Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2, 547-562
2026
Publisher: Learning Gate
DOI: 10.55214/2576-8484.v10i2.12153

The impact of teacher competence on learning outcomes in university flipped classroom teaching

Hao Wang[1*], Junainah Abd Hamid[2], Jacquline Tham[3]
[1]Shanxi Institute of Science and Technology, Jincheng 048011, China; d193948969@gmail.com (H.W.).
[2]Management and Science University, Shah Alam 40100, Malaysia; junainah@msu.edu.my (J.A.H.).
[3]Postgraduate Centre, Management and Science University, Shah Alam 40100, Malaysia; jacquline@msu.edu.my (J.T.).

Abstract: With the deepening of higher education teaching reform, the flipped classroom, as a new teaching model, is gradually replacing traditional rote learning and becoming an important path to improve the quality of university teaching. Since the researchers aim to clarify the relationship between teacher competence and learning outcomes in flipped classroom implementation in higher education institutions in Shanxi Province, China, the purpose of this study can be summarized as hypothesis testing. Through stratified random sampling, the study covers 10 undergraduate institutions in Shanxi Province. Data was collected using a Likert scale, and a student learning efficacy scale was designed to address the research questions. Research has found that teacher competence has a direct impact on teaching effectiveness, but different teacher competencies have varying degrees of impact on the various dimensions of learning outcomes. This paper defines the core dimensions of teacher competence, analyzes the mechanism by which teacher competence affects student learning outcomes, and verifies the correlation between the two through empirical analysis. This provides theoretical support and practical reference for improving flipped classroom teaching practices and building a strong teaching force in higher education institutions.

Keywords: *Flipped classroom, Learning outcome, Teacher competence.*

1. Introduction

Driven by the "Internet + Education" initiative and the construction of new engineering and liberal arts disciplines, China's higher education is transforming. The traditional teaching model centered on teachers and focused on classroom lectures has failed to meet students' needs for individualized learning and the goal of cultivating their innovation abilities. Flipped Classroom, as a disruptive teaching model, restructures traditional teaching and grants students more autonomy in learning. This process includes three stages: before class, during class, and after class, and the role of the teacher is that of a guide [1].

In recent years, the application scope of the flipped classroom in China's higher education institutions has been continuously expanding, covering multiple disciplines such as liberal arts, science, engineering, agriculture, and medicine. However, in practice, the teaching effects of some flipped classrooms have not met expectations, with problems such as "formal flipping but no substantial change," "insufficient student participation," and "inadequate internalization of knowledge" emerging. A deep analysis reveals that teachers, as the design, organization, and guidance subjects of the flipped classroom, their ability levels directly determine the implementation quality of the teaching model and are the key variable influencing students' learning outcomes. Compared with traditional classrooms, the flipped classroom requires teachers to not only have solid professional knowledge but also master comprehensive abilities such as course design, information technology application, interactive guidance, and diversified evaluation. However, the current ability structure of some university teachers still makes it difficult to meet the teaching demands of the flipped classroom, and this contradiction has become the

History: Received: 18 November 2025; Revised: 12 January 2026; Accepted: 16 January 2026; Published: 16 February 2026
* Correspondence: d193948969@gmail.com

core bottleneck restricting the improvement of the teaching effectiveness of the flipped classroom. Teachers will use classroom time to carry out more learning projects, such as discussions, exercises, interactions, and activities [2]. Therefore, systematically studying the impact of teachers' abilities on learning outcomes in the flipped classroom of universities has significant theoretical value and practical significance.

In the research on teachers' capabilities, the role of teachers in the flipped classroom undergoes a fundamental transformation, and their capability requirements cover multiple dimensions. Teachers need to possess the ability to digitize course content, design and push learning resources, and organize classroom interactions. At the same time, they should be able to precisely control students' pre-class learning situations through online platforms. Subsequent scholars have further expanded the dimensions of teachers' capabilities, suggesting that teachers should also have the ability to conduct multi-dimensional evaluations, provide personalized guidance, and integrate technology. Among these, the ability to integrate technology is the foundation for the smooth implementation of the flipped classroom, which can help teachers optimize teaching processes and enhance teaching efficiency through information technology. This makes the flipped classroom a highly promising teaching method for teachers [3].

In research on the impact of teachers' capabilities on learning outcomes, many scholars have verified the correlation between the two through empirical studies. Some studies have found that teachers' course design capabilities directly affect the effectiveness of students' pre-class learning. Scientific and reasonable pre-class learning task design can stimulate students' interest in learning and enhance their autonomous learning efficiency. Teachers' interactive guidance capabilities are positively correlated with students' classroom participation and the internalization of knowledge. Efficient classroom interaction can promote students' active thinking and collaborative exploration, thereby improving learning outcomes. Additionally, some studies have pointed out that teachers' evaluation and feedback capabilities play a crucial role in maintaining students' learning motivation. Timely and accurate evaluation and feedback can help students identify learning problems and adjust learning strategies, thereby enhancing learning effectiveness.

Teachers need to enhance their awareness and continuously improve their teaching skills, including the application of technology, utilization of resources, and teaching methods, to provide better education. To achieve the goal of enhancing digital literacy, continuous training must be carried out. The age of teachers and their ability to use information devices both impact teaching skills [4]. Online teaching methods and flipped teaching methods both have immediate and delayed positive effects on students' writing abilities, but the effectiveness of flipped teaching methods is superior to online teaching methods. Specialized training on online teaching and flipped teaching needs to be provided for teachers [5]. Higher education institutions should enhance teachers' performance expectations and technological self-efficacy, thereby promoting teachers to adopt flipped classrooms and other active learning teaching models more actively [6]. A survey research by Eli [7] on college students' cognition of innovative and interactive teaching methods showed that over 70% of respondents hoped to continue training in innovative and interactive teaching methods for teachers. Teachers are encouraged to adopt more systematic teaching organization methods, consider the practical impact of the knowledge imparted on practice, and design practical exercises and tasks to deepen students' learning effects through practical activities [8]. University teachers use learning analysis reports to diagnose and intervene in students' learning activities, which prompts interaction between teachers and students. Learning analysis reports not only provide information but also offer intervention suggestions, thereby offering more comprehensive support for teachers [9]. Despite individual differences in teaching, when flipped classrooms and digital technology are used synergistically, they can provide effective support for physical education teaching [3]. By building a teacher training system centered on ability development, focusing on the key teaching methods and learning models of flipped classrooms, it can effectively stimulate various factors that affect the effectiveness of flipped classrooms [10].

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

The effectiveness of the flipped classroom model largely depends on teachers' digital literacy and systematic training [4], while technological self-efficacy [6] and structured design [8] are the keys to success. At the student level, there is an adaptive contradiction: 91.1% of students recognize innovative teaching [7], but their attitudes towards video learning are polarized [11], and the cultivation of higher-order skills (such as computational thinking) relies on peer connections and intrinsic motivation [12]. Subject practice demonstrates differentiated value: physical education classes can optimize exercise duration [3], and the effectiveness of English writing is better than the pure online model [5]. Breakthrough strategies need to be implemented simultaneously in three improvements: targeted teacher training [10], embedding gamification incentive mechanisms [13], and learning analysis intervention [9] in order to break through the collaborative obstacles among "technology tools, teaching proficiency, and student acceptance".

2. Materials and methods

This study aims to explore the factors by which teacher competencies influence student learning outcomes. It outlines the methodology employed during the research process, focusing on research hypotheses, research design procedures, sampling design procedures, instrument development procedures, and data analysis procedures.

Teachers need to receive training in relevant fields to improve their teaching skills and better implement flipped classroom instruction. Their performance expectations and technological self-efficacy should be enhanced [6]. Teachers should be encouraged to actively participate [8].

Teachers with strong instructional design skills can effectively plan teaching content and methods, clarify learning objectives and key points, and develop scientifically sound teaching plans based on syllabi and student characteristics. This helps students better comprehend and master knowledge while improving learning outcomes. For instance, in flipped classrooms, carefully designed pre-class materials and tasks not only guide targeted preparation but also lay the foundation for in-class learning. Teachers' instructional organization and guidance capabilities are crucial to learning effectiveness. In classroom teaching, teachers must allocate time and activities wisely, facilitate discussions and practical exercises, and promptly guide students in problem-solving. For example, in group cooperative learning, teachers can effectively enhance student engagement and collaboration efficiency, fostering teamwork and communication skills. This deepens students' understanding through interaction and strengthens learning outcomes. Teachers' profound subject expertise and extensive pedagogical knowledge enable them to thoroughly explain complex concepts and principles, flexibly apply diverse teaching methods and strategies to meet varied student needs, promote deep learning, and enhance their ability to apply knowledge and innovate.

2.1. Research Design Process

This study aims to elucidate the relationship between teacher competence and factors influencing learning outcomes in Shanxi Province's universities implementing flipped classrooms. Therefore, the purpose of this study can be summarized as hypothesis testing. The study adopted a stratified random sampling method and selected 10 undergraduate institutions in Shanxi Province as the research subjects. The data collection was conducted using the Likert scale, and a student learning efficiency scale was designed to answer the research question. After the questionnaire was distributed, the researchers used the collected large sample data to analyze the reliability and validity of the questionnaire again, in order to verify the rationality and scientificity of the questionnaire. Finally, based on the collected data, this study conducted a descriptive analysis of the basic characteristics of the research subjects, laying the foundation for subsequent result analysis.

2.1.1. Research Paradigm

Positivist research pursues objectivity and strives to discover universal laws. It focuses on the collection and analysis of quantitative data and emphasizes the reproducibility of results. Positivist

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

research concentrates on controlling for other variables that may affect research results to ensure their validity. In the experimental study of a flipped classroom, students can be randomly selected to control for interference from other influencing factors. Positivist research typically attempts to identify causal relationships, that is, the influence of one factor on another. For flipped classroom research, positivism can help determine whether flipped classrooms directly improve students' academic performance. By reviewing the widely existing paradigms in the literature briefly discussed earlier, the researchers intend to develop a research design process based on the post-positivist paradigm, which aligns well with the current research objectives and hypotheses of quantitative research, namely the impact of teacher competence on learning outcomes.

2.1.2. Research Method

This study adopts quantitative research methods. The data was collected through a questionnaire survey and analyzed using numerical analysis methods.

2.1.3. Type of Data

The data collected in this study is primary data, which refers to first-hand information of the relevant variables. Primary data will be collected through the distribution of questionnaires, and it is expected that 800 questionnaires will be distributed.

2.2. Sampling Design Process

All the projects within the field of interest to the researchers are collectively referred to as the population. A statistical survey conducted on all the projects is called a census. One might think that if there are no omissions in the population, higher accuracy can be achieved. However, without surveys or sampling, it is impossible to test whether the census results are biased or the degree of bias. Moreover, a census requires a significant amount of resources, such as funds, time, and human resources. On the other hand, sometimes sampling the population can also provide sufficient accuracy. Therefore, in the field of research, collecting information from samples rather than the entire population is a common practice. At this time, the sampling design process becomes extremely important as it guides how to select an appropriate number of samples that can represent the relevant population.

2.2.1. Unit of Analysis

Before selecting a sample, it is necessary to determine the sampling unit or analysis unit. Since this study aims to investigate the factors affecting college students' learning outcomes, the analysis unit is the average level of college students in Shanxi Province.

2.2.2. Sampling Design

This study adopts probability sampling, which means that the probability of each element in the population being included in the sample is equal. In this design, researchers randomly select samples from the population. Generally speaking, if the general applicability of research results is more important than other factors such as time and resources, then probability sampling design is more desirable. Given the crucial importance of teaching and learning outcomes for college students in Shanxi Province, a probability sampling design is more suitable for this study.

2.2.3. Sample Size

According to Cohen [14] and Krejcie and Morgan [15] sample determination method was used, and it was decided to select 384 students from 10 universities in Shanxi Province as the sample. According to the principle that the effective response rate of the questionnaire is generally not less than 60%, 384/(0.6)=640. Considering the need to eliminate invalid questionnaires, it is expected to distribute 800 questionnaires.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

2.3. Instrument Development Process

Developing effective and reliable tools is crucial for achieving research objectives. Researchers need to collect accurate and useful information from respondents, which requires the development of appropriate data collection tools. In this study, data were collected through a structured questionnaire. The following sections will provide a detailed description of this process.

2.3.1. Instrument Development

Fairness issues can be maintained by constructing consistent measurement methods. To ensure the fairness of the questionnaire, we formed an expert group of six university professors to review the language, content, and items to avoid dissatisfaction or discomfort among respondents. Subsequently, we compiled a question bank.

2.3.2. Pre-Test and Item Modification

The initial question bank will be sent to a selected group of experts for review. This helps to eliminate unnecessary questions and further refine the remaining questions. In this study, six university professors participated in the questionnaire review process. After the experts' review, the researchers distributed questionnaires to a small number of respondents for a pre-test to assess their cognitive abilities and motivation levels. Based on the feedback from the participants, the questionnaire was slightly modified. After these steps of modification, the research can officially commence.

2.3.3. Reliability of the Questionnaire

Reliability is one of the most important indicators for measuring the quality of a measurement tool. The degree of measurement error and the guarantee of the consistency of measurement results across different time periods and measurement items are called the reliability of measurement. For a given measurement, reliability can be evaluated through two methods: stability and internal consistency. Stability refers to whether the same measurement conducted at two different times remains consistent, unaffected by uncontrollable factors such as test conditions and respondents' emotions. Internal consistency refers to whether a set of specific concepts' items can independently measure that concept. The most common method for evaluating the internal consistency of a scale is Cronbach's alpha coefficient, whose reliability coefficient ranges from 0.00 to 1.00, with a higher coefficient indicating higher reliability.

2.3.4. Validity of the Measurement Scale

The validity of the measurement scale is evaluated through various validity tests. These tests can be broadly classified into three categories: content validity, criterion-related validity, and construct validity. Content validity ensures that the tool includes sufficient and representative items that can reflect the relevant concepts. A group of university professors can assess the developed tool and ensure its content validity. If the results obtained using this tool are consistent with the theoretical concepts, the structural validity of the measurement tool is supported. The correlation that conforms to the expected pattern helps to prove the structural validity.

2.3.5. Instrumentation of Measurement Items

This questionnaire aims to investigate the effectiveness of the flipped classroom. The questionnaire contains 50 items and is measured using a five-point Likert scale, with options ranging from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = unsure, 4 = agree, 5 = strongly agree). Students can only select one answer for each item based on the actual situation.

2.3.6. Questionnaire

The questionnaire used in this study is an adapted version that draws on and integrates multiple validated scales. To make it more suitable for the actual situation and cultural background of

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

undergraduate students in Shanxi Province, the wording of some questions has been moderately modified; however, the overall scale structure and core measurement dimensions remain unchanged. The questionnaire was initially written in English, and a Chinese version was produced for distribution. To ensure conceptual and linguistic equivalence, we adopted a forward-backward translation procedure and invited bilingual experts to participate. All items are scored using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Demographic statistics:

1. Class year

a. Freshman (First year)

b. Sophomore (Second year)

c. Junior (Third year)

d. Senior (Fourth year)

2. Genders

a. Female (Female)

b. Male (Male)

TC (Teacher competence)

3. Flipped classrooms allow teachers more time to demonstrate specific skills.

4. My instructor provided illustrations that made the course content more understandable to me.

5. My instructor reinforced the development of a sense of community among course participants.

6. My instructor clearly communicated important due dates/time frames for course activities.

7. My instructor clearly communicated the goals of the course activities.

8. My instructor provided clear instructions on how to participate in course activities.

LO (Learning outcome)

9. One of the advantages of the Flipped Classroom teaching approach is that it can improve learners' learning performance.

10. One of the advantages of the Flipped Classroom teaching approach is that it can make class time more efficient.

11. Flipped learning enables me to prepare better for the test.

12. Flipped learning helps me to enrich my knowledge.

13. Flipped learning improves my higher-order thinking skills (analysing, evaluating, creating).

2.4. Data Analysis Process

The determination of statistical testing methods should be carried out during the planning stage of the research, rather than during the implementation stage. This is because, without effective statistical testing methods to analyze the information, it is easy to draw incorrect conclusions.

2.4.1. Data Collection

The researchers used self-administered questionnaires to collect data in a short period of time and had the opportunity to answer any questions raised by respondents during the filling process. The data collection was entirely completed by the researchers themselves, without the assistance of interviewers, thus ensuring that the researchers were directly involved throughout the process.

2.4.2. Data Coding

Data coding is the first step in the data recovery and analysis process. During this step, participants' responses will be numbered so that the data can be entered into the database. This method effectively avoids confusion when the questionnaire is large in number and there are many questions. In this study, each collected questionnaire is assigned a code, which represents the student who filled out the questionnaire.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

2.4.3. Data Analysis

This study uses SPSS and Amos software to complete data organization and analysis. Since the questionnaire contains multiple items and the main statistical factors are of simple types, the measures of central tendency are represented by the mode and median. Bar charts, pie charts, and probability tables are used to display the frequency and percentage of information related to the respondents.

2.4.4. Ethical Considerations

Ethical norms in data collection are crucial for the accuracy of research results. Before distributing questionnaires to students and teachers, the researchers obtained the informed consent of the students themselves. In particular, it is worth noting that the researchers were responsible for maintaining the anonymity of the respondents when distributing the questionnaires and encouraging the respondents to freely express their opinions and views. Therefore, this study did not require the respondents to provide their names. The researchers explained the purpose of the study to the respondents and informed them that participating in the survey was completely voluntary and that the respondents would not be subject to any negative consequences. First of all, it is necessary to ensure that the respondents give informed consent. At the beginning of the questionnaire, clear and understandable language should be used to inform the respondents of the purpose, use, time required, and that participation is completely voluntary, and the respondents have the right to withdraw at any time without any negative consequences. After the respondents fully understand the relevant information, they should have the right to decide whether to participate in the questionnaire survey on their own.

Secondly, protect privacy and confidentiality. We must promise to strictly keep confidential all information provided by the interviewee and ensure that it will not be disclosed to any unrelated third party. In questionnaire design, unnecessary sensitive information and personal identification information should be avoided. If such information is indeed needed, encryption and other appropriate storage measures should be taken. For example, for some questions involving personal academic performance and family background, caution should be exercised, and the confidentiality process should be clearly explained to the interviewee.

In addition, it is necessary to ensure the authenticity and objectivity of the data. The questionnaire title should avoid using guiding and biased language to prevent affecting the independent judgment of respondents, and truthfully present all aspects related to the survey topic, without exaggeration or concealment, in order to provide sufficient space for respondents to express their true thoughts.

Finally, the rights of the interviewees must be respected. If the interviewee has any questions about the questionnaire content and data usage, clear answers should be provided in a timely manner. If data errors or additions are found in subsequent research, the same ethical principles must be followed when contacting the respondents again, including obtaining their consent again. Only by adhering to these ethical requirements in all aspects can the data collected from questionnaire surveys have a solid ethical foundation and provide reliable support for subsequent research analysis.

2.4.5. Findings from the Pilot Study

A preliminary test was conducted on 100 samples, and the results showed that Cronbach's Alpha > 0.8, indicating that the scale has excellent reliability and high internal consistency and can be used. See Table 1 for details.

Table 1.
Reliability analyses from pilot tests.

Variables	No. Items	Cronbach Alpha
Teacher competence	6	0.933
Learning outcome	5	0.914

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

3. Results

A total of 800 questionnaires were distributed, and 550 valid questionnaires were retrieved. The data were analyzed using SPSS and AMOS software. The results indicated that the model fit well.

3.1. Overview

During the research process of the doctoral thesis, the quality and reliability of the data are crucial factors for ensuring the scientificity and effectiveness of the research results. Through in-depth analysis of the data using SPSS software, the goodness of fit of the data can be comprehensively evaluated from multiple dimensions. This article will detail how to use SPSS to analyze the goodness of fit of the data, covering important aspects such as data completeness, accuracy, consistency, normality, reliability, and validity.

3.1.1. Data Screening

In the field of data analysis, normality is an important prerequisite assumption for many statistical analysis methods. When the data follows a normal distribution, it can provide a solid foundation for subsequent analysis and ensure the reliability and validity of the results.

Table 2.
Descriptive statistics.

Items	MV	SD	Skewness		Peakedness	
			Statistics	Standard error	Statistics	Standard error
TC1	4.32	0.819	-1.099	0.104	0.877	0.208
TC2	4.29	0.805	-1.059	0.104	1.011	0.208
TC3	4.20	0.879	-.934	0.104	0.419	0.208
TC4	4.29	0.815	-1.157	0.104	1.388	0.208
TC5	4.28	0.795	-.981	0.104	0.735	0.208
TC6	4.33	0.819	-1.081	0.104	0.760	0.208
LO1	4.25	0.833	-1.158	0.104	1.483	0.208
LO2	4.13	0.870	-.985	0.104	1.037	0.208
LO3	4.09	0.867	-.939	0.104	1.071	0.208
LO4	4.14	0.850	-.915	0.104	0.816	0.208
LO5	4.26	0.863	-1.271	0.104	1.830	0.208

In Table 2, the mean of the normal distribution data can well reflect the central tendency of the data, with most of the data distributed around the mean. Meanwhile, the standard deviation reflects the degree of dispersion of the data. In the normal distribution, approximately 68% of the data fall within the range of the mean ± 1 standard deviation, approximately 95% of the data fall within the range of the mean ± 2 standard deviations, and approximately 99.7% of the data fall within the range of the mean ± 3 standard deviations. This reasonable balance between the central tendency and the degree of dispersion makes the data have good stability and regularity.

The symmetry of the normal distribution ensures that the distribution of data on both sides of the mean is relatively balanced, without obvious skewness. Unimodality means that there is only one peak in the data, which coincides with the mean and the median, and the data distribution shows a clear central tendency. This symmetrical unimodal pattern makes it easier to handle and interpret data when conducting statistical analysis.

When the data follow a normal distribution, the estimation of overall parameters (such as the mean, variance, etc.) based on sample data is more accurate and reliable. For example, when estimating the overall mean, if the data follow a normal distribution, the sample mean is an unbiased estimate of the overall mean, and its sampling distribution also follows a normal distribution. This makes it easier to calculate the confidence interval, thereby enabling a more accurate inference of the range of the overall mean.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

Under the assumption of normal distribution, the performance of various statistical tests is better. For data that conform to the normal distribution, the t-test can accurately compare whether there is a significant difference between the means of two groups of samples; analysis of variance (ANOVA) can effectively test whether the differences in the means of multiple groups of samples are statistically significant; in addition, the estimation of model parameters and hypothesis testing in linear regression analysis are also more reliable. These test results can provide strong evidence for research questions and help researchers draw scientific conclusions.

3.1.2. Assessment of Multicollinearity

When constructing statistical models, such as multiple regression analysis, multicollinearity is a critical issue that needs to be given special attention. If there is no severe multicollinearity or the multicollinearity is in a good state in the SPSS model, it is of great significance for the accuracy and stability of the model as well as the interpretation of the results. The data in Table 3 is reasonable.

Table 3.
Multicollinearity.

Model	Tolerance	VIF
TC	0.679	1.472

The variance inflation factor (VIF) is a commonly used indicator for assessing the severity of multicollinearity. It is calculated by performing a regression analysis on one independent variable with the remaining independent variables. The VIF value is determined by the coefficient of determination obtained from this regression. The larger the VIF value, the stronger the covariance between the independent variables. In SPSS, the variance inflation factor can be obtained through the regression analysis options. Generally, when the VIF value is greater than 10, it indicates a serious problem of multicollinearity. If the VIF value is between 1 and 5, it is usually considered that the multicollinearity is acceptable, meaning that the multicollinearity control of the model is good.

Tolerance is the reciprocal of the variance inflation factor (VIF). The smaller the tolerance value, the stronger the covariance between the independent variables. Similar to VIF, tolerance is also an indicator used to determine the degree of multicollinearity. Usually, a tolerance value less than 0.1 indicates a serious problem of multicollinearity. In this study, the tolerance values of the independent variables in the model are greater than 0.1, indicating that the model performs well in terms of multicollinearity. When the multicollinearity of the model is low, the estimated values of the regression coefficients are more stable, and the regression coefficients estimated using SPSS can reasonably reflect their independent effects on house prices.

3.2. Sample Characteristics

This study selected students from 10 universities in Shanxi Province as the research subjects. A total of 800 questionnaires were distributed, and 550 valid questionnaires were retrieved. The effective sample size was 550, with 291 males (52.9%) and 259 females (47.1%).

Table 4.
Distribution of the Respondents by Gender.

Gender	Frequency	Percent
Male	291	52.90%
Female	259	47.10%
Total	550	100%

Table 5 shows the distribution of sample sizes by grade.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

Table 5.
Sample size grade distribution.

Class year	Frequency	Percent
Freshman	109	19.80%
Sophomore	156	28.40%
Junior	148	26.90%
Senior	137	24.90%
Total	550	100%

3.3. Data Analysis

This section analyzes the data.

3.3.1. EFA (Exploratory Factor Analysis)

Table 6.
Summary of Final KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.935**
Bartlett's Test of Sphericity	Approx. Chi-Square	8680.613
	df	630
	Sig.	0.000

Eigenvalues are indicators for measuring the significance of factors. Generally, factors with eigenvalues greater than 1 are considered significant. The factor analysis results list the eigenvalues of each factor and their contribution rates. The contribution rate represents the proportion of the total variance explained by the factor. The larger the contribution rate, the more significant the factor. The absolute value of the factor loading reflects the strength of the correlation between the observed variable and the factor. In general, when the absolute value of the factor loading is greater than 0.5, it indicates a strong correlation between the variable and the factor, and the loading of the variable on this factor is higher. The factor loading matrix should avoid having too many loads with small absolute values as much as possible; otherwise, it will affect the interpretability of the factor. The purpose of factor rotation is to make the factor loading matrix easier to interpret. Orthogonal rotation maintains the orthogonality (independence) of factors, such as variance maximization rotation (Varimax Rotation), which maximizes the variance of the square of each factor loading, making the factor have a clearer explanatory meaning, suitable for situations where factors are indeed independent of each other. On the other hand, oblique rotation allows for some correlation between factors, such as direct oblique rotation (Direct Oblimin Rotation), which may provide more realistic results in actual data where there may be correlations between factors, but its interpretation is relatively complex. Researchers need to choose the appropriate rotation method based on the characteristics of the research problem and the actual situation of the data.

Table 7.
Results of the factor analysis of constructs.

Construct/Sub-construct	Item code	Factor loading	KMO	Bartlett's test of sphericity
Teacher competence 74.027%	TC1	0.790	0.919	<0.001
	TC2	0.725		
	TC3	0.700		
	TC4	0.713		
	TC5	0.717		
	TC6	0.797		
Learning outcome 75.902%	LO1	0.826	0.897	<0.001
	LO2	0.728		
	LO3	0.695		
	LO4	0.698		
	LO5	0.848		

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

High-quality data is the key to obtaining good results from exploratory factor analysis. During the data collection process, attention should be paid to the accuracy, completeness, and consistency of the data. For questionnaire data, it is necessary to ensure that the questionnaire design is clear, unambiguous, and easy for respondents to understand and answer; for experimental data, it is necessary to strictly control the experimental conditions to ensure the reliability of the data. At the same time, preliminary data cleaning and checks should be carried out, such as handling missing values (depending on the missing situation and research purpose, appropriate interpolation methods or deletion of cases containing missing values can be used), checking outliers (outliers can be identified through data visualization or statistical methods, and depending on the specific situation, they can be handled, such as correcting erroneous data or deleting outliers under reasonable circumstances), etc., to ensure that the data quality meets the requirements of factor analysis.

Table 8.
Rotated Component Matrix (Factor Analysis).

Items	Component	
	1	2
TC1	0.826	
TC6	0.804	
TC5	0.794	
TC3	0.792	
TC4	0.791	
TC2	0.774	
LO5		0.732
LO1		0.718
LO4		0.660
LO2		0.639
LO3		0.620

In exploratory factor analysis, the quality of rotated factor loadings is one of the key elements ensuring the validity and interpretability of the analysis results. When the structure of the rotated factor loadings is good, they can clearly reveal the relationship between observed variables and latent factors, thereby providing strong support for an in-depth understanding of the data structure and research questions.

Good rotated factor loadings help reveal the underlying latent structure hidden behind the observed data. By analyzing the size and distribution of factor loadings, it is possible to determine which variables are mainly related to which latent factors. This process simplifies the complexity of numerous observed variables into a smaller number of meaningful latent factors, thereby simplifying the data structure and facilitating understanding and analysis. Clear rotated factor loadings can provide a basis for factor naming and give the factors practical interpretability. When a factor has a high loading on certain variables and a low loading on others, it can be named based on the conceptual meaning of the high-loading variables. Generally, the absolute value of rotated factor loadings greater than 0.5 is considered significant. This indicates a strong correlation between the observed variables and the corresponding latent factors, and a significant contribution to the factor. High factor loadings indicate a close relationship between the variable and the factor, thereby enhancing the interpretability of the factor. When most variables have significant factor loadings on their respective factors, it means that factor extraction is effective and the model successfully summarizes the underlying structure of the related variables.

The factor loadings after full rotation should also reflect the relative independence of the extracted factors. Although there may be some degree of correlation between factors in real-world data, factor rotation aims to minimize these correlations. This enhances the uniqueness of each factor, allowing for clearer identification and interpretation of their contributions. After rotation, the factor structure should

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

exhibit relative independence, thereby reducing overlap, avoiding confusion between factors, and improving the overall accuracy of the analysis.

3.3.2. CFA Individual

The standard for the validity of knowledge judgment.

Table 9.
Model Fit Indices and Threshold Values.

Name of category	Name of index	Level of acceptance	Reference
Absolute fit	RMSEA	RMSEA < 0.08	Browne and Cudeck (1992)
Incremental fit	CFI	CFI > 0.90	Bentler (1990)
Parsimonious fit	Normed-Chi Square (Chi Square/df)	Chi-Square/df < 5.0	March and Hocevar (1985)

Table 10.
Summary of CFA Model Fit Indices for the Individual Constructs.

Construct	Initial model			
	Normed Chi-Square	CFI	RMSEA	Comments
TC	4.449	0.987	0.079	The required level is achieved in the initial model.
LO	0.251	1.000	0.000	The required level is achieved in the initial model.

The confirmatory factor analysis (CFA) model is based on theoretical hypotheses and actual observed data. Establishing a micro-model for each variable means that the accuracy of data collection is guaranteed. This indicates that the researcher adopted a scientific and rigorous method during the data collection stage to ensure the representativeness of the sample and the reliability and validity of the measurement tools. Only in this way can the collected data lay a solid foundation for the subsequent construction of the micro-models. At the same time, reasonable hypothesis setting is the key guidance for constructing the variable micro-models. Based on previous research results and mature theoretical frameworks, the researcher pre-plans the relationships between latent variables and observed variables and assumes the paths between them. This targeted assumption provides a clear direction for the successful construction of the variable micro-models in the CFA model.

When the variable micro-models are effective, the connection between observed variables and latent variables is firmly established, and the latent variables are no longer vague abstract concepts but are visualized through observed variables, which helps clarify the causal chain. Establishing micro-models for each variable provides a stable foundation for expanding the CFA model. On this basis, researchers can further explore higher-order factor models, that is, to summarize multiple related latent variables into higher-level factors, thereby deepening the understanding of complex phenomena.

4. Discussion

Teacher competence directly impacts teaching effectiveness. In the flipped classroom, teachers need to precisely set learning objectives. Unlike traditional classrooms, flipped classroom objectives should not only encompass knowledge transmission but also emphasize cultivating students' comprehensive qualities, such as self-directed learning and problem-solving abilities. New teaching methods are implemented through teacher-developed videos and content-based teacher-student interactive activities [16]. Teachers with strong instructional design skills can break down complex knowledge systems into specific, measurable learning objectives based on curriculum standards and students' actual situations. For example, regarding knowledge points, teachers can set goals such as students understanding the basic concepts and formulas of laws during self-study, applying laws to solve simple practical problems during classroom interaction, and continuing in-depth exploration during after-class extension activities. This precise goal setting provides students with a clear direction for learning, guiding them to achieve corresponding learning outcomes at different stages, thereby improving the effectiveness of teaching and learning.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

Teachers need to integrate teaching content reasonably to adapt to the flipped classroom teaching mode. This includes selecting appropriate teaching resources, such as online courses, academic videos, virtual laboratories, etc., and organically integrating them with the content of teaching materials. Through carefully designed teaching resources, these can support the achievement of learning objectives, ensure students acquire knowledge, and promote active and collaborative learning [17]. Excellent teachers can select the most valuable learning content based on students' cognitive levels and learning styles, ensuring that students are exposed to rich and easily understandable knowledge during the self-directed learning stage. During the integration process, teachers also consider the difficulty and logical order of the content, arranging simple and easy-to-understand material in the self-learning stage, and placing content that needs discussion and expansion in depth in the classroom interactive section. This arrangement of teaching content conforms to students' learning rules, thereby improving students' learning efficiency and effectiveness. Flipped classrooms have raised higher requirements for teachers' teaching design abilities.

In the flipped classroom process, the teacher's classroom guidance ability is crucial. The emergence of the flipped classroom as a new educational model marks the beginning of a transformation in the classroom education system. This change is not accidental but a complex process [18]. Teachers need to guide students to engage in deep thinking through carefully designed questions. These questions should not be just a simple knowledge review, but should be inspiring and challenging. In class, students come to the classroom with questions arising from self-directed learning, interact with the teacher, and receive answers. This process has stimulated the thinking of both teachers and students, and the increase in teacher-student interaction has also been highly valued [19]. If that's the case, how should we embody these values in our lives? This type of question can guide students to go beyond the text itself, connect it with real-life thinking, and cultivate their critical and innovative thinking. Teachers can stimulate students' interest in learning through clever questioning and guidance, allowing them to deepen their understanding of knowledge through thinking and discussion, thereby improving teaching effectiveness. The overall classroom teaching experience has been significantly improved as a result. Students have transformed from passive learners to active initiators, working together with teachers to build a learning environment, thereby enhancing their learning motivation [20].

Teachers should be able to effectively control the direction and pace of classroom discussions. In flipped classrooms, classroom discussions are an important part for students to deepen their understanding of knowledge and expand their thinking horizons. Teachers need to encourage students to actively speak up while preventing discussions from deviating from the topic or getting into confusion. For example, when discussing hot social issues in a political flipped classroom, students may engage in heated debates due to different viewpoints. At this point, teachers should promptly guide students to view problems from different perspectives, respect others' viewpoints, and use rational thinking for analysis. Teachers can guide in-depth discussions by summarizing students' viewpoints, providing relevant theoretical support or case studies, etc., so that students can not only express their own ideas in the discussion but also absorb the wisdom of others, broaden their thinking, and thus improve teaching effectiveness.

The teaching evaluation ability of teachers can affect students' learning motivation and effectiveness in flipped classrooms. In this teaching mode, teachers need to use multiple evaluation methods to comprehensively evaluate students. Besides traditional exam scores, teachers should also pay attention to students' self-directed learning process, online interactive performance, and participation.

In classroom discussions, teachers can use learning management systems to record data such as the duration of students' viewing of instructional videos, the quantity and quality of their questions, and their activity levels in online discussions. This data can serve as a basis for evaluating students' self-directed learning processes. Teachers must consider that not all students possess computer literacy and, therefore, must provide appropriate resources for students who require additional support [21]. In the classroom, teachers can observe students' performance in group assignments and the quality of their answers to evaluate their classroom learning. This diversified evaluation method can more

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

comprehensively reflect students' learning progress, making students realize the importance of all aspects of learning, thereby motivating them to pay more attention to improving their overall quality during the learning process and enhancing teaching effectiveness.

Teachers need to provide timely and targeted feedback to students. In the flipped classroom, students require teacher feedback to adjust their learning strategies during both self-directed learning and classroom interaction. Teachers can identify students' strengths and weaknesses based on their learning data and classroom performance, and provide specific feedback. In the flipped classroom, when grading student essays, teachers not only point out errors but also comment on students' learning processes and other aspects, offering suggestions for improvement. This timely and effective feedback helps students clarify their learning direction, correct mistakes promptly, and continuously improve, thereby enhancing teaching effectiveness. Continuous and in-depth research is crucial; teachers must practice based on scientific evidence to find the most effective methods to guide teaching and learning [22].

5. Conclusion

This paper systematically explores the impact of teacher competence on learning outcomes in university flipped classrooms through theoretical analysis and empirical research, drawing the following main conclusions: There is a significant positive impact of teacher competence on learning outcomes, but the degree of influence varies across different dimensions of learning outcomes depending on the teacher's competence. Curriculum design competence has the most significant impact on knowledge mastery, technology application competence has the most significant impact on comprehensive literacy, interactive guidance competence has the most significant impact on collaborative inquiry competence, evaluation and feedback competence has the most significant impact on self-directed learning competence, and self-directed learning guidance competence also has a significant impact on self-directed learning competence. Currently, the overall competence of university teachers implementing flipped classroom teaching is at a moderately high level, but their self-directed learning guidance competence and technology application competence are relatively weak. Some institutions do not support or value teachers' efforts in educational innovation [23], and teachers in higher education institutions may lack teaching training or experience [24]. Students' overall learning outcomes are good, but their collaborative inquiry competence needs further improvement. Based on the above conclusions, this paper proposes targeted strategies for optimizing teachers' capabilities, including strengthening curriculum design capabilities, improving technology application capabilities, highlighting interactive guidance capabilities, improving evaluation and feedback capabilities, strengthening self-directed learning guidance capabilities, and building a long-term training mechanism.

This paper enriches the theoretical research on flipped classrooms and teacher competence. Existing research largely focuses on the design of flipped classroom teaching models, the evaluation of application effects, or strategies for cultivating a single dimension of teacher competence, lacking in-depth exploration of the intrinsic connection and mechanism between teacher competence and learning outcomes. This paper defines the core dimensions of teacher competence in the flipped classroom scenario, constructs a model of the impact of teacher competence on learning outcomes, reveals the interaction path between the two, fills the theoretical gap in existing research, and provides a new theoretical perspective and analytical framework for subsequent related research. By establishing sharing platforms on the internet, teachers around the world begin to share knowledge, which can then be reused and applied globally. This requires teachers to spend a significant amount of additional time preparing lessons and developing teaching materials needed for flipped classrooms [25]. Simultaneously, this paper combines constructivist learning theory, humanistic learning theory, and flipped classroom practice, deepening the understanding of the teaching and learning relationship under modern teaching models and providing support for the innovative development of higher education teaching theory.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153

The research conclusions of this paper can provide practical guidance for flipped classroom teaching practices and teacher development in universities. To address the varying impacts of different teacher competency dimensions on learning outcomes, universities can develop targeted teacher training programs to optimize teacher competency structures and enhance teachers' ability to adapt to flipped classroom teaching. Simultaneously, these programs can provide teachers with clear directions for competency improvement, helping them accurately identify their weaknesses and refine their teaching practices, thereby enhancing the quality of flipped classroom instruction. In this context, teachers can better understand students' learning needs and difficulties, providing targeted guidance and support, while also helping students strengthen connections with their classmates [26]. Furthermore, the findings of this study can provide a reference for university teaching management departments to formulate flipped classroom promotion policies and improve teaching evaluation systems, promoting the standardized and efficient application of flipped classrooms in higher education and ultimately achieving comprehensive improvement in student learning outcomes.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Copyright:

References

[1] J. Bergmann and A. Sams, *Flip your classroom: Reach every student in every class every day*. Washington, DC: International Society for Technology in Education, 2012.

[2] M. Y. Abdullah, S. Hussin, and K. Ismail, "Implementation of flipped classroom model and its effectiveness on English speaking performance," *International Journal of Emerging Technologies in Learning (Online)*, vol. 14, no. 9, p. 130, 2019. https://doi.org/10.3991/ijet.v14i09.10348

[3] J. Sargent and A. Casey, "Flipped learning, pedagogy and digital technology: Establishing consistent practice to optimise lesson time," *European Physical Education Review*, vol. 26, no. 1, pp. 70-84, 2020. https://doi.org/10.1177/1356336X19826603

[4] A. J. Moreno-Guerrero, R. Soler-Costa, J. A. Marín-Marín, and J. López-Belmonte, "Flipped learning and good teaching practices in secondary education," *Comunicar*, vol. 29, no. 68, pp. 107-117, 2021.

[5] L. Dobakhti, M. Zohrabi, and S. Masoudi, "Scrutinizing the utility of flipped and online instructions for ameliorating EFL learners' writing ability," *Journal of Modern Research in English Language Studies*, vol. 10, no. 3, pp. 71-94, 2023.

[6] T. Long, J. Cummins, and M. Waugh, "Investigating the factors that influence higher education instructors' decisions to adopt a flipped classroom instructional model," *British Journal of Educational Technology*, vol. 50, no. 4, pp. 2028-2039, 2019. https://doi.org/10.1111/bjet.12703

[7] T. Eli, "Studentsperspectives on the use of innovative and interactive teaching methods at the University of Nouakchott Al Aasriya, Mauritania: English department as a case study," *international Journal of Technology innovation and Management (Ijtim)*, vol. 1, no. 2, pp. 90-104, 2021.

[8] P. Strelan, A. Osborn, and E. Palmer, "The flipped classroom: A meta-analysis of effects on student performance across disciplines and education levels," *Educational Research Review*, vol. 30, p. 100314, 2020. https://doi.org/10.1016/j.edurev.2020.100314

[9] A. Van Leeuwen, "Teachers' perceptions of the usability of learning analytics reports in a flipped university course: When and how does information become actionable knowledge?," *Educational Technology Research and Development*, vol. 67, pp. 1043-1064, 2019. https://doi.org/10.1007/s11423-018-09639-y

[10] J. Oudbier, G. Spaai, K. Timmermans, and T. Boerboom, "Enhancing the effectiveness of flipped classroom in health science education: A state-of-the-art review," *BMC Medical Education*, vol. 22, p. 34, 2022. https://doi.org/10.1186/s12909-021-03052-5

[11] Y. Xiu, M. E. Moore, P. Thompson, and D. P. French, "Student perceptions of lecture-capture video to facilitate learning in a flipped classroom," *TechTrends*, vol. 63, pp. 369-375, 2019. https://doi.org/10.1007/s11528-018-0293-6

[12] D. Gong, H. H. Yang, and J. Cai, "Exploring the key influencing factors on college students' computational thinking skills through flipped-classroom instruction," *International Journal of Educational Technology in Higher Education*, vol. 17, no. 1, p. 19, 2020. https://doi.org/10.1186/s41239-020-00196-0
[13] S. Carrasco, J. A. Ruiz, E. Contreras-Reyes, and F. Ortega-Culaciati, "Shallow intraplate seismicity related to the Illapel 2015 Mw 8.4 earthquake: Implications from the seismic source," *Tectonophysics*, vol. 766, pp. 205-218, 2019. https://doi.org/10.1016/j.tecto.2019.06.011
[14] J. Cohen, *Statistical power analysis for the behavioral sciences*. New York: Academic Press, 1969.
[15] R. V. Krejcie and D. W. Morgan, "Determining sample size for research activities," *Educational and Psychological Measurement*, vol. 30, no. 3, pp. 607–610, 1970. https://doi.org/10.1177/001316447003000308
[16] H. Tekin, E. Top, and K. Cagiltay, *Flipped classroom approach in higher education: Enhancing learning outcomes and teacher-student interaction*. Ankara, Turkey: Pegem Akademi, 2020.
[17] M. Dooly and R. Sadler, ""If you don't improve, what's the point?" Investigating the impact of a "flipped" online exchange in teacher education," *ReCALL*, vol. 32, no. 1, pp. 4-24, 2020. https://doi.org/10.1017/S0958344019000107
[18] T. R. Guskey, "Flip the script on change," *The Learning Professional*, vol. 41, no. 2, pp. 18-22, 2020.
[19] M. Westerlaken, I. Christiaans-Dingelhoff, R. M. Filius, B. De Vries, M. De Bruijne, and M. Van Dam, "Blended learning for postgraduates; an interactive experience," *BMC Medical Education*, vol. 19, p. 289, 2019. https://doi.org/10.1186/s12909-019-1717-5
[20] M. Jdaitawi, "Does flipped learning promote positive emotions in science education? A comparison between traditional and flipped classroom approaches," *Electronic Journal of e-learning*, vol. 18, no. 6, pp. 516-524, 2020.
[21] L. Cilliers and J. Pylman, "South African students' perceptions of the flipped classroom: A case study of higher education," *Innovations in Education and Teaching International*, vol. 59, no. 3, pp. 296-305, 2022. https://doi.org/10.1080/14703297.2020.1853588
[22] C. Dominguez, *Evidence-based teaching: Strategies for improving student learning outcomes*. New York: Routledge, 2021.
[23] D. Bouvier *et al.*, "Factors affecting the adoption of peer instruction in computing courses," in *Proceedings of the Working Group Reports on Global Computing Education*, 2019.
[24] E. Sointu, M. Hyypiä, M. C. Lambert, L. Hirsto, M. Saarelainen, and T. Valtonen, "Preliminary evidence of key factors in successful flipping: Predicting positive student experiences in flipped classrooms," *Higher Education*, vol. 85, pp. 503-520, 2023. https://doi.org/10.1007/s10734-022-00848-2
[25] F. Miras, M. Öztürk, and S. Ercan, *Implementing flipped classrooms in higher education: Challenges and strategies*. Istanbul, Turkey: Pegem Akademi, 2022.
[26] S. Berry, "Teaching to connect: Community-building strategies for the virtual classroom," *Online Learning*, vol. 23, no. 1, pp. 164-183, 2019.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 10, No. 2: 547-562, 2026
DOI: 10.55214/2576-8484.v10i2.12153