consent form and acknowledged that the interview would be recorded, I verbally reaffirmed his or her permission to record the session prior to each interview.

The recordings were not video based but rather audio based. Utilizing my laptop, I completed the online Blackboard interviews. I transcribed each conversation using the *otter* website To decrease the possibility of interpretative validity, I asked each participant to review the transcription of his or her interview. After obtaining confirmation from all student participants that their statements were authentic, I uploaded the transcribed interviews as different cases – but one project – into a qualitative data analysis package, specifically NVivo 12.

4.4.2. Results of Interview Analysis

On the data collected from student interviews, a CCA was conducted (Glaser & Strauss, 1967). This analysis consisted of reviewing each student's transcript and finding any relevant thoughts expressed by the participants. These discovered concepts were codified and analyzed for patterns or themes (Strauss & Corbin, 1998) using NVivo 12 Pro. Multiple cycles of coding were completed to categorize the original 80 codes into 19 related groups of codes, which were then arranged into five main themes: (1) Theme 1: Perceptions about the mode of instruction and the course design, (2) Theme 2: The Effect of the Online Component, (3) Theme 3: Learning Preferences, (4) Theme 4: Ways to Improve, and (5) Theme 5: Challenges.

Theme 1: Perceptions About the Mode of Instruction and the Course Design.

This theme featured codes that reflected students' positive and negative feelings or ideas associated with the FCM versus LBM instructional strategy, preference for the type of instructional strategy, and the efficiency of the instructional strategy from the point of view of the students enrolled in the FCM and LBM sections. The students enjoyed having a sense of inclusion in the FCM sections, which constituted a novel and unique way to watch videos and prepare for class. Moreover, by

analyzing the learners' SSIs, I captured their discernments and observations about the effectiveness or ineffectiveness of the instructional strategy and their insights into how to improve the design of the course. The theme mentioned above manifested itself when the learners responded to interview questions about their likes or dislikes about the learning and teaching model introduced in this term.

When comparing and contrasting the two teaching approaches, it is crucial to both understand the learner's perspective of the FCM/LBM instructional technique to improve course design for the next generation of learners during the following terms as well as to comprehend the learners' better performance in FCM classes, despite this not being statistically significant. Students discussed how they felt about the flipped classroom's outside-of-class and inside-of-class components. Students' responses to several interview questions revealed a variety of opinions regarding their experiences outside of the classroom. The efficiency of watching videos, completing video quizzes, and having extra practice time in class were all topics of discussion among students in the FCM, whereas the LBM students talked about how they would have learned more effectively if they had had access to instructional videos to watch before class rather than just the lecture. Moreover, I used a notation such as "(HP, FCM)" to indicate that the student is a high-performing student enrolled in an FCM section and "(LP, LBM)" to indicate that the student is a low-performing student enrolled in an LBM section.

Several FCM students mentioned how convenient the lecture videos were for their schedules. Students expressed their enthusiasm for short videos because they allowed them to prepare fully for class by devoting just a small amount of time from their hectic schedules to watching one video. During the interviews, students also discussed their feelings of anxiety in relation to quantitative

subjects. Also, many students aired their dissatisfaction with the sudden move to online learning due to the COVID-19 pandemic.

In response to an interview question on what the learner thinks about learning statistics in Term 1 using the flipped model, posed to FCM and FCM-light (i.e., the few students in the LBM sections who noted that they watched the flipped videos before coming to the class) students who had access to the lecture videos Mandana, (HP, LBM) (FCM-light), noted the following:

> The videos, it was very useful, especially the videos were short, not too long, less than maybe 10 or 13 minutes, as I remember. And you try to just come to the information about the good points in the video quizzes. And I think it was a good idea to make it very short. If it was very long, with the video, maybe the students would become tired. And they had no patience to watch the video more than one time. Because it becomes boring, but you just explained everything very good in the video, and video quizzes were clear. And it was helpful, but sometimes, for me, maybe I need more than one time to watch the video.

Fatima (LP, FCM), explained that

> I learned so much more in this course than I learned in the pre-requisite statistics course leading to this course. I have to say this because I can say in the previous course, she, she never, you know, the teacher didn't get videos like this for us to watch and practice from them. So, whatever I have to learn, I have to learn in class time from her at the time. So, I didn't have this option to watch something before class, whenever I would feel bored, I can stop the video, go do something else, come back again and watch from where I stopped. So as a result, I can have my full concentration on what I'm learning.

Sue (LP, LBM) (FCM-light) mentioned,

> for me personally, I would prefer the videos more because I know what I'm supposed to learn. So, I know where I'm supposed to head if that makes any sense. If I look at the video, I know what the class is going to be about. And I know when the teacher is teaching this, he actually means this. And this is where he is linking it to. So that personally makes more sense to me because I actually learn via videos.

Ana (HP, FCM), noted that she watched the videos even if it was after the class rather than before. She stated,

> They were not very long videos. So, it was like the attention span, you didn't have to spend, you know, watch like a 40-minute video to an hour video. It was quite short, but very detailed. And you've explained it clearly. So, it was helpful in terms of coming to class and understanding. And if I hadn't watched the videos before the class, then it would be harder. And after the class, I would watch it, and then I would understand it a lot easier.

Steve (LP, FCM) noted the following:

> I think I was okay. Because it allowed me to prepare for the class. And if there was anything that I was unsure about, I can either wait for the class and then ask you or see being done in the lesson, or I can rewind the videos or go back to the beginning and go through it again. So, it kind of gave it a little bit extra help when you needed it. And it was a very good way of preparing your students or myself for the class.

Lab (LP, FCM) remarked that,

> what I liked is that we could, as I mentioned earlier that we could use our own time, and because those videos were very detailed, and, you know, you explained it quite well. So, I think the students, including me, we were able to use our own time to study and then know if we had any confusion, we could go back to those videos and then just see again, yeah, they were very useful.

Praew (LP, FCM) stated that he had never had a class with short videos to watch before coming to the class and noted that,

> I was interested about flipped program because I didn't have a course that we can watch the video that you record in every way before we start the class. I only have to read a PowerPoint or maybe the study materials that another teacher has to see but don't have a video like you.

In contrast, when asking the same question to students from the LBM group and asking whether it would have been better to include videos during Term 2 when no videos were offered to the LBM students, Raj (HP, LBM) revealed the following:

> to be honest, I think it was because everyone was at their own pace, right? So, if you put videos, maybe some people can go to them faster. And they can learn at their own pace. But when you do a lecture, basically everyone has to listen. And some people honestly prefer more interactive stuff, like, in class activities. I feel like that makes a difference.

Nu (HP, LBM) noted that "Many times, it's too boring. The teacher is just giving a lecture and

doesn't let us participate. I don't think this class gives me a strong sense of participation". Gop (HP, LBM) concluded that "I would like to include video that shows the lecture because when I can't remember or understand something, I could just go back to look at the last lecture."

Phan (HP, LBM) declared that,

> to be honest, to me that will be better to include videos like I can know a little about how the lessons are at like the foundation, I mean, I will have the general idea of that lesson. So, if I have time, I can find a little more bio about it than just being in class to listen to a lecture. I like to do more practical to get more knowledge than just listen to a lecture like that. Remarkably, most FCM students who had enrolled in previous lecture-based classes noted that they believed that the FCM method was more efficient than was the LBM method of instruction.

When asked whether a flipped approach is more efficient than a previously experienced LBM course, 98% of FCM students favored the FCM method. Ana (HP, FCM) mentioned that

> I think it's the flipped because there's more work involved rather than the traditional, which is just kind of listening to the lecture. I think the flip one, there's more things involved in, you know, just not just coming to the lecture and just sitting through it and then not having to do anything. So, yeah, I would have to say it's the flipped method.

Ploy (LP, FCM) also noted her preference for FCM and stated, "Flipped format, because we get to do activities than just listening to the lecture".

Mandana (HP, LBM) (FCM-light) noted that

> if we think about efficiency, then flip format is more efficient because the students can watch the video anytime in a free time they have. They can watch the video early in the morning, or late at night. Yeah, only I can give this answer. It's only saving time. And flexible time is flexible for students.

Theme 2: Effect of the Online Component

The second theme consisted of codes that helped the students express their opinion of forced online classes, such as the COVID-19 effect on the learning environment, classroom interaction due to the online effect from the perspective of the FCM and LBM students, and the efficiency of group work in an online environment.

Unfortunately, I received negative comments in the interviews, mainly due to the COVID-19 pandemic. One of the emerging negative codes was the forced mode of delivery from face-to-face to an online format. Many students, both FCM and LBM students alike, expressed their dissatisfaction with online learning, and many noted that they preferred face-to-face learning. Based on both FCM and LBM student interviews, one of the major adverse effects of the online component was demotivation due to the lack of interaction in online classes. Students in both modes of instruction seemed to believe that a face-to-face environment is more motivating than is an equivalent online class. The following is a sample of FCM student responses about the adverse effects of COVID-19 pandemic on their learning.

John (LP, FCM) noted that because of the online learning format, the probability of academic dishonesty is higher. This student mentioned that

> Because I mean for every exam [examination] or presentation, we've had to do across all my subjects, I'm constantly getting messages from my peers asking how do you know the answer to this question? How do I answer that question? And it's just distractions while you're sitting, trying to do something yourself. Even when we were doing our statistics presentations, I was getting messages from other classmates that you are asking questions about what's the answer to this? Or how do I answer this question? What does that mean? And I've got to tell these people that "listen, but I don't understand either, you know, I'm just trying to it myself". So that's a bit frustrating. Having to do everything online.

John added that the lack of interaction in online classes in comparison to face-to-face classes, can cause demotivation, stating that,

> So, I prefer interacting face to face. The fact that I've had to sit and stare at my laptop for the better part of a year doing these courses has really, really hurt my motivation. Because I mean, I can just sleep while in a lecture. And then I can go and do something else. You know, I've got the lecture in the background, and I'm doing work for another course. So that in that sense, COVID-19 has impacted the way I feel about the course, the lectures, and everything. I think face to face is much more beneficial for not only the students, but for the lectures as well. Because I can't imagine how mind numbing it is to sit for lectures to sit and stare at a computer for 6 hours, and only have maybe three people per class interact with you. It must be the most frustrating, it must be one of the most frustrating things in the world. Face to face is just a much better platform to learn on. Because it forces you to interact.

Taengmo (HP, FCM) stated that there is less interaction in online classes by explaining that,

> it plays a very vital role in my learning process. Because like, since I was young, I was always learning face to face. And when I switched to online, the most important factor that affects me, are like no new friends and, you know, greeting each other and getting to know the teacher, because I think for me, the relationship between students and teachers are important. When it comes to online, we just chatting, we don't see each other. And sometimes we just misunderstood each other. And sometimes, like I tried the question in the chat, some teachers maybe they're too busy, and then they didn't read my question. So, it's not that effective to me.

Lab (LP, FCM) mentioned that the online format is demotivating. This student revealed the following:

> For me, I think, like about other courses, yes, I would have preferred it to be face to face because online is really demotivating. Like, I could do it the first two terms, but it really started becoming demotivated after like one or two terms because everything was online. And, you know, it was just demotivating.

Somchai (HP, FCM) mentioned factors such as bad Internet connection hampering one's studies and concluded that

> I think COVID-19 affected me too much. Like I barely understand when I study, unlike face to face. And when the COVID came, everything changed and I will study in the online class and it's really hard when the teacher explains and sometime when the connection is not good, you will not understand what the teacher is teaching at all. When the teacher is

> teaching about the chapter and after that your WiFi is gone you have to lose 5 minutes to fix the connection and after that when you come back you have lost the lecture or practice.

The LBM students expressed similar sentiments. Zahra (LP, FCM) admitted that online classes made her lazy because she relied a lot on watching the class recording rather than joining the class. She stated,

> I wouldn't mind having to go to school because that would make learning easier because now having to have this online class has made me I would say very lazy than how I was before I came to Thailand and having to go to school, because now I feel very more relaxed and it's barely times where I would feel like I have to pay attention because I'm relying on watching my recordings from classes.

It is important to note that she was not talking about watching the lecture videos, but rather the two-hour recordings of the online class.

Another student, Yuze (LP, LBM), cited the lack of attention and student interaction in the online format of classes. Yuze reported that,

> Online, I lose my attention but f2f [face to face], I will pay more attention to the class. Honestly, it didn't go well because now the situation is like everybody stays at home and have computer and camera, like make the communication less. Like I only talk with the people I know like before I joined class but like actually in the class just contact with teacher is well but with another student not very good contact.

Khemera (LP, LBM), mentioned that his grade point average (GPA) had been adversely affected because of the online format of learning, as the following interview passage indicates:

> COVID-19 has affected not just statistics, of course, mathematical subjects, I've been discussing this with my parents as well that mathematical subjects are quite hard to cope with given the COVID-19 pandemic. And, of course, other subjects have been affected as well. Looking at my GPA and looking at my performance, from the very first and comparing it with after COVID-19, there is a vast difference. So, it has affected learning in many ways, but there's no option to learn face to face. So, we have to go through online and it hasn't affected statistics much, but I would say I would have done better if it was face to face learning.

One LBM student even mentioned that she had to change her major from Communication Art, which had lots of practical photography courses, to a less practical major because she could not follow the practical parts in an online format. Sue (LP, LBM) explained

> I changed my major from communication arts to international relations, after doing communication arts for a year and a half, so like four semesters. Communication arts was much more difficult when I had to do it online, because I had no idea what the teacher was teaching because it was more or less, everything was more practical. And turning practical courses like courses like photography and the teacher had to show you the camera angle and everything. And then having to do that through a video where 10 other students are talking and asking questions, that was difficult. But then when I changed to international relations, I think it actually helped a lot because I can hear the teacher without any interruption. So, the distance in the class and everything didn't make any, like wasn't an

> issue. So, I could hear the teacher and whatever questions I had, I could like answer. I could ask the question and it was answered without any other students interrupting.

Students in both modes of instruction noted that group work is more engaging in a face-to-face environment. Many learners indicated that there was simply no communication when groups were formed online and many students were simply not present in the class, although they are logged in.

Taengmo (HP, FCM) observed that groups are more effective in a face-to-face environment and stated that, "of course, face to face group is way better. I used to work in a face-to-face group last year and everybody's just encouraging and talking to each other. And it was fun". In addition, Gop (HP, LBM) reiterated that groups function better in a face-to-face class and stated that "I think groups are better in face-to-face. It's easier to interact with each other when it comes to face to face and people don't disappear." Another student in the LBM section, Noo (HP, LBM), echoed the same sentiment:

> I think when we were put into the groups, like couple of times during the term, when we had to do the practical questions on McGraw Hill Connect, it was very hard to interact. No one really talks. So, the only time I had interactions was when we were doing our project.

Yet another LBM student, Zahra (LP, LBM), mentioned the lack of communication in groups and stated that there was no communication at all: "Everyone was always doing their own work on their own. There was no Hey, guys, did you understand that question? Or what? I felt like putting people in the group didn't help".

Overall, the students believed that the sudden online move due to COVID-19 was not conducive to their learning experience.

Theme 3: Learning Preferences. The third theme generated from the students' SSIs was the learning preferences. Students mainly discussed their feelings and preferences with respect to self-paced learning versus instructor-led method of learning, both of which, I utilized during the FCM and LBM sections, albeit, much less during the LBM sections due to the fact that lecturing would consume most of the class time. After exposure to instructor-led training and self-paced learning in both modes of instruction, I asked the interviewees in both sections about their preferred method. I noted that the majority of students preferred the instructor-led method, mostly because communication in groups was problematic in an online mode of delivery. John (LP, FCM) stated the following:

> I prefer the instructor led. Because when you put us into the break-out groups, that would just be what it would be. Okay, what's the answer? Okay, here's the answer, it wouldn't really be much discussion about how the spreadsheet was solved, or why we decided to do a one-tailed test or a two-tailed test, or why the *p* value is 0.81. So, the instructor-led learning for me was a bit better because the breakout groups were essentially just the answers were just put in the group and there was no real discussion about how the number was reached or what steps was used to get there.

Another student, Fatima (LP, FCM), noted that,

> But in the class, when you show us the whole thing, if we're stuck at one place, you're showing us how to complete that place to get a result, we are learning the whole thing

> again, but when in group if one person can do it, it happened to me in my group. In Chapter 10, I completed all the answers really quick. And they were like, Okay, tell us the answers. I told them and when you came in the group, then all of them were quiet. I say that and this is how I completed it, but they didn't know how to do it. So, when you're showing us the homework by yourself, then we know how to do the whole thing.

This student suggested that when in groups, one person does the whole thing for the groups and the remaining students copy the answers without learning how to do it. Then, when I check on the groups, most are silent.

An FCM-light student, Nastran (HP, LBM), reflected a similar feeling of doing the work for others and her preference for instructor-led learning by revealing the following:

> I prefer instructor-led with you and help us. I don't want a group at all. Being in the group was not good for me. And actually, I had to answer all the questions by myself and then write the question in the group and not only in the Blackboard, but I had to write again in the line application and actually I did a statistic not only for myself, but I did for other students. And for the project too. It made me all crazy this semester, not only with a statistic with other courses. It was only waste time. I lost my energy.

Sue (LP, LBM) expressed a similar viewpoint, stating that,

> Because instructor led actually makes a student who actually wants to answer get involved more. But then if you put them in groups, and then make them do it, it's mostly like one student who knows is going to do work on it. And the others are just there to copy.

***Theme 4: Ways to Improve*.** This theme centered around what the students believed represented ways to improve the course design. Most students cited playing games, followed by the advantages of group work, then applying a more project-centric approach, and providing a simpler explanation of topics as activities to add to improve learning. Interactive assignments was the assignment that the students thought should be eliminated to improve the learning in classes. When asked for ways to improve the class learning environment, Somsak (HP, LBM), stated that,

> Playing games such as Quizlet, you know, has a lot of games about statistics and it is fun. I had to play it before in finance and in some subjects. I think you can make the student enjoy and a happy and relaxed learning environment.

Gop (HP, LBM) noted that more emphasis on projects would be more beneficial. She stated, "Maybe a little bit more group projects and the permission that we could choose our own topic and stuff like that. So, basically more chapter projects. I feel like it's quite productive for learning". Phan (HP, LBM), noted the importance of the instructor using "baby language" to simplify the statistical expressions. She remarked,

> The instructor may consider using simple words to explain the complicated terms or definitions. It can be called "baby language". For example, for some complicated words or terms, I must find a way to break it down to basic words to understand the concept, not just only read the definition in the textbooks. You already did that but finding a more creative way to adapt "baby language" will help.

Liqian (HP, FCM) suggested the elimination of the interactive assignments, making the following recommendation:

> Maybe just delete the interactive assignments. I noticed that in these interactive assignments, all these questions are about conceptual questions without number. So, they didn't keep pace with you. If you have done something wrong there, you have to go back and do it again. Interactive is annoying because it takes a long time. I remember that I have to take one hour or 90 minutes to finish one of your interactive assignments. During my final week, I have to prepare for other final exams. And also, I have to do the interactive assignment.

Appen (HP, FCM) mentioned that groupwork adds value to the class. She observed,

> When you put us into groups, there are more opportunities to talk with other people. We discussed a lot about the course, and it will be so easy, you know, because we have an online class and we're kind of shy, we don't have the opportunity to come directly to the school. And by keeping in contact, I think that is a very good idea if you put us into groups so that we can know each other well and do the work.

Theme 5: Challenges. *Challenges* was the final theme that developed from the SSIs. The students cited factors such as dislike of quantitative subjects, and mathematics anxiety and test anxiety to be challenging factors obstructing their learning. Sue (LP, LBM) cited test anxiety as a challenge during the course:

> I think I like taking tests online because it creates less environmental pressure than if you take them face to face because you'll you see your friends finishing fast and then you panic and then it actually creates an environmental pressure more than the subject matter itself.

Sue also noted that her dislike of quantitative subjects to be a problem and stated that,

> Within maths [mathematics] as always, like mathematics in general, like numbers have always been difficult for me. So, I need to, like if other students are putting 10 hours of time, I need to put 30 hours just to get the hang of it.

Lab (LP, FCM) stated that although she was not fond of statistics, the FCM method had helped her to overcome that feeling:

> I am really bad at stats. So, usually, when I find something difficult, I just, you know, stop listening to it in the class, like I just, I just lose all interest. So, when you get the videos for stats, I could use my own time I could, you know, go back to it again and see what's wrong. I could take my notes on my own time and was very easy for me.

Results of content analysis. A content analysis was performed to discover how many codes appeared inside each of the five themes obtained by constant comparison analysis (CCA). Table 8 depicts the grouping of these codes into themes.

Table 8. Themes, Codes, and Frequencies Derived from Constant Comparison Analysis and Content Analysis

Theme	Codes Used	Count of Each Individual Code	Count of Codes in each theme	Percentage of Codes in each Theme
Perceptions about the mode of instruction and the course design	Positive feelings towards FCM	159	320	57.45
	Positive feelings towards LBM	31		
	Negative feelings towards FCM	30		
	Negative feelings towards LBM	6		
	Preference of the mode of instruction	51		
	The efficiency of the instructional strategy	43		
The Effect of the Online Component	COVID-19 effect on the learning environment	35	108	19.39
	Classroom interaction	25		
	Disadvantages of groupwork	48		
Learning Preferences	Preference for Instructor-led training	36	59	10.59
	Preference for self-paced learning	23		
Ways to Improve	Playing games	14	50	8.98
	Advantages of group work	10		
	Project-centric approach	5		
	simpler explanation of topics	4		
	Elimination of interactive assignments	17		
Challenges	Dislike of quantitative subjects	12	20	3.59
	Math anxiety	8		
Total			557	100

Note. Obtained using NVivo Version 12. $n = 36$.

The occurrence of the most frequent codes within each theme is provided in Table 9, which reveals that the most focus is placed on the codes that include “positive feelings towards FCM” representing Theme 1, followed by “disadvantages of group work due to the forced online component” representing Theme 2, the “preference for instructor-led training” representing Theme

3, “playing games” representing Theme 4 and, finally, “dislike of quantitative subjects” demonstrating Theme 5. After transcribing the 36 SSIs, 557 portions of data (i.e., collection of words, sentences, or paragraphs) were labeled and categorized under 8 developed codes using NVivo 12.

Table 9. Most Prevalent Codes Derived from Content Analysis of the Qualitative Data

Theme	Most Prevalent Codes	Count of Code	Percentage of Codes in each Theme
Perceptions about the mode of instruction and the course design	Positive feelings towards FCM	159	49.69
The Effect of the Online Component	Disadvantages of group work	48	44.44
Learning Preferences	Preference for instructor-led training	36	61.02
Ways to Improve	Playing games	14	28.00
Challenges	Dislike of quantitative subjects	12	60.00

Note. Obtained using NVivo Version 12. $n = 36$.

Results of Explanatory Analysis to Determine the Prevalence Rate of Each Student Theme

Given that the FCM student performances were higher across the board, albeit not statistically significant, I relied on the qualitative analysis to explain the quantitative results. The CUCEI

survey showed an environment more conducive to learning in FCM sections in comparison to the LBM sections. Next, I attempted to analyze the SSI data.

Theme 1: Perceptions about the Mode of Instruction and the Course Design. This theme was the most prevalent of the five themes, with a prevalence rate of 57.45%. The most emphasized code in this theme, "positive feelings towards FCM", was the only code in the theme that was discussed by all 17 FCM students and many LBM students. The reasons that some LBM students had expressed positive feelings toward the LBM were two-fold. First, during Term 1, the flipped videos (FVs) were offered to the LBM classes as well, although no emphasis was applied in terms of watching the videos. The second reason was that while interviewing the LBM students, I defined what an FCM environment was and asked if they would like to watch short lecture videos before coming to the class. I received many positive responses from many LBM students in relation to the FCM environment.

Using a word frequency search in NVivo 12 to search for the word "video" resulted in the greatest number of counts (i.e., the word that was used the most in student interviews). The short videos provided the FCM students with an environment more favorable to learning. Each student mentioned this positive feeling toward flipped learning using personalized videos at least twice during his or her interview.

Fatima (LP, FCM) compared her FCM experience involving watching videos before coming to the class with other traditional classes:

> For me, it was actually a good step. Because, you know, we usually face problems whenever we do any math [mathematics] or whenever we are going to practice. Moreover,

in class, it is common for us to, you know, to lose our concentration easily. So, we may not be able to put toward our total concentration in what you're teaching us in class. But whenever we get other free time, at whatever time, so we can watch those videos and learn from it properly.

Table 10 shows the breakdown of codes by the number of references and cases along with a few student responses.

Table 10. Theme 1: Codes and Selected Statements from Students

Codes	Statements	Count of Codes in each theme	Percentage of Codes in each Theme	Number of cases
Positive feelings towards FCM	"Whenever I feel bored, I can stop the video, go do something else, come back again and watch from where I stopped. So, as a result, I can have my full concentration on what I'm learning." "It allowed me to, like, prepare for the class. And if there was anything that I was unsure with, I can either wait for the class and then ask you or see being done in the lesson, or I can rewind the videos or go back to the beginning and go through it again. So, it kind of gave it a little bit extra help when you needed it. And it was a very good way of preparing your students or myself for the class."	159	49.69	33
Negative feelings towards FCM	"I'm not really a person who go through stuff before coming to class, like, you know what I mean. I have a different learning style."	30	9.38	15

Positive feelings towards LBM	"Learning statistics on lecture-based format is alright for me because paying more attention to detail and taking notes was easier to try and attend to my homework activities. It also helped me with my classwork activities."	31	9.69	19
Negative feelings towards LBM	"Many times, it's too boring. The teacher is just giving a lecture and doesn't let us participate."	6	1.88	5
Preference of the mode of instruction	"I would prefer to do the flipped because I just think it's easier. In traditional-based format, it's kind of like you listen, and then you kind of follow through. But sometimes, like if you have to listen for two hours straight, and it's such a complicated subject that sometimes like your mind goes off and wanders off. And it's kind of difficult. So, if I had to choose, I would think the flipped one."	51	15.94	30
The efficiency of the instructional strategy	"I think definitely the flipped. I think that's a much more efficient use of my time."	43	13.44	25

Note: Obtained using NVivo Version 12. $n = 36$.

Theme 2: The Effect of the Online Component. This theme was the second most prevalent theme among the student participants, with a prevalence rate of 19.39%. Associated with this theme were three codes, which were the "Disadvantages of group work", "COVID-19 effect on the learning environment", and "Classroom interaction", as seen in Table 11. The most prevalent code within this theme was the "Disadvantages of group work", with a prevalence rate of 44.44%. Due to the COVID-19 situation and the forced online mode of delivery, many students expressed dismay and negative feelings towards online learning and, in particular, the role of group work in online classes, regardless of being FCM or LBM. However, group work had a larger role in FCM sections. Zahra (LP, LBM) noted that "The students were absent, obviously. So, then, whenever I had to do

something, it was on my own. Like, if we were six people in one, group 3 would be present here and 3 would not answer anything." It seemed that most students cited the sudden disappearance of some classmates during the in-class activities, and some cited that group work is more efficient in a face-to-face environment.

The next prevalent code was "COVID-19 effect on the learning environment", with a prevalence rate of 32.41%. Kiry (LP, LBM) noted that online misunderstandings of the question-and-answer process had affected him and stated that, "Online mode affects me. If face to face, I can ask questions in real time. I don't know why when I asked some questions online, it makes me feel that I am misunderstanding something, but it's just my feeling". The last code in this theme was classroom interaction with a prevalence rate of 23.15%. Lab (LP, FCM), made the following observation:

> I'm talking about interaction, and I think face-to-face classes were better for interaction. Like I said, many students were not even in the classroom, maybe because they had already done the whole thing and left or they just, you know, did not attend.

Table 11 shows the codes in Theme 2 with some of the student sentiments.

Table 11. Theme 2: Codes and Selected Statements from Students

Codes	Statements	Count of Codes in each theme	Percentage of Codes in each Theme	Number of cases

Disadvantages of group work	"I don't think group work is really a good idea for us because I don't think everybody is doing work. To be honest, I've been doing a lot of good work, and not everybody does the work. So, it's better to be individual, to be honest. You get what I mean?"	48	44.44	27
COVID-19 effect on the learning environment	"For me, sometimes I have a bad Internet connection. So, I needed to watch the recording after the class finished. And sometimes I didn't understand anything and even when I sent emails to you, I felt I didn't get the answer that I needed."	35	32.41	31
Classroom interaction	"A lot of people wouldn't contribute or like myself, I wouldn't understand how to do it. So, I wouldn't really know what to do. So, I don't think the class interaction was so much better than the traditional way."	25	23.15	18

Note: Obtained using NVivo Version 12. $n = 36$.

Theme 3: Learning Preferences. This theme was the third most prevalent theme among the student participants, with a prevalence rate of 10.59%. There were only two codes associated with this theme: (1) preference for Instructor-led training, with a 61.02% prevalence rate; and (2) preference for self-paced learning, with a 38.98% prevalence rate. It was evident from the student interviews that many students in an online delivery mode preferred the instructor-led training that I used in classrooms mainly because they believed that there were no interactions in groups in an online environment. Praew (LP, FCM) stated that "I liked it when you helped us more than we do in a group because, you know, sometimes I cannot interact with the others or maybe I don't like it". However, a few students mentioned that they preferred self-paced learning. Zahra (LP, LBM) stated that, "Yes, I like self-paced learning 100%. But then I also must have the discipline of knowing when and what I should be learning, you know". Table 12 shows Theme 3 and its codes along with selected interview responses.

Table 12. Theme 3: Codes and Selected Statements from Students

Codes	Statements	Count of Codes in each theme	Percentage of Codes in each Theme	Number of cases
Preference for Instructor-led training	"I think instructor-led is a good way of learning because when we helped you, and our calculations were wrong, you could correct us right away. Like, you can correct our mistakes right way."	36	61.02	27
Preference for self-paced learning	"I know how to learn by myself."	23	38.98	9

Note: Obtained using NVivo Version 12. n = 36.

Theme 4: Ways to Improve. The fourth most prevalent theme among the students was the "Ways to Improve" theme, with a prevalence rate of 8.98%. The five most prevalent codes that emerged within Theme 4 were "playing games", "advantages of group work", "project centric approach", "simpler explanation of topics", and the "elimination of interactive assignments". The most prevalent code within Theme 4, as far as adding components to improve the classroom experience, was "playing games", with a prevalence rate of 28.00%. Students in both modes of instruction noted that playing games will add value to learning regardless of the mode of instruction. Ana (HP, FCM) noted, "because it is such a difficult, complicated subject, I think making it a bit more fun, like with games would be very helpful to a lot or to most actually, I think".

Although many students complained about the disadvantages of group work in an online environment (Theme 2), some students expressed positive sentiments about the concept of group

work, yielding 20.00% within this theme. Kiry (LP, LBM) noted the buildup of friendships and learning to work as a team in a group environment:

> I like to work with team. I like to have new friends and making friendship with them. I like to do work, the project with my friends, we can know each other better. And we can know each other how to work as a team.

Peter (LP, FCM) noted that he was presented with different explanations than the way the lecturer clarified and reported that "For me, in groups, some of the classmates explain to you in a different way than the lecturer explains."

The third code, with a prevalence rate of 10.00% in Theme 4, was the concept of the project-centric approach. John (LP, FCM) suggested that using more projects would encourage the students to learn:

> I think probably, in my opinion, less weight to quizzes, in terms of grades with maybe more project-centric tasks about each chapter would probably be a bit more beneficial because then it forces the students to actually try and figure out what they're learning and how to apply it to these projects.

"Simpler explanation of topics" was the fourth prevalent code in Theme 4, with a prevalence rate of 8.00%. Some students, mostly from the LBM sections, revealed that a more straightforward explanation of topics would be better, especially when encountering students whose first language is not English. Phan (HP, LBM) stated, "I have a book of economics and they tell a story and then explain the basic words to explain the economic terms. So, I find it helpful because English is not my first language."

The codes mentioned earlier were the students' sentiments on what to add to improve learning. However, there was also a code in relation to what to eliminate for a better learning environment. The "elimination of interactive assignments" had a 34% prevalence rate. Many students in both sections believed that the interactive assignments should be eliminated because they are more theory-driven and did not help them to pass quizzes or to solve the homework assignments. Based on the student interviews, it seemed that many preferred more hands-on practices and projects for better learning in future classes rather than theoretical assignments.

John (LP, FCM) declared,

> That's definitely helpful for understanding, but not so much with the numbers, but the theory behind the subject. Personally, I struggled with interactive assignments to translate it over into doing the actual work, trying to solve the problems and which formulas and everything to use.

Mark (LP, FCM) revealed that "the interactive assignments, I don't think it has any benefit at all because it's very punishing, instead of rewarding." Table 13 details Theme 4 and its codes within the theme, along with selected interview responses.

Table 13. Theme 4: Codes and Selected Statements from Students

Codes	Statements	Count of Codes in each theme	Percentage of Codes in each Theme	Number of cases

Playing games	"I think playing games is probably something that could be a lot of fun. And very useful to learn because I'm quite competitive. So, if you told me that we're going to play this game, and the group or the individual that gets the most points get an extra 2% or whatever added on to the project or onto the total grade, it's good motivation."	14	28.00	10
Elimination of interactive assignments	"I found that to be quite difficult and it wasn't really the same as the other assignments. So, it also took a lot longer for me to complete. And I just found that to be harder for me, and kind of like I was a bit all over the place in terms of doing the interactive assignments."	17	34	11
Advantages of group work	"When the teacher had put us into groups, it was so great that we could discuss the topics or questions we need to do in class. It was also great that I have many new friends now."	10	20.00	7
Project-centric approach	"More real-life related projects to understand the concepts better."	5	10.00	5
Simpler explanation of topics	"Improve by focusing more on the simple side of explanation as some students are not familiar with statistic terms of words."	4	8.00	3

Note: Obtained using NVivo Version 12. $n = 36$.

Theme 5: Challenges. Theme 5, with a prevalence rate of 3.59%, contained two codes: dislike of quantitative subjects and mathematics anxiety. The most prevalent code within this theme was dislike of quantitative subjects, with a prevalence rate of 57.14%. Given that most students major in non-mathematical majors, dislike of quantitative subjects seemed to hinder them learning statistics. John (LP, FCM) stated,

> But for individuals like myself who struggle quite heavily with math [mathematics] and algebra and things of that nature, I can find the flipped learning environment to be quite overwhelming. Because it's, it's essentially an overload of information. And I couldn't differentiate between what was more important versus what might have been less important.

The second most prevalent code closely related to the first code was mathematics anxiety, with a prevalence rate of 38.10%. Zahra (LP, LBM) revealed, "when it comes to writing exams for me particularly, I tend to have a lot of anxiety. I'm scared of failure".

Table 14 shows Theme 5 and the codes within the theme, along with the selected interview responses.

Table 14. Theme 5: Codes and Selected Statements from Students

Codes	Statements	Count of Codes in each theme	Percentage of Codes in each Theme	Number of cases
Dislike of quantitative subjects	"Business research and the likes of that I quite enjoy. But when it comes to mathematics, accounting, statistics, and algebra, I struggle to enjoy it just because I get frustrated very easily with these subjects."	12	60.00	10
Math Anxiety	"When I do Quiz 1, Quiz 2, till Quiz 5, as in every quiz, I must calm down myself. And count from 1 to 5 and do the quiz, because I panic. Maybe my answer is wrong. So, I calm myself with counting and start again."	8	40.00	7

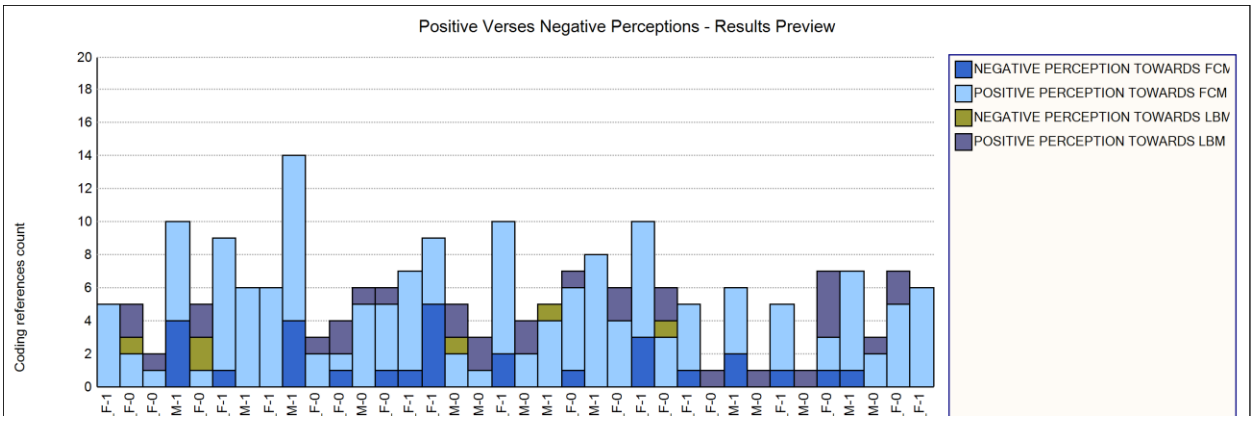
Note: Obtained using NVivo Version 12. $n = 36$.

4.5. Mixed Research Results

4.5.1. Findings of Crosstab Analysis of Students' Themes

By performing a crosstab analysis in NVivo 12, I assigned the 36 interviewees using a stacked bar chart (see Figure 4) to represent the four codes (i.e., Code 1: Negative FCM Perception, Code 2: Positive FCM Perception, Code 3: Negative LBM Perception, Code 4: Positive LBM Perception) derived from Theme 1, the most prevalent theme in the SSIs. The light blue bars represent the positive feelings expressed toward FCM, which comprises the majority of the feelings/perceptions expressed. I chose these codes rather than the five emerging themes because I was interested primarily in student views regarding the two modes of instruction. Moreover, the perceptions about the mode of instruction accounted for 57.45% of all the codes.

Figure 4. Crosstab Plot of Students Versus the Codes



In addition, I assigned a "1" whenever a sentiment was expressed for one of these codes and a "0" if no sentiment was indicated. Consequently, an inter-respondent matrix of students versus the

codes was constructed, which assisted in determining the occurrence rate of each code (Onwuegbuzie, 2003a; Onwuegbuzie & Teddlie, 2003). Additionally, the inter-respondent matrix (student x codes) in Table A13, Appendix A shows the total frequency as the effect size used in qualitative research (Onwuegbuzie, 2003a).

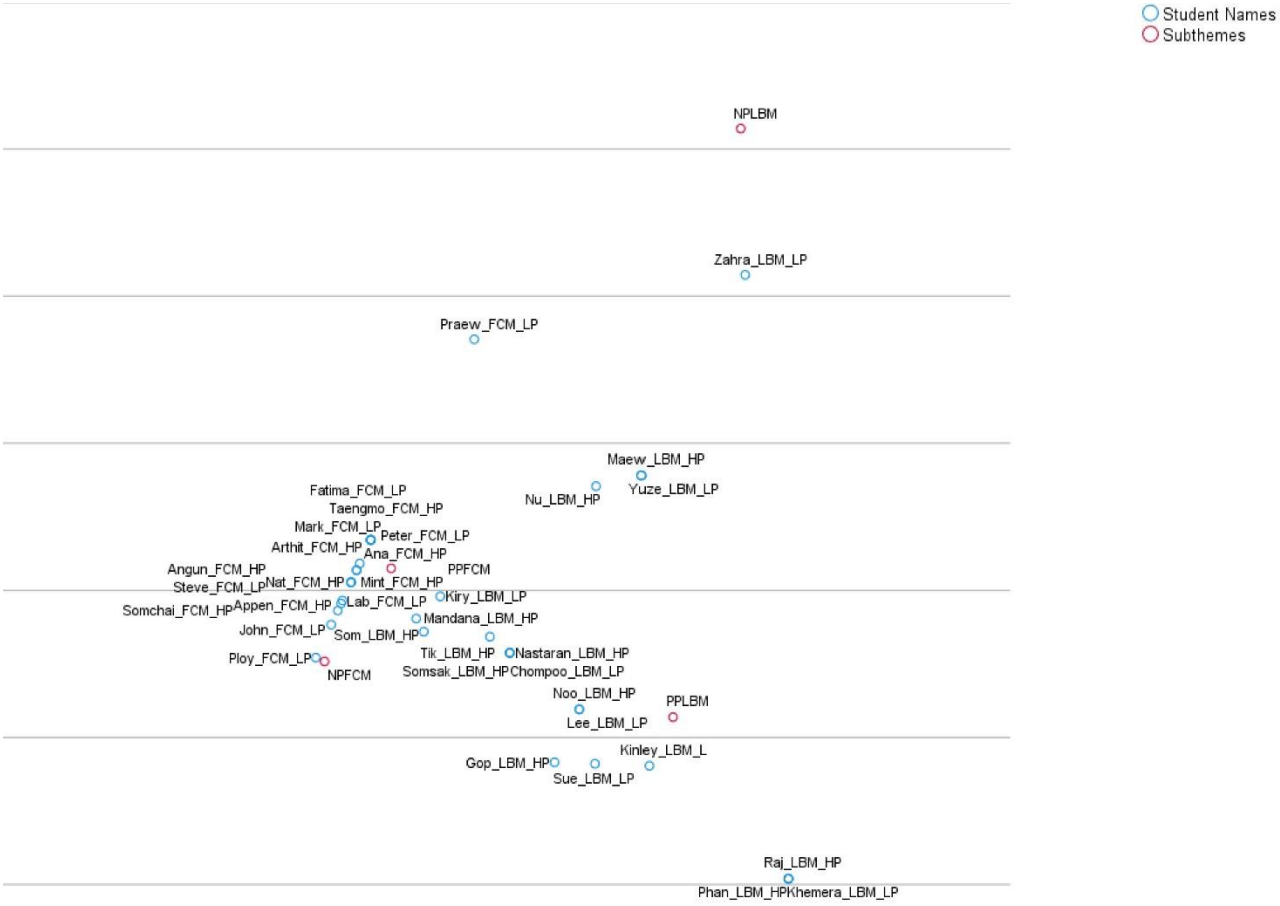
Based on Table A13, Appendix A, I performed a Chi-square goodness of fit test to determine whether the proportions of students' positive and negative perceptions were equal with respect to the mode of instruction (i.e., negative FCM, positive FCM, negative LBM, and positive LBM perceptions respectively). The proportions of perceptions differed statistically significantly by the mode of instruction, χ^2 (3, N = 210) = 219.98, $p < .001$, r = .49. In addition, because positive perceptions of FCM had the highest frequency compared to all other perceptions, I conducted six pairs of binomial tests to determine whether the proportion of positive perceptions of FCM was statistically significantly different from the proportions of all other perceptions. Following the result of the binomial tests, I applied the Bonferroni correction (i.e., I multiplied all p values by six) to control for the number of false positives (Haynes, 2013). Even after applying the Bonferroni correction, all p values between positive FCM perceptions and all other perceptions were less than .001, indicating that the proportion of positive perceptions toward FCM was statistically significantly higher than all other perceptions.

4.5.2. Findings of Correspondence Analysis 1 of Students' Themes

I utilized SPSS 28 to conduct a correspondence analysis (CA) to better comprehend and examine the association between the students and the four generated codes under Theme 1 (i.e., Code 1: Negative FCM, Code 2: Positive FCM, Code 3: Negative LBM, Code 4: Positive LBM Perceptions respectively). Figure 5 is a visual representation of the CA. The light red dots represent the codes

as acronyms (i.e., PPFCM represents the code “Positive perceptions toward FCM”, PPLBM represents “Positive perceptions toward LBM”, NPFCM represents “Negative perceptions toward FCM”, and NPLBM “Negative perceptions toward LBM”). From this correspondence plot several observations can be made, including even students who scored poorly in quantitative terms in FCM sections while many LBM students who received the FVs in the very first trimester expressed positive feelings/opinions about FCM, the majority of data points are clustered around positive perceptions of FCM, negative perceptions about FCM are almost exclusively from quantitatively low-performing students, and quantitatively low-performing students are more likely to have negative perceptions in relation to both modes of instruction.

Figure 5. Correspondence Plot of Students Versus the Codes



After the crosstab and CA had been conducted in NVivo 12 and SPSS 28, the crosstab and the correspondence plots were studied. Based on the information gained from analyzing the qualitative data through NVivo 12 software, which showed that the term “video”, or any variant thereof, emerged as the most frequently articulated word in student interviews, the examination of the crosstab and correspondence plots in Figures 4 and 5, and inter-respondent matrix in Table A13, Appendix A, along with the student interviews, it can be clearly seen that there is a vast favorable perception of FCM in both FCM and the LBM students who were exposed to the FVs. Moreover, it appears that high-performing students excel regardless of the mode of instruction, which could be due to the factors that were not studied in this research, such as having an intrinsic motivation and desire to learn and to succeed, being organized, using time effectively, understanding how to prioritize tasks, exercising self-directed learning, and adapting oneself to different teaching pedagogies (Baumann & Harvey, 2021; Nnadozie & Khumalo, 2023).

4.5.3. Results of Principal Component Analysis

After conducting a CA on only the perception codes in NVivo 12 Pro, a PCA was conducted on the entire set of themes (i.e., not only on positive and negatives perceptions of the mode of instruction, but rather the entire set of themes). Next, I analyzed the PCA results to identify all the components (meta-themes) that could be retained. From PCA, five meta-themes emerged: (1) “Flexible and collaborative learning”; (2) “The Pros and Cons of the Lecture-Based Model of Teaching and Learning”; (3) “Balancing Lecture-Based and Flipped-Based Learning”; (4) “Face-to-Face Learning Preference and the Impact of COVID-19 on Education”; and (5) “Transforming Lecture-Based Learning into Flipped Learning: The Importance of Simplicity and Efficiency”. These meta-themes will be discussed.

Meta-Theme 1: Flexible and Collaborative Learning. The first observed meta-theme from PCA was "Flexible and collaborative learning". At the core of this meta-theme is the idea of flipped learning, in which students are provided with educational lecture videos to watch outside of class time. This allows for more hands-on, interactive activities in class, as students have already been introduced to the core concepts. Flipped learning has several benefits, including the ability for students to pause, to rewind, and to re-watch videos as needed, as well as the opportunity for teachers to tailor in-class activities to the needs and interests of their students. Group work also is an important aspect of flexible and collaborative learning strategies. In addition, group work can foster teamwork skills, problem-solving abilities, and communication skills, all of which are important in both educational and professional contexts. Noo (HP, LBM), who had access to the lecture videos, stated, "If I was to repeat this class in the same way, in terms of the same theory that we've covered, I would be more confident in doing the flip format, because I think I know the concepts better and the theory and how to do. It would be more feasible". Gop (HP, LBM) expressed her opinion about the group work by stating that, "I like working through the latest project group that I had in statistics, they're quite good. They helped and everything. I feel like I enjoyed it". The group work to which Gop referred was the class project, not the group work for class practicals. The group members for solving the practical exercises were randomly allocated to random groups. The students seemed to enjoy the group work when they chose their own groups with peers with whom they were acquainted.

Meta-Theme 2: The Pros and Cons of the Lecture-Based Model of Teaching and Learning. The lecture-based model of teaching and learning is a traditional approach in which a teacher presents information to students through a lecture. It allows teachers to cover a large amount of material in a short period of time. However, it can be difficult for some students to stay engaged

and motivated during a lecture, and it does not provide many opportunities for interaction with the material or with each other. As a result, it might not be the most effective approach for engaging and motivating all students. Chompoo (LP, LBM) expressed her feelings about the LBM section, stating that, “I think lecture based is more boring and adds more work to learning”. In contrast, Noo (HP, LBM) expressed her opinion of LBM as follows:

> I like to follow when you show us the Excel [spreadsheet], I like to follow them. And then when sometimes I do not catch up or something, it would be easier for me to ask the question right away. The lecture is an important part of my studies, it helps me to understand the homework.

It was evident that the high-performing students, despite the teaching strategy, could adapt the strategy to their own learning style.

Meta-Theme 3: Balancing Lecture-Based and Flipped-Based Learning. When I asked two different LBM students whether they would prefer to repeat the same class in a traditional lecture-based format or a flipped learning format, Nastaran (HP, LBM) (FCM-light) class, stated,

> I think both traditional and flipped mixed together. It makes me interested to know what I am I have to learn and sometimes I could challenge the teacher and I enjoyed answering teacher’s question in the class. It gave me more motivation to learn and more motivated to participate in the class.

Answering the same question, Mandana (HP, LBM) (FCM-light) revealed,

> I think the mix of traditional and flipped learning. The flip is not a bad idea. It's a good idea. But it depends on the teacher, and it depends on the student. Because some students, they don't have the ability to do all in in their own.

The last two students were high-performing LBM students who had access to the FVs and that might explain why they preferred a mix of both strategies.

Meta-Theme 4: Face-to-Face Learning Preference and the Impact of COVID-19 on Education. This meta-theme explored the desire for in-person teaching and learning and the challenges and changes brought about by the COVID-19 pandemic. There were many students from both the LBM and FCM groups as well as both levels of performance who were of the opinion that group work is better done and delivered in a face-to-face environment. Many of the students have been quoted previously. Ploy **[(LP, FCM)]** mentioned that "because when you're online, people are in front of their devices reading, getting distracted". It appears that the COVID-19 epidemic and the rapid and forced transition to online education did not resonate well with many university students, particularly those enrolled in business statistics subjects.

Meta-Theme 5: Transforming Lecture-Based Learning into Flipped Learning: The Importance of Simplicity and Efficiency. This meta-theme involves changing the way in which the classroom instruction is delivered. This theme appeared because, during the first trimester, I provided the LBM sections with the flipped lecture videos, although I did not emphasize watching the videos before coming to the classes, as I did with the students enrolled in the FCM section. Unpredictably, many LBM students in the first trimester had transformed their learning experience to an FCM-light experience by referring to the videos, and some students even watched the videos

before coming to the classes. Som (HP, LBM), who created a mini-FCM class for herself, revealed the following:

> I dropped the course last semester. I think this semester is better than last semester because of the new way you have…A new way to help the students develop themselves. I think is quite well. But it does take more time for flip-based a lot. But it helped me a lot.

Som was referring to the flipped videos as a "new way". Phan (HP, LBM) who had access to the videos, mentioned that,

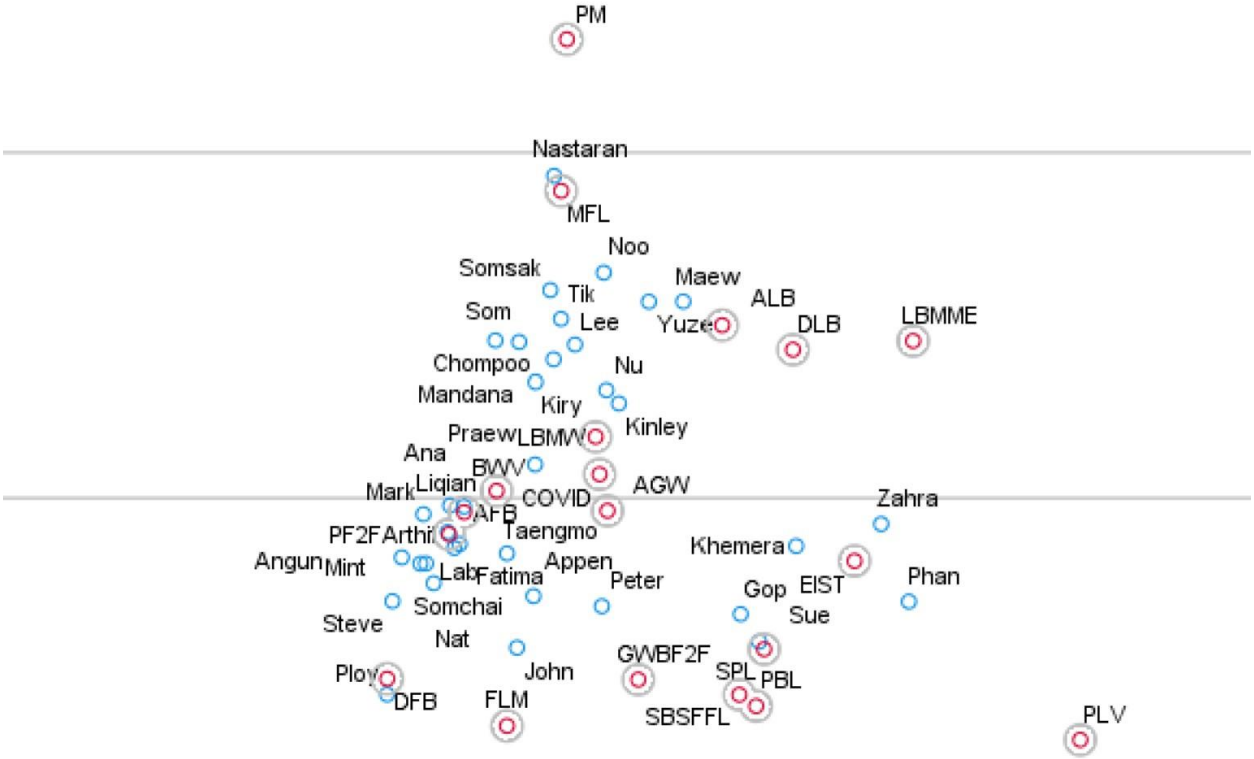
> for me watching the videos was very effective, because I prefer to learn a lot and understand the material first. And then if I have any question, I just go to the class, and that will save much more time for me.

However, most LBM students who took advantage of the FVs were quantitatively high-performing students.

4.5.4. Results of Correspondence Analysis 2 of Students' Loaded Themes by PCA

As per Table A14, Appendix A, I proceeded by coding the learners' loaded themes as a result of conducting a PCA to generate a less cluttered correspondence chart. I used SPSS 28 to conduct a second CA to further evaluate and explore the association between the students at different levels of performance and the 19 themes derived from PCA. Figure 6 is a graphical representation of the second CA, with the red circles representing the themes and the blue circles representing the learners.

Figure 6. Correspondence Plot of the Themes Loaded Using PCA



There is a very interesting observation to be made based on Figure 6. Five themes are clustered in the third quadrant, which are advantages of a flipped-based model of teaching and learning, benefits of watching lecture videos, preference for a face-to-face format of any teaching and learning strategy, disadvantages of flipped-based model of teaching and learning, and preference for flipped learning. There are 15 students who populate the third quadrant, which is almost one-half of the students interviewed. All 15 students were FCM students. Sixty percent of these students were high-performing students. These students appeared to have been very open to flipped learning, enjoyed learning on their own by watching lecture videos, and preferred a face-to-face environment because most believed that one of the most significant drawbacks of online FCM was that group work was not as effective as in a face-to-face environment.

4.5.5. Integrating/Mixing the Quantitative and the Qualitative Results

As Ivankova et al. (2006) have remarked,

> Mixing in the sequential explanatory design can take two forms: (1) connecting quantitative and qualitative phases of the study through selecting the participants for the second phase and developing qualitative data collection protocols grounded in the results of the statistical tests and (2) integrating quantitative and qualitative results while discussing the outcomes of the whole study and drawing implications. Such mixing of the quantitative and qualitative methods results in higher quality of inferences. (p.17)

As explained earlier, I chose my qualitative sample based on the results of the quantitative phase of the study, which is the first point mentioned by Ivankova et al. (2006). Next, I integrated the qualitative and the quantitative components in the report that followed. Although the quantitative

data I collected suggested that the better performance of the flipped learning sections in all assignment categories might not be statistically significant, the qualitative analysis provided me with insight into the other ways in which flipped learning might meaningfully impact student performance. Therefore, mixing the quantitative and qualitative results gave me a better perspective on interpreting the quantitative and qualitative analysis.

Perhaps one of the most noteworthy impacts of flipped learning is its potential to enhance student engagement (Karaoglan-Yilmaz et al., 2022). With this method, students are empowered to take a more active role in their education, which can foster a deeper understanding of the material (Vollmer & Drake, 2023). Flipped learning allows real-time feedback and personalized attention as instructors can dedicate more face-to-face time to address individual conceptual challenges (Seng & Chuan, 2023). These earlier points were captured via qualitative feedback from the students' interviews discussing their personal experiences and learning gains. Mint (HP, FCM) expressed the following sentiment when asked about her perception of FCM,

> I actually felt more responsible for my learning. Like, class time was meant for discussing what I learned before, so that really, you know, motivated me to prepare before logging into class. You know, I wanted to ask a question from Ajarn [an instructor], and I wanted to be ready. I think the best part of flipped learning was, you know, I enjoy be free and reviewing with my own speed [flexibility]. If I didn't get [understand] some concept, I could just hit rewind and watch videos again. I could also go faster in things that were easy for me, you know what I mean?

As I began to delve into the interview data for the third and fourth time, I was genuinely struck by the strong sentiment favoring flipped learning. The students' narratives were enthusiastic,

revealing a thread of shared experience that was both profound and illuminating: As Angun (HP, FCM) recounted, “In lecture format class I had before, I felt like I was only sitting and listening to Ajarn […] but with flipped, I felt, like, I am more active in class”. The sense of empowerment was tangible in her words, a sentiment echoed by many others. It was inspiring to witness how the flipped learning model had taken the students from mere spectators to active agents in their own learning (McClellan et al., 2023). “I felt more control over my learning,” Appen (HP, FCM) recalled, “I could check the material many, many times as much as I wanted before class, and then in class, it was more meaningful for me with the practice and all”.

However, it was not just about control but also concerned collaborative group work (Cubelo, 2023). Although some learners had expressed negative sentiments concerning group work in an online environment, in the students’ narratives, particularly with the high-performing students, flipped learning was an opportunity for learning collectively. “It was the first time I felt learning was a process that is, you know, collective,” Arthit (HP, FCM) elaborated, “We learned from each other, and with each other, and I thought, like, that was motivating”. To some, the approach was daunting initially; the absence of a straightforward lecture seemed perplexing. However, gradually, they found reassurance and, ultimately, satisfaction. As Nat (HP, FCM) admitted,

> I was unsure first about this flip thing […] but soon, like, I understood, instead of listening to a long lecture, sometimes boring, I was more involved. I think, you know, I had something to give to discussions and questions and answers, too, and it made me better understand the topic in class.

The students’ narratives reflected a preference for flipped learning in terms of its capacity to foster engagement, collaboration, and deepen understanding.

As an educator conducting qualitative analysis and interviews for the first time, I realized that focusing on collaborative work and problem-solving skills in a flipped learning environment assisted the students in developing critical skills that might not be directly reflected in examination scores but are invaluable in real-world applications of their knowledge and the process of life-long learning. Subsequently, using a qualitative perspective assisted me in emphasizing the broader impact of the teaching method on student engagement, critical thinking skills, and overall learning experience, which are considered to be core competencies by many researchers and educators (Lilly et al., 2022; Shaw et al., 2020). Quantitative measures like test scores might not readily capture these benefits but are nevertheless vital components of a practical educational experience (Orbeta & Paqueo, 2022; Scheltens, 2020; Shaw et al., 2020). On the issue of mixing the quantitative and the qualitative results, I had initially attempted to conduct a QUAN⟶qual study, in which the qualitative component was a small part of the study. However, in practice the qualitative component and the interviews gave me more insight regarding the efficacy of FCM. The qualitative component offered more insight into students' performance and perceptions of the FCM. Moreover, due to a lack of statistically significant quantitative results, in practice the study changed to a quan⟶QUAL study. Therefore, the qualitative phase offered more understanding and comprehension of the flipped learning model.

4.6. Summary of the Qualitative and Mixed Methods Results

All subscales of the CUCEI survey, which assessed the classroom climate, indicated a statistically significant difference in favor of the FCM sections. Moreover, as shown in Table A4 in Appendix A, the medians of all FCM subscales were higher than were the LBM sections. Students viewed

the FCM teaching technique more favorably in terms of learning as indicated by the higher medians.

In addition, the analysis of the interviews, the themes and codes generated, the crosstab analysis, the word frequency chart, the PCA, and a statistically significantly higher prevalence rate of positive perceptions of the FCM instructional strategy indicated that students perceived the FCM instructional strategy to be more promising in terms of learning statistics. Additionally, many high-performing LBM students in the first trimester had converted their LBM to an FCM-light class, which is indicative of the point that learners, regardless of the mode of instruction, had a favorable view of utilizing small lecture videos to compliment the course. From the analysis of the students' SSIs, it is also evident that the COVID-19 pandemic had a negative effect on student learning, making the group work ineffective, although some still enjoyed the group work. However, it was also clear that, in an online environment, it is best to allow the learners to choose their own groups.

In addition, I imported the 36-student data from NVivo 12 to SPSS 28 and conducted another set of crosstab analyses and CA. The crosstab analyses of the qualitative data and the second correspondence plot (see Figure 6) supported the finding of the crosstab analyses during the quantitative component that there is a very strong association between the mode of instruction and the quantitative performance (i.e., Cramer's V = .79).

Moreover, the CA conducted on the data imported from NVivo 12 shows that the higher-performing students were clustered around more positive perceptions toward FCM, whereas the low-performing students were equally clustered around negative perceptions toward FCM and positive perceptions on LBM. I will provide a concise summary of this study in Chapter 5. Then, I will detail the steps I took to address the internal and external validity and credibility of the

quantitative, qualitative, and legitimation of the of data in the mixed research phases. In addition, I will address the RQs and focus on the recommendations and broader implications of this study.

4.7. Practical Contribution and the Original Knowledge Claim of the Study

From the findings of my study, I can make a pragmatist knowledge claim. A pragmatist approach is based on the contention that knowledge is both constructed and influenced by actions, values the practical application of ideas, embraces the idea that different methods can coexist, and "opens the door to multiple methods" (Creswell & Creswell, 2018, p.48) to answer research questions. In line with the pragmatist knowledge claim, I believe that research should be aimed at driving action and creating positive change (Creswell & Creswell, 2018). Making use of this pragmatist stance, I identified a gap in Thailand's FCM literature where studies had small sample sizes and where *p* values are reported without their corresponding effect sizes. Moreover, I am unaware of any flipped studies focusing on the context of a private Thai international university (PTIU).

Based on an article by Fuchs (2021c), there are indeed some studies in Thailand that have involved the use of both control groups and treatment groups to compare flipped learning to lecture-based learning, as I have undertaken. However, I have noticed three critical limitations that my thesis addresses. Firstly, such studies are scarce in number, making my contribution a valuable addition to the limited pool of research in this area. Secondly, the sample sizes of these studies tend to be relatively small. In contrast, my study includes larger sample sizes in both the quantitative and qualitative components, thereby increasing the robustness of my results. Thirdly, I have observed that existing studies often report statistically significant *p* values without simultaneously reporting effect sizes such as the studies done by Suebsom (2020) and Phurikultong and Kantathanawat

(2022).] This approach can potentially give a misleading picture of the practical implications of their findings.

To provide a comprehensive view, my thesis reports both *p* values and effect sizes, when statistically significant results were found, enhancing my findings' interpretability and real-world significance. In these ways, I believe that my thesis makes a novel and important contribution to our understanding of the effectiveness of flipped learning in a private international university in Thailand. Moreover, I am making the knowledge claim that more comprehensive and balanced reporting can lead to more impactful findings within the field of flipped learning. I believe that my study adds to the existing literature by presenting an in-depth understanding of how students perceive and perform in flipped learning environments in a PTIU and by suggesting that student engagement and preference indeed matter when assessing the effectiveness of different teaching models. The subjective experiences could have meaningful impacts on long-term learning outcomes, which merits further research.

The mixed methods research approach allowed me to explore both objective statistical data and students' subjective experiences, delivering a comprehensive understanding of the perceived and quantifiable benefits of flipped learning. Although the quantitative data did not demonstrate a statistically significant advantage in favor of FCM over LBM in test scores, the qualitative data revealed a strong preference for flipped learning on the part of the students. It is important to note, however, that the sample size limits the generalizability of these findings. The qualitative findings are based on 36 students, whereas the quantitative analysis stemmed from a larger pool of 216 students. However, this study has caused positive changes within my organization, and it has

contributed to the FCM literature in Thailand, where higher education-based FCM studies are limited (Fuchs, 2021).

A noteworthy and practical contribution of my study is that, as a result of my findings and sharing these findings with the university administration, I was permitted to introduce a new teaching system in all statistics courses at the PTIU in which this study was conducted. I have switched statistics courses to be more conducive to a flipped learning environment using intelligent adaptive learning products from *Assessment and Learning in Knowledge Spaces* (ALEKS). These courses now operate on the principle of individualized learning and consider prior understanding and skills. ALEKS assesses each student's prior knowledge and skillset using a series of tests, creating a personalized learning path that adapts as the student progresses. This focus on individualized learning aligns with the pragmatist's belief in practical application, because these courses now directly address each student's unique learning needs. In fact, at the start of the previous trimester, I conducted workshops to train the instructors on flipped teaching. In summary, my research contributes to FCM literature and academic knowledge within the field of flipped learning in Thailand's higher education, and has led to a positive change in my organization (i.e., Flipped Learning Workshops), and directly affected teaching at a practical level within the private university where the study took place (i.e., changing the teaching system of statistics courses), contributions in line with a pragmatist knowledge claim.

CHAPTER 5: Summary, Implications, and Recommendations

5.1. Summary of the Sections to Follow

In this chapter, I will discuss Steps 10, 11, 12, and 13 of Collins et al.'s (2006) 13-step procedure for conducting a mixed methods investigation. This chapter starts with a summary of the entire thesis, followed by the procedures of data legitimation, a discussion of the research questions from multiple perspectives, the implications of the findings for various stakeholders, and recommendations for the latter. Moreover, I discuss whether my study achieved educational significance, along with outlining proposals to circumvent the limitations initially noted in Chapter 1. Finally, I provide a succinct recapitulation of the thesis.

5.2. Summary

The research on flipped learning (i.e., the idea that initial exposure to new content occurs outside of class but applied learning activities and higher-order thinking are handled in class) is developing rapidly. Educational leaders (e.g., school administrators and instructors) are committed to discovering methods to aid students in attaining success as evaluated by various indicators, allowing administrators to allocate funds. The differences in teaching strategies, particularly between flipped classroom model (FCM) and lecture-based model (LBM) strategies, provide difficulties for both instructors and students due to the varied amounts of labor required to set up and traverse the learning environment.

New methods for incorporating technology into educational settings are investigated as technological advancements increase. As an educator, while working for a U.S. university I

observed the FCM technique being implemented mainly in the Western hemisphere with a predominantly U.S. and European student population. While employed at a private Thai international university (PTIU) with a mainly Thai and Chinese student body, I started to explore alternative content delivery and student learning strategies such as FCM because I noticed a 25% to 35% failure rate in statistics courses in previous years, and also because FCM was not very prevalent in Eastern universities. It was uncertain whether FCM impacted the success rate of students enrolled in a business statistics course for undergraduates. In addition, it was uncertain whether the advantages of the FCM exceeded the accompanying costs. Therefore, my research had two objectives, firstly, to compare the success rates of students in an undergraduate business statistics course using FCM versus LBM; and secondly to enhance our understanding of the consequences of employing FCM in undergraduate business courses.

5.3. Step 10: Validating/Legitimating the Mixed Research Findings

5.3.1. Quantitative Phase

There are threats at three primary stages of the research process, which are research design and data collection, data analysis, and data interpretation. I will address the identified threats to internal validity throughout the three stages of research mentioned earlier.

Threats to Internal Validity in the Research Design/Data Collection Stage/Data Interpretation. Bleijenbergh et al. (2011) has referred to internal validity as the extent to which a study can demonstrate a causal link between the independent variable (i.e., the variable being controlled by the researcher) and the dependent variable (i.e., the variable being measured). Initially, I identified six possible threats to internal validity at the research design/data collection stage of the quantitative phase. The threats were, testing, mortality, evaluation anxiety, behavior

bias, history, and treatment diffusion (Benge et al., 2012; Onwuegbuzie, 2003b; Onwuegbuzie & Collins, 2007).

Table 15 briefly presents each identified internal limitation in the quantitative phase and how I addressed the threat. The two threats that I believed warranted further discussion were history and treatment diffusion. Onwuegbuzie (2003b) stated that this threat (i.e., history) occurs when "events or conditions that are unrelated to the treatment but that occur at some point during the study to produce changes in the outcome measure" (p.15). Unfortunately, due to the COVID-19 situation, I was unable to control for this threat because the occurrence was a sudden forced online content delivery. According to the data extracted from the semi-structured interviews (SSIs), this occurrence had a negative impact on group work in FCM classrooms. Many students believed that face-to-face group work was more effective than was online group work. Treatment diffusion ensues when the learners in different sections communicate with one another (Onwuegbuzie, 2003b). Unfortunately, I was not able to control for this threat. However, the analysis of the SSIs indicated that there was no statistically significant communication between the learners in different sections.

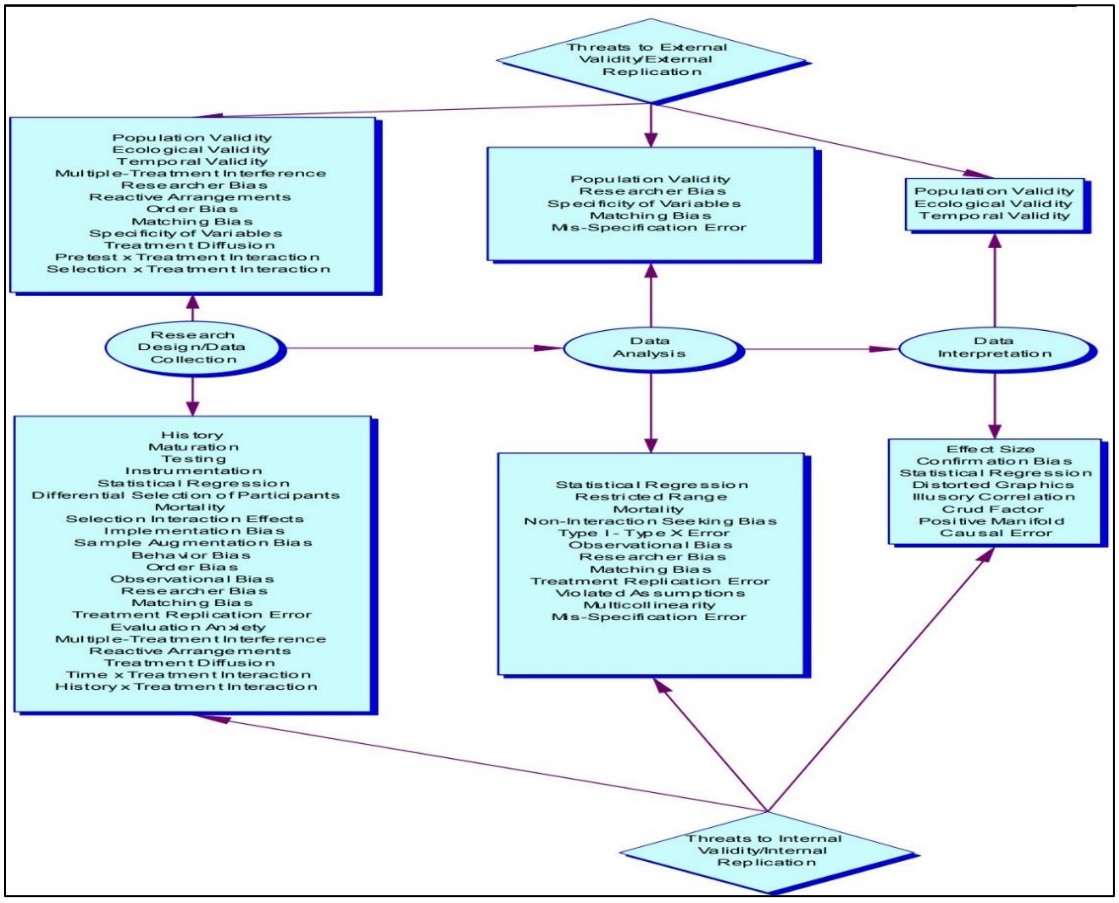
Table 15. Threats to Internal Validity at the Research Design/Data Collection/Data Interpretation Stage of the Quantitative Phase

Stage of Design/ Limitation	Description	Manifestations in Current Study
Research design/ data collection:		
History	"The occurrence of events or conditions that are unrelated to the treatment but that occur at some point during the study to produce changes in the outcome measure" (Onwuegbuzie, 2003b, p. 15).	I was not able to control for the occurrence of the forced online component of the class due to the COVID-19 pandemic.
Testing	"refers to changes that may occur in participants' scores obtained on the second administration or post-intervention measure as a result of having taken the pre-intervention instrument" (Onwuegbuzie, 2003b, p. 15).	The objectives of both the pretest and the posttest were the same. There was a chance that some students would memorize the objectives used in the pretest and would be more test smart for the posttest. In order to counter this threat, the same test with the same objectives but with different numbers was given as a posttest.
Treatment diffusion	"Occurs when different intervention groups communicate with each other, such that some of the treatment seeps out into another intervention group" (Onwuegbuzie, 2003b, p. 28).	I was unable to control for the likelihood of learners communicating with each other about the mode of instruction. However, learners reported feelings of isolation and lack of communication due to the forced online component, thereby suggesting minimal contact with classmates.

Stage of Design/ Limitation	Description	Manifestations in Current Study
Mortality	"Refers to the situation in which participants who have been selected to participate in a research study either fail to take part at all or do not participate in every phase of the investigation" (Onwuegbuzie, 2003b, p. 18).	There was a chance for a significant percentage of student withdrawal in one of the experimental groups due to a new pedagogy being introduced. However, due to the COVID-19 pandemic, all FCM and LBM sections were abruptly moved online, and no unusually large number of cases withdrew from any FCM or LBM section.
Research design/ data collection / data analysis		
Evaluation anxiety	"Occurs when participants endure excessive stress that may impair performance and produce measurement errors" (Onwuegbuzie, 2003b).	Test anxiety can be a confounding factor affecting the dependent variable (performance and attitude) more than the manipulation of the independent variable (the mode of instruction). In order to counter the threat of test anxiety, open-book tests were given. Moreover, the analysis of the SSIs showed that the students had less anxiety about taking tests in an online environment due to the lack of instructor supervision.
Behavior Bias	"Occurs when an individual has a strong personal bias in favor of or against the intervention prior to the beginning of the study" (Onwuegbuzie, 2003b, p. 21).	Students accustomed to a lecture-based pedagogy might have been disengaged or resentful toward a student-centered learning pedagogy, thereby negatively affecting the outcome. To counter this threat, students were observed closely during the class by using an at-risk student Excel spreadsheet. If a student seemed at risk of falling behind and failing, extra help was offered.

Threats to External Validity in the Research Design/Data Collection Stage. All the external and internal threats at different stages of the research process identified by Onwuegbuzie (2003b) are shown in Figure 7.

Figure 7. Major Threats to Validity at the three Major Stages of the Quantitative Research Process



Adapted from Onwuegbuzie (2003b, p.75; see Figure C3, Appendix C)

Findley et al. (2021) have defined external validity as "the extent to which inferences drawn from a given study's sample apply to a broader population or other target populations" (p.365). Using

Onwuegbuzie's (2003b) Quantitative Legitimation Model (see also Benge et al., 2012), Table 16 briefly presents each identified external limitation in the quantitative phase and how I addressed the threat.

Table 16. Threats to External Validity

Stage of Design/ Limitation	Description	Manifestations in Current Study
Research design/ data collection:		
Ecological validity	"Extent to which findings from a study can be generalized across settings, conditions, variables, and contexts—thereby representing the extent to which findings from a study are independent of the setting or location in which the investigation took place" (Benge et al., 2012, p. 87).	The study took place in an East Asian international university with a minimal representation of students from Western countries. Therefore, there was a chance that the results were not generalizable to the statistics courses taught at Western universities. This threat was countered by selecting a few students from Western countries for an interview during the second phase of the research.
Selection x treatment interaction	"Stems from important pre-intervention differences between intervention groups that emerge because the intervention groups are not representative of the same underlying population—making it unjustifiable for the researcher to generalize the results from one group	In order to counter this threat, a chi-square test was used to assess whether the sample's demographic was close to the population. The Chi-square test showed that the sample's demographic was not different from the population's demographics.

Stage of Design/ Limitation	Description	Manifestations in Current Study
	to another group" (Benge et al., 2012, p. 88).	
Research design/ data collection / data analysis		
Population validity	"Extent to which findings are generalizable from the sample of individuals on which a study was conducted to the population from which the sample was drawn" (Benge et al., 2012, p. 87).	The new COVID-19 virus spread worldwide at the start of the data collection phase with ramifications such as travel restrictions. Approximately 18% of the students at the university where the data collection occurred were Chinese. A chi-square test showed that the sample's demographic was not different from the demographics of the population. This threat also was countered by selecting a few Chinese students for an interview during the second phase of the research.
Treatment diffusion	"Extent to which the intervention is diffused to other treatment conditions in a unique (i.e., unreplicable) way that threatens the researcher's ability to generalize the Findings" (Benge et al., 2012, p. 88).	There was a possibility for contact between the students in the control and the experimental groups, whereby the material between the two groups would be shared among the students. However, the analysis of SSIs showed a lack of communication between different sections.

5.3.2. Qualitative Phase

According to Onwuegbuzie and Leech (2007), there are 14 internal and external threats to qualitative research's internal and external credibility. In my study, I identified and addressed many of these issues.

Threats to Internal Credibility and External Credibility of Qualitative Findings. Using Onwuegbuzie and Leech's (2007) Qualitative Legitimation Model (see also Benge et al., 2012), the threats to the internal and external credibility in the qualitative stage of the study and the way that I managed them are presented in Tables 17 and 18.

Table 17. Threats to Internal Credibility

Stage of Design/ Limitation	Description	Manifestations in Current Study
Research design/ data collection:		
Descriptive validity	"The factual accuracy of the account (e.g., transcripts obtained via an interview, focus group), as documented by the researcher" (Benge et al., 2012, p. 94).	The students were interviewed in a non-native language (i.e., English). Although the students were proficient in English, there is a possibility that they would have used an incorrect word or phrase to express their experiences or perceptions.
Reactivity	"Involves changes in a participant's responses that arise from being aware that he/she is participating in a research investigation" (Benge et al., 2012, p. 94).	There is a chance that the students would modify their behaviors, knowing that they are being researched or observed. One approach I used was conducting the interviews after the final grades were submitted. Also, I explained the purpose of the study in a debriefing session after the interview and explained how the data would be used.
Research design/ data analysis		
Researcher Bias	"Occurs when the researcher has personal biases or a priori assumptions that he/she cannot	Many educators tend to assume that active learning is superior to passive learning. Because FCM involves the use of an active learning approach, I took extra care to suspend my bias

Stage of Design/ Limitation	Description	Manifestations in Current Study
	bracket (i.e., suspend), which unduly affects his/her analysis of the data" (Benge et al., 2012, p. 95).	during the data analysis phase of the study. My approach to reduce the researcher bias by involving my doctoral supervisor to determine whether the interpretations stemmed from the findings.
Research design/ data interpretation		
Researcher Bias	"Occurs when the researcher has personal biases or a priori assumptions that he/she cannot bracket (i.e., suspend), which unduly affects his/her interpretations of the findings" (Benge et al., 2012, p. 95).	Many educators tend to assume that active learning is superior to passive learning. Because FCM involves the use of an active learning approach, I took extra care to suspend my bias during the data analysis phase of the study. My approach to reduce the researcher bias by involving my doctoral supervisor to determine whether the interpretations stemmed from the findings.
Illusory correlation	"Occurs when the researcher identifies a relationship among events, people, and the like, when no such relationship actually exists" (Benge et al., 2012, p. 96).	It is possible to discover a relationship such as "FCM increases the performance" when such a relationship might not exist or is due to a different factor, such as active learning lessons that can be used in the LBM classes. This problem was countered by reporting and interpreting effect sizes associated with these *p* values and then using effect-size criteria, such as those provided by Cohen (1988), to help interpret these effect sizes.

Table 18. Threats to External Credibility

Stage of Design/ Limitation	Description	Manifestations in Current Study
Research design/ data collection:		
Order bias	"Occurs when the order of the questions that are posed in an interview or focus group or the order in which observations are made unduly affects the dependability and confirmability of the data" (Benge et al., 2012, p. 97).	Because it was the first time that I designed interview questions, there was a chance that a flawed interview protocol would result in the collection of data that were not dependable. One way that I countered this was by relying on the feedback of the doctoral supervisor in relation to the interview questions. A second way was to find previously conducted interviews, in a similar context, with trustworthy interview questions to be used as a framework to produce my own interview protocol.
Research design/ data analysis		
Catalytic validity	"Degree to which a given research study empowers and liberates a research community" (Benge et al., 2012, p. 95).	There was a possibility within East Asian culture that the participants would be very indifferent toward using a student-centered pedagogy. Therefore, the results of this study might not have empowered the community of students in East Asia. One approach I used to identify whether the learners were indifferent was to include questions during the interviews to determine whether there was a problem with indifference towards a student-centered pedagogy. A second way to

Stage of Design/ Limitation	Description	Manifestations in Current Study
		determine whether the students were indifferent was via my class observations.
Action Validity	"Justification of the legitimation of the research findings is based on whether or not it works—that is, whether or not the research findings are used by decision makers and other stakeholders" (Benge et al., 2012, p. 95)	There is a possibility that the research does not show a statistically significant difference between LBM and FCM, and therefore, it might not be used by the stakeholders. My approach to encourage the stakeholders to use the findings from the research was to design a rigorous study that was transparent, had the approval of the management, facilitated management that could oversee the process at any time, if necessary, and involved management in the project.
Interpretive Validity	"Extent to which a researcher's interpretation of an account represents an understanding of the perspective of the individuals or group(s) under study and the meanings attached to their words and actions" (Benge et al., 2012, p. 95)	Because this was the first time that I interpreted qualitative data, there was a chance that the interpretation might be incomplete or erroneous. To counter this lack of experience, I read journal articles, such as the article by Glaser (1965), or books, such as the book written by Glaser and Strauss (1967), to learn qualitative analysis and the coding schemes in general and constant comparative analysis in particular, which was the method used to drive the qualitative analysis in this study. I also took an online course to learn NVivo 12 software and its usage in analyzing interviews. I also shared my interpretation with my primary doctoral supervisor for feedback.
Consensual Validity	"Based on the opinion of others, with an agreement among competent	There is a possibility that I could not find colleagues who could give input on my interpretation, description, and

Stage of Design/ Limitation	Description	Manifestations in Current Study
	others that the description, interpretation, and evaluation and thematics of an educational situation are right" (Benge et al., 2012, p. 95)	evaluation of the educational context in which this study takes place. However, I was able to depend on my doctoral supervisor for feedback.
Research design/ data interpretation		
Ecological generalizability	"Occurs when researchers over-generalize their findings across settings or contexts" (Benge et al., 2012, p. 97).	There is a possibility of overgeneralizing the findings to other contexts, such as other courses offered at the university. A way to counter this risk was to ensure that I did not overgeneralize any of my findings, thereby not giving consumers any justification to overgeneralize.
Reactivity	"Involves changes in a participant's responses that arise from being aware that he/she is participating in a research investigation that are so unique that it affects the transferability of the findings" (Benge et al., 2012, p. 97).	There is a chance that the students would modify their behaviors, knowing that they are being researched or observed. One approach I used was conducting the interviews after the final grades were submitted. I also explained the purpose of the study in a debriefing session after the interview and explained how the data would be used.

However, it is important to discuss in more detail how I managed to minimize the threats at this point. Onwuegbuzie and Leech (2007) proposed 23 practices for enhancing the credibility of qualitative data: prolonged engagement; persistent observation; triangulation; leaving an audit trail; member checking/informant feedback; weighting the evidence; checking for representativeness; checking for researcher effects/clarifying researcher bias; assessing rival explanations; negative case analysis; confirmatory data analysis; ruling out spurious relations; referential adequacy; following up surprises; structural relationships; peer debriefing; rich and thick description; the Modus Operandi approach; making contrast/comparisons; theoretical sampling; checking the meaning of outliers; using extreme cases; and effect sizes. I implemented "leaving an audit trail", "member checking/informant feedback", and "peer debriefing" to enhance the credibility and trustworthiness of the qualitative data.

Leaving an Audit Trail. Johnson (1997) have described descriptive validity as "the factual accuracy of the account as reported by the qualitative researcher" (p.292). To mitigate the threat to descriptive validity, I recorded each interview using the Blackboard Collaborate platform, with the interviewees' agreement. In addition, I transcribed each participant interview within one week. This contributed to the accuracy of each interview transcript.

Member Checking/Informant Feedback. Member checking is the practice of actively assessing whether the reports and descriptions of the interviews and observations are accurate and comprehensive (Lincoln & Guba, 1985). To reduce the threat of descriptive validity and researcher bias further, I requested each participant to engage in member checking. I highlighted the

importance of member verification following the conclusion of each interview. As stated previously, within one week following the interview each participant received a copy of the transcription of their interview. None of the participants requested that their transcriptions be altered.

***Peer Debriefing*.** Before conducting more interviews, I engaged in a peer debriefing with my primary thesis supervisor to reflect on the data collecting process and, if necessary, to make adjustments to reduce the risk of researcher bias.

5.3.3. Mixed Research Phase

Onwuegbuzie and Johnson (2006) have identified nine types of threats to legitimation in the mixed research phase.

Threats to legitimation of the mixed methods research findings. Using Onwuegbuzie and Johnson's (2006) mixed methods legitimation typology (see also Benge et al., 2012), Table 19 presents the threats to legitimation of the mixed methods research findings, their descriptions, and the way that I managed to counter these threats.

Table 19. Threats to Mixed Methods Legitimation

Limitation	Description	Solutions to counter the threat in the Study
Sequential legitimation	"references the need to reduce any impact that the problems associated with the order of the quantitative and qualitative phases might have had on making quality meta-inferences" (Benge et al., 2012, p. 110).	Using a Zoom conference, my primary supervisor and I explored whether reversing the data collection sequence would have substantially affected the overall qualitative narrative.
Paradigmatic mixing	"The degree to which the mixed researcher reflects on, understands, and documents his or her 'integrated' mixed research philosophical and methodological paradigm, including his or her epistemological, ontological, axiological, methodological, and rhetorical beliefs about mixed research" (Benge et al., 2012, p. 80).	Using a Zoom conference, my primary supervisor and I reviewed whether I had accurately merged quantitative and qualitative data from a pragmatic perspective.

5.4. Discussion of Findings in Relation to Research Questions

The worldview of a researcher is subject to change and evolution. At the time of my research, I most closely identified with the pragmatism-of-the-middle philosophy (Johnson & Onwuegbuzie, 2004). This perspective resonated with me as a mixed methods researcher because it emphasizes that there are various approaches to acquiring knowledge (Onwuegbuzie et al., 2009).

Additionally, pragmatic research depends on both qualitative and quantitative perspectives to acquire a deeper grasp of the real-world scenario being investigated (Onwuegbuzie et al., 2009). This mindset assisted me in interpreting the mixture of quantitative and qualitative data. Step 11 of the 13-step process for mixed methods research (Collins et al., 2006) is described in the sections that follow and relates to the two hypotheses and the overarching mixed research question consisting of the two quantitative sub-questions and one qualitative sub-question.

5.5. Step 11: Interpreting the Mixed Research Findings

The central mixed methods research question was: "What is the difference in learning experiences between the undergraduate college students from a Thai International University enrolled in a traditional lecture-based model of teaching statistics and undergraduate college students from a Thai International University enrolled in a flipped model of the same statistics course?" To answer this mixed methods question, I will discuss its three sub-questions.

Quantitative Sub-question 1: What is the Difference in Statistics course attainment through assessment of assignments Between Undergraduate College Students from a Thai International University Enrolled in a Traditional Lecture-Based Model of Teaching Statistics and Undergraduate College Students from a Thai International University Enrolled in a Flipped Model of the Same Statistics Course?

Before examining the findings of this sub-question and the related Hypothesis 1, it is necessary to keep in mind that all assignments, quizzes, and practices in both the LBM and FCM sections were computer-graded by the McGraw-Hill system. Thus, there was no bias in assessing FCM students more favorably than LBM students.

As demonstrated in Chapter 4, I categorized student scores into five groups (i.e., in-class practice averages, homework averages, comprehensive examination averages, the difference between pre- and post-tests, and final class averages). Then, I explored the shape of the data. Because neither the overall data nor any of the aforementioned categories of data were normally distributed, I employed nonparametric statistics to analyze the data. Specifically, I applied a number of nonparametric independent sample tests, including the Mann-Whitney *U* test and Kruskal-Wallis test.

The analysis showed only one statistically significant result ($U[N_{FCM} = 95, N_{LBM} = 121] = 4842.00$, $z = -1.986$, $p = .047$, $\eta^2 = 0.018$ and CL = 57.59%) in favor of the FCM students in the homework category. This outcome is rather predictable, given that, in the FCM sections, I had more time to devote to practice problems and frequently assisted students with their homework issues after completing in-class exercises. Although analysis and comparison of all other categories between the LBM and the FCM students did not show a statistically significant difference, the FCM students' mean rank scores and averages were higher in all other categories. The students enrolled in the FCM sections outscored the students in the LBM sections in all assignment categories. The FCM students had a smaller interquartile range and a higher median score compared to the LBM group, as previously shown in Table 7. This suggests better consistency, less variable scores, and concentrated higher performance in the FCM cohort, underlining the consistent effectiveness of the flipped classroom approach. Additionally, based on the discussion of the results of the previous chapter from a qualitative standpoint, it is evident that achieving higher grade performance is not the only consideration in labelling a certain educational pedagogy a more effective one. The environment in which the learning occurs also is very important. Therefore, this study shows that a combination of higher grades and an environment more conducive to learning has made the FCM

more favorable to students. Therefore, I can claim that the FCM teaching strategy positively impacted student achievement in the context of undergraduate business courses at the PTIU where this study occurred.

Quantitative Hypothesis 1: Students enrolled in the FCM sections of a statistics course have higher levels of achievement than do students enrolled in the LBM sections of the same statistics course.

A Mann-Whitney test was employed at a significance level of .05 to compare the quantitative performance of students enrolled in FCM sections against that of students enrolled in LBM sections across five assignment categories. As previously indicated, the quantitative analysis revealed a statistically significant result in favor of the FCM students in the homework category. The mean ranks and the medians of the other four were higher in the FCM sections than in the LBM sections. However, this difference was not statistically significant. I cannot conclude that their performance is significantly higher in every single assignment category. However, as noted in Quantitative Sub-question 1, the FCM students outperformed their LBM counterparts across all assignments, demonstrating less score variability and consistently higher performance, as indicated by a smaller interquartile range and a higher median score (see Table 7). These results underscore the effectiveness of the flipped classroom approach in the context of the private university in which the study took place.

Quantitative Sub-question 2: What is the Difference in Attitudes Towards Statistics Between Undergraduate College Students from a Thai International University Enrolled in a Traditional Lecture-Based Model of Teaching Statistics and Undergraduate College Students from a Thai International University Enrolled in a Flipped Model of the Same Statistics Course?

The analysis of pre- and post-survey of attitude toward statistics (SATS) and its results was discussed in detail in Chapter 4. To my surprise, the analysis revealed that neither the LBM nor the FCM instructional strategy led to a statistically significant positive shift in students' attitudes. In fact, the mean rankings of the post-SATS were lower than were the pre-SATS for most of the SATS subscales in both the LBM and FCM sections, albeit not statistically or practically significant. Given that SATS is designed such that higher scores indicate a more positive attitude, perhaps one might argue that the sudden forced online mode of delivery had marginally deteriorated the students' attitude toward learning in general and statistics in particular, as was subsequently revealed by the analysis of students' interviews.

Quantitative Hypothesis 2: Students enrolled in the FCM sections of a statistics course have more positive attitudes toward statistics courses than do students enrolled in the LBM sections of the same statistics course.

After examining the subscale score reliabilities and eliminating the difficulty subscale due to low reliability score, the Mann-Whitney test with a significance level of .05 was utilized to compare the remaining subscale scores of students enrolled in the FCM sections with those of students enrolled in the LBM sections. At a significance level of .05, I cannot conclude that learners enrolled in FCM sections had a more positive attitude toward the subject of statistics, despite a

subsequent qualitative analysis revealing that learners enrolled in FCM sections consider the FCM environment to be more conducive to learning.

Qualitative Sub-question 3: What is the Difference in Perceptions About the Pedagogical Effectiveness Between Undergraduate College Students from a Thai International University Enrolled in a Traditional Lecture-Based Model of Teaching Statistics and Undergraduate College Students from a Thai International University Enrolled in a Flipped Model of the Same Statistics Course?

Utilizing NVivo 12, I developed five themes from the 36 interviews conducted with student participants concerning their perceptions and experiences of the mode of instruction, in which they were enrolled in relation to their learning: Perceptions about the mode of instruction and the course design, the effect of the online component, learning preferences, ways to improve, and challenges. The theme with the most prevalent rate was the perceptions about the mode of instruction, and the codes within this theme with the most prevalent rate was the positive experiences with the FCM instructional strategy. During the interviews, most FCM and some LBM students who had access to flipped material often spoke about the uniqueness of watching a short lecture video before coming to the class. In fact, the word “video” and derivations of this word such as “videos” was used the most by the interviewees. Many students referred to being able to review the short videos multiple times and remarked on how this feature enabled them better to learn those concepts that they found challenging. The FCM students and a few LBM students who had watched the short lecture videos believed that these videos, along with solving a small quiz about the concepts discussed in the videos, were effective in helping them to learn.

Moreover, many FCM students noted that if they did not watch the videos before the class for any reason, they found watching the videos and solving the small quizzes helpful in learning, even after the class. It is vital to highlight that viewing the videos as a means of delivering the lecture outside of the classroom resulted in additional time to engage students in active learning during class time, thereby enhancing the efficacy of the FCM.

In addition, the FCM students believed that the FCM instructional pedagogy was more efficient as far as learning was concerned, although it took more work. Furthermore, the FCM students noted that they preferred the FCM method of learning in comparison to the lecture-based classes that they had enrolled in previously. In addition, the LBM students who had access to the videos during Term 1 and the LBM students who knew what an FCM instructional strategy was preferred the FCM method over the LBM. After sharing their positive experiences, several FCM students offered suggestions on ways to improve the FCM model in business statistics courses so that future students could benefit more. In contrast, some LBM students used the word “boring” when referring to listening to a lecture for the most part of the class. Additionally, some LBM students believed that they were not sure where to apply these concepts because most of the class time was consumed by lecturing rather than the application of the concepts.

There were, however, similarities in the perceptions and experiences of many students enrolled in both the LBM and FCM sections. Many LBM and FCM students believed that group work in an online environment was not as effective as group work in a face-to-face class. For various reasons, many students from both FCM and LBM sections thought that the interactive assignments were too punishing and did not translate into solving quizzes and tests.

The median scores of the student performances across all five categories of assignments and examinations were higher, although not statistically significant. The qualitative phase of the study confirmed and explained the results of the quantitative phase (i.e., FCM was associated with a higher success rate in business statistics courses). The most prevalent effect of FCM was the benefits that FCM instructional strategy provided to the students. Some benefits noted by the students included the following: being able to watch and to re-watch videos as needed, being able to see step-by-step explanations in short videos, and less frustration with homework assignments. The FCM students found their environment more conducive to learning and had more positive perceptions and experiences than did their LBM counterparts. I concluded that having an environment perceived more positively for learning by the FCM students resulted in higher performance.

The findings of this mixed methods research study highlight the important benefits of the FCM compared to the LBM in a private international university setting. The quantitative results indicate that FCM students consistently outperform LBM students, underscored by higher median scores, a lower interquartile range signaling greater score consistency, and statistically significant difference in homework assignments' scores. Qualitatively, the study revealed that FCM students demonstrated a more enthusiastic appreciation of their learning environment than did their LBM counterparts. They notably valued elements inherent to the flipped model, such as the flexibility of video lectures. This positivity towards FCM was observed even among students whose quantitative performance was less promising, suggesting the model's broader effects on learning attitudes. Correspondence analysis further solidified the positive inclination towards FCM, with most data points clustered around positive perceptions of FCM. Interestingly, even students who

scored lower in FCM classes expressed favorable opinions about the approach, indicating its beneficial impact beyond purely academic contexts.

Moreover, principal component analysis (PCA) revealed emergent meta-themes pointing to the advantages of FCM including flexibility, collaboration, and the transition from lecture-based to flipped learning. Furthermore, a preference exists for face-to-face teaching, but students also acknowledged the impact of the COVID-19 pandemic on their education. These findings suggest that the FCM has an academically advantageous and generally positive impact on students' learning experiences, extending beyond mere academic performance to encompass attitudes and perceptions of learning. The importance of this multi-faceted approach draws attention to the need for greater and deeper implementation of flipped classrooms.

5.6. Discussion of the Findings in Relation to the Literature Review

The literature review contained in Chapter 2 was classified into several primary sections, namely, the concept of a flipped classroom within the wider blended learning paradigm; flipped classroom movement; research on the Flipped Model based on attitude, perception, and academic performance; the most recent flipped classroom model studies in Thailand; and statistics education in relation to FCM.

Instructors are always looking for strategies to increase the student success rate. A growing number of educators, weary of providing the same lectures each academic term, have abandoned the traditional classroom concept in favor of FCM. Instructors of flipped classrooms record short videos of their lectures or find widely available videos, as a substitute for delivering the main curriculum through lectures. These lecture videos are frequently followed by a small quiz to re-

enforce the concepts, allowing students to learn the basic concepts outside of the classroom. Educators then are free to fill class time with a variety of activities, ranging from group projects to problem-based learning.

There are many benefits of the FCM model, such as constructing one's own knowledge before coming to the classroom, which is in line with constructivist theory; more practice on problem solving during class time; more collaboration with other students and more interaction with the instructor; and learning at one's own pace (Romaker, 2023; Yurtseven Avci et al., 2022). Unfortunately, there are also challenges associated with the model. Some of the challenges include, but are not limited to technology issues, students and teachers who are accustomed to the traditional LBM might find the new method of learning and teaching annoying and uncomfortable, and no real-time feedback from the educator while learning at home (Abuzaid, 2022; Rahman et al., 2020).

There are "limited amount of relevant research in Thai higher education related to the flipped classroom" (Fuchs, 2021, p.129). Therefore, educators in Thailand should conduct more research to establish whether the FCM method's benefits exceed this instructional strategy's implementation costs. As the need for a statistically trained workforce and statistically educated citizens increases, educators have the task of updating, adapting, or altering the instructional materials, pedagogies, and techniques used to teach statistics. Due to dissatisfaction with the basic college courses in statistics, it has been recommended that the field as a whole be taught differently (Zieffler et al., 2018). Statistics classes will now place a larger focus on data rather than theory. The reforms recommend improvements, including less probability and more data analysis, less lecturing and more active learning techniques, and utilizing technology to concentrate on

simulations and data analysis (Dani & Joan, 2004). Intriguingly, the analysis of the interviews revealed that the majority of students did not enjoy the interactive assignment, which is a theoretical approach to learning, but they did appreciate the practical and real-world tasks, which is consistent with previously stated recommendations about statistics education in Section 2.5.

This study analyzed the effects of FCM on students' academic performance, along with their perceptions and experiences in relation to using FCM in undergraduate business statistics courses at a Thai international university. Consequently, the results of this study have contributed to the limited relevant literature on FCM in Thailand's higher education system (HES) (Fuchs, 2021) and statistics education in Thailand.

5.7. Discussion of the Findings in Relation to the Conceptual Frameworks

Three distinct conceptual frameworks led my research. First, I used Kolb's (2015) experiential learning theory (ELT), which posits that experiences are the source of all learning. Kolb describes four learning stages, namely, concrete experience where the learner undergoes a learning experience; reflective observation, in which the learner reflects upon the learning experience; abstract conceptualization, in which the learner constructs his own understanding; and, finally, active experimentation, in which the learner implements the newly acquired concept.

Kolb's ELT applies to a students' learning of business statistics in an FCM environment. First, prior to coming to the classroom, the students were encouraged to watch a short lecture video (concrete experience) and take and re-take a small quiz (reflective observation). Next, they were directed to the interactive assignments to correct any conceptual misconceptions (abstract

conceptualization) and, finally, during class time, using class activities in small groups, they applied the concepts to real-world problems (active experimentation).

Using FCM instructional strategy, I was able to organize the business statistics course in ways that differed from the traditional LBM. By providing students with extra materials (lecture videos and brief tests), I minimized the amount of time they needed to search for alternate explanations. In addition, the higher averages, median scores, and mean rankings across the different categories in favor of FCM sections demonstrated that the adoption of FCM improved student academic performance. A smaller interquartile range for FCM scores in all assignment categories indicates a lesser degree of variability, thereby suggesting a higher level of consistency within the FCM scores (see Table 7).

The fact that the most prominent code of the interview analysis was "positive perceptions about FCM," further suggesting that the students perceived that FCM provided better content delivery, which might imply that the students considered FCM more conducive to learning. Regrettably, due to the sudden and forced online component because of the COVID-19 situation, there were a few drawbacks, such as a lack of participation by some students during group work, and students' gravitating toward instructor-led training rather than self-paced learning.

5.8. Implications of the Findings

5.9. Step 12: Writing the Mixed Research Report

Step 12 of the 13-step process for mixed methods research (Collins et al., 2006) is to write the mixed methods research report. To practitioners, this step is the most important aspect of the research process. Writing this report, I was mindful of not distorting the students' viewpoints and

did my best to portray their thoughts accurately and forthrightly. In light of this, I analyzed, verified, and presented the data in a report format in terms of possible implications.

5.10. A Reflective Account of the Study as an Instructor-Researcher

Reflecting on my experience and the findings, I have recognized several paradigmatic challenges, practical challenges, learning areas, and opportunities for growth as an educator. The first challenge was to adopt an epistemological worldview to conduct the research, and I gravitated toward a pragmatic paradigm (Johnson & Onwuegbuzie, 2004). This paradigm is inclusive of all methods and methodologies, rather than exclusive. Adopting a pragmatic approach as a researcher allowed me variety and flexibility in choosing methods and methodologies, and helped me circumvent the often-counterproductive paradigm wars. I discovered that a significant benefit of this viewpoint was the ability to focus on the question at hand, rather than becoming entangled in debates over research methodologies. From a pragmatic standpoint, I put the research question in the center and used the method of investigation simply as a tool to garner the necessary data. Thus, as a pragmatic researcher, I could utilize quantitative, qualitative, or mixed methods as necessary, based on how best to answer the research question. This adaptive approach opened up many options for inquiry that I might not have considered under a more restricted methodological viewpoint. By subscribing to the pragmatic viewpoint, I could remain focused on the endpoint: answering the research question to produce valuable, practical knowledge.

The second challenge concerned ethical considerations and maintaining the anonymity of the students (Cousin, 2009). Seeing how the procedural diligence emphasized and approved by the University of Liverpool contributed to the study's integrity was reassuring. This strengthened my belief in the importance of ethics in research and its influence on the trustworthiness and

authenticity of results. Looking at my teaching practice objectively, I was pleased to see that the students responded positively to a variety of teaching strategies, particularly the FCM method, which was reflected in their performances and perceptions. The students appreciated the use of technology and the flexibility provided through flipped videos. I realized that pedagogical innovations could enhance student learning and academic experience. Feedback from the students also was extremely valuable. It highlighted that the students prefer a blend of face-to-face teaching and flipped learning over purely online or traditional "lecture-based" strategies.

In evaluating student learning, academic performance improved in FCM groups. Students seemed more engaged, interactive, and developed better problem-solving skills. I realized that the idea of comprehensive learning evaluation went beyond just academic grades or performance. From a personal and professional development perspective, this research allowed me to understand better the impact of my teaching practices and how they affected student learning outcomes. It also gave me insights into balancing various teaching strategies to optimize learning. My findings have significant implications for the future of teaching statistics in our PTIU, such as applying more active learning methods (e.g., projects using real-world data, small group problem-solving tasks), using better online platforms to allow students to perform statistical analyses, and fostering an environment to allow students to make mistakes, ask questions, and learn.

This research project has contributed significantly to my growth as an educator and will influence my future teaching strategies. As I advance, the reflections and findings from this study have encouraged me to adapt my teaching strategies continually. Incorporating more pedagogical innovations such as FCM and blending them with face-to-face teaching will be critical to my design. In fact, because the positive perceptions toward FCM was the most prevalent code used by

the students, I made an argument in the university and effectively changed the delivery of statistics courses. I also see room for further research, particularly in studying the long-term effects of FCM and similar strategies. Furthermore, I plan to explore how artificial intelligence can be integrated into teaching statistics for a more personalized learning experience. It also helped me to recognize the classroom's power dynamics and encouraged me to sustain an equitable and respectful learning environment.

5.11. Implications for Students

As technology continues to develop, society becomes increasingly mobile. New instructional strategies supported by improved technologies are designed to facilitate innovative content delivery to learners. Many learners, along with educators and educational institutions, are choosing more flexible courses and learning options (Collis & Moonen, 2002). One such flexible teaching and learning strategy is FCM.

The process-driven disciplines such as mathematics or statistics need in-depth preparation to be delivered in an FCM format. Initially, students in this study expressed apprehension about taking statistics in the online format forced on them by the COVID-19 pandemic. However, the fact that the most frequent code was "positive perceptions toward FCM" suggests that many students had a positive learning experience in this course's online format because of their exposure to the FCM instructional method.

Moreover, the analysis of all assignment categories revealed that the FCM student outscored the LBM student in every category. The qualitative research also found that the students perceived FCM as a more conducive learning environment. In particular, the FCM students considered the

flipped videos (FVs) as an excellent addition to the course content. In addition, as technology continues to advance, new opportunities for using FCM in statistics courses for students might develop. Students might, for instance, be permitted to record and upload videos of themselves solving a statistical problem. Finally, a FCM instructional strategy might be rendered ineffective if the learner does not complete the pre-class work. Therefore, the most basic and important implication for the learner might be the extra time spent in preparatory work before coming to the class.

5.12. Implications for Educators

Based on my own personal experience designing an FCM platform and supported by many systematic reviews of the FCM instructional strategy, the very first implication for educators is an increased preparatory workload (Karabulut-Ilgu et al., 2018). The time requirement of preparing individual videos per chapter or per objective can be overwhelming for many educators who are employed in demanding academic environments with a "publish or perish" culture, beside from their own personal and family obligations. In addition, it might be time-consuming to construct a short quiz for each objective in each video.

Moreover, I advocate for comprehensive professional development programs for faculty members implementing flipped learning. These programs should include several essential components. First, training should address the development of interactive, student-centered activities for classroom sessions. Second, it should include techniques for creating effective, engaging, and graded quiz-embedded FVs outside of classroom because the fundamental assumption of flipped learning, namely, that students can and will complete the required preparatory work, might be its Achilles' heel (Fisher et al., 2020). Lastly, because assessment strategies in a flipped classroom

differ significantly from traditional methods, professional development also should include comprehensive assessment design and implementation training.

In addition, based on the qualitative analysis of my research, instructors might need to implement or to design entertaining games to play in the classroom to maintain student involvement and to foster a healthy academic competitive atmosphere. Furthermore, based on my qualitative analysis and in the context of my university, instructors might have to employ a blend of face-to-face interaction and the online environment to include engaging group activities in terms of content delivery.

Lastly, faculty and staff must be trained in artificial intelligence (AI). This process is fundamental to understanding how AI works and its potential application in the educational context. Faculty should be trained to comprehend the mechanics of AI, its capabilities, limitations, and ethical considerations (Al-Slehat et al., 2023; Ellis & Slade, 2023).

5.13. Implications for Administrators

To implement appropriately this strategy in institutions of higher education, the necessary infrastructure must be in place. This technique requires the availability of software, instructional resources, and short FVs that promote learning and are engaging. Hence, it is recommended that instructors have access to these services. Additionally, instructors must be trained on how to implement FCM; thus, it is recommended that FCM training be provided for educators.

To improve the quality of the FCM approach by practitioners in the university, the following training recommendations might be useful: involving the Instructional Technology (IT) staff or educators with technology backgrounds in training the educators in designing and producing

flipped videos and educational content; creating a university-wide database of flipped videos to be used by newly hired educators and adding more up-to-date educational videos to the database; and implementing a regular training program to familiarize educators with the FCM method. In addition, the administrators should promote research on FCM to further analyze its effectiveness, teachers' and students' satisfaction with the FCM, and its impact on students' performance.

5.14. Implications for Staff

Based on the findings of this study, there are several implications for the university's general and IT staff. The overall positive perception and higher performance of students utilizing the FCM suggest that increased support and resources might be required to facilitate this type of learning. It underlines the necessity for the university's IT staff to ensure the robustness and accessibility of the tools needed for FCM, like video hosting platforms, flexible online learning environments, and technical support for faculty and students. It might also mean that the IT staff could provide ongoing training for academic staff to use these tools effectively. For general staff, particularly those involved in planning and resource allocation, understanding the benefits of FCM can help prioritize logistics and deduce where to allocate resources. The reported benefits of FVs may guide infrastructural and pedagogical decision-making. This study signifies that it is crucial to factor in these variables when creating policies, planning professional development, or considering budget allocations for technology and training.

5.15. More Thoughts on the Implications of the Research

The findings of this mixed methods research study present several implications for the university's faculty, students, management, and staff. For faculty, the results highlight the benefits of the FCM methodology, wherein students showed improved performance and favorable perceptions. They suggest that faculty might consider adopting this methodology for teaching, which might require training and professional development. The findings reflect a positive perception of FCM, hinting that students might be more engaged and perform better in such a learning environment. Hence, decision-makers in the university should take note of these findings when designing learning experiences. For management, the improvement in median test scores and positive perceptions in FCM sections underscore the need to consider incorporating more flipped learning strategies into courses. Also, given these findings, the staff involved in course development and infrastructure should consider making resources available to assist faculty in incorporating flipped learning. Such resources might include video recording equipment and training to create flipped classrooms.

Moreover, these findings emphasize the importance of the interplay between pedagogical methods and perceptions: even low-performing students expressed a favorable view of FCM. This underscores the notion that students' learning preferences and affective factors are crucial in learning. This could serve as a reminder for all stakeholders, such as faculty, students, management, and staff, to place equal emphasis on understanding students' experiences and perceptions as they do on test scores and grades in the educational process.

Regarding the small sample size, these conclusions must be taken cautiously as these cannot necessarily be applied broadly due to the possible lack of representative diversity in the sample. The small sample size limits how much the findings can be extrapolated for a larger population of

students or different educational settings. The study's findings, therefore, not only contribute to academic knowledge in the field of flipped learning within Thailand's higher education sector but also facilitate meaningful, practical changes within my organization. My research findings directly implemented a new teaching system that aligns courses with a pragmatic and individualized learning approach. This enhances the practical applicability of the research findings, which is synonymous with the pragmatist knowledge claim.

5.16. Recommendations for Future Research

5.17. Step 13: Reformulating the Mixed Research Questions

Based on the examination of SSIs, the forced online component of the research due to COVID-19 had a negative effect on student collaborative group work, one of the pillars of FCM. My first recommendation is to duplicate the present research in a face-to-face context now that the environment and course structure have returned to normal.

My second recommendation for future study would be to examine the association between the time spent watching flipped videos and student accomplishment. Does the amount of time spent watching flipped videos influence student course attainment?

Finally, researchers might compare FCM and LBM teaching methodologies to determine the efficacy of these two models concerning a variety of topic areas. Are there any courses that might be better served by FCM delivery? Is FCM sufficiently general to apply to any topic? Are there any subjects better suited to using a traditional form of delivery?

As a result of this study's findings, I have already used statistical games in my courses and observed how interested and involved students become when playing games. Future researchers

might replicate this study by introducing educational games into FCM sections to investigate whether game-playing significantly improves motivation and performance.

Here are some recommendations for my future course of action as an instructor-researcher. I would like to conduct a larger scale study employing larger samples to strengthen the generalizability of the findings, extend the research to other subjects to examine the flipped classroom concept's efficacy in various disciplines, conduct a meta-analysis on the available FCM literature in Thailand and, finally, conduct a longitudinal study over an extended period to establish whether FCM might be as beneficial over a more extended period compared to a few trimesters.

Chapter 1 cited high failure rates in business statistics courses as a particular institutional challenge. During the two trimesters that the study took place, there were lower failure rates in FCM sections compared to LBM sections. Because FCM might lower failure rates, the following recommendations to the university's administrators are appropriate: considering the positive impact of FCM on students' academic performance and the fact that it is regarded as a more conducive learning model, the school should explore incorporating FCM into its statistics course curriculum. The FCM implementation should help the students and promote the institution's image and competitiveness in the education market. To ensure that FCM is executed efficiently, faculty members should receive training on its implementation to ensure that they are familiar with the FCM model and have the requisite skills and resources to apply it correctly. It is vital to monitor FCM deployment and to evaluate its efficacy regularly. This monitoring should allow the institution to identify difficulties or obstacles and take remedial measures promptly. The effectiveness of FCM in statistics classes indicates that the school should explore extending it to other classes. The university should consider performing a pilot study to assess the viability of

FCM in additional classrooms and to evaluate any necessary improvements. Finally, the institution should consider promoting the benefits of FCM to students, parents, and the greater community. This promotion should assist in raising awareness and garner support for FCM, eventually resulting in the organization's success. Overall, the institution should explore introducing FCM as a learning approach for statistics classes and monitor its implementation to ensure its efficacy.

5.18. Achieving the Educational Significance of the Study

At the onset of the study, I noted that one institutional problem within the university is high failure rates in statistics courses, which are as high as 25-35%. Given that the failure rates during the two trimesters of flipped learning dropped to 8%, I am confident that this study has achieved its significance by offering a new way of teaching and learning to reduce the high failure rates.

Moreover, and as noted in Chapter 1, I identified another educational significance of this study: it investigates whether FCM positively impacts students' quantitative performance as evidenced by assignment scores. The higher median grades and lower interquartile ranges in the quantitative results demonstrated that students in FCM classes outperformed those in LBM groups across all assignment categories. Therefore, this educational significance also was achieved.

The study also contributed to the existing FCM literature in Thailand, where FCM studies are limited in higher education settings (Fuchs, 2021). Hence, another educational significance of the study was met. Additionally, by restructuring the statistics courses to utilize ALEKS (Assessment and Learning in Knowledge Spaces), I changed the instructional practices and how statistics courses are taught, which was another educational significance of the study.

Furthermore, based on the study's results, comprehensive recommendations were offered to statistics educators, administrators, faculty, students, and staff, which can further impact the educational practices of the institution wherein the research took place. Lastly, the qualitative and mixed results revealed that the students, including those with low quantitative performance, preferred FCM as a pedagogical approach within the blended learning paradigm. Thus, all of the potential educational significances outlined in the first chapter were met.

5.19. Mitigating the Limitations of the Study

The limitations of the study, as mentioned in Chapter 1, were the fact that the study was conducted during the COVID-19 pandemic, which means the study was undertaken using an online flipped format rather than a face-to-face flipped format as originally intended; the study only included students from a single PTIU; the study might have been affected by selection bias due to convenience sampling; the study only included a specific demographic group; the study did not consider the time and resource constraints of the learners; the study has limited generalizability due to the small sample size; the study had a short duration; and finally, the researcher also was the instructor, which could have resulted in instructor bias.

I implemented several strategies to mitigate the limitations mentioned above. Firstly, although the pandemic-induced switch to online learning added an unexpected variable, it also presented an interesting opportunity to compare student performance in online flipped classes versus a traditional face-to-face format. Moreover, I made sure that students in both FCM and LBM groups knew that I was available by video-conferencing during normal business hours if any personal or academic issues arose.

Secondly, I did not overgeneralize the results and emphasized that this study's results might not apply or be generalized to other educational settings. Thirdly, to mitigate potential selection bias due to convenience sampling, I conducted a Chi-square test and ensured that both the FCM and LBM groups were representative of the population by nationality and gender. Concerning time constraints that learners face (Bakla & Mehdiyev, 2022), I personally designed the FCM classes to ensure that the demands did not surpass the students' available time by limiting the time for the flipped videos to 10 minutes or less and including concise, focused pre-class materials paired with active learning exercises during class. To account for the potentially limited generalizability caused by the small sample size, yet again I did not overgeneralize the quantitative results and relied on the qualitative results to explain the findings.

Concerning the short duration of the study, I did not overgeneralize my findings, **and** relied more on qualitative findings. Lastly, to minimize potential instructor bias, I involved my primary supervisor in every step of the research and was debriefed by him at every stage. Moreover, all examinations were computer-graded without human involvement unless a student had a problem with a grade. These actions helped me to enhance the validity and reliability of the results. In order to improve the quality and impact of my work, it was crucial that I, as a researcher-instructor, constantly acknowledged and addressed limitations and was in continuous touch with my supervisors.

5.20. Conclusion

As the need for better educated and better skilled workers increases, educational policymakers look for measures to improve the literacy and, in particular, the mathematical and statistical literacy, of learners as well as the general public. Educational psychologists and practitioners

create unique teaching and learning techniques, such as FCM, to address the needs of learners in pursuit of learning.

This study examined the impact of FCM on students' academic performance and their attitudes toward statistics, as well as the students' perceptions and experiences in a flipped model of instruction and its comparison to a lecture-based model of the same course. This study's quantitative study showed that the FCM environment contributed to an improvement in student performance. Moreover, higher-performing students were better able to take advantage of flipped learning and, conversely, the flipped model of teaching contributed to the better performance of the high- and low-performing students in comparison to the traditional lecture-based model of teaching and learning.

The qualitative findings complemented the quantitative findings in that the perceptions of learners enrolled in FCM sections were more favorable toward the FCM learning environment, and the FCM environment was more conducive to learning. However, the abrupt and forced transition to online instruction linked to the COVID-19 outbreak negatively impacted the learning environment. As a consequence, these results have contributed to the body of information about the use of FCM in business statistics courses for undergraduates at a PTIU as well as opening up new avenues for future study.

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Appendix A

Table A1

Mapping of LBM and FCM Activities on to Kolb's (2015) ELT

Learning Phase Mapped to ELT	Kolb's Definition	LBM Activity	FCM Activity
Concrete experience (pre-class)	being involved in experiences and dealing with immediate human situations (Kolb, 2015, p. 85)	Attempt to undertake the homework assigned by the instructor after the lecture class.	Learners watch the lecture videos designed and assigned by the instructor.
Reflective observation (pre-class)	understanding the meaning of ideas and situations by carefully observing and impartially describing them (Kolb, 2015, p. 85).	Reflect on the problems that were not undertaken correctly after receiving the solutions. The students then will retake the same homework with different dataset to improve their score.	Learners take the graded small quizzes based on the topics discussed in the videos and receive the solutions to reflect on the results. The students then will retake the quiz to improve the grade.
Abstract conceptualization (pre-class)	using logic, ideas, and concepts. It emphasizes thinking as opposed to feeling;	The student then will refer back to the assigned interactive conceptual assignment to edit	The student then will refer back to the assigned interactive conceptual assignment to edit

	a concern with building general theories as opposed to intuitively understanding unique, specific areas; a scientific, as opposed to an artistic approach to problems (Kolb, 2015, p. 85).	and to correct any conceptual misconception, if any, or add a new conceptual understanding.	and to correct any conceptual misconception, if any, or to add a new conceptual understanding.
Abstract conceptualization (in-class)	using logic, ideas, and concepts. It emphasizes thinking as opposed to feeling; a concern with building general theories as opposed to intuitively understanding unique, specific areas; a scientific, as opposed to an artistic approach to problems (Kolb, 2015, p. 85).	The educator lectured on the concept and ideas involved using white board, Excel software, and some worked examples, followed by a question-and-answer session on the topics taught.	The educator reviewed the concepts on the lecture videos and using a question-and-answer session helped the students to correct any conceptual misconception, if any, or add a new conceptual understanding.
Active experimentation (in-class)	actively influencing people and changing situations. It emphasizes practical applications, as opposed to reflective understanding (Kolb, 2015, p. 85).	Once the lecture has been finalized, the students then undertake a small in-class practice in small groups better to understand and to apply the concepts. However, the in-class practices were shorter than was the FCM class because the bulk of the time was allocated for lecturing.	In small groups, and with the educator's help, the Learner used part of the remaining time to work on the homework assignments and the remaining time on the application of the concepts to the real-world problems. An example of a real-world problem at this stage was to download the data from the center for disease control and compare and contrast different parameters between different

		states or countries in order to answer real-world questions (e.g., On average is there more daily death per million of population in England or France, at the 5% level of significance?)

Table A2

Qualitative Sample Size by Gender, Level of Performance, and Mode of Instruction

Sample size	Men	Women	Total
LBM and High Performance	2	9	11
LBM and Low Performance	5	3	8
FCM and High performance	2	7	9
FCM and Low performance	5	3	8
Total	14	22	36

n = 36.

Table A3

Pseudonyms of Student Participants During the Qualitative Phase by Gender, Mode of Instruction, and Level of Quantitative Performance

Pseudonyms Used	Gender	Mode of Instruction	Quantitative level of Performance
Ana	W	FCM	High
Maew	W	LBM	High
Noo	W	LBM	High
John	M	FCM	Low
Zahra	W	LBM	Low
Fatima	W	FCM	Low
Mark	M	FCM	Low
Taengmo	W	FCM	High
Kinley	M	LBM	Low
Steve	M	FCM	Low
Nastaran	W	LBM	High
Gop	W	LBM	High
kiry	M	LBM	Low
Som	W	LBM	High
Mint	W	FCM	High
Ploy	W	FCM	Low
Yuze	M	LBM	Low
Lab	W	FCM	Low
Lee	M	LBM	Low
Praew	M	FCM	Low
Mandana	W	LBM	High
Peter	M	FCM	Low
Chompoo	W	LBM	Low

Appen	W	FCM	High
Nu	W	LBM	High
Nat	W	FCM	High
Phan	W	LBM	High
Somchai	M	FCM	High
Raj	M	LBM	High
Angun	W	FCM	High
Khemera	M	LBM	Low
Sue	W	LBM	Low
Arthit	M	FCM	High
Somsak	M	LBM	High
Tik	W	LBM	High
Liqian	W	FCM	High

Note. Requested to be interviewed on Blackboard Collaborate. n = 36.

Table A4

Kruskal-Wallis Test to compare the differences in CUCEI between the LBM and FCM Sections

Survey subscales	Personalization	Involvement	Student-cohesiveness	Satisfaction	Task Orientation	Innovation	Individualization
Kruskal Wallis H	16.624	10.754	14.711	22.116	11.232	14.919	22.719
p-value	< .001	< .001	< .001	< .001	< .001	< .001	< .001

Note. Obtained using SPSS 28. $n = 36$.

Table A5

FCM Versus LBM CUCEI Subscales by Medians, and Interquartile Ranges (IQR)

Survey subscales		Personalization	Involvement	Student-cohesiveness	Satisfaction	Task Orientation	Innovation	Individualization
Median	FCM	3.86	3.40	4.00	4.00	3.67	4.00	4.00
	LBM	3.43	3.00	3.50	3.43	3.17	3.53	3.42
IQR	FCM	0.36	0.10	0.21	0.86	0.50	0.58	0.21
	LBM	0.14	0.10	0.17	0.14	0.33	0.29	0.14

Note. Obtained using SPSS 28. $n = 36$.

Table A6

Test of Normality for all Data Collected

Shapiro-Wilk Test		
Assignments	Statistics	*p* value
Practicals	0.890	<0.001
Homework Assignment	0.756	<0.001
Comprehensive Exams	0.938	<0.001
Difference of pre and post tests	0.974	<0.001
Final Class Averages	0.922	<0.001

Note. Obtained using SPSS 28. *n = 216*

Table A7

Test of Normality for the LBM Data Collected

Shapiro-Wilk Test		
Assignments	Statistics	*p* value
Practicals	0.878	<0.001
Homework Assignment	0.778	<0.001
Comprehensive Exams	0.902	<0.001
Difference of pre and post tests	0.956	<0.001
Final Class Averages	0.892	<0.001

Note. Obtained using SPSS 28. $n = 121$.

Table A8

Test of Normality for the FCM data collected

Shapiro-Wilk Test		
Assignments	Statistics	*p* value
Practicals	0.910	<0.001
Homework Assignment	0.721	<0.001
Comprehensive Exams	0.988	0.537
Difference of pre and post tests	0.984	0.318
Final Class Averages	0.949	<0.001

Note. Obtained using SPSS 28. $n = 95$.

Table A9

SATS Subscale Score Reliabilities (Cronbach's Alphas)

Survey subscales	Affect	Cognitive Competence	Value	Difficulty	Interest	Effort
Pre-SATS FCM	.87	.83	.92	.63	.86	.81
Post-SATS FCM	.80	.80	.79	.56	.94	.83
Pre-SATS LBM	.81	.74	.84	.54	.90	.74
Post-SATS LBM	.81	.73	.80	.61	.89	.73

Note. Obtained using SPSS 28. FCM SATS n = 83. LBM SATS n = 110

Table A10

Comparison of Pre-and Post-SATS Subscales in FCM Sections

Survey subscales	Affect	Cognitive Competence	Effort	Interest	Value
Mann-Whitney *U*	2712.500	2586.000	2475.500	2743.000	2573.000
Wilcoxon W	5197.500	6342.000	5961.500	6229.000	6059.000
Z	-0.706	-0.180	-1.585	-5.95	-1.217
p-value	0.480	0.857	0.113	0.552	0.224

Note. Obtained using SPSS 28. FCM SATS $n = 83$.

Table A11

Comparison of Pre-and Post-SATS Subscales in LBM Section

Survey subscales	Affect	Cognitive Competence	Effort	Interest	Value
Mann-Whitney *U*	5464.000	5039.500	4688.000	5491.000	4786.000
Wilcoxon W	11569.000	11144.500	10793.000	11596.000	10891.000
Z	-0.206	-1.166	-1.978	-0.145	-1.737
p-value	0.837	0.244	0.048	0.885	0.082

Note. Obtained using SPSS 28. $n = 110$.

Table A12

CUCEI Subscales Score Reliability-Cronbach's Analysis

Survey subscales	Personalization	Involvement	Student-cohesiveness	Satisfaction	Task Orientation	Innovation	Individualization
CUCEI_FCM	.83	.70	.93	.79	.72	.82	.73
CUCEI_LBM	.85	.83	.72	.81	.75	.77	.81

Note. Obtained using SPSS 28. $n = 36$.

Table A13

Inter-Respondent Matrix (Student x codes*: Student perceptions)*

Name	Negative FCM Perception	Positive FCM Perception	Negative LBM Perceptions	Positive LBM Perceptions	Total Frequency
Ana	0	5	0	0	5
Maew	0	2	1	2	5
Noo	0	1	0	1	2
John	4	6	0	0	10
Zahra	0	1	2	2	5
Fatima	1	8	0	0	9
Mark	0	6	0	0	6
Taengmo	0	6	0	0	6
Steve	4	10	0	0	14
Nastran	0	2	0	1	3
Gop	1	1	0	2	4
kiry	0	5	0	1	6
Som	1	4	0	1	6
Mint	1	6	0	0	7
Ploy	5	4	0	0	9
Yuze	0	2	1	2	5
Kinley	0	1	0	2	3

Lab	2	8	0	0	10
Lee	0	2	0	2	4
Praew	0	4	1	0	5
Mandana	1	5	0	1	7
Peter	0	8	0	0	8
Chompoo	0	4	0	2	6
Appen	3	7	0	0	10
Nu	0	3	1	2	6
Nat	1	4	0	0	5
Phan	0	0	0	1	1
Somchai	2	4	0	0	6
Raj	0	0	0	1	1
Angun	1	4	0	0	5
Khemera	0	0	0	1	1
Sue	1	2	0	4	7
Arthit	1	6	0	0	7
Somsak	0	2	0	1	3
Tik	0	5	0	2	7
Liqian	0	6	0	0	6
Effect size	29	144	6	31	210

Prevalence rate of Each perception (i.e., Manifest effect size)	13.81	68.57	2.86	14.76

n = 36.

Table A14

Coded Themes Shown on the Second Correspondence Chart (Figure 6)

Codes	Themes loaded by Principal Component Analysis
AFB	Advantages of flipped-based model of teaching and learning
AGW	Advantages of groupwork
ALB	Advantages of traditional lecture-based model of teaching and learning
BWV	Benefits of watching lecture videos
COVID	Negative effects of COVID-19 pandemic on learning
DFB	Disadvantages of flipped-based model of teaching and learning
DLB	Disadvantages of traditional lecture-based model of teaching and learning
EIST	Explaining material in simple terms
FLM	Prefer to have flipped learning
GWBF2F	Groupwork is better suited in a face-to-face environment
LBMME	Lecture-based model of teaching and learning is more efficient
LBMW	Lecture-based learning requires more work
MFL	Created a flipped learning out of lecture-based learning because lecture videos were provided
PBL	Project Based Learning
PF2F	Prefer a face-to-face format of any teaching and learning strategy
PLV	Providing educational lecture videos for students to watch
PM	Prefer a mix of lecture-based and flipped based learning

SBSFFL	Subjects better suited for flipped learning
SPL	Self-Paced learning

Appendix B

Figure B1

Ethics Approval from the University of Liverpool

UNIVERSITY OF LIVERPOOL

Centre for Higher Education Studies

Doctor of Education (EdD) in Higher Education Programme

Candidate: Kambiz Akhavein

Provisional Title of Thesis: The Flipped Classroom Model for an undergraduate level Business Statistics Course in an International University in Thailand: Impacts on Student Performance, Attitudes, Perceptions, and Experiences

Primary Supervisor: Dr Anthony Onwuegbuzie

Secondary Supervisor: Dr Martin Gough

Dear Mr Akhavein,

I am pleased to inform you that your proposed thesis research on the EdD in Higher Education now has expedited ethical approval to proceed. You should include this letter as an appendix to your final thesis to be submitted. It is important to point out that the process undertaken to grant approval is a governance process, ensuring that you are aware of aspects of your research study which have, or may have, ethical importance. In other words, it is expected that you proceed ethically in all your research actions. You must raise such incidents and circumstances immediately with your Primary Supervisor and together report back details as soon as possible to the EdD programme administrator <docedd@liverpool.ac.uk>, and marked for the attention of the EdD Ethics Review Coordinator.

We recognise that research does not necessarily follow exactly any plan made in advance. If you find that you need to make an amendment to your research plan, you should notify the programme. Where this is Major, and your research requires actions such as further data collection not envisaged at the time of applying for ethical approval, there is another form to submit in the VLE. Your Review Panel will need to approve the amendments before you can proceed again. More detail on the above procedures is in the EdD research ethics approval applications guidance document.

Does the Thesis Research Proposal have formal approval?

Yes

Are there conditions of ethical approval?

Yes

1. That you double check both the PISs for typographical errors resulting from copy and pasting between the two.
2. That you make it clear to potential participants that there will be no payment for their contribution to the study. Currently this section refers to them incurring expenses or payments.

Your EdD Research Ethics Panel Reviewers:

Dr Julie-Anne Regan (lead reviewer)

Dr Mariya Ivancheva (second reviewer)

Date: 15/06/2021

Ref.: (Akhavein.K.1)

Figure B2

Information Presentation During a Blackboard Session

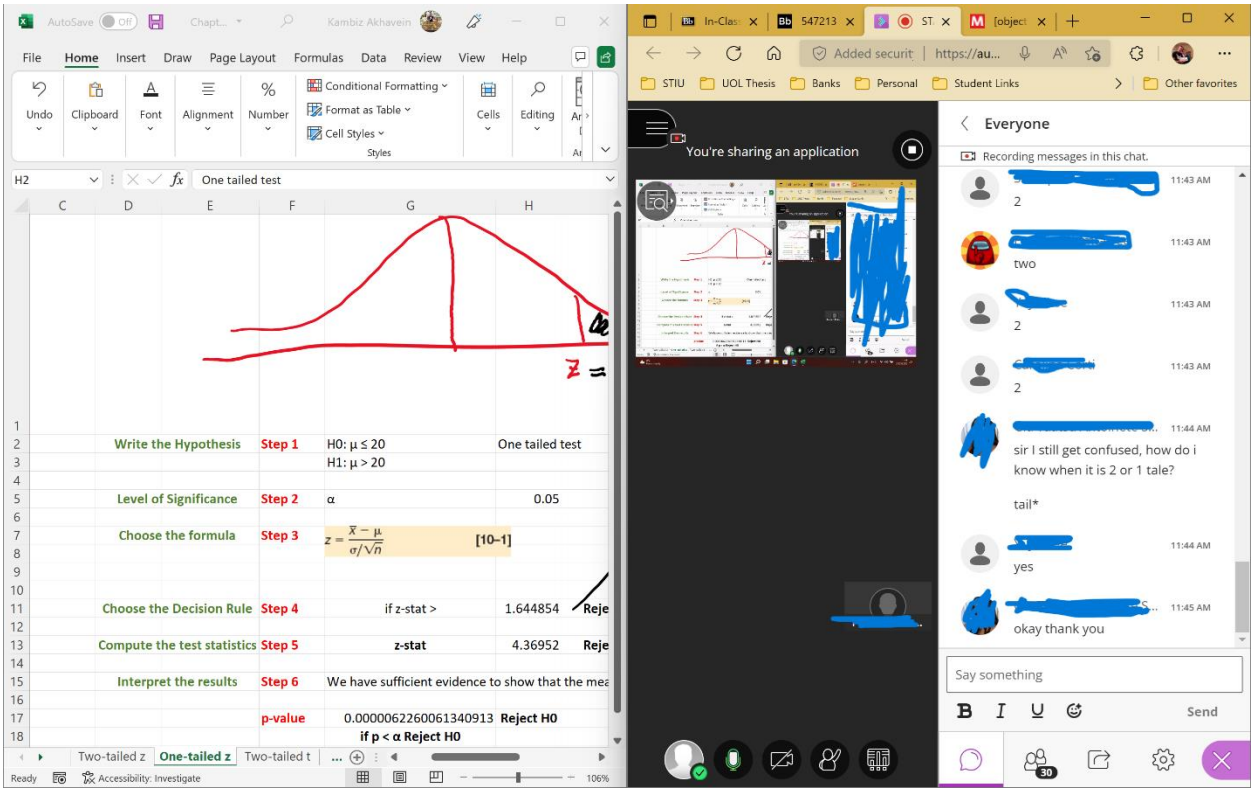

Figure B3

Student Collaboration in Small Groups

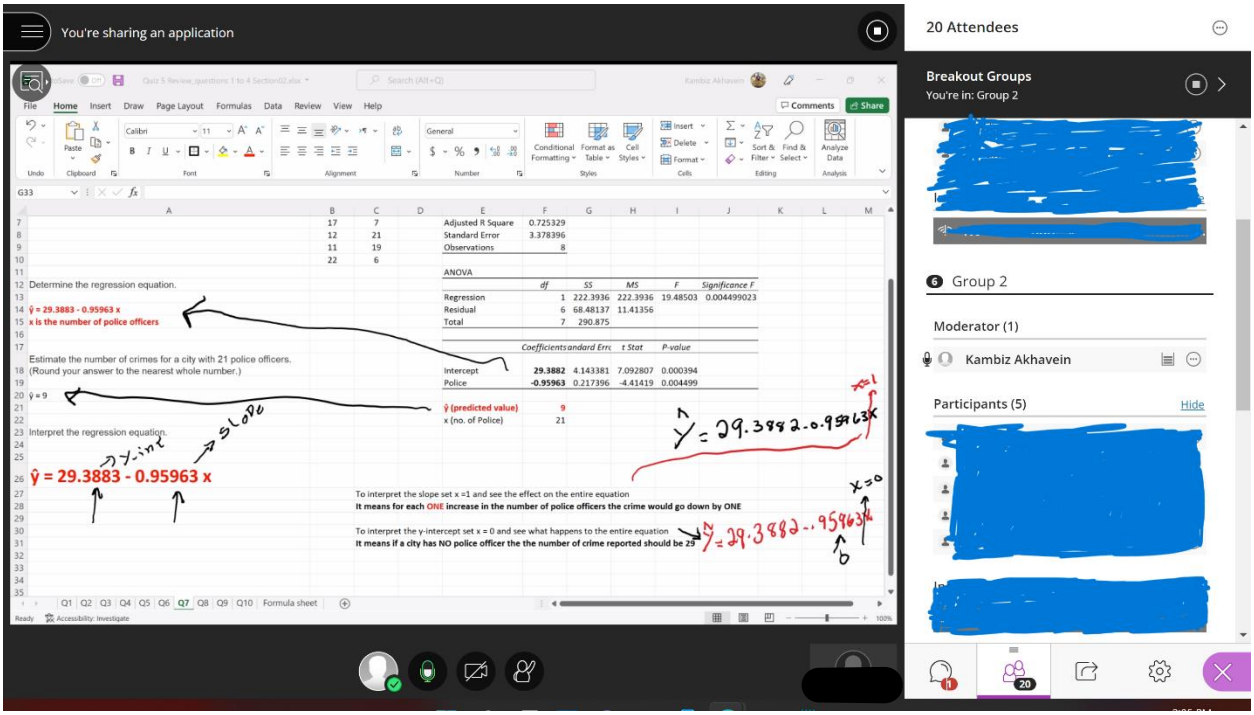

Figure B4

Instructor-led Training

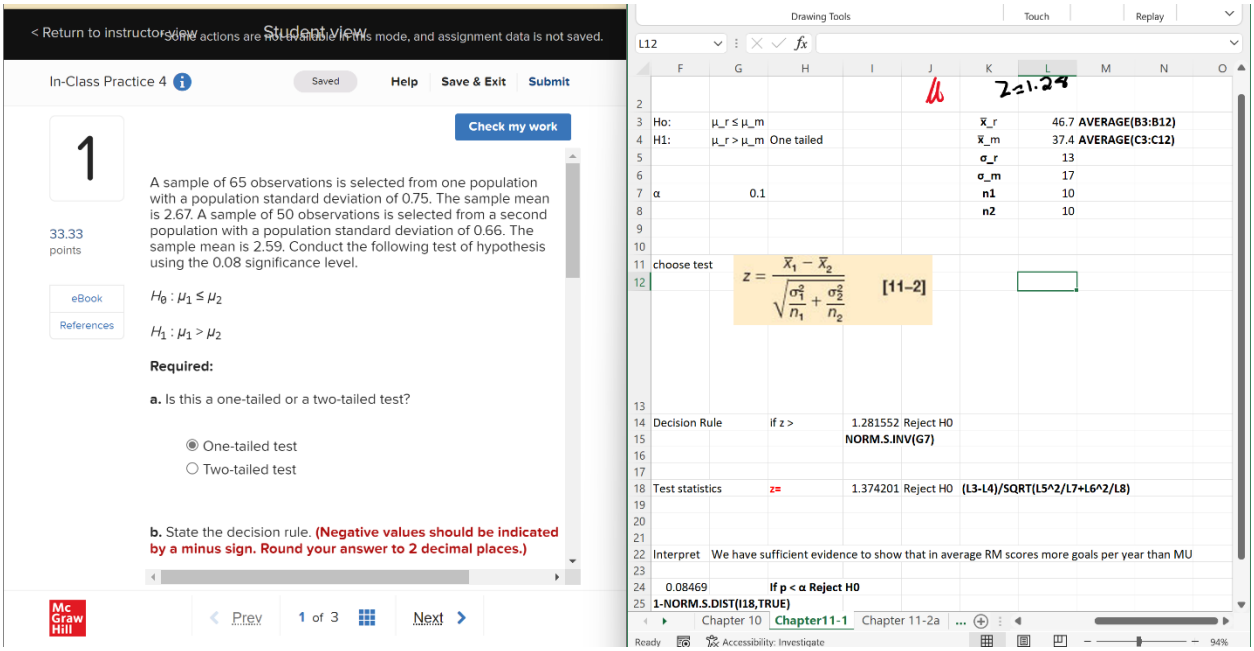

Figure B5

Pre-Survey of Attitude Toward Statistics

Survey of Attitudes Toward Statistics

Pre

© Schau, 1992, 2003

DIRECTIONS: The statements below are designed to identify your attitudes about statistics. Each item has 7 possible responses. The responses range from 1 (strongly disagree) through 4 (neither disagree nor agree) to 7 (strongly agree). If you have no opinion, choose response 4. Please read each statement. Mark the one response that most clearly represents your degree of agreement or disagreement with that statement. Try not to think too deeply about each response. Record your answer and move quickly to the next item. Please respond to all of the statements.

	Strongly disagree			Neither disagree nor agree			Strongly agree
I plan to complete all of my statistics assignments.	1	2	3	4	5	6	7
I plan to work hard in my statistics course.	1	2	3	4	5	6	7
I will like statistics.	1	2	3	4	5	6	7
I will feel insecure when I have to do statistics problems.	1	2	3	4	5	6	7
I will have trouble understanding statistics because of how I think.	1	2	3	4	5	6	7
Statistics formulas are easy to understand.	1	2	3	4	5	6	7

Statistics is worthless.	1	2	3	4	5	6	7
Statistics is a complicated subject.	1	2	3	4	5	6	7
Statistics should be a required part of my professional training.	1	2	3	4	5	6	7
Statistical skills will make me more employable.	1	2	3	4	5	6	7
I will have no idea of what's going on in this statistics course.	1	2	3	4	5	6	7
I am interested in being able to communicate statistical information to others.	1	2	3	4	5	6	7

	Strongly disagree			Neither disagree nor agree			Strongly agree
Statistics is not useful to the typical professional.	1	2	3	4	5	6	7
I plan to study hard for every statistics test.	1	2	3	4	5	6	7
I will get frustrated going over statistics tests in class.	1	2	3	4	5	6	7
Statistical thinking is not applicable in my life outside my job.	1	2	3	4	5	6	7
I use statistics in my everyday life	1	2	3	4	5	6	7
I will be under stress during statistics class.	1	2	3	4	5	6	7
I will enjoy taking statistics courses.	1	2	3	4	5	6	7
I am interested in using statistics.	1	2	3	4	5	6	7
Statistics conclusions are rarely presented in everyday life.	1	2	3	4	5	6	7
Statistics is a subject quickly learned by most people.	1	2	3	4	5	6	7
I am interested in understanding statistical information.	1	2	3	4	5	6	7

Learning statistics requires a great deal of discipline.	1	2	3	4	5	6	7
I will have no application for statistics in my profession.	1	2	3	4	5	6	7
I will make a lot of math errors in statistics.	1	2	3	4	5	6	7
I plan to attend every statistics class session.	1	2	3	4	5	6	7
I am scared by statistics.	1	2	3	4	5	6	7
I am interested in learning statistics.	1	2	3	4	5	6	7
Statistics involves massive computations.	1	2	3	4	5	6	7

	Strongly disagree			Neither disagree nor agree			Strongly agree
I can learn statistics.	1	2	3	4	5	6	7
I will understand statistics equations.	1	2	3	4	5	6	7
Statistics is irrelevant in my life.	1	2	3	4	5	6	7
Statistics is highly technical.	1	2	3	4	5	6	7
I will find it difficult to understand statistical concepts.	1	2	3	4	5	6	7
Most people have to learn a new way of thinking to do statistics.	1	2	3	4	5	6	7

Please notice that the labels for each scale on the rest of this page change from item to item.

	Very poorly						Very well
How well did you do in mathematics courses you have taken in the past?	1	2	3	4	5	6	7

	Very poor						Very good
How good at mathematics are you?	1	2	3	4	5	6	7

In the field in which you hope to be employed when you finish school, how much will you use statistics?	Not at all 1	2	3	4	5	6	Great deal 7
How confident are you that you can master introductory statistics material?	Not at all confident 1	2	3	4	5	6	Very confident 7
Are you required to take this statistics course (or one like it) to complete your degree program?	Yes 1			No 2			Don't know 3
If the choice had been yours, how likely is it that you would have chosen to take any course in statistics?	Not at all likely 1	2	3	4	5	6	Very likely 7

DIRECTIONS: For each of the following statements mark the one best response. Notice that the response scale changes on each item.

What is your major? If you have a double major, pick the one that best represents your interests.

1. Arts/Humanities
2. Biology
3. Business
4. Chemistry
5. Economics
6. Education
7. Engineering
8. Mathematics
9. Medicine/Pre-Medicine
10. Psychology
11. Sociology/Social Work
12. Statistics
13. Other

Current grade point average (please estimate if you don't know; give only one single numeric response: e.g., 3.52). If you do not yet have a grade point average, please enter 99: _____

For each of the following three items, give one single numeric response (e.g., 26). Please estimate if you don't know exactly.

Number of credit hours earned toward the degree you are currently seeking (don't count this semester): _____

Number of high school mathematics and/or statistics courses completed: _____

Number of college mathematics and/or statistics courses completed (don't count this semester): _____

Degree you are currently seeking:

1. Associate
2. Bachelors
3. Masters
4. Doctorate
5. Certification
6. Post-bachelor's Licensure
7. Specialist
8. Other

What grade do you expect to receive in this course?

1. A +
2. A
3. A-
4. B+
5. B
6. B-
7. C+
8. C
9. C-
10. D+
11. D
12. D-
13. F

In order to describe the characteristics of your class as a whole, we need your responses to the following items.

Your sex: 1. Male 2. Female

Your citizenship: 1. US citizen 2. Foreign student 3. Other

Your age (in years): _____

THANKS FOR YOUR HELP!

Figure B6

Post-Survey of Attitude Toward Statistics

Survey of Attitudes Toward Statistics

Post

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DIRECTIONS: The statements below are designed to identify your attitudes about statistics. Each item has 7 possible responses. The responses range from 1 (strongly disagree) through 4 (neither disagree nor agree) to 7 (strongly agree). If you have no opinion, choose response 4. Please read each statement. Mark the one response that most clearly represents your degree of agreement or disagreement with that statement. Try not to think too deeply about each response. Record your answer and move quickly to the next item. Please respond to all of the statements.

	Strongly disagree			Neither disagree nor agree			Strongly agree
I tried to complete all of my statistics assignments.	1	2	3	4	5	6	7
I worked hard in my statistics course.	1	2	3	4	5	6	7
I like statistics.	1	2	3	4	5	6	7
I feel insecure when I have to do statistics problems.	1	2	3	4	5	6	7
I have trouble understanding statistics because of how I think.	1	2	3	4	5	6	7
Statistics formulas are easy to understand.	1	2	3	4	5	6	7

Statistics is worthless.	1	2	3	4	5	6	7
Statistics is a complicated subject.	1	2	3	4	5	6	7
Statistics should be a required part of my professional training.	1	2	3	4	5	6	7
Statistical skills will make me more employable.	1	2	3	4	5	6	7
I have no idea of what's going on in this statistics course.	1	2	3	4	5	6	7
I am interested in being able to communicate statistical information to others.	1	2	3	4	5	6	7

	Strongly disagree			Neither disagree nor agree			Strongly agree
Statistics is not useful to the typical professional.	1	2	3	4	5	6	7
I tried to study hard for every statistics test.	1	2	3	4	5	6	7
I get frustrated going over statistics tests in class.	1	2	3	4	5	6	7

Statistical thinking is not applicable in my life outside my job.	1	2	3	4	5	6	7
I use statistics in my everyday life	1	2	3	4	5	6	7
I am under stress during statistics class.	1	2	3	4	5	6	7
I enjoy taking statistics courses.	1	2	3	4	5	6	7
I am interested in using statistics.	1	2	3	4	5	6	7
Statistics conclusions are rarely presented in everyday life.	1	2	3	4	5	6	7
Statistics is a subject quickly learned by most people.	1	2	3	4	5	6	7
I am interested in understanding statistical information.	1	2	3	4	5	6	7
Learning statistics requires a great deal of discipline.	1	2	3	4	5	6	7
I will have no application for statistics in my profession.	1	2	3	4	5	6	7
I make a lot of math errors in statistics.	1	2	3	4	5	6	7
I tried to attend every statistics class session.	1	2	3	4	5	6	7

I am scared by statistics.	1	2	3	4	5	6	7
I am interested in learning statistics.	1	2	3	4	5	6	7
Statistics involves massive computations.	1	2	3	4	5	6	7

	Strongly disagree			Neither disagree nor agree			Strongly agree
I can learn statistics.	1	2	3	4	5	6	7
I understand statistics equations.	1	2	3	4	5	6	7
Statistics is irrelevant in my life.	1	2	3	4	5	6	7
Statistics is highly technical.	1	2	3	4	5	6	7
I find it difficult to understand statistical concepts.	1	2	3	4	5	6	7
Most people have to learn a new way of thinking to do statistics.	1	2	3	4	5	6	7

NOTICE that the labels for the scale on each of the following items differ from those used above.

	Very poor						Very good
How good at mathematics are you?	1	2	3	4	5	6	7

In the field in which you hope to be employed when you finish school, how much will you use statistics?	Not at all 1	2	3	4	5	6	Great deal 7
How confident are you that you have mastered introductory statistics material?	Not at all confident 1	2	3	4	5	6	Very confident 7
As you complete the remainder of your degree program, how much will you use statistics?	Not at all 1	2	3	4	5	6	Great deal 7
If you could, how likely is it that you would choose to take another course in statistics?	Not at all likely 1	2	3	4	5	6	Very likely 7
How difficult for you is the material currently being covered in this course?	Very easy 1	2	3	4	5	6	Very difficult 7

DIRECTIONS: For each of the following statements mark the one best response. Notice that the response scale changes on each item.

Do you know definitely what grade you will receive in this course?

1. Yes 2. No

What grade do you expect to receive in this course?

1. A +	5. B	9. C-	13. F
2. A	6. B-	10. D+	
3. A-	7. C+	11. D	
4. B+	8. C	12. D-	

In a usual week, how many hours did you spend outside of class studying statistics? Give only one single numeric response that is a whole number _____

	Very low						Very high
In the past week, how would you describe your overall stress level?	1	2	3	4	5	6	7

THANKS FOR YOUR HELP!

Figure B7

College and University Classroom Environment Inventory

College and University Classroom Environment Inventory (CUCEI)

1. The instructor considers students' feelings.
2. The instructor talks rather than listens.
3. The class is made up of individuals who don't know each other well.
4. The students look forward to coming to classes.
5. Students know exactly what has to be done in our class.
6. New ideas are seldom tried out in this class.
7. All students in the class are expected to do the same work, in the same way and in the same time.
8. The instructor talks individually with students.
9. Students put effort into what they do in classes.
10. Each student knows the other members of the class by their first names.
11. Students are dissatisfied with what is done in the class.
12. Getting a certain amount of work done is important in this class.
13. New and different ways of teaching are seldom used in this class.
14. Students are generally allowed to work at their own pace.
15. The instructor goes out of his/her way to help students.
16. Students "clockwatch" in this class.**
17. Friendships are made among students in this class.
18. After the class, the students have a sense of satisfaction.
19. The group often gets sidetracked instead of sticking to the point.
20. The instructor thinks up innovative activities for students to do.
21. Students have a say in how class time is spent.
22. The instructor helps each student who is having trouble with the work.
23. Students in this class pay attention to what others are saying.
24. Students don't have much chance to get to know each other in this class.

25. Classes are a waste of time.
26. This is a disorganized class.
27. Teaching approaches in this class are characterized by innovation and variety.
28. Students are allowed to choose activities and how they will work.
29. The instructor seldom talks with students. ***
30. Students seldom present their work to the class.
31. It takes a long time to get to know everybody by his/her first name in this class.
32. Classes are boring.
33. Class assignments are clear so everyone knows what to do.
34. The Blackboard classroom materials are arranged the same way every week.***
35. Teaching approaches allow students to proceed at their own pace.
36. The instructor isn't interested in students' problems.
37. There are opportunities for students to express opinions in this class.
38. Students in this class get to know each other well.
39. Students enjoy going to this class
40. This class seldom starts on time.
41. The instructor often thinks of unusual class activities.
42. There is little opportunity for a student to pursue his/her particular interest in this class.
43. The instructor is unfriendly and inconsiderate towards students.
44. The instructor dominates class discussions.**
45. Students in this class aren't very interested in getting to know other students.
46. Classes are interesting.
47. Activities in this class are clearly and carefully planned.
48. Students seem to do the same type of activities in every class.
49. It is the instructor who decides what will be done in our class.

Figure B8

Interview protocol

Interview Questions for the flipped class	Interview Questions for the lecture-based class
1. What do you think about learning statistics by watching videos and taking notes outside of class, and then using the class time to solve problems?	1. What do you think about learning statistics in a lecture-based format by listening to the lecture and taking notes and then using your own time to solve the homework problems to reinforce the lecture?
2. What do you like about the statistics flipped course that you took this term?	2. What do you like about the statistics course that you took this term?
3. What do you dislike about the statistics flipped course that you took this term?	3. What do you dislike about the statistics course that you took this term
4. Which part(s) of the flipped classroom (watching videos, video quizzes, in-class practices, taking notes, and/or quizzes) do you find the most useful in learning statistics?	4. Which part(s) of the lecture-based classroom (listening to the lectures, short in-class practices, taking notes, doing homework assignments, and/or quizzes) do you find the most useful in learning statistics?
5. Which part(s) of the flipped classroom (watching videos, video quizzes, in-class practices, taking notes, and/or quizzes) do you find the least useful in learning statistics?	5. Which part(s) of the lecture-based classroom (listening to the lectures, short in-class practices, taking notes, doing homework assignments, and/or quizzes) do you find the least useful in learning statistics?
6. If you were to repeat this class, would you prefer a flipped or a traditional format? Why?	6. (*At this point, I defined the flipped classroom model for the student in the lecture-based class*) If you were to repeat this class, would you consider taking a statistic flipped format? Why or why not?
7 Do you think that you would learn better in a statistic flipped format or a traditional lecture-based format? Why?	7. Have you had a flipped format of a course before? If yes, do you think that you would learn statistics better in a traditional lecture-based format or a flipped format? Why?
8. Which format requires more work to learn on your part? The flipped or the traditional format? Explain.	8. Have you had a flipped format of a course before? If yes, which format requires more work to learn on your part? The flipped or the traditional format? Explain.
9. Do you think learning in a flipped format or a traditional lecture-based format results in a more efficient use of your time in learning statistics? Why?	9. Have you had a flipped format of a course before? If yes, do you think learning in a traditional lecture-based format results in a more efficient use of your time in learning statistics? Why?
10. Did you have better interaction with other students in this flipped classroom in comparison to the earlier lecture-based classes that you have taken? Why or why not?	10. Did you have good interactions with other students in this lecture-based statistics course? Explain.
11. In your opinion, how can the flipped college statistics format be improved?	11. In your opinion, how can the lecture-based college statistics format be improved?
12. What would you do to make the class more interesting?	12. What would you do to make the class more interesting?
13. Is there any other information you would like to provide about flipped classroom experience?	13. Is there any other information you would like to provide about the lecture-based classroom experience?

Appendix C

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Figure C1

Springer Publishing Authorizing the Use of CUCEI

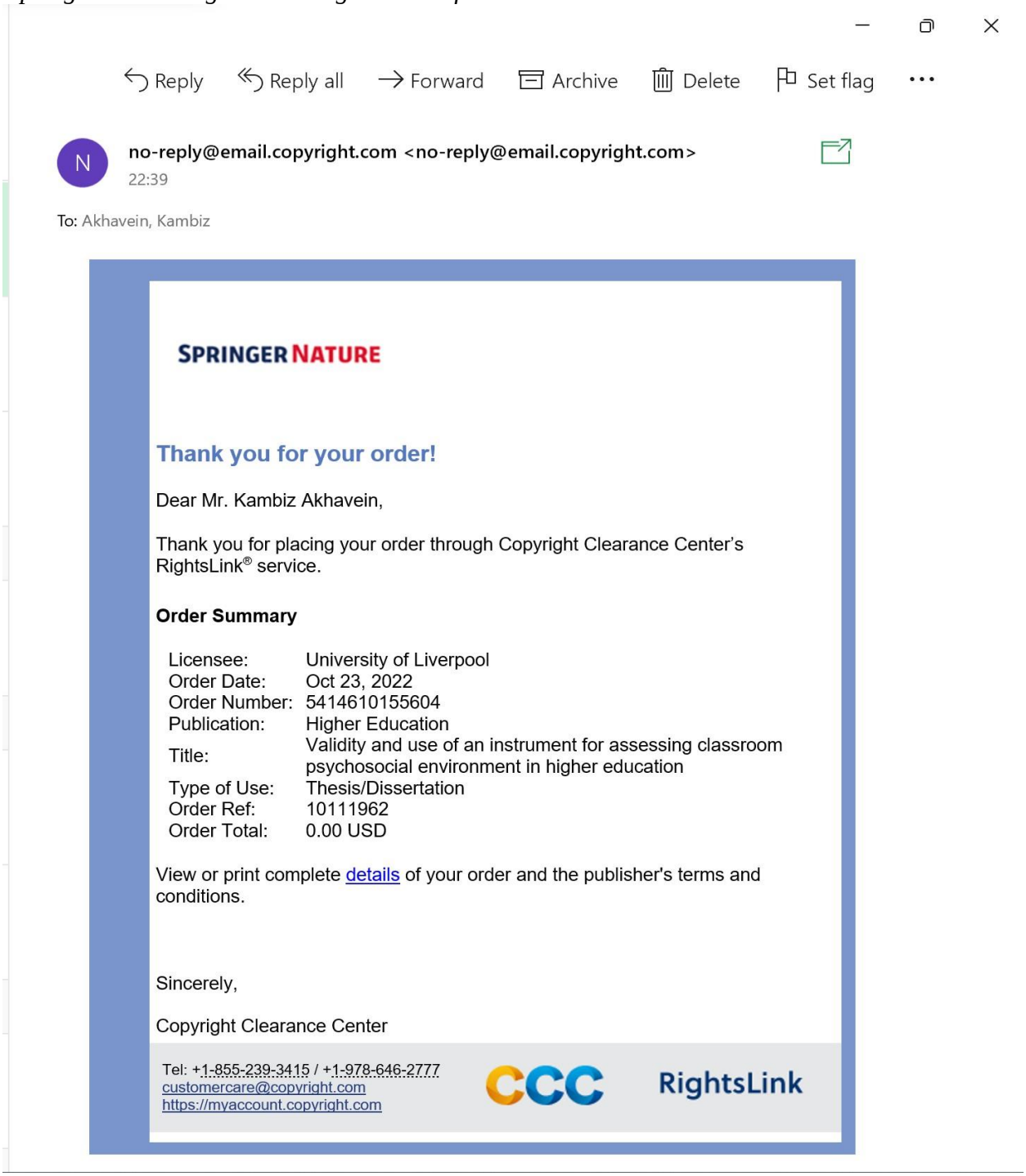

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Figure C2

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A Typology of Mixed Methods Sampling Designs in Social Science Research

Anthony J. Onwuegbuzie, *Sam Houston State University*
Kathleen M.T. Collins, *University of Arkansas*

Follow

Abstract
This paper provides a framework for developing sampling designs in mixed methods research. First, we present sampling schemes that have been associated with quantitative and qualitative research. Second, we discuss sample size considerations and provide sample size recommendations for each of the major research designs for quantitative and qualitative approaches. Third, we provide a sampling design typology and we demonstrate how sampling designs can be classified according to time orientation of the components and relationship of the qualitative and quantitative sample. Fourth, we present four major crises to mixed methods research and indicate how each crisis may be used to guide sampling design considerations. Finally, we emphasize how sampling design impacts the extent to which researchers can generalize their findings.

Keywords
Sampling Schemes, Qualitative Research, Generalization, Parallel Sampling Designs, Pairwise Sampling Designs, Subgroup Sampling Designs, Nested Sampling Designs, and Multilevel Sampling Designs

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Figure C3

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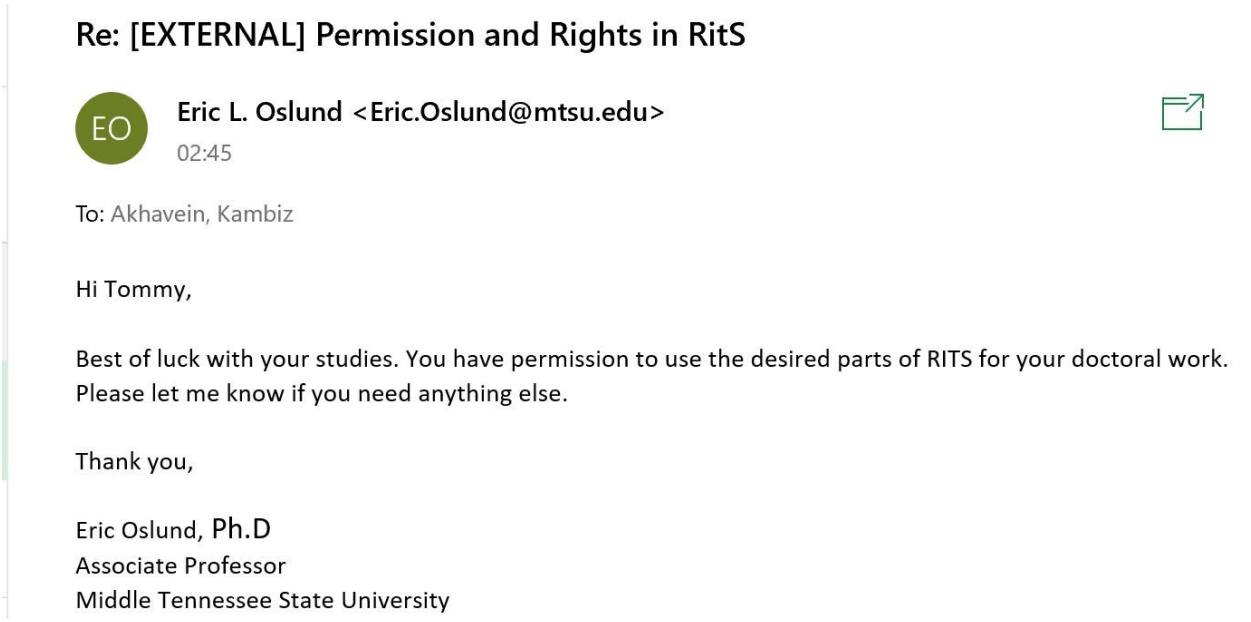

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EO Eric L. Oslund <Eric.Oslund@mtsu.edu>
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To: Akhavein, Kambiz

Hi Tommy,

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Thank you,

Eric Oslund, Ph.D
Associate Professor
Middle Tennessee State University

Figure C4

Permission to Employ SATS

From: cschau@comcast.net
Sent: Tuesday, January 28, 2020 3:18
To: Tommy Akhavein
Subject: RE: Register & Request SATS form

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Thanks for your interest in using my SATS. You have my permission to use the SATS free for one year. At the end of your year, contact me again if you would like to continue to use my measure. I do require that you send/e-mail me a copy of anything you write that includes information about your use of the SATS. Also, when you use the SATS or write about it, you need to indicate that I hold the copyright.

You need to use all of the items that comprise each attitude component on the SATS (and I encourage you to use the other items too). If you want to omit or change any of those items, you will need to contact me again. Scores from the SATS attitude components using all of the items have been carefully validated on postsecondary students with a wide variety of characteristics taking statistics in a large number of institutions both within and outside of the US. That validation work does not apply to altered items, individual items or to incomplete components. Also, it is not appropriate to use a "total" attitude score. You are welcome to change the demographic and academic items to fit your circumstances.

You can find references and scoring information on my web site. I have attached the pretest and posttest versions of the SATS.

I hope your work goes well.

Candace

Candace Schau, PhD