THE INFLUENCING FACTORS OF MATHEMATICS LEARNERS' SATISFACTION WITH FLIPPED CLASSROOM AT SHANDONG KEVIN TECHNICAL SCHOOL

SU XIAOLING
6517195833

AN INDEPENDENT STUDY SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION GRADUATE SCHOOL OF BUSINESS
SIAM UNIVERSITY
2024

THE INFLUENCING FACTORS OF MATHEMATICS LEARNERS' SATISFACTION WITH FLIPPED CLASSROOM AT SHANDONG KEVIN TECHNICAL SCHOOL

SU XIAOLING

This Independent Study has been Approved as a Partial Fulfillment of the Requirements for the Degree of Master of Business Administration

Advisor: .....
(Dr. Ma Yu)

Date: ...12.../.....8...../....2024...

.....

(Associate Professor Dr. Jomphong Mongkhonvanit)
Dean, Graduate School of Business

Date.....4...../.....2...../.....2025

Title: The Influencing Factors of Mathematics Learners' Satisfaction with Flipped Classroom at Shandong Kevin Technical School
By: Su Xiaoling
Degree: Master of Business Administration
Major: Education Management

Advisor: .....Ma Yu..... (Dr. Ma Yu)

Date: ...17.../...9.../...2024...

ABSTRACT

The arrival of information technology in education has put forward new requirements for mathematics teaching in technical schools. Given the many problems of traditional mathematics teaching, the reform of mathematics teaching is imminent. With the continuous promotion of education information technology, the emergence of flipped classrooms has improved the current situation of mathematics teaching to a great extent. Therefore, it becomes important to explore the satisfaction of mathematics learners in technical schools with flipped classrooms and the factors affecting the students' satisfaction with classroom experience.

The objective of this study was to examine the influence of perceived quality, perceived value, students' expectations, and independent learning ability on mathematics learners' satisfaction with flipped classroom. The quantitative method was used in this study. A total of 450 questionnaires were distributed to mathematics learners at Shandong Kevin Technical School, and 386 valid questionnaires were recovered, with a validity rate of 85.8%. This study found that perceived quality, perceived value, student expectations, and independent learning have a significant positive effect on the mathematics learners' satisfaction with flipped classroom. For recommendations, the following strategies should be adopted to enhance mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School: 1) Designing high-quality flipped classroom; 2) Adding perceived value; 3) Responding to expectations of students; and 4) Cultivating self-directed learning ability.

Keywords: influencing factors, flipped classroom, mathematics, student satisfaction, Shandong Kevin Technical School

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to my advisor, for his invaluable guidance, support, and encouragement throughout my master's independent study. His insightful comments and constructive criticism have significantly improved the quality of my work.

Additionally, I am grateful to Associate Professor Dr. Jomphong Mongkhonvanit, the Dean of the Graduate School, for his support and encouragement throughout my studies. His dedication to the graduate program and commitment to excellence have inspired me to strive for academic excellence.

Finally, I would like to extend my appreciation to all the faculty members and staff of Siam University who have contributed to my growth and development as a scholar. Their unwavering support and encouragement have been a source of inspiration and motivation to me.

DECLARATION

I, Su Xiaoling, hereby certify that the work embodied in this independent study entitled "The Influencing Factors of Mathematics Learners' Satisfaction with Flipped Classroom at Shandong Kevin Technical School" is result of original research and has not been submitted for a higher degree to any other university or institution.

.....SU Xiao Ling.....

(Su Xiaoling)
July, 18 2024

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1 Introduction

1.1 Background of the Study

With the rapid development of communication technology, the flipped classroom, as a new hybrid teaching mode relying on computer technology, has changed the mode of traditional teaching, formed the teaching process of "learning before teaching", and has been utilized in teaching in many fields. The active participation of students in the classroom can improve their learning performance. Flipped classrooms, as a product of the trend of education informationization, have become one of the most popular forms of classroom teaching in the world (Chua & Islam, 2020). A flipped classroom improves students' initiative. The flipped classroom is a hybrid teaching mode, which relies on computer technology, the absorption of knowledge in the classroom, with the help of classroom teacher-student and student-student interaction, to help students complete the process of internalization of knowledge, to complete the flip of the traditional teaching process. Flipped classrooms are essentially supported by interactive technology, which enhances the interaction between teachers and students and students to promote active learning (Cicha et al., 2021). Therefore, flipped classroom plays an important role in deepening education reform and expanding education opening.

More importantly, students' mathematical learning has broken through the limitations of time and space. Rich learning materials, and modern learning platforms, coupled with a professional teaching team, have enhanced students' enthusiasm for learning mathematics, improved their learning efficiency, and increased opportunities for students to communicate and interact. The learning of mathematics has become more open, flexible, and efficient. In the process of formative assessment of flipped classroom, learners' satisfaction, as a feeling or attitude of students towards learning activities, reflects their learning experience to a large extent, implies their motivation, expectations, and behavioral outcomes of learning activities, and is one of the core criteria for measuring teaching effectiveness and conducting curriculum evaluation.

The arrival of the era of education informatization has put forward new requirements for mathematics teaching in technical schools. Given the many problems of traditional mathematics teaching, the reform of mathematics teaching is imminent. Traditional mathematics teaching focuses on the input of knowledge and mathematics learning to be an input-to-output process, which led to mathematics teaching problems, such as stereotyped teaching content, boring teaching design, and rigid teaching mode (Cicha et al., 2021; Folke, 2006). With the continuous advancement of education informatization, the emergence of flipped classrooms has greatly improved the status quo of mathematics teaching. The teaching mode of "learning before teaching" in a flipped classroom promotes the improvement of students' independent learning ability, on the one hand, the classroom functions are realized on the other hand, students and teachers have more opportunities for interaction and communication in the classroom (Gong et al., 2020). Learners' perceived satisfaction is a good predictor of learners'

behavioral tendencies. Learner satisfaction can have a significant impact on student loyalty. Measuring students' satisfaction can not only help educators find the deficiencies of the flipped classroom, but also enable educators to design student-centered teaching activities, arrange teaching content, and implement teaching evaluation, to realize personalized teaching (Gunawardena & Liyanage, 2018). Therefore, it is important to explore the satisfaction of math learners in technical schools with the flipped classroom and the factors affecting the satisfaction from the students' actual classroom experience.

1.2 Questions of the Study

Most of the related research results focus on the construction and optimization of the teaching mode, although the attention of researchers to the study of the influence factors of the flipped classroom has increased in recent years, the study of student satisfaction and its influence factors is still relatively small (Han, 2018). Although many studies have tried to use customer satisfaction theory and technology acceptance theory to construct a model of influencing factors of student satisfaction in the flipped classroom, their exploration of influencing factors is still not comprehensive enough, and there is still a gap for improvement. Therefore, this paper attempts to understand the current situation of flipped classroom research through literature combing, and based on relevant theories, to investigate the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School through the questionnaire method from the perspective of student satisfaction, and to analyze the factors affecting students' satisfaction as well as the relationship between the factors, to provide reference for improving the application effect of the flipped classroom in the teaching of mathematics in technical schools (Hsiung et al., 2017). The following are some of the factors that affect students' satisfaction with the flipped classroom.

(1) Does perceived quality affect the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School?

(2) Does perceived value affect the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School?

(3) Does student expectation affect the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School?

(4) Does self-directed learning ability affect the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School?

1.3 Objectives of the Study

(1) To explore the effect of perceived quality on mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.

(2) To explore the effect of perceived value on mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.

(3) To explore the effect of student expectations on mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.

(4) To explore the effect of independent learning ability on mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.

1.4 Scope of the Study

This study takes math learners from Shandong Kevin Technical School as the research subjects to explore their satisfaction with and the influencing factors of the flipped classroom model. The research focuses on students enrolled in the school and participating in the flipped classroom teaching of mathematics, aiming to comprehensively understand students' perceptions and feedback on this teaching mode. Data collection was conducted from March 2024 to June 2024, covering mathematics courses across all grades and majors in the school. The research scope primarily encompasses students' overall satisfaction with the flipped classroom, the primary factors influencing this satisfaction, as well as the specific manifestations and effects of the flipped classroom in mathematics learning. Through a questionnaire survey, the study systematically analyzes students' learning experiences, engagement, autonomous learning abilities, and their evaluations of learning outcomes within the flipped classroom. Furthermore, the study integrates teachers' feedback to comprehensively assess the application effects of the flipped classroom in mathematics teaching and identify areas for improvement.

1.5 Significance of the Study

This study enriches the theoretical perspective of the study of math flipped classrooms in technical schools. This study combines relevant theories to construct a model of factors influencing student satisfaction in the math flipped classroom in technical schools, which enriches the contents and perspectives of the study to a certain extent. It provides an empirical basis for future research on math flipped classrooms in technical schools. Based on analyzing related studies, this study will construct the "Satisfaction Scale of Mathematics Flipped Classroom in Technical Schools" and "Satisfaction Influencing Factors Scale of Mathematics Flipped Classroom in Technical

Schools". This provides a basis for future research on scale design (Khanova et al., 2015).

This study helps to understand the actual feelings and needs of students for math flipped classrooms, and discover the possible deficiencies in the current design of flipped classrooms, to provide a realistic basis for technical schools to carry out math flipped classrooms in a targeted way, thus further improving the quality of math flipped classroom teaching in colleges and universities. It helps the flipped classroom math teachers clarify the possible problems in the teaching design and the reasons, promote the teachers' teaching reflection, and improve their comprehensive quality, to realize a more effective flipping. It is conducive to increasing attention to student satisfaction and improving the learning experience of math learners in the flipped classroom, to promote more efficient independent learning and deep learning (Lin & Hwang, 2018).

1.6 Definition of Key Terms

Perceived quality refers to students' overall evaluation of the content, teaching methods, and teaching resources in the flipped classroom, specifically including the clarity of instructional videos, the ease of understanding the content, and the practicality of textbooks and supplementary resources.

Perceived value refers to students' assessment of the overall benefits of the flipped classroom compared to traditional classrooms, which is the contrast between the knowledge and skill improvements students gain after participating in the flipped classroom and the time and effort they invest.

Student expectations refer to the anticipations students hold before entering the flipped classroom learning environment regarding the effectiveness and experience of this teaching mode, including expectations for learning outcomes, classroom interactions, and teacher guidance.

Self-directed learning ability is defined as the capacity of students in the flipped classroom model to independently arrange their study time, actively acquire knowledge, and solve learning problems, reflecting their learning initiative and self-management skills in the absence of real-time teacher supervision.

Student satisfaction refers to students' overall satisfaction with the flipped classroom learning experience, encompassing a comprehensive evaluation of various aspects such as classroom content, teaching methods, learning outcomes, classroom interactions, and teacher guidance.

1.7 Limitations of the Study

The limitations of the study's research objects are primarily reflected in sample selection. This study specifically targets mathematics learners of Shandong Kevin Technical School, resulting in a sample constrained by geography and school type. The limitations of data collection methods may also compromise the accuracy of the research findings. Relying primarily on questionnaire surveys can be susceptible to subjective factors from students, such as the authenticity and accuracy of their responses. This study focuses on students' subjective experiences, potentially overlooking objective assessments of teaching effectiveness, such as test scores and knowledge mastery, leading to research outcomes.

The effectiveness of flipped classroom implementation is influenced by multiple factors, including teachers' instructional abilities, classroom management skills, and institutional support from the school. These factors may not have been fully considered and analyzed in this study, affecting the comprehensiveness and depth of the research conclusions.

Lastly, limitations exist in the study's theoretical model and analytical methods. The selection and analysis of factors influencing satisfaction with the flipped classroom may not be comprehensive or in-depth enough, constraining the persuasiveness and applied value of the research conclusions.

Chapter 2 Literature Review

2.1 Introduction

This chapter summarizes the influencing factors of the flipped classroom, encompassing four aspects: perceived quality, perceived value, student expectations, and self-directed learning ability. The flipped classroom has been shown to enhance student satisfaction and classroom engagement. Based on the literature, the interrelationships among various variables are proposed.

2.2 Literature Review

2.2.1 Flipped Classroom

The concept of the flipped classroom, also known as the inverted classroom, originated from the "peer teaching method" proposed by Eric Mazur. The description of the process of using it in the academic world has roughly outlined the framework of the flipped classroom model. Among other things, "inverting the classroom means that activities that should traditionally take place in the classroom, and vice versa." Scholars at the Flipped Classroom Conference held in Colorado, USA, further clarified the concept: it is an instructional model that mixes direct instruction with constructivist learning. Related studies have divided the model. It is defined as a conversion teaching mode in the blended teaching mode. Flipped classroom is a new type of teaching mode. Some scholars believe that the flipped classroom is a form of teaching organization, teaching philosophy, and teaching method (Hsiung et al., 2017; Lin & Hwang, 2018). A flipped classroom takes the process of absorbing knowledge before class and internalizing knowledge after class, realizing the reversal of the teaching process. The flipped classroom includes two learning spaces, which mix the virtual cyberspace and the physical classroom space. Therefore, this study believes that the flipped classroom is a new type of blended teaching mode, which allows students to complete the initial absorption of knowledge by using teaching video-based learning resources before class, and further internalization of knowledge in class through interactive communication (Cicha et al., 2021; Folke, 2006).

The flipped classroom is a teaching model that reverses the traditional classroom learning sequence. It encourages autonomous learning outside the classroom using various resources, in-class time is dedicated to internalizing knowledge through discussions, interactions, and addressing doubts, thereby flipping the roles of students and teachers: students become active participants and explorers, while teachers act as facilitators. This teaching model combines rich learning resources outside the classroom with professional guidance from teachers in the classroom, fully leveraging students' subjective initiative and enhancing their comprehensive qualities, making it

favored by both teachers and students. College students, with their more prominent autonomous learning abilities, have made the flipped classroom particularly popular in universities, often applied in public courses and some specialized courses. Among them, task-driven and project-based flipped classrooms are the most well-known among teachers and students. The flipped classroom is a novel teaching model, yet some scholars consider it a teaching organization form, teaching philosophy, or teaching method. The flipped classroom places the process of knowledge acquisition before class and the process of knowledge internalization after class, achieving the teaching flow. It encompasses two learning spaces, blending the virtual online space with the physical classroom space. Therefore, this study posits that the flipped classroom is a new type of blended learning model, where students utilize learning resources primarily consisting of instructional videos to complete the initial acquisition of knowledge before class, and further internalize knowledge through collaborative inquiry and interactive exchanges between teachers and students, as well as among students, during class.

2.2.2 Perceived Quality

Perceived quality is known as perceived service quality. Service quality is defined as the sum of all attributes of a product or service that can meet both explicit and implicit needs. Quality can be divided into two types: objective and subjective. Objective quality refers to the actual quality, while subjective quality refers to perceived quality. Service marketers must recognize the significance of perceived meaning. Therefore, according to research, perceived quality is an assessment where customers compare their expectations with their perceptions, thereby deriving the perceived service quality. Scholars have further supported this notion by defining service quality as the discrepancy between customer expectations and perceptions. Service quality is a predictive perception of behavior after appropriate evaluation, whereas pure quality is an ambiguous and unpredictable construct. The development of SERVQUAL, a widely accepted measurement tool, has made significant contributions to the field of service quality.

The subject of perception in this study is math learners in technical schools, and the object of perception is the flipped classroom related to math learning. The perceived quality here refers to the quality of the flipped classroom that math learners in technical schools participate in the flipped classroom. In economics, there are three main dimensions of perceived quality observation, i.e., the customization of quality, the reliability of quality, and the overall evaluation of quality. The flipped classroom cannot be a commodity or service. Perceived quality dimensions need to be classified more scientifically according to the characteristics of the flipped classroom and the characteristics of the students (Gong et al., 2020). This study refers to the theory and subsequent related research, and the criteria of perceived quality into three dimensions, i.e., the quality of interpersonal relationships, the quality of individual development,

and the quality of system maintenance and change, each dimension having its measurement index. The perceived quality of relationships includes student cohesion, teacher support, and engagement; the perceived quality of individual development includes task orientation, research, collaboration, and youthfulness; and the perceived quality of maintenance and change includes equity, personalization, and use of technology platforms (Gunawardena & Liyanage, 2018). As a result, a system of indicators for evaluating the potential variable of perceived quality was established.

2.2.3 Perceived Value

Perceived value can be defined as the perceived assessment of "the ratio of benefits to costs," with learning efficiency being a crucial measurement indicator. Efficiency should be considered a vital metric in evaluating learners' perceptions. From a perceived value perspective, in the current blended education models, few studies have incorporated the concept of "cost-effectiveness," a measure of learning efficiency, into satisfaction models. Organizational behavior studies generally agree that improved efficiency contributes to the fulfillment of behavioral agents, thereby enhancing their satisfaction (Zhu et al., 2016). In the educational context, students' perceived value rarely relates to monetary costs; instead, it should correlate with "learning efficiency." In a flipped classroom environment, the perceived value of mathematics scholars in technical schools stems from their comparison of "effort" and "gain." Here, "effort" primarily refers to study time rather than money, while "gain" mainly encompasses mastery of knowledge and enhancement of abilities. The observable indicators of perceived value manifest in two aspects: the perception of quality given the price and the perception of price given the quality, essentially the "cost-effectiveness." Consequently, the observation of students' perceived value is correspondingly divided into two aspects: whether the flipped classroom model helps students grasp more knowledge and develop abilities within the same study time; and whether the flipped classroom model enables students to acquire relevant knowledge compared to traditional methods, given the same level of knowledge acquisition and ability development (Wan et al., 2020).

2.2.4 Student Expectations

Customer satisfaction theory suggests that learners will perceive the flipped classroom as having high-quality usability and be satisfied only when their expectations are met, enabling them to acquire knowledge and skills. The experiential learning theory emphasizes the significance of learners' prior experiences, such as technology application, teaching methodologies, and the effectiveness of their learning. Prior experiences not only guide individual learning but also influence the formation of students' attitudes, expectations, and goals. In a flipped classroom setting, students anticipate completing learning tasks more efficiently and are sensitive to the effort

invested in their studies. Once their expectations are met, their overall satisfaction significantly increases.

In this study, "students' expectations" refers to the quality estimation of what kind of quality standard the flipped classroom should achieve and what kind of needs and expectations the students should fulfill before participating in the flipped classroom (Walsh & Rísquez, 2020). Since education is different from the sale of ordinary products or services, which is not for profit, and the evaluation of "educational products or services" is more complicated, the indicator of "student expectation" in this paper should be adjusted according to the specific indicator of "perceived quality". Therefore, the indicators of "students' expectations" in this paper should be adjusted according to the indicators of "perceived quality", and should form a certain correspondence with the observed dimensions of students' perceived quality. Therefore, the indicators of students' expectations are expectations of interpersonal relationships, expectations of personal development, expectations of system maintenance and change, and expectations of the overall quality of the flipped classroom (Tsai & Wu, 2020).

2.2.5 Self-Directed Learning Ability

The theory of autonomous learning does not refer to a single theory; as different theoretical schools have varying definitions of its connotation. The study of autonomous learning in the West has a long history. Before the 20th century, masters such as Socrates, Plato, Aristotle, and Rousseau paid attention to the students in learning, emphasizing the importance of students' initiative and enthusiasm. In the 1950s, researchers represented by John Dewey emphasized learning by doing and respected students' subjectivity and autonomous learning. Skinner, a behaviorist psychologist, even created the programmed instruction method. Since then, numerous psychological schools have interpreted autonomous learning from different theoretical perspectives, leading to various views, including operationalize, information processing, social cognition, and verbal guidance. The reason for the disagreements among these theoretical schools in elucidating the essence of autonomous learning lies in their focus on only one or two aspects based on their respective theoretical stances and research perspectives. After the 1990s, Professor Zimmerman (1988) drew on the research achievements of various schools and established a distinctive theory of autonomous learning, attracting widespread attention in the educational field (Zimmerman & Martinez-Pons, 1988).

There is no unified definition of self-directed learning ability, and scholars have introduced the concept of autonomous learning into the field of education, defining it as "the ability to control one's learning." This study also adopts this approach to define the "self-directed learning ability" of mathematics learners. Schunk & Zimmerman (1998) suggests that students' self-directed learning ability should be evaluated from three aspects: metacognition, motivation, and behavior. Self-directed learning ability

can be divided into three dimensions: motivation, metacognitive strategies, and learning behavior. Some scholars categorize it into six dimensions: motivation, confidence, goal content, knowledge and planning of learning strategies, evaluation, and monitoring skills (Schunk & Zimmerman, 1998). There are numerous measurement dimensions for self-directed learning ability.

Flipped classroom learning is based on students' autonomous learning before class, relying on modern computers and information technology. It emphasizes students' subjectivity and initiative, focusing on cultivating their self-directed learning ability. The entire flipping process embodies the essence of autonomous learning theory. Moreover, students' self-directed learning ability is both the goal and outcome of flipped classroom mathematics learning, as well as the premise and foundation for them to engage in autonomous mathematics learning. The level of students' self-directed learning ability influences their performance and ultimate learning outcomes in the flipped classroom. "Student satisfaction," as a subjective emotion and feeling arising from the learning process, is influenced by the individual. Mathematics learners with varying degrees of self-directed learning ability may have different satisfaction with the flipped classroom. Therefore, this study explores the impact of students' self-directed learning ability on their satisfaction based on the theory of autonomous learning. Drawing on my observations of flipped classrooms and literature review, this paper focuses on investigating six aspects of students' self-directed learning ability: self-monitoring ability, self-planning ability, self-efficacy, learning responsibility, learning attitude, and learning motivation, to reflect their overall self-directed learning ability.

2.2.6 Student Satisfaction

Research into learners' satisfaction with the classroom environment originated in the United States, where it was also prioritized and conducted extensively on a large scale. Building upon the Selwyn scale, Tsai (2001) developed an 18-item student online attitude scale, encompassing four subscales: perceived usefulness, affect, perceived control, and behavior. Liaw (2008) examined students' satisfaction, behavioral intention, and effectiveness in online learning. His study revealed that self-efficacy is a critical factor influencing learners' satisfaction with online learning systems; both perceived usefulness and perceived satisfaction have an impact on learners' behavioral intention to use online learning systems; furthermore, the quality of multimedia instruction, interactive learning activities, and e-learning systems also contribute to the effectiveness of e-learning. Chang et al. (2011) found that teamwork dynamics affect students' satisfaction with courses in blended classrooms, with attitudes toward teammates and tasks being closely related to effective team performance and student satisfaction.

Students' satisfaction with the flipped classroom has become an important indicator of how good the flipped classroom is. In addition, students' evaluation and satisfaction can be found everywhere in numerous application effect studies (Lin &

Hwang, 2018; Tsai & Wu, 2020). Therefore, although they explicitly indicate that the study aimed at exploring students' satisfaction, the specific content of the study emphasizes the attention to students' satisfaction from time to time. Research shows that student satisfaction is improved in the flipped classroom compared to the traditional classroom, and some studies show no significant difference in satisfaction. In the research on the factors affecting student satisfaction, some characteristics of the learners themselves also have an impact on student satisfaction (Tsai & Wu, 2020; Wan et al., 2020). The type of course and the degree of adaptation in the pre-flip classroom also affect the actual effect of flipping as well as students' satisfaction (Tsai & Wu, 2020; Wan et al., 2020; Zhu et al., 2016). Empirical studies have illustrated the flipped classroom in promoting learning through the changes in students' math scores, and fewer studies have been conducted on student satisfaction. There is a relative lack of results on learner satisfaction in the flipped math classroom.

2.3 Conceptual Framework

The factors influencing mathematics learners' satisfaction with flipped classrooms at Shandong Kevin Technical School encompass several aspects: perceived quality, perceived value, student expectations, and self-directed learning ability. Based on literature review, the relationships between these variables are analyzed and clarified. Subsequently, a research conceptual model is proposed, as illustrated in Figure 2.1, grounded on the comprehensive understanding derived from the literature synthesis.

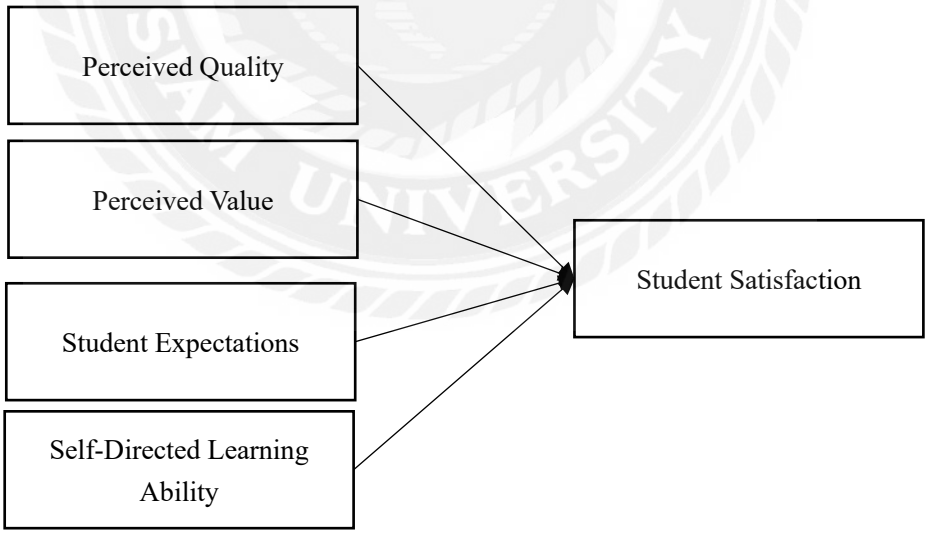

Figure 2.1 Conceptual Framework

Chapter 3 Research Methodology

3.1 Introduction

This chapter focuses on validating the relationships between the variables. This study designs a conceptual model examining the effects of perceived quality, perceived value, student expectations, and self-directed learning ability on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School. In this model, the independent variables include perceived quality, perceived value, student expectations, self-directed learning ability, while the dependent variable is student satisfaction. This research adopted a questionnaire survey method to collect data, which was then analyzed using descriptive and inferential statistics.

3.2 Research Design

The quantitative method was used in this study. The study adopted a questionnaire survey, involving the design of items for each variable. In the survey questionnaire, perceived quality is measured by five items, encompassing the clarity of course content, the richness of teaching materials, teachers' teaching skills, the availability of post-class resources, and the technical quality of the learning platform. Perceived value is assessed through five items related to time efficiency, learning outcomes, knowledge mastery, experience effectiveness, and value. Student expectations are captured by five items, including expected improvements in grades, knowledge mastery, learning skills, participation, and interest in learning. Self-directed learning ability is evaluated using five items that focus on self-planning, utilization of learning resources, problem-solving skills, learning goals, and self-monitoring. Lastly, student satisfaction is measured by six items covering teaching methods, classroom interaction, classroom atmosphere, course content, feedback and support, and overall experience. In total, the survey questionnaire comprises 26 items. For each variable, measurement items were designed, as shown in Table 3.1.

Table 3.1 Measurement Items

Measurement Item	NO.
Perceived Quality	
1. The content of this course is clear and easy to understand.	Q1
2. The teaching materials (e.g., videos, courseware, practice problems, etc.) are informative and help me understand the course content.	Q2
3. The teacher's explanations were well organized and helped me to better understand the course content.	Q3
4. The learning resources provided after the class (e.g. recorded videos, courseware downloads, etc.) are very helpful for me to review.	Q4
5. The learning platform runs stably and the experience of using it is good, which will not affect my learning effect.	Q5

Perceived Value	
1. I feel that I can use my study time more efficiently by learning in a flipped classroom.	Q6
2. I feel better about learning through the flipped classroom.	Q7
3. Through the flipped classroom, my mastery of what I have learned has improved.	Q8
4. I am satisfied with the curriculum and content of the flipped classroom.	Q9
5. The learning style of the flipped classroom enhances my interest and motivation in learning.	Q10
Student Expectations	
1. I expect that my academic performance will be significantly improved through the flipped classroom learning method.	Q11
2. I expect that through the flipped classroom, I will be able to master what I have learned in a more comprehensive and in-depth way.	Q12
3. I expect to improve my independent learning and problem solving skills through the flipped classroom.	Q13
4. I expect to participate more actively in class discussions and learning activities through the flipped classroom.	Q14
5. I expect that the flipped classroom will stimulate my interest and enthusiasm in learning mathematics.	Q15
Self-Directed Learning Ability	
1. I can reasonably plan my study time and study tasks.	Q16
2. I am good at utilizing various learning resources (e.g. textbooks, online resources, extracurricular books, etc.) to assist my learning.	Q17
3. I am able to solve the problems encountered in my study independently and look for relevant solutions.	Q18
4. I can set clear learning goals for myself and try to achieve them.	Q19
5. I am able to check and evaluate my learning progress regularly and adjust my learning strategies as necessary.	Q20
Student satisfaction	
1. I am satisfied with the instructor's teaching methods.	Q21
2. I am satisfied with the opportunities for interaction and discussion in the classroom.	Q22
3. I am satisfied with the learning atmosphere in the classroom.	Q23
4. I found the course content to be informative and challenging and to meet my learning needs.	Q24
5. I was satisfied with the feedback and post-course support provided by the instructor.	Q25
6. Overall, I was satisfied with my experience in this class.	Q26

3.3 Hypothesis

H1: Perceived quality has a significant positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.

H2: Perceived value has a significant positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.

H3: Student expectations have a significant positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.

H4: Self-directed learning ability has a significant positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.

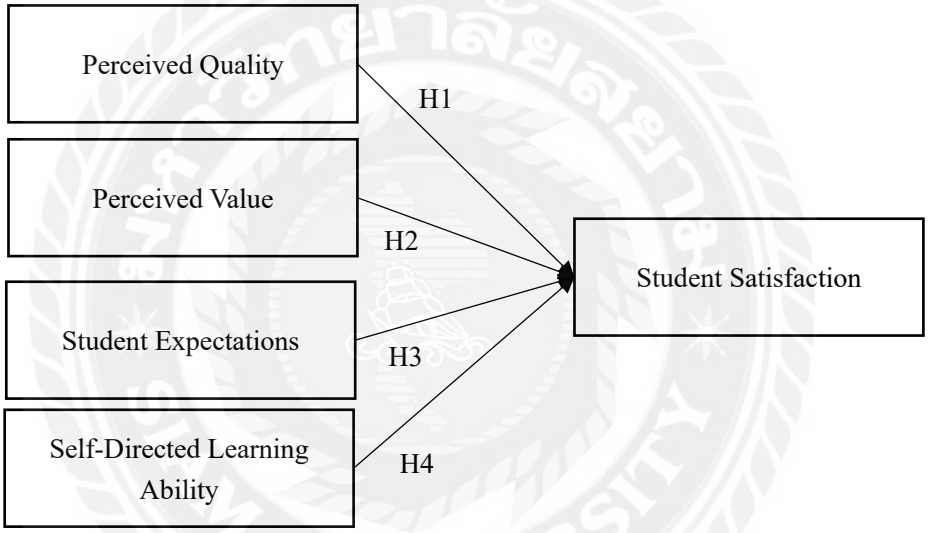

Figure 3.1 Hypotheses

3.4 Population and Sampling

This study took mathematics learners at Shandong Kevin Technical School as the research subjects, aiming to explore their satisfaction with flipped classrooms and the influencing factors behind it. The sampling method employed in this study is the simple random sampling.

$$\mathrm{n} = \frac{s^2 * p^2}{E}$$

In the formula, n represents the sample size, and s is the quartile of the standard normal distribution with a confidence level of typically 95%, currently Z=1.96. p is the sample standard deviation, which is typically estimated to be 0.5. The permissible margin of error, E (i.e., the maximum permissible difference between the sample mean

and the overall mean), is set at 0.05. The calculated result is that the sample size is 450.

3.5 Data Collection

This study focused on mathematics learners at Shandong Kevin Technical School, exploring their satisfaction with and the influencing factors of the flipped classroom teaching model. The research subjects were students enrolled in the school who participated in mathematics flipped classroom instruction, aiming to gain a comprehensive understanding of their perceptions and feedback towards this teaching approach. The data collection process commenced in March 2024 and concluded in June 2024, encompassing mathematics courses across all grades and majors within the school.

The research team collaborated with the school administration and the mathematics teaching and research group to obtain research permission and finalize cooperation details. Subsequently, a representative sample of students was randomly selected from each grade and major. Before the official data collection, all mathematics teachers involved in flipped classroom instruction underwent training to comprehend the content and objectives of the survey questionnaire, encouraging their cooperation during the data collection process. Teachers introduced the purpose and significance of the study to students in class and distributed the questionnaires. The survey questionnaires were administered anonymously to ensure students could express their feelings and feedback truthfully. Upon completion of data collection, the research team organized and coded all returned questionnaires to ensure data accuracy and completeness. A total of 450 questionnaires were distributed and 386 valid questionnaires were collected for analysis. Ultimately, statistical software was utilized to analyze the data, aiming to identify key factors influencing student satisfaction and provide insights for future teaching improvements within the school.

3.6 Data Analysis

3.6.1Reliability of the Questionnaire

Reliability analysis is a statistical process that reflects the degree of truth of the characteristic being tested based on the consistency or stability of the results of the test scale. The more uniform the test results are, the more representative the data are of the overall situation and the higher the reliability. Through reliability analysis, we can understand whether the questionnaire design is reasonable and make corrections to avoid the problem of misclassification. Cronbach's alpha is used to evaluate the degree of internal consistency of test items. The larger the value of Cronbach's alpha, the higher the degree of consistency between items. When the reliability coefficient of the subscales is above 0.7, the reliability coefficient of the scale or questionnaire is better;

when the reliability coefficient of the subscales is between 0.6 and 0.7, it is also acceptable; and when the reliability coefficient of the total scale needs to be 0.8 or higher, it proves that the overall reliability is better.

The reliability of the questionnaire is a prerequisite for data analysis, this study used SPSS to analyze the reliability of the data collected from 386 learners of mathematics in Shandong Kevin Technical School, and obtained the reliability coefficient Cronbach's Alpha for each factor, as shown in Table 3.2. Table 3.2 shows that the variables have a high degree of internal consistency. The reliability coefficients of Cronbach's Alpha of the questionnaires are all greater than 0.8, which indicates that the questionnaires have reached a high level of reliability. As shown in Table 3.2.

Table 3.2 Variable Reliability Test

Variable	Cronbach's Alpha	N of Items
Perceived Quality	0.892	5
Perceived Value	0.868	5
Student Expectations	0.875	5
Self-directed Learning Ability	0.866	5
Student Satisfaction	0.872	6

3.6.2 Validity of the Questionnaire

KMO and Bartlett's Test of Sphericity are usually prerequisites for factor analysis and are used to determine whether the scale is ready for factor analysis. The results showed that: KMO=0.941>0.7, Bartlett's Test of Sphericity approximate sig value is 0.000<0.05 Reject the original hypothesis. See Table 3.3. Therefore, the questionnaire fulfills the prerequisites for exploratory factor analysis. The results of the common factors show that the standardized factor loadings of each question item are greater than 0.6, the common degree of the variables is greater than 60%, and some of the factor loadings reach 67.364%, which indicates that these variables have a high amount of information. A total of five factors were extracted from the Rotated Factor Loadings Matrix table, which indicates to some extent that it is feasible and reasonable to measure the five variables in this study.

Table 3.3 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.941
Bartlett's Test of Sphericity	Approx. Chi-Square	4384.251
	df	190
	Sig.	0.000

Table 3.4 Confirmatory Factor Analysis（CFA）

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		Rotation Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	% of Variance	Cumulative %	% of Variance	Cumulative %
1	8.989	44.943	44.943	8.989	44.943	3.448	17.239
2	1.693	8.467	53.409	1.693	8.467	3.380	34.139
3	1.451	7.257	60.666	1.451	7.257	3.333	50.804
4	1.440	6.772	63.321	1.440	6.772	3.322	63.321
5	1.340	6.698	67.364	1.340	6.698	3.312	67.364
6	0.578	2.888	73.407				
7	0.541	2.706	76.114				
8	0.510	2.551	78.665				
9	0.468	2.339	81.004				
10	0.452	2.261	83.266				
11	0.431	2.153	85.419				
12	0.411	2.056	87.475				
13	0.394	1.968	89.443				
14	0.390	1.966	89.501				
15	0.387	1.960	89.601				
16	0.384	1.952	89.770				
17	0.379	1.901	89.810				
18	0.373	1.890	90.112				
19	0.369	1.851	91.103				
20	0.365	1.826	91.269				
21	0.352	1.760	93.029				
22	0.337	1.687	94.716				
23	0.312	1.559	96.275				
24	0.272	1.359	97.634				
25	0.240	1.202	98.836				
26	0.233	1.164	100.000				

Through confirmatory factor analysis, all items were classified into five dimensions. Based on the results of the independent variable factor analysis, five items with eigenvalues greater than 1 were extracted, which aligned with the original item categorization. Furthermore, the factor loadings of the questionnaire's measurement items were all greater than 0.5, indicating good discriminant validity among the dimensions and demonstrating their strong independence. This suggests that the overall validity of the questionnaire is satisfactory, as shown in Table 3.5.

Table 3.5 Rotated Component Matrix

	1	2	3	4	4
Q1	**0.785**	0.209	0.212	0.266	0.266
Q2	**0.706**	0.228	0.161	0.292	0.292
Q3	**0.794**	0.212	0.178	0.170	0.170
Q4	**0.723**	0.154	0.227	0.216	0.216
Q5	**0.745**	0.240	0.234	0.173	0.173
Q6	0.195	0.180	**0.781**	0.160	0.160
Q7	0.221	0.245	**0.692**	0.161	0.161
Q8	0.167	0.241	**0.700**	0.275	0.275
Q9	0.226	0.196	**0.755**	0.115	0.115
Q10	0.161	0.236	**0.714**	0.235	0.235
Q11	0.141	**0.818**	0.218	0.199	0.199
Q12	0.244	**0.708**	0.217	0.204	0.204
Q13	0.244	**0.695**	0.260	0.112	0.112
Q14	0.228	**0.725**	0.178	0.143	0.143
Q15	0.155	**0.753**	0.219	0.210	0.210
Q16	0.281	0.129	0.137	**0.775**	0.212
Q17	0.160	0.251	0.174	**0.685**	0.161
Q18	0.176	0.204	0.356	**0.702**	0.102
Q19	0.218	0.099	0.154	**0.763**	0.263
Q20	0.191	0.188	0.151	**0.743**	0.343
Q21	0.275	0.143	0.218	0.161	**0.778**
Q22	0.115	0.210	0.217	0.178	**0.802**
Q23	0.155	0.212	0.260	0.227	**0.775**
Q24	0.281	0.161	0.178	0.234	**0.769**
Q25	0.160	0.178	0.321	0.311	**0.734**
Q26	0.119	0.123	0.221	0.221	**0.810**

3.6.3 Analysis of Questionnaire Date

After data collection, analysis was required, and the specific process was as follows: Firstly, the collected data were cleaned and inspected, including checking for missing data, outliers, and abnormal values. If there were issues, the data were processed or excluded. Secondly, descriptive statistical analysis was performed on the survey sample, including the sample size and proportions. Correlation analysis was conducted on the collected data to determine the interactions between variables. Finally, regression analysis was performed. Regression analysis was done using path coefficient diagrams and coefficient tables to describe the relationships between latent and observed variables, verifying research hypotheses.

Chapter 4 Findings

4.1 Introduction

Through a comprehensive literature review, we have identified the factors influencing mathematics learners' satisfaction with flipped classrooms at Shandong Kevin Technical School. Employing a quantitative research approach, the collected questionnaires were analyzed to ascertain the reliability and validity of the data. Descriptive statistics, correlation analysis, and regression analysis were performed on the data to understand the relationships among variables. Through this analysis, the hypotheses were verified, and the interactions among the variables within the model were clarified.

4.2 Demographic Characteristics of Participants

This study primarily conducted research through online questionnaire distribution. A total of 450 questionnaires were issued, with 386 valid responses collected, yielding an effective response rate of 85.8%.

Table4.1 Descriptive Statistical Analysis of Demographics

Item	Options	Frequency	Percent%
Gender	Male	205	53.1
	Female	181	46.9
Age	Under 23	241	62.4
	23-28	127	32.9
	Above 28	18	4.7
Year of Study	Freshman	172	44.6
	Sophomore	73	18.9
	Junior	45	11.7
	Others	96	24.9
Major	Science and Engineering	59	15.3
	Humanities	47	12.2
	Economics and Management	62	16.1
	Arts	75	19.4
	Others	143	37.0
Total		386	100.0

Data analysis revealed the sample characteristics encompassing gender, age, year of study, and major. In terms of gender, the sample comprised 53.1% males and 46.9% females, indicating a relatively balanced ratio with a slight male dominance but not significantly so. Regarding age, 62.4% of respondents were under 23 years old, 32.9%

were between 23 and 28 years old, and only 4.7% were over 28 years old, clearly demonstrating a predominance of young individuals, particularly those under 23. The year of study showed that 44.6% of respondents were first-year students, 18.9% were second-year students, 11.7% were third-year students, and the remaining 24.9% were categorized as "others," potentially including fourth-year students or individuals with other educational backgrounds. Notably, first-year students constituted a significant proportion of the sample. The major distribution was relatively dispersed, with "others" accounting for the largest proportion of 37.0%. Among specific majors, arts represented 19.4%, economics and management 16.1%, science and engineering 15.3%, and humanities 12.2%, suggesting a diverse range of academic backgrounds among respondents but with a high "others" category that may encompass unspecified majors, potentially affecting the targeted nature and detailed analysis of the data. See Table 4.1. The sample as a whole meets the statistical requirements, as shown in Table 4.1.

4.3 Results of the Study

4.3.1 Correlation Analysis

In this study, the correlation between the factors affecting student satisfaction was examined by SPSS. Perceived quality, perceived value, students' expectations, self-directed learning ability, and student satisfaction, are five potential variables that have some positive correlation between them. The correlation strength $0.4<r<0.8$, $P=0.000<0.01$, belongs to the significant correlation. The correlation between the student satisfaction and self-directed learning ability of the learners of mathematics in Shandong Kevin Technical School is the highest and reaches 0.517. Therefore, the study suggests the following conclusions. There is a significant positive correlation between perceived quality, perceived value, student expectations, self-directed learning ability, and student satisfaction. According to the analysis results in Table 4.2, the relationship between each variable was obtained.

Table 4.2 Correlation Between Variables (Pearson Correlation Matrix)

	Perceived Quality	Perceived Value	Student Expectations	Self-Directed Learning Ability	Student Satisfaction
Perceived Quality	1	.561**	.566**	.584**	.469**
Perceived Value	.561**	1	.593**	.549**	.437**
Student Expectations	.566**	.593**	1	.518**	.472**
Self-Directed Learning Ability	.584**	.549**	.518**	1	.517**

Student Satisfaction	.469**	.437**	.472**	.517**	1

NOTE：*P<0.05, **P<0.01, ***P<0.001

The study elaborated on the correlations among various variables, including perceived quality, perceived value, student expectations, self-directed learning ability, and student satisfaction. The results indicated that all correlation coefficients among these variables were statistically significant. Perceived quality exhibited a strong positive correlation with the other four variables. Specifically, its correlation with perceived value was 0.561, with student expectations was 0.566, with self-directed learning ability was 0.584, and with student satisfaction was 0.469. This suggests that higher perceived quality leads to higher perceived value, expectations, self-directed learning ability, and satisfaction among students. Perceived value also showed significant positive correlations with other variables. Its correlation with student expectations was 0.593, with self-directed learning ability was 0.549, and with student satisfaction was 0.437. This indicates that an increase in perceived value enhances student expectations, self-directed learning ability, and student satisfaction. Student expectations demonstrated significant correlations with other variables as well. Its correlation with self-directed learning ability was 0.518, and student satisfaction was 0.472, suggesting that higher expectations among students lead to higher self-directed learning ability and student satisfaction. Lastly, the correlation between self-directed learning ability and student satisfaction was 0.517, implying that students with stronger self-directed learning abilities tend to have higher satisfaction with the classroom.

4.3.2 Multiple Regression Analysis

The perceived quality, perceived value, student expectations, and self-directed learning ability were centered. Then, stratified regression analysis was used. The path coefficient of perceived quality (β=0.618, p=0.000<0.001) in model 1 is significant. Model 2 with the addition of the variable (perceived value) to model 1, the path coefficients of perceived quality (β=0.590, p=0.000<0.001), and perceived value (β=0.535, p=0.000<0.001) were significant, and the R Square increased significantly from 0.521 to 0.624. Model 3 after adding student expectations to model 2, perceived quality (β=0.618, p=0.000<0.001), perceived value (β=0.546, p=0.000<0.001), and student expectations (β=0.614, p=0.000<0.001) have significant path coefficients, and the R Square increases significantly from 0.624 to 0.697. Model 4, after adding student expectations to model 3, perceived quality (β= 0.618, p=0.000<0.001), perceived value (β=0.546, p=0.000<0.001), student expectations (β=0.614, p=0.000<0.001), self-directed learning ability (β=0.655, p=0.000<0.001) had significant path coefficients, and R Square increased significantly from 0.697 to 0.744. The stratified regression illustrates that the effect of each variable on student satisfaction is significant. As shown in Table 4.3.

Table 4.3 Multiple Regression Analysis

Model		Unstandardized Coefficients		t	Sig.	VIF	R Square	Adjusted R Square
		B	Std. Error					
1	(Constant)	2.345	0.144	16.314	0.000			
	Perceived Quality	0.618	0.040	10.394	0.000	1.000	0.521	0.518
2	(Constant)	1.946	0.163	11.974	0.000			
	Perceived Quality	0.590	0.047	6.152	0.000	1.460		
	Perceived Value	0.535	0.049	4.801	0.000	1.460	0.624	0.611
3	(Constant)	1.754	0.166	10.592	0.000			
	Perceived Quality	0.618	0.049	4.412	0.000	1.664		
	Perceived Value	0.546	0.052	2.788	0.000	1.744		
	Student Expectations	0.614	0.051	4.215	0.000	1.758	0.697	0.679
4	(Constant)	1.541	0.165	9.327	0.000			
	Perceived Quality	0.530	0.051	2.568	0.000	1.870		
	Perceived Value	0.479	0.052	3.501	0.000	1.857		
	Student Expectations	0.570	0.050	3.407	0.000	1.810		
	Self-directed Learning Ability	0.655	0.049	5.221	0.000	1.752	0.744	0.732
a Dependent Variable: Student satisfaction								

NOTE：*P<0.05, **P<0.01, ***P<0.001

Based on the data analysis, it can be concluded that perceived quality has a significant positive impact on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School. Thus, Hypothesis H1 is supported. Similarly, perceived value has a significant positive influence on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School. Hence, Hypothesis H2 is also supported. Student expectations exhibit a significant positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School, confirming that Hypothesis H3 holds. Furthermore, self-directed learning has a significant positive impact on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School, verifying that Hypothesis H4 is valid.

Chapter 5 Conclusion and Recommendation

5.1 Conclusion

This study adopted the quantitative research method. A total of 450 questionnaires were distributed for this study, with 386 valid responses collected, resulting in an effective response rate of 85.8%. The analysis revealed that perceived quality ($\beta=0.618$, $p=0.000<0.001$) has a significant positive impact on the satisfaction of mathematics learners at Shandong Kevin Technical School with their flipped classroom experience. Similarly, perceived value ($\beta=0.546$, $p=0.000<0.001$) positively influences their satisfaction with the flipped classroom setting. Student expectations ($\beta=0.614$, $p=0.000<0.001$) also contribute positively to their satisfaction, while self-directed learning ability ($\beta=0.655$, $p=0.000<0.001$) demonstrates the strongest positive effect on their satisfaction. Consequently, there exists a significant positive correlation between the variables of perceived quality, perceived value, student expectations, self-directed learning ability, and student satisfaction. All hypotheses are supported.

5.1.1 Perceived Quality Has a Significant Positive Effect on the Mathematics Learners' Satisfaction with Flipped Classroom

The findings showed that perceived quality ($\beta=0.618$, $p=0.000<0.001$) had a positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School. This means that when students perceive their learning in the flipped classroom as valuable, their satisfaction with this mode of instruction increases significantly. If students perceive that the flipped classroom is effective in helping them understand and master mathematics, improve their learning efficiency, or promote their ability to learn independently, they will be more satisfied with this mode of instruction. The increase in satisfaction may be manifested in students' more active participation in classroom activities, their greater willingness to invest time in pre-class pre-study and post-class review (Hsiung et al., 2017; Khanova et al., 2015), and their recognition of the teacher's teaching methods and classroom arrangements.

5.1.2 Perceived Value Has a Significant Positive Effect on the Mathematics Learners' Satisfaction with Flipped Classroom

Perceived value ($\beta=0.546$, $p=0.000<0.001$) has a positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School. When students perceive their learning with the flipped classroom as valuable, their satisfaction with this instructional model increases significantly. The higher the students' perceived value of the flipped classroom, the higher their satisfaction with this instructional model, which may promote better learning outcomes and positive learning

attitudes.

5.1.3 Student Expectations Have a Significant Positive Effect on the Mathematics Learners' Satisfaction with Flipped Classroom

Student expectations (β=0.614, p=0.000<0.001) have a positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School. When students' expectations of the flipped classroom are high, their satisfaction with this instructional model is also significantly higher. Students are more likely to be satisfied during actual participation if they expect the flipped classroom to result in better understanding, more efficient learning, and a better learning experience (Pitt et al., 2020; Tsai & Wu, 2020; Walsh & Rísquez, 2020). Enhancing students' positive expectations of the flipped classroom is essential to increasing their satisfaction and learning outcomes.

5.1.4 Self-Directed Learning Has a Significant Positive Effect on the Mathematics Learners' Satisfaction with Flipped Classroom

Self-directed learning ability (β=0.655, p=0.000<0.001) has a positive and positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School. This means that when students have independent learning abilities, their satisfaction with the flipped classroom as a teaching mode will be increased. Independent learning ability refers to students' ability to independently acquire knowledge, solve problems, and manage learning time and resources (Chua & Islam, 2020; Cicha et al., 2021; Folke, 2006). If students have good independent learning abilities, they can understand and master the pre-course learning materials more effectively and actively participate in and benefit from the classroom activities. This positive learning experience will enhance their satisfaction with the flipped classroom. See Table 5.1.

Table 5.1 Hypothesis Test Results

NO.	Hypothesis	Result
H1	Perceived quality has a significant positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.	Supported
H2	Perceived value has a significant positive effect on the mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.	Supported
H3	Student expectations have a significant positive effect on the mathematics learners' satisfaction with flipped classroom at	Supported

	Shandong Kevin Technical School.	
H4	Self-directed learning has a significant positive effect on mathematics learners' satisfaction with flipped classroom at Shandong Kevin Technical School.	Supported

5.2 Recommendation

(1) Designing High-Quality Flipped Classrooms

Perceived quality refers to the quality of the flipped classroom as perceived by students, while actual quality represents the actual level of quality in the flipped classroom. The perception of quality towards the flipped classroom by both teachers and students in the classroom can vary due to their different roles and perspectives. Student expectations, to a certain extent, reflect their functional needs for the flipped classroom. Only when certain characteristics of the flipped classroom align with these needs can students develop a sense of satisfaction. Therefore, educators should be reminded, from a student-centric perspective, to design high-quality flipped classrooms by avoiding "working in isolation" and instead, continuously understanding students' needs and designing accordingly. Efforts to unilaterally enhance the quality of the flipped classroom without addressing students' actual demands are futile.

To effectively improve the overall quality level of the flipped classroom, the focus lies in the design of its teaching process. While the flipped classroom has transformed teaching forms to a certain extent, effective teaching design, methods, and strategies are the keys to educational success, with technology serving merely as an auxiliary tool. Only a solid and effective teaching design can maximize the facilitative role of the flipped classroom. Classroom design, as a concentrated expression of teaching design, is the most tangible quality system perceived by students. It encompasses the organization of classroom activities, the setup of the classroom environment, the organization of teaching content, and the selection and application of teaching methods and strategies. Actively adopting scenario-based or task-based teaching approaches encourages student participation and stimulates their learning interest. Emphasizing teaching design implicitly enhances teaching quality, not only improving students' perceived quality and satisfaction but also enhancing the overall effectiveness of the flipped classroom.

(2) Adding the Perceived Value

Students will favor the flipped classroom if they think they can spend less effort to get better learning results in the flipped classroom. If students believe that there is no such superiority in the flipped classroom, or even feel that learning in that mode is less efficient than in the traditional classroom, they will have an indifferent or negative attitude toward the flipped classroom. This phenomenon reminds educators of the need

to focus on both quality and value when designing a flipped classroom. Educators need to be clear that the ultimate goal of quality improvement is to enable students to carry out learning activities more efficiently, reduce their learning burden, and make them learn more easily. In the process of flipping, it is necessary to pay attention to the "degree", such as controlling the difficulty of learning materials, paying attention to students' participation and acceptance in the classroom, and enhancing the degree of feedback and attention to students. The control of the "flip degree" can make students learn "more easily" and more willingly in the flipped classroom, and also make teachers' flipped teaching more flexible and efficient.

(3) Responding to Expectations of Students

The dimension of student expectations corresponds to the dimension of perceived quality, primarily encompassing expectations in four aspects: interpersonal relationships, personal development, and system maintenance and change. Students initially hold high expectations for the inherent characteristics of the flipped classroom (such as fairness, flexibility, and openness). Next, they anticipate interpersonal experiences within the flipped classroom (like teacher-student and student-student interactions). Lastly, they consider whether this model will facilitate their personal capability development. Therefore, enhancing the quality level of the flipped classroom itself, by increasing its fun, flexibility, and openness, can elevate students' learning expectations to a certain extent, fostering a strong interest in flipped classroom learning from the outset and creating a favorable beginning for the learning process.

Student expectations are diverse. In mathematics learning, students aspire not only for theoretical development but also for greater emotional support and interest guidance. Learning mathematics should not be confined to acquiring knowledge and skills but should also focus on emotional exchanges and interactions, enhancing interest, and allowing students to experience the fun of numbers, the collision of ideas, and the warmth of collaboration. Only in this way can mathematics transcend being merely a tool or skill and become an emotional bond, thereby satisfying students' multifaceted needs, igniting their passion for learning, and strengthening their motivation. Hence, while emphasizing knowledge transmission, teachers must also attend to students' emotional experiences, for instance, by integrating the origins and implications of mathematical formulas into explanations, instilling a sense of numerical aesthetics, and fostering mutual learning among teachers, students, and their peers.

(4) Cultivating Self-directed Learning Ability

One of the purposes of flipped classroom teaching is to better promote the cultivation of students' independent learning ability, which involves students' cognition, motivation, behavior, and other aspects. A flipped classroom has a positive effect on

promoting students' independent learning ability. The flipped classroom has the functions of supporting knowledge transfer, improving self-efficacy, cultivating higher-order thinking, and developing independent learning ability. The flipped classroom facilitates the development of students' higher-order thinking skills. Students' independent learning ability is also a prerequisite for flipped classroom teaching. The lack of students' independent learning ability will make it difficult for them to integrate into the learning process of the flipped classroom. At the same time, the gap between students' independent learning abilities will also pull the learning gap of university students in the flipped classroom to a certain extent. Therefore, it is necessary to pay attention to the level of student's independent learning ability, and make reasonable assessments on the difficulty of the course content, the ability level of students, and the characteristics of different learning stages, to realize the "progressive flipping".

To make students better adapt to the flipped classroom teaching and promote the development of their independent learning ability, teachers carry out "gradual flipping" according to the specific teaching content, i.e., flipping part of the content and class time, and adopting the traditional teaching method for part of the content. When the students have adapted to the model, they will gradually realize the complete reversal. The advantage of this approach is that students have sufficient time to understand the flipped classroom model, gradually change the concept and method of learning, to avoid all kinds of negative emotions at the beginning due to the lack of adaptation. At the same time, teachers have accumulated some experience and have rational thinking and judgment about the characteristics of the curriculum and students, which to a certain extent avoids the emergence of "blind flipping" and helps teachers to improve the quality of flipping gradually. Therefore, teachers should follow the principle of "turning to a certain extent" and carry out gradual turning in classroom turning. In addition, in mathematics learning, not all types of courses or course content are suitable for flipped teaching, educators need to be rational, not to flip for the sake of flipping, for some complex and difficult mathematics courses, traditional classroom teaching may achieve better teaching results and student satisfaction.

References

Chang, Y.-J., Chen, C.-H., Huang, W.-T., & Huang, W.-S. (2011). Investigating students' perceived satisfaction, behavioral intention, and effectiveness of English learning using augmented reality. *2011 IEEE International Conference on Multimedia and Expo*, *Computers & Education*, (51). https://doi.org/10.1109/icme.2011.6012177

Chua, K., & Islam, M. (2020). The hybrid project-based learning–flipped classroom: A design project module redesigned to foster learning and engagement. *International Journal of Mechanical Engineering Education*, *3*(44). 030641901983833. https://doi.org/10.1177/0306419019838335

Cicha, K., Rizun, M., Rutecka, P., & Strzelecki, A. (2021). COVID-19 and higher education: First-Year students' expectations toward distance learning. *Sustainability*, *13*(4), 1889. https://doi.org/10.3390/su13041889

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*, *16*(3), 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002

Gong, Y. (Frank), Gao, X. (Andy), & Lyu, B. (2020). Teaching Chinese as a second or foreign language to non-Chinese learners in mainland China (2014–2018). *Language Teaching*, *53*(1), 44–62. https://doi.org/10.1017/s0261444819000387

Gunawardena, L., & Liyanage, M. P. P. (2018, July 1). *Flipped classrooms using social networks: An investigation on learning styles*. IEEE Explore. https://doi.org/10.1109/IIAI-AAI.2018.00199

Han, Z. (2018). Task-Based learning in task-based teaching: Training teachers of Chinese as a foreign language. *Annual Review of Applied Linguistics*, *38*(23), 162–186. https://doi.org/10.1017/s026719051800003x

Hsiung, H.-Y., Chang, Y.-L., Chen, H.-C., & Sung, Y.-T. (2017). Effect of stroke-order learning and handwriting exercises on recognizing and writing Chinese characters by Chinese as a foreign language learner. *Computers in Human Behavior*, *74*(3), 303–310. https://doi.org/10.1016/j.chb.2017.04.022

Khanova, J., Roth, M. T., Rodgers, J. E., & McLaughlin, J. E. (2015). Student experiences across multiple flipped courses in a single curriculum. *Medical Education*, *49*(10), 1038–1048. https://doi.org/10.1111/medu.12807

Lin, H.-C., & Hwang, G.-J. (2018). Research trends of flipped classroom studies for medical courses: A review of journal publications from 2008 to 2017 based on the technology-enhanced learning model. *Interactive Learning Environments*, *27*(8), 1011–1027. https://doi.org/10.1080/10494820.2018.1467462

Pitt, M. B., Li, S.-T. T., & Klein, M. (2020). Novel educational responses to COVID-19: What is here to stay? *Academic Pediatrics*, *20*(6), 733–734. https://doi.org/10.1016/j.acap.2020.06.002

Schunk, D. H., & Zimmerman, B. J. (1998). *Self-regulated learning: From teaching to self-reflective practice*. Guilford Press.

Tsai, C.-C., Lin, S. S. J., & Tsai, M.-J. (2001). Developing an internet attitude scale for high school students. *Computers & Education*, *37*(1), 41–51. https://doi.org/10.1016/s0360-1315(01)00033-1

Tsai, H.-L., & Wu, J.-F. (2020). Bibliometric analysis of flipped classroom publications from the web of science core collection published from 2000 to 2019. *Science Editing*, *7*(2), 163–168. https://doi.org/10.6087/kcse.212

Walsh, J. N., & Rísquez, A. (2020). Using cluster analysis to explore the engagement with a flipped classroom of native and non-native English-speaking management students. *The International Journal of Management Education*, *18*(2), 100381. https://doi.org/10.1016/j.ijme.2020.100381

Wan, S., Xiang, Y., Fang, W., Zheng, Y., Li, B., Hu, Y., Lang, C., Huang, D., Sun, Q., Xiong, Y., Huang, X., Lv, J., Luo, Y., Shen, L., Yang, H., Huang, G., & Yang, R. (2020). Clinical features and treatment of COVID-19 patients in northeast Chongqing. *Journal of Medical Virology*, *12*(34). https://doi.org/10.1002/jmv.25783

Zhu, Z.-T., Yu, M.-H., & Riezebos, P. (2016). A research framework of smart education. *Smart Learning Environments*, *3*(1). https://doi.org/10.1186/s40561-016-0026-2

Zimmerman, B. J., & Martinez-Pons, M. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of Educational Psychology*, *80*(3), 284–290. https://doi.org/10.1037/0022-0663.80.3.284

Appendix

Dear Sir/Madam,

Thank you for your participation in this questionnaire survey. The survey will be conducted anonymously, and your relevant information will be kept confidential. Thank you again for your cooperation.

Part Ⅰ:

1. Gender? A Male B Female

2. Age A Under 23 B23-28 C Above 28

3. Grand 1. Freshman □ 2. Sophomore
□ 3. Higher than the Master's degree 4. Other

4. Position 1. Operation □ 2. Manager/senior
□ 3. Junior □ 4. Other.....

5. Tenure in current position (year)
□ 1. Science and Engineering □ 2. Humanities
□ 3. Economics and Management □ 4. Arts
5. Other.

Part Ⅱ: Please judge to what extent you agree with the following statement; choose the most appropriate option, and mark the corresponding number " √. " The questionnaire used a Likert scale, ranging from 1 to 5 in which one indicates strongly disagree (or strongly disagree), two indicates relatively disagree (or relatively disagree), three indicates neutral, four indicates relatively agree (or relatively agree), and five indicates strongly agree (or strongly agree)

Measuring item	Strongly disagree	Disagree	General	Agree	Strongly agree
Perceived Quality					
1. The content of this course is clear and easy to understand.					

2. The teaching materials (e.g., videos, courseware, practice problems, etc.) are informative and help me understand the course content.					
3. The teacher's explanations were well organized and helped me to better understand the course content.					
4. The learning resources provided after the class (e.g. recorded videos, courseware downloads, etc.) are very helpful for me to review.					
5. The learning platform runs stably and the experience of using it is good, which will not affect my learning effect.					
Perceived Value					
1. I feel that I can use my study time more efficiently by learning in a flipped classroom.					
2. I feel better about learning through the flipped classroom.					
3. Through the flipped classroom, my mastery of what I have learned has improved.					
4. I am satisfied with the curriculum and content of the flipped classroom.					
5. The learning style of the flipped classroom enhances my interest and motivation in learning.					
Student Expectations					
1. I expect that my academic performance will be significantly improved through the flipped classroom learning method.					
2. I expect that through the flipped classroom, I will be able to master what I have learned in a more comprehensive and in-depth way.					
3. I expect to improve my independent learning and problem solving skills through the flipped classroom.					
4. I expect to participate more actively in class discussions and learning					

activities through the flipped classroom.					
5. I expect that the flipped classroom will stimulate my interest and enthusiasm in learning mathematics.					
Self-Directed Learning Ability					
1. I can reasonably plan my study time and study tasks.					
2. I am good at utilizing various learning resources (e.g. textbooks, online resources, extracurricular books, etc.) to assist my learning.					
3. I am able to solve the problems encountered in my study independently and look for relevant solutions.					
4. I can set clear learning goals for myself and try to achieve them.					
5. I am able to check and evaluate my learning progress regularly and adjust my learning strategies as necessary.					
Student Satisfaction					
1. I am satisfied with the instructor's teaching methods.					
2. I am satisfied with the opportunities for interaction and discussion in the classroom.					
3. I am satisfied with the learning atmosphere in the classroom.					
4. I found the course content to be informative and challenging and to meet my learning needs.					
5. I was satisfied with the feedback and post-course support provided by the instructor.					
6. Overall, I was satisfied with my experience in this class.					