International Journal of Computer Information Systems and Industrial Management Applications
ISSN 2150-7988 Volume 18 (2026) pp. 1-13

https://doi.org/10.70917/ijcisim-2026-0025
Article

Research on the Innovation Path of English Education Teaching Mode in Colleges and Universities Based on Differentiated Data Analysis

Qingyan Ge *

Kangda College, Nanjing Medical University, Lianyungang, Jiangsu, 222001, China; Gqyan1203@163.com

Abstract: Differentiated data analysis promotes the precision of teaching management and the scientification of educational decision-making, which is an important path to improve English education and teaching in colleges and universities. This paper gives a teaching model of English education in colleges and universities in combination with the problem-driven unit overall teaching concept. Apriori algorithm is used to mine the association rules of the data of SPOC course Comprehensive English, and the data are further analyzed differentially by K-means algorithm. The empirical analysis examines the impact and path of English education teaching model on students' academic performance. According to the path analysis, video learning resources (0.317) have the greatest impact on students' subjective attitudes, pre-course video learning resources determine learning activities, and teachers' classroom teaching is an important part of knowledge internalization. There is a relatively large correlation between the use of innovative teaching models and students' academic performance $p < 0.05$.

Keywords: apriori algorithm; k-means algorithm; differentiated data; path analysis

1. Introduction

The development of English education in colleges and universities is realized through the continuous innovation of education and teaching mode [1]. With the help of model innovation, the existing deficiencies in English teaching can be continuously improved, and at the same time, English teaching can be made more in line with the current teaching needs [2-3]. At present, the wide application of Internet technology in various fields marks the arrival of the information age, and in the information age, students' information acquisition habits and learning habits have undergone great changes [4-5]. Therefore, in order to better cater to students' information acquisition habits and learning habits, and to make English teaching work better, it is necessary to actively innovate the teaching mode to ensure that students can receive English knowledge more smoothly and efficiently, and optimize their comprehensive English proficiency level [6-8].

In English teaching, the innovative teaching mode mostly encourages students to learn independently and explore learning, stimulates students' innovative thinking and creativity, and pays attention to the guidance and inspiration of students, which is conducive to the development of students' thinking ability and self-learning ability, so as to provide support for their future development [9-11]. At this stage, the popularization and application of Internet technology has made information literacy gradually become an important standard for the society to measure and screen talents, and colleges and universities, as an important institution for cultivating talents needed by the society, need to innovate and optimize their own teaching mode according to the actual demand for talents, so as to make the cultivated talents more in line with the social demand [12-14]. In addition, innovation as an important driving force to promote teaching reform, the innovation of English education teaching mode in colleges and universities can trigger widespread concern and thinking in the education sector, which is conducive to promoting the reform and development of the entire education system [15-17]. At the same time, the innovation process

of all kinds of teaching methods and means of constantly trying new, can improve the existing education system, improve the quality and effectiveness of education [18].

This paper takes the problem of the ontogeny of knowledge under problem-driven as a starting point and proposes an innovative model of English education and teaching in colleges and universities. Learning data from the SPOC course management background of a university's Comprehensive English course are selected as research samples, and the Apriori algorithm and K-means algorithm are combined to perform correlation analysis and differentiation analysis on the student data, which is dedicated to predicting students' learning performance and extracting students' individual or group characteristics. Structural equation modeling was used to test the hypotheses of the path relationships between the measured variables, and to explore the impact and correlation of the innovative model of English education and teaching in colleges and universities on academic performance.

2. Innovative Models for Teaching English Language Education in Higher Education

2.1. Problem-Driven Teaching of the Unit as a Whole

Problem-driven English teaching in colleges and universities takes the original problem of knowledge as the starting point, and is oriented to the holistic understanding of the knowledge structure and ideas of English in colleges and universities, and focuses on the generative process of driving the concepts and principles from "non-formalization" to "formalization" by means of problems, so as to prompt students to deepen their understanding of the essence of knowledge in problem discernment, and improve their problem-solving ability from the root. Deepen the understanding of the essence of knowledge in the problem discernment, and improve the problem solving ability from the root; Unit overall teaching starts from the students' existing cognitive structure, and is oriented to the structural learning of knowledge and continuous intervention in the problem situation, paying attention to the wholeness of teaching, the coherence of logic and the systematicity of thinking, and encouraging the students to form good cognitive structure in the connection of knowledge, and expanding the breadth and depth of the migration of knowledge.

2.2. Overall Pedagogical Characteristics of the Unit

Through the above literature research on the theory of problem-driven college English teaching and the theory of unit-whole teaching, the author makes a feature-specific analysis of problem-driven unit-whole teaching based on problem-driven teaching, which is summarized as follows:

2.2.1. Main Lines of Unit of Study

The English curriculum in higher education should be student development-oriented, grasp the essence of English in higher education, highlight the main line of knowledge, so that through the learning of English in higher education, students can further acquire the basic knowledge of English in higher education, the basic skills, the basic ideas and the basic experience of activities needed for their studies and future development, and improve their ability to find and raise problems, analyze and solve problems from the perspective of English in higher education.

Therefore, when designing problem-driven unit teaching as a whole, teachers should first analyze the textbook unit systematically and deeply, grasp the design concept of the textbook, familiarize themselves with the arrangement characteristics of the textbook, and understand the need for the resources provided by the textbook. It is necessary to consider the contents of each module of the unit, to explore the essence of the unit knowledge and its intrinsic connection; it is also necessary to know the requirements of the curriculum standard, and to make clear what position and status the knowledge of this unit is in the knowledge system of English in colleges and universities in the year group. Secondly, the learning situation should be analyzed systematically and deeply. Meanwhile, in this process, two levels should be considered, one level is to do a good job of the core concepts of this unit and its progression of decomposition, mainly to solve the problem of "teaching". Another level is to consider the organization of the unit's teaching content clues, mainly to solve the "learning" problem. The overall pedagogical characteristics of the problem-driven unit are shown in Figure 1.

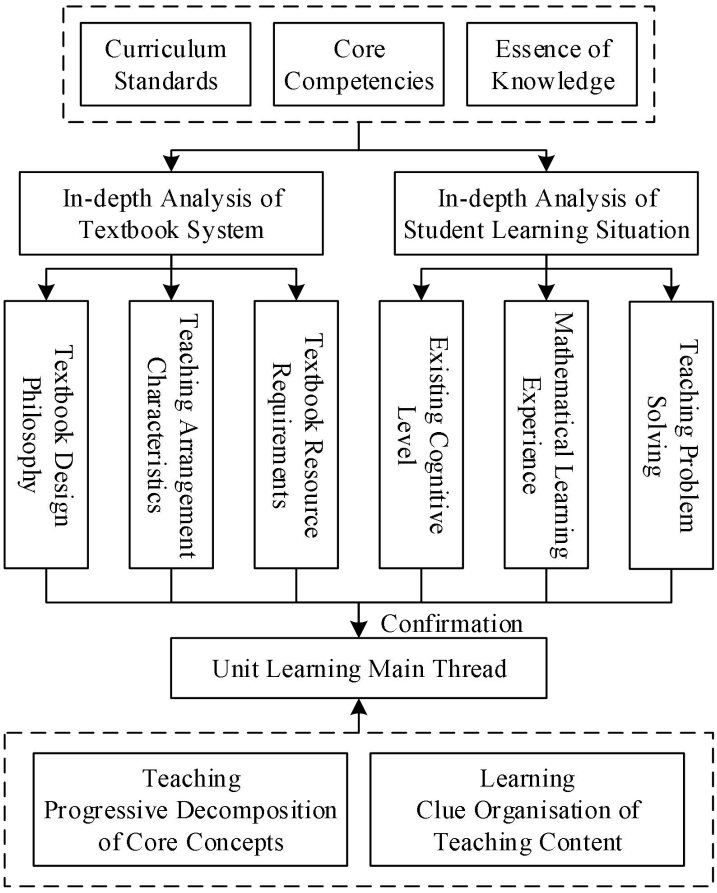

Figure 1. Problem driven unit overall teaching characteristics.

2.2.2. Nature of Unit Knowledge

Problem-driven English teaching in colleges and universities aims to present the ideas of English in colleges and universities hidden behind the “cold form”. The holistic view of teaching and the problem-driven theory are the theoretical basis for guiding the holistic teaching of English in colleges and universities, and the holistic design of the unit as the main body needs to be driven by the core problem of classroom teaching. The new curriculum standard proposes that “important college English concepts and college English ideas and methods should reflect the principle of spiral upward”, focusing more on the depth of the essence of college English knowledge mining and width expansion. The classroom teaching led by the core problem is the “true leadership” to realize “true thinking and true inquiry”. Starting from the original problem of knowledge generation, and taking the unit as a unit, a series of sub-problems led by the inquiry around the core problem of the unit and its inquiry will lead to the learning of new subunit contents, which can really point to the essence of college English knowledge, promote the depth of students' college English learning, and gain the understanding, migration and innovation of the essence of the unit's knowledge and methodology during the process of continuous thinking and discernment.

2.2.3. Unit Teaching Objectives

When making instructional objective determinations, it is important to move from unit objectives to lesson objectives. The big unit objectives lead the sub-unit objectives, while the lesson time objectives need to be centered around the sub-unit objectives so that the whole unit teaching can be carried out closely around the unit teaching objectives. Because in the process of learning English knowledge in colleges and universities, the establishment of basic concepts or theorems, can not be satisfied with the formalization, deductive given, but to focus on the creation of the problem situation to expose the essence of the ideas embedded; Furthermore, the development of students' thinking is the development of the stage, in order to help students to clear up the thinking process of the bias and the doubts of the process of inquiry. Therefore, in the teaching of specific lessons, clear need to achieve the overall goal of teaching

and stage goals, through the creation of problem situations.

2.2.4. Module Logical Structure

The English Curriculum Standards for Colleges and Universities points out that it is necessary to "grasp the teaching content as a whole and promote the continuity and stage-by-stage development of the core literacy of the English subject in colleges and universities". In accordance with the structure of theme-to-unit-to-content, and on the basis of the history of the development of college and university knowledge of English and in combination with the cognitive ability of the students, the teacher grasps the knowledge system as a whole and the content of college and university knowledge of English in a macroscopic manner. The content of English knowledge in colleges and universities, through digging out the knowledge of English in colleges and universities contained in the problematic situation, designing contextual problems, organizing appropriate unit teaching activities, prompting students to establish interconnections between the learning of new knowledge and the old knowledge, so that it is organically embedded in the existing schematic system and can be maintained, guiding the students to construct a rich and full of links to the overall structure of knowledge, and in the spiral of constructing the structure of knowledge to promote the formation of a good and stable cognitive structure, and to construct a good and stable cognitive structure, and to promote the formation of the students. In the spiral construction of knowledge structure to promote students to form a good and stable cognitive structure, construct a systematic knowledge and deep ability to promote the transfer of learning to achieve the teaching objectives.

2.3. Differentiated Data Collection and Processing

Formative assessment in the online learning process has become the main method of assessing students' performance. Based on the data of existing courses, how to model, analyze and predict students' achievement in the future and suggest learning strategies is a problem worthy of in-depth research [19]. In this paper, we use the data of the SPOC course Comprehensive English. Formative assessment data for association analysis, based on the course data, using the Apriori algorithm on the data formed between the two semesters, mining association rules [20]. An optimized K-means algorithm was also used to further analyze the data and discuss the performance characteristics of different categories [21].

2.3.1. Data Collection

The data are taken from the learning data of SPOC course management background in the Comprehensive English course of a university, and the data of the university is chosen because the university has customized and deployed a mode suitable for the learning plan of the university, which makes full use of the teachers' resources from the preparation of the lessons to the delivery of the lessons, and is of great significance to the research and subsequent development of this paper. The data of SPOC courses are chosen because the platform is committed to providing scientific course teaching informatization services for university classrooms, and it is an online education platform with a relatively high usage rate by teachers in China at present. The reliability of its data was also analyzed. The course data statistics include four major modules, which are shown in Figure 2.

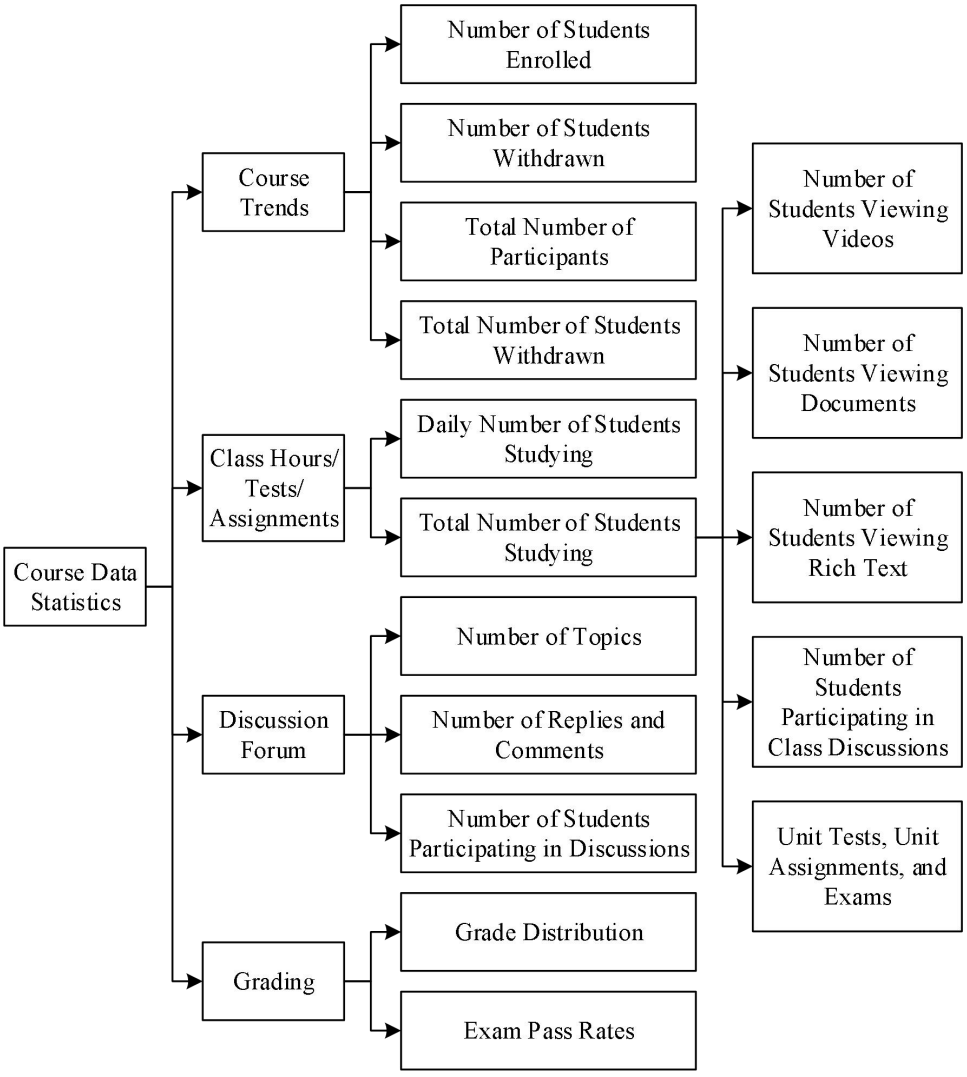

Figure 2. The course data statistics module.

In order to investigate the performance of the same students in different semester courses, data from two semesters of SPOC were selected for analysis. Meanwhile, among the freshmen who took the course for the first time, the performance of the high school entrance examination score was also regarded as a research feature, because it reflected the students' enrollment ability to some extent. The feature extraction includes gender, major, province, final exam performance, and high school entrance exam performance.

2.3.2. Data Processing

(1) College entrance examination scores

Since students come from different provinces, the full marks of the college entrance examination vary from province to province, so the college entrance examination marks need to be processed. Assuming that a student's Gao Kao score is qs, and the full score of the student's province is ts, the student's Gao Kao processed score q is:

$$q = (qs / ts) * 100 \tag{1}$$

(2) Mapping course scores to grades

Taking a perfect score of 100 as an example, a score of 60 passes and a score below 60 fails.Above 60, every 10 points belongs to a grade, and there are 5 grades, A, B, C, D and E. Since the raw perfect score for each score is different, the grades are classified according to percentages. The mapping between scores and grades is shown in Table 1. Where S is the raw score and TS is the perfect score.

Table 1. The mapping relationship between scores and grades.

Grade	Score
A	$TS*0.9 \le S \le TS$
B	$TS*0.8 \le S \le TS*0.9$
C	$TS*0.7 \le S \le TS*0.8$
D	$TS*0.6 \le S \le TS*0.7$
E	$0 \le S \le TS*0.6$

(3) Classification of students' scores

The SPOC platform scores reflect the students' learning performance on the SPOC platform, the offline course scores reflect the students' participation in the offline course and completion of daily assignments, in addition, the final exam is a way to check the students' mastery of knowledge at the end of the week. Students' scores in this study were calculated as the following four scores: the SPOC platform score, the SPOC platform post-course task score, the final exam score and the college entrance exam score.

2.3.3. Association Rules

Association rule mining is a method of finding possible associations from data.Apriori algorithm is one of the most influential frequent itemset algorithms which uses $k-1$ order itemsets to search for k order itemsets. The algorithm consists of two subtasks frequent itemset mining and strong association rules.Apriori algorithm is used to construct frequent itemsets. The relevant definitions of association rules are as follows:

(1) Association rule: when X and Y are both itemsets, itemset X and itemset Y have the following relations for transaction set S : X and Y are both subsets of S and X and Y do not have common elements. An association rule is usually denoted as $X \to Y$, where X and Y are called the leading and following terms of the association rule, respectively;

(2) Confidence: $X \to Y$ expresses the probability that Y occurs simultaneously when X occurs;

(3) Support: $X \to Y$ expresses the probability that X and Y occur simultaneously;

(4) Strong association rule: after setting the minimum support and minimum confidence, if the support and confidence of the association rule are greater than or equal to the set threshold, the rule is considered a strong association rule.

In this study, the Apriori algorithm was used to mine association rules between course grades to find potential correlations between several semester grades.

3. Research Model and Analysis of Results

3.1. Research Model

SPOC classroom reverses the two learning stages of knowledge transmission and knowledge internalization, students complete knowledge content learning independently through information technology means before class, and the classroom is mainly used to complete knowledge internalization in collaboration with teachers and classmates, so it is necessary to reconstruct the influence mechanism of students' learning behavior. This study takes the theory of rational behavior as the basic framework, draws on the technology acceptance model, takes full account of the characteristics of the SPOC classroom teaching mode links, and constructs a hypothetical model of the factors influencing the learning behavior of students in the SPOC classroom, which contains two major dimensions of subjective norms and subjective attitudes, as well as eight key elements, such as the learning task, learning environment, and so on, and examines the differences in the impact of these factors on the students' learning performance through empirical analysis. The influence factor hypothesis model is shown in Figure 3.

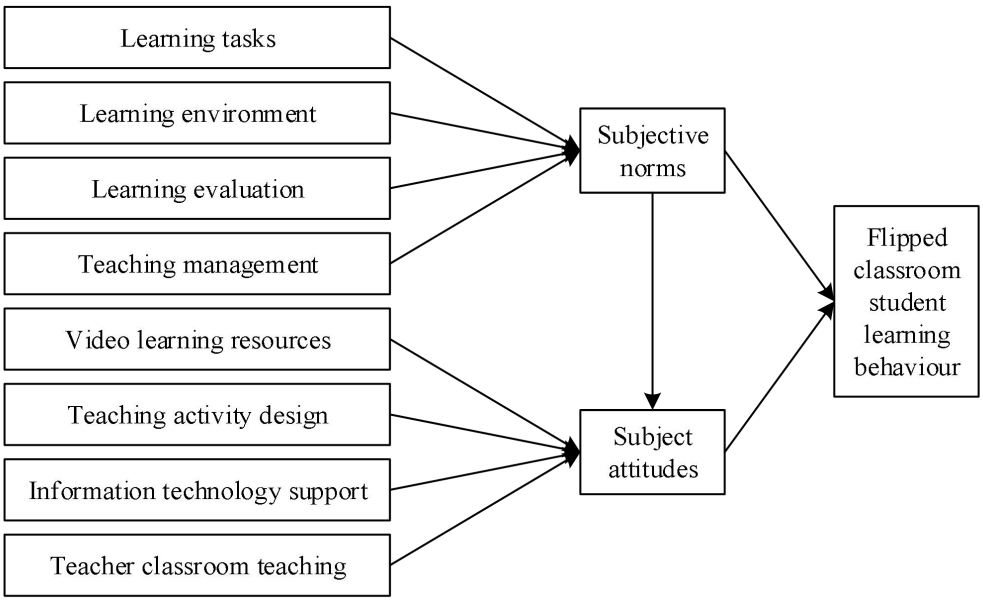

Figure 3. Impact factor hypothesis model.

3.2. Research Process and Results

In this study, a questionnaire was used to collect data, and the influencing factors in the model belong to latent variables that cannot be directly measured, which need to be transformed into measurable variables through the corresponding questionnaire items, thus exploring the path relationships among the latent variables. The questionnaire items in this study are based on the reference of existing related literature, and the existing measurement items are supplemented and amended according to the purpose and needs of this study. In order to ensure the reliability and validity, a small-scale pilot test was carried out before the questionnaire was formally distributed, and adjustments and optimizations were made according to experts' opinions and the results of the focus group discussions, and finally 11 latent variables and 41 measurement items were identified. The samples were five universities in East China that had adopted SPOC classrooms in the teaching of university English courses, and the survey respondents were students who participated in SPOC classroom teaching in these schools. On the basis of guaranteeing parameter multiplicity and considering the need for structural equation modeling (SEM) validation, 400 questionnaires were distributed, 374 were recovered, 350 were valid, and all the question items in the questionnaires were on a Likert 5 scale, and model validation and hypothesis testing were carried out by using SPSS19.0 and AMOS21.0 statistical software.

3.2.1. Reliability Test

Reliability refers to the stability and reliability of the measurement results of questionnaire items, and Cronbach's alpha coefficient is now commonly used in empirical studies as a measure to test internal consistency. The validity test is shown in Table 2. The value of Cronbach's alpha coefficient for each variable in this study is greater than 0.7, indicating that the model has good reliability. Validity is the degree to which a measurement questionnaire is able to accurately measure the thing to be measured, indicating the correctness of the instrument. Validity test usually includes two aspects of content validity and construct validity, this questionnaire was optimized through expert consultation and focus group discussion in terms of content, and through pilot testing before formal distribution, so it can ensure a good content validity. After SPSS19.0 test, this questionnaire measured variable KMO=0.869, Sig=0.001, suitable for further factor analysis. Validated factor analysis of the question items using AMOS 21.0 yielded factor loadings greater than 0.5, combined reliability (CR) greater than 0.7, and average extracted variance (AVE) greater than 0.5 for each of the measured variables, indicating that the model has good construct validity.

Table 2. Validity test results.

Measured latent variable	Mean	Standard deviation	Combination reliability CR	Mean extraction variance AVE	Cronbach's α
Learning task	2.92	1.013	0.773	0.539	0.798
Learning environment	3.05	1.204	0.858	0.686	0.842
Learning evaluation	2.79	0.937	0.806	0.552	0.804
Teaching management	2.64	0.945	0.797	0.543	0.786
Video learning resources	2.95	1.068	0.829	0.71	0.869
Teaching activity design	2.93	1.149	0.812	0.589	0.795
Information technology support	3.41	1.283	0.761	0.551	0.813
Classroom teaching	3.12	1.026	0.855	0.622	0.84
Subjective specification	2.98	1.171	0.818	0.604	0.848
Subject attitude	3.07	1.045	0.797	0.608	0.774
Learning behavior	3.2	0.987	0.77	0.535	0.831

3.2.2. Goodness-of-Fit Tests

In order to ensure that the measurement tool can better satisfy the fitting conditions, we need to test the fit of the constructed conceptual model before using structural equation modeling (SEM) to analyze the relationships between multivariate factors in path analysis. Usually, we use absolute fit index and relative fit index to judge the validity of the measurement model. The absolute fit indices are: χ^2 (chi-square test), χ^2/df (chi-square to degrees of freedom ratio), RMSEA (root mean square of approximation error), GFI (model goodness-of-fit index); while the relative fit indices are commonly used: AGFI (adjusted goodness-of-fit index), NFI (standardized fit index), IFI (corrected fit index), CFI (comparative fit index) etc. In this study, χ^2/df, RMSEA, GFI, NFI, CFI, IFI are mainly chosen as test indexes, and a good measurement model needs to meet the requirements on the above fitting indexes, and the specific test results are shown in Table 3.

Table 3. Fitting test results.

	Absolute fitting index			Relative fitting index		
Fitting index	χ^2/df	RMSEA	GFI	NFI	CFI	IFI
Judgment standard	<3	<0.09	>0.91	>0.91	>0.91	>0.91
Model result	1.582	0.048	0.922	0.922	0.930	0.932
Test conclusion	Acceptance	Acceptance	Acceptance	Acceptance	Acceptance	Acceptance

3.2.3. Path Analysis Test

In this study, AMOS 21.0 was used to test the hypotheses of the path relationship between the measured variables, mainly with the help of the significance P-value and the size of the path coefficient as the basis of analysis, and the specific results are shown in Table 4.

Table 4. Path analysis and hypothesis test results.

Path			Path coefficient	*p* value	Test result
Subjective specification	←	Learning task	0.243	0.003	Support
Subjective specification	←	Learning environment	0.208	0.042	Support
Subjective specification	←	Learning evaluation	0.425	***	Support
Subjective specification	←	Teaching management	0.380	***	Support
The subject attitude	←	Video learning resources	0.317	***	Support
The subject attitude	←	Teaching activity design	0.233	0.008	Support
The subject attitude	←	Master information technology support	0.153	0.130	Support
The subject attitude	←	Classroom teaching	0.284	***	No support
The subject attitude	←	Subjective specification	0.299	***	Support
Learning behavior	←	Subjective specification	0.467	***	Support
Learning behavior	←	Subject attitude	0.311	***	Support

The results of the path analysis are shown in Figure 4.

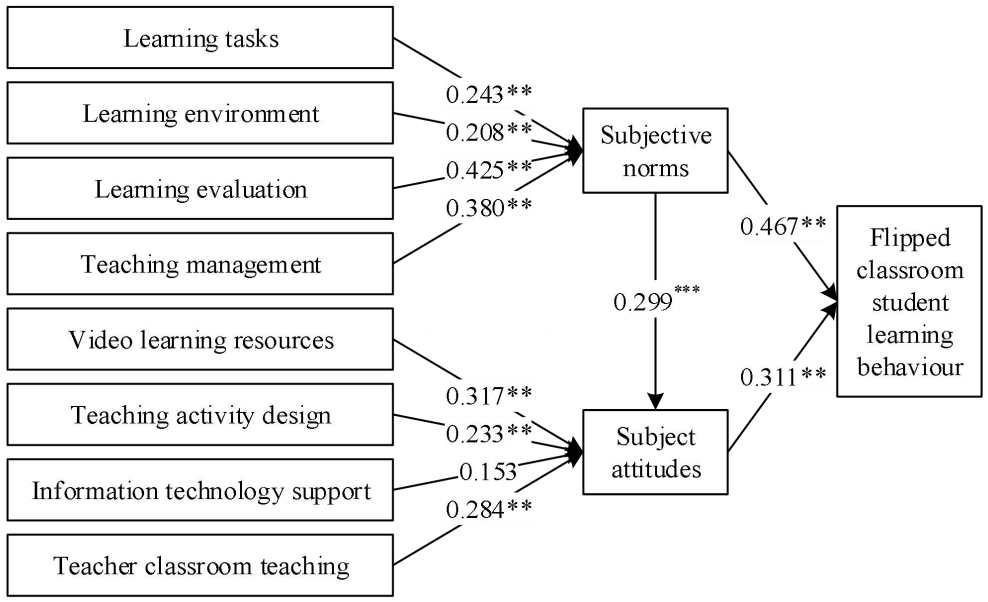

Figure 4. Path analysis.

Learning tasks, learning environment, learning evaluation, and teaching management in SPOC classroom mode all have a significant effect on students' subjective norms. This indicates that in the SPOC classroom teaching model, appropriate learning tasks, a good atmosphere of the learning environment, a reasonable learning evaluation system, and a sound teaching management system as an

external social pressure help students to form a sense of self-subjective norms. According to the path analysis, the element that has the greatest influence on students' subjective norms is learning evaluation (0.425), followed by teaching management (0.380), learning tasks (0.243), and learning environment (0.208). However, researchers generally emphasize the latter two in the process of SPOC classroom construction, i.e., they pay more attention to the collaborative learning atmosphere and pre-course learning tasks, and pay less attention to learning assessment and teaching management, which have a more influential role. The results of this study are instructive for current SPOC classroom practice in China. The most influential factor on students' subjective attitudes is video learning resources (0.317), followed by teachers' classroom teaching (0.284) and teaching activity design (0.233). The quality of pre-course video learning resources directly determines the subsequent learning activities in the SPOC classroom, teacher classroom teaching is indispensable for students to complete the internalization of knowledge, and the design of teaching activities is also an important factor affecting learning attitudes.

3.3. Impact of Innovative Teaching Models on English Achievement

The successful application of innovative teaching models will lead to the desired changes in students' consciousness, emotions and behaviors, and ultimately affect students' academic performance. In studies that have assessed the effectiveness of the use of related tools, students' academic performance is usually used for assessment. Therefore, in order to assess the teaching effect of the innovative teaching model in this study, we use students' final exam results, e-learning results and total results for analysis. Among them, the e-learning performance contains five assessment modules such as learning hours, learning completion, learning correctness, usual test and effort value, reflecting the effect and quality of the students' usual e-learning; the total final grade consists of three parts: final-style examination results (50%), e-learning results (30%) and usual classroom performance (20%), which is the overall reflection of the students' learning situation. According to the students' results exported from the system and processed using spss22, the collated senior high school English grades, final exam grades, network learning grades and total final grades grades grades of the experimental class (N=175) and the control class (N=175) were processed by independent samples t-tests, and the collated results are shown in Fig. 5.

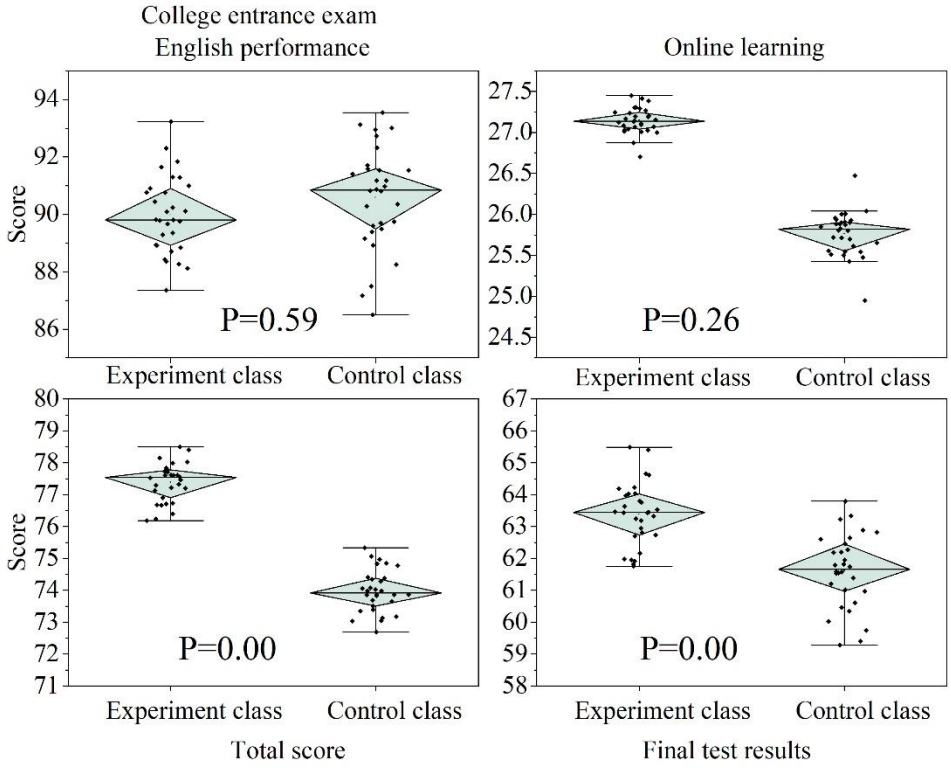

Figure 5. Finishing result.

Data processing results and analysis:

(1) The results from the analysis of the college entrance examination scores indicate that the difference between the English scores of the experimental class (M = 90.06, sd = 1.54) and those of the

control class (M = 90.05, sd = 1.48) is very small, and the results of the t-test indicate that there is no difference in the level of learning ($p = 0.59 > 0.05$);

(2) Purely from the final exam scores, the experimental class scores (M = 63.89, sd = 0.98) showed a significant increase in the average grade compared to the control class (M = 61.57, sd = 1.04), but there was no statistically significant difference ($p = 0.26 > 0.05$);

(3) From the analysis of online learning achievement, the experimental class (M = 27.14, sd = 0.13) and the control class (M = 25.78, sd = 0.26), and the t-test showed that the level of significance was reached ($p = 0.00 < 0.05$), which indicated that there was a significant difference between the experimental class and the control class in terms of online learning achievement.

(4) Analyzing the total achievement, the experimental class (M = 77.26, sd = 0.55) and the control class (M = 73.98, sd = 0.63), and the t-test showed that the level of significance was reached ($p = 0.00 < 0.05$), indicating that there is a significant difference between the experimental class and the control class in terms of the total achievement.

3.4. Correlation Analysis between Innovative Teaching Models and Academic Achievement

Innovative teaching models present students with a variety of information about their learning, prompting them to self-assess and change their behavior, leading to good grades. We correlate the innovative teaching model with the final exam grade, overall grade, e-learning grade, and its assessment modules (study hours, usual test, and study effort value) in order to understand the relationship between the use of the innovative teaching model and each of the grades, and to explore the impact of the innovative teaching model on their behavior. We used Spearman's method to analyze the correlation, which is organized as shown in Table 5.

Table 5. Analysis of academic performance.

		Final test results	Network learning	Total score	Usual test results	Learning length	Study effort value
The number of times used for innovative teaching modes	Correlation	0.168**	0.394**	0.132*	0.345**	0.278**	0.441**
	Sig.(2-tailed)	0.012	0.001	0.038	0.001	0.001	0.001
Innovation teaching mode USES depth	Correlation	0.312**	0.372**	0.165**	0.332**	0.305**	0.436**
	Sig.(2-tailed)	0.047	0.001	0.001	0.001	0.001	0.001
Innovation teaching mode is used often	Correlation	0.328**	0.389**	0.292**	0.350**	0.271**	0.457**
	Sig.(2-tailed)	0.045	0.001	0.002	0.001	0.001	0.001

Through the statistical analysis of the academic performance of the experimental class and the control class, it can be obtained that after one semester of teaching practice, there is a significant difference between the experimental class and the control class in the final examination results, and there is a significant difference between the learning results of the formative assessment network that can reflect the learning process and efforts of the students and the overall results. It shows that the innovative teaching mode promotes the students in the experimental class to study hard outside the classroom, make up for the deficiencies in intelligence, and pursue a better result.

There is a strong correlation between the use of innovative teaching mode and students' academic performance. This suggests that the innovative teaching model has a greater impact on students' learning behavior, which is mainly reflected in the increase in the length of study and the degree of effort, as well as a greater emphasis on the regular test tasks, which is the result of students' self-regulation. The innovative model of teaching and learning prompted students to reflect and act in ways that increased the length and effort of study, as well as increased attention to the quality of regular tests, which ultimately

affected their overall performance. This also reveals that the impact of the learning dashboard on achievement is indirect and comprehensive, and requires continuous feedback to induce lasting changes in students' learning behaviors and strategies. The more often and the longer the innovative teaching model is used, the more likely it is that students will be able to identify their own gaps more clearly, thus causing them to put more effort into their learning. Specifically, more access to e-learning platforms and more attempts at weekly tests until they are satisfied.

4. Conclusion

This paper mainly proposes an innovative model of English education and teaching in colleges and universities, and uses Apriori algorithm and K-means algorithm to differentially analyze the learning data in the background of SPOC course management. Combined with structural equation modeling to study the influence path of college English education teaching innovation model on learning achievement. The empirical study shows that

Learning tasks, learning environment, learning evaluation, and teaching management under the innovative teaching mode all have a significant impact on students' subjective norms. The order of influence of students' subjective attitudes is video learning resources (0.317) > teachers' classroom teaching (0.284) > teaching activity design (0.233).

Innovative teaching mode has a positive correlation with final exam grade, overall grade, e-learning grade and its assessment modules (learning hours, usual test, learning effort value).

References

1. Jing, L. (2022). Innovation of College English Teaching Mode Based on the Goal of Cultivating Innovative Talents. Frontiers in Educational Research, 5(5), 52-55.
2. Wang, Y. (2022). The reform and innovation of college English teaching mode based on the OBE concept. International Journal of Educational Economy and Management, 37.
3. Zhu, L. (2018). Innovative english teaching modes based on higher education Informatization. Educational Sciences: Theory & Practice, 18(6).
4. Xu, D. (2020). Research on the Model of Autonomous Creation of College English Teaching Based on Innovation Perspective. Journal of Advances in Education Research, 5(2), 51.
5. Sun, X. (2021). 5G joint artificial intelligence technology in the innovation and reform of university English education. Wireless Communications and Mobile Computing, 2021(1), 4892064.
6. SU, T. (2017). Study on the improvement of English teaching in college students' english comprehensive ability from the practical perspective. Journal of Mines, Metals & Fuels, (13).
7. Zhu, B., Chau, K. T., Mokmin, N. A. M., & Wu, L. (2023). Using multimedia technology to improve English comprehensive ability. Language Related Research, 14(5), 109-139.
8. Sang, H. (2021, December). English teaching comprehensive ability evaluation system based on K-means clustering algorithm. In 2021 International Conference on Aviation Safety and Information Technology (pp. 138-141).
9. Novia, F., Nurdianti, D., & Purwanto, M. B. (2024). English learning and innovation skills in 21st: Implementation of critical thinking, creativity, communication, and collaboration. Asian Journal of Applied Education (AJAE), 3(2), 113-124.
10. Kumar, S. S., Kumar, R. S., & Sankar, G. (2016). Creative thinking of English language teaching to the secondary language learners. International Journal of Linguistics, Literature and Culture, 2(4), 150-155.
11. Moiseyenko, N. V. (2021). Creativity and Innovation: Basic Concepts and Approaches in Teaching English. Science and Education a New Dimension, IX (261), 48, 43-45.
12. Liu, Q., & Yang, Z. (2021). The construction of English smart classroom and the innovation of teaching mode under the background of Internet of things multimedia communication. Mobile information systems, 2021(1), 6398067.
13. Maimaiti, K. (2019). Modelling and analysis of innovative path of English teaching mode under the background of big data. International Journal of Continuing Engineering Education and Life Long Learning, 29(4), 306-320.
14. Ling, Z. (2021, May). Innovation of College English Teaching Mode Based on Computer. In 2021 2nd International Conference on Computers, Information Processing and Advanced Education (pp. 1047-1051).
15. Sun, W., & Rong, X. L. (2021). English education reform in Asian countries. In Oxford research encyclopedia of education.
16. Pajarwati, D., Mardiah, H., Harahap, R. P., Siagian, R. O., & Ihsan, M. T. (2021). Curriculum reform in Indonesia: English education toward the global competitiveness. ETDC: Indonesian Journal of Research and Educational Review, 1(1), 28-36.
17. Nasser, R. (2017). Qatar's educational reform past and future: Challenges in teacher development. Open Review of Educational Research, 4(1), 1-19.
18. Li, D., & Edwards, V. (2014). English language teaching and educational reform in Western China: A knowledge management perspective. System, 47, 88-101.

19. Zhou Weiran. (2025). Analysis of Student Behavior in English Online Education Under the Perspective of Big Data. International Journal of Decision Support System Technology (IJDSST),17(1),1-22.
20. Wang Chunxia. (2021). Analysis of Students' Behavior in English Online Education Based on Data Mining. Mobile Information Systems,2021.
21. Wei Li & Zhaoxia Xue. (2025). Factors influencing student engagement and behavioral differences based on K-means cluster analysis. Journal of Computational Methods in Sciences and Engineering,25(2),1835-1844.