

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

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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 status quo of mathematics teaching to a great extent. Therefore, it becomes important to explore the satisfaction of math learners in technical schools with the flipped classroom and the factors affecting the satisfaction of the student's classroom experience.

The objectives of this study are: 1) to explore whether perceived quality affects the flipped classroom satisfaction of math learners; 2) to explore whether perceived value affects the flipped classroom satisfaction of math learners; 3) to explore whether students' expectations affect the flipped classroom satisfaction of math learners; and 4) to explore whether independent learning ability affects the flipped classroom satisfaction of math learners. The quantitative method was used in this study. A total of 450 questionnaires were distributed in this study, and 386 valid questionnaires were recovered, with a validity rate of 85.8%. This paper found that: 1) perceived quality has a significant positive effect on the flipped classroom satisfaction of math learners; 2) perceived value has a significant positive effect on the flipped classroom satisfaction of math learners; 3) student expectations have a significant positive effect on the flipped classroom satisfaction of math learners; 4) independent learning has a significant positive effect on the flipped classroom satisfaction of math learners. For recommendations, the flipped classroom satisfaction of math learners in Shandong Kevin Technical School should focus on the following aspects: 1) designing a high-quality flipped classroom; 2) improving the perceived value; 3) improving the learning expectations of students; and 4) cultivating the ability of independent learning.

Keywords: Influencing Factors, Flipped Classroom Satisfaction, Mathematics Learners, Shandong Kevin Technical School

Introduction

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 informatization, 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, by enhancing the interaction between teachers and students, students and students, to promote students' active learning (Cicha et al., 2021). Therefore, flipped classrooms play an important role in deepening education reform and expanding education opening.

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). W

With the continuous advancement of education informatization, the emergence of flipped classrooms has improved the status quo of mathematics teaching to a great extent. 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.

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 flipped classroom satisfaction of mathematics learners in 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).

It 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 school, 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).

It 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).

Research Objectives

(1) To explore whether perceived quality affects math learners' flipped classroom satisfaction in Shandong Kevin Technical School.

(2) To explore whether perceived value affects the satisfaction of math learners' flipped classrooms in Shandong Kevin Technical School.

(3) To explore whether student expectations affect the satisfaction of flipped classrooms of math learners in Shandong Kevin Technical School.

(4) To explore whether independent learning ability affects the satisfaction of flipped classrooms of mathematics learners in Shandong Kevin Technical School.

Research Hypotheses

H1: Perceived quality has a significant positive effect on the satisfaction of math learners' flipped classrooms in Shandong Kevin Technical School.

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

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

H4: Self-directed learning has a significant positive effect on the flipped classroom satisfaction of learners of mathematics in Shandong Kevin Technical School.

Literatures Review

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 virtual cyberspace and 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).

Perception 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.

Perceived value

In education, students' perceived value is rarely related to price, but rather to "learning efficiency". In a flipped classroom environment, the perceived value of math students in a technical school should arise from comparing the "give" and "take". The "give" in this context refers more to learning time than money (Zhu et al., 2016). "Gain" mainly refers to the mastery of knowledge and, the ability to improve. Perceived value is characterized by two main indicators, namely, the perception of quality for a given price and the perception of price for a given quality, i.e., "value for money". Therefore, the observation of students' perceived value is also divided into two aspects accordingly: whether the adoption of the flipped classroom mode helps students master more knowledge and realize the enhancement of their abilities under the same learning time; whether the adoption of the flipped classroom mode can promote students to master relevant knowledge more quickly under the same knowledge learning and ability acquisition (Wan et al., 2020).

Student Expectations

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).

Autonomous Learning Ability

There is no uniform definition of autonomous learning ability, scholars have introduced autonomous learning into teaching and learning and defined autonomy as "the ability to take control of one's learning". This study also adopts this approach to define the "independent learning ability" of mathematics learners (Tsai & Wu, 2020; Walsh & Rísquez, 2020).

Students' self-directed learning ability should be assessed by metacognition, motivation, and behavior. Independent learning ability is divided into three dimensions: motivation, metacognitive strategies, and learning behaviors. Some scholars divide independent learning ability into six dimensions: motivation, confidence, target content, knowledge of learning strategies and planning, assessment, and monitoring skills. There are numerous dimensions of measuring independent learning ability (Lin & Hwang, 2018; Pitt et al., 2020). Therefore, this paper focuses on the six dimensions of students' self-monitoring skills, self-planning skills, self-efficacy, learning responsibility, learning attitudes, and motivation to reflect their independent learning ability based on their own experience of flipped classroom observation and the information from the literature they read.

Classroom 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.

Methodology

This study adopted the quantitative research method. This study was conducted to collect data from learners of mathematics at Shandong Kelvin Technical School. The questionnaire of this study consists of two parts. The first part is to know the basic information of the research subjects, i.e., gender, specialty, and grade level. The second part is the specific measures of student satisfaction and the factors affecting satisfaction. All of them were measured using a five-point Likert scale, with scales 1 to 5 indicating "very dissatisfied", "dissatisfied", "average", "satisfied" and "very satisfied", respectively. and "very satisfied". This study was mainly conducted by distributing questionnaires online. A total of 450 questionnaires were distributed and 386 valid questionnaires were recovered, with an effective rate of 85.8%.

Results

1) Reliability analysis

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 1. Table 1 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. See Table 1.

Table 1: Reliability analysis

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
Classroom Satisfaction	0.872	6

2) Validity analysis

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 2. 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 four factors were extracted from the Rotated Factor Loadings Matrix table, which indicates to some

extent that it is feasible and reasonable to measure the four variables in this study.

Table 2: Validity analysis

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

3) *Correlation Analysis*

In this study, the correlation between the factors affecting students' satisfaction was examined by SPSS. Perceived quality, perceived value, students' expectations, self-directed learning ability, and classroom 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 flipped classroom 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 classroom satisfaction.

4) *Multiple regression*

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 ($\beta = 0.618$, $p = 0.000 < 0.001$) in model 1 is significant.

Table 3: Multiple regression

Model		Unstandardized Coefficients		t	Sig.	VIF	R Square	Adjusted R Square
		B	Std. Error					
1	(Constant)	2.345	0.144	16.314	0.000		0.521	0.518
	Perceived Quality	0.618	0.040	10.394	0.000	1.000		
2	(Constant)	1.946	0.163	11.974	0.000		0.624	0.611
	Perceived Quality	0.590	0.047	6.152	0.000	1.460		
	Perceived Value	0.535	0.049	4.801	0.000	1.460		
3	(Constant)	1.754	0.166	10.592	0.000		0.697	0.679
	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		
4	(Constant)	1.541	0.165	9.327	0.000		0.744	0.732
	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		

a Dependent Variable: Classroom Satisfaction

Model 2 with the addition of the variable (perceived value) to model 1, the path coefficients of perceived quality ($\beta=0.590$, $p=0.000<0.001$), and perceived value ($\beta=0.535$, $p=0.000<0.001$) 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 ($\beta=0.618$, $p=0.000<0.001$), perceived value ($\beta=0.546$, $p=0.000<0.001$), and student expectations ($\beta=0.614$, $p=0.000<0.001$) 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 ($\beta=0.618$, $p=0.000<0.001$), perceived value ($\beta=0.546$, $p=0.000<0.001$), student expectations ($\beta=0.614$, $p=0.000<0.001$), self-directed learning ability ($\beta=0.655$, $p=0.000<0.001$) 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 classroom satisfaction is significant. See Table 3.

Discussion

This paper confirms that perceived quality, perceived value, student expectations, and self-directed learning ability have a significant positive effect on the flipped classroom satisfaction of math learners in technical schools. There are also some correlations and causal relationships between these influences. The perceived quality is the quality of the flipped classroom as perceived by students, while actual quality is the quality of the flipped classroom. The perceived quality of the flipped classroom by teachers and students in the flipped classroom also varies depending on their identities and perspectives. Students' expectations reflect their functional needs for the flipped classroom to a certain extent, and only when certain features of the flipped classroom are compatible with students' needs can students be satisfied.

Therefore, educators should be reminded from the students' perspective that to design a high-quality flipped classroom, they should avoid "closed-door work", understand the students' needs in real-time, and carry out the design in a targeted manner. If the designers try to improve the quality of the flipped classroom but fail to meet the actual needs of the students, their efforts will be futile (Tsai & Wu, 2020; Wan et al., 2020; Zhu et al., 2016).

Students will favor the flipped classroom if they think they can get better learning results with less effort. If students believe that the flipped classroom does not have such superiority, or even feel that they can learn less efficiently in the model than in the traditional classroom, they will have an indifferent or negative attitude towards the flipped classroom. This phenomenon reminds educators to focus on 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, to reduce their learning burden, and to make it easier for them to learn. The student expectation dimension corresponds to the perceived quality dimension, which consists of four main

aspects: expectations about interpersonal relationships, personal development, and system maintenance and change. Students will first have high expectations for the characteristics of the flipped classroom itself (e.g., fairness, flexibility, and openness), then for the interpersonal experience in the flipped classroom (e.g., teacher-student and student-student interactions), and finally for whether the model will promote their ability development.

Therefore, improving the quality of the flipped classroom and increasing its interest, flexibility, and openness will enhance students' learning expectations to a certain extent, so that students will have a strong interest in flipped classroom learning from the very beginning, which creates a good start for flipped classroom learning (Khanova et al., 2015; Tsai & Wu, 2020).

One of the purposes of flipped classroom teaching is to promote 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 (Chua & Islam, 2020; Cicha et al., 2021).

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 students' learning gap in the flipped classroom to a certain extent. Combined with the results of independent learning research, this study mainly reflects students' independent learning ability through five aspects: self-monitoring ability, self-planning ability, self-efficacy, sense of responsibility for learning, and learning attitude.

Conclusions

The findings showed that perceived quality ($\beta=0.618$, $p=0.000<0.001$) had a positive effect on the satisfaction of learners in the 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.

Perceived value ($\beta=0.546$, $p=0.000<0.001$) has a positive effect on the satisfaction of math learners in the flipped classroom at Shandong Kevin Technical School. When students perceive their learning in 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. Student expectations ($\beta=0.614$, $p=0.000<0.001$) have a positive effect on the satisfaction of math learners in the 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 & Risquez, 2020). Enhancing students' positive expectations of the flipped classroom is essential to increasing their satisfaction and learning outcomes. Self-directed learning ability ($\beta=0.655$, $p=0.000<0.001$) has a positive and positive effect on the satisfaction of math learners in the 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.

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