Research on the Effect of Online Learning and Influencing Factors of University Students Based on Questionnaire Survey

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Abstract. With the development of modern education technology, college students' learning is not only limited to traditional teaching methods, but online learning is rapidly gaining popularity. This study investigated the online learning of Chinese college students using questionnaires and analyzed the collected data with spss modoler data analysis tool to find out the effect of online learning and its influencing factors of Chinese college students. This study found that teachers' teaching, learning strategies, online teaching platforms, and interactive learning all have some influence on the online learning effect. By improving the quality of teachers' online teaching, adopting appropriate learning strategies, and using online teaching platforms comprehensively, the online learning effect can be effectively improved.

Keywords: Online Learning, Quantitative Research, Learning Effectiveness, Influencing Factors.

1. Introduction

In the past decade or so, with the rapid development of information technology and Internet, online learning has become an important means for college students to acquire knowledge and master skills According to statistics, among 118,191 college students surveyed in 334 colleges and universities in China, 97.1% of them have participated in online learning [1]. However, while online teaching in China's colleges and universities has made great development, questions about the effectiveness of online teaching have emerged, such as "students' online learning experience is poor, teaching satisfaction is not high, and teaching quality is worrying" [2]. At present, theoretical research on online learning focuses on four dimensions: constructivist research on online learning, behavioral and cognitive research on online learning, knowledge management research on online learning, and technical support research on online learning; however, there has been a large debate on whether online learning can enhance learning effectiveness [3]. The long-term practice of online education shows that most learners' online learning effect is not satisfactory. This study adopts a quantitative research method, collecting data through questionnaires, and conducting research on online learning platforms, learning strategies, teachers' teaching, interactive learning, and learning effects from university students. Finally, the correlation analysis, regression equation analysis and k-means clustering analysis were used to find out the factors influencing the online learning effect and further propose methods to improve the online learning effect.

2. Literature Review

With the development of network technology and modern education technology, online learning for college students has become one of the emerging learning methods. Therefore, the effect of online learning and its influencing factors have become the focus of research in recent years. Many scholars have analyzed the factors influencing the effectiveness of online learning through research. Among them, the analysis of external factors found that the difference of network technology due to regional differences has an important impact on the effect of online learning (Wang, Weiping et al., 2020) [4]. In terms of internal factors in the classroom, Dong Wei et al. (2020) identified four major factors affecting the effectiveness of online learning - platform design, teaching resources, teachers, and interaction - through interviews with students [5]. In terms of the internal factors of the classroom, Dong Wei et al. (2020) interviewed students and identified four major factors that influence the

effectiveness of online learning: platform design, teaching resources, teachers, and interaction [6]. And further focusing on the learner ontology, it was further determined that student-centered online course design and evaluation (Zhu Liancai et al., 2020) [7], students' online learning emotions (Wang Xue et al., 2021) [8], and learning engagement patterns (Wu Linjing et al., 2022) [9] all have an impact on learning effectiveness.

3. Research Methods

3.1. Subjects

This study was conducted by direct interview through questionnaire star online to university students, and 200 questionnaires were collected. Among the surveyed students, according to gender distribution, 53 male students, accounting for 26.5%; 147 female students, accounting for 73.5%; according to grade distribution, 42 freshmen, accounting for 21%; 83 sophomores, accounting for 41.5%; 64 juniors, accounting for 32%; 6 seniors and above, accounting for 3%; 5 postgraduates (including master and doctoral students), accounting for 2.5%. According to the distribution of professional categories, the types of colleges involved are diverse, with 27 students in engineering, accounting for 13.5%; 18 students in science, accounting for 9%; 26 students in economics and management, accounting for 13%; 75 students in humanity, accounting for 37.5%; 32 students in social sciences, accounting for 16%; 14 students in medicine, accounting for 7%; 4 students in arts and sports, accounting for 2%, and the distribution basically meets the requirements of the sample survey, as shown in Figure 1 and Figure 2.

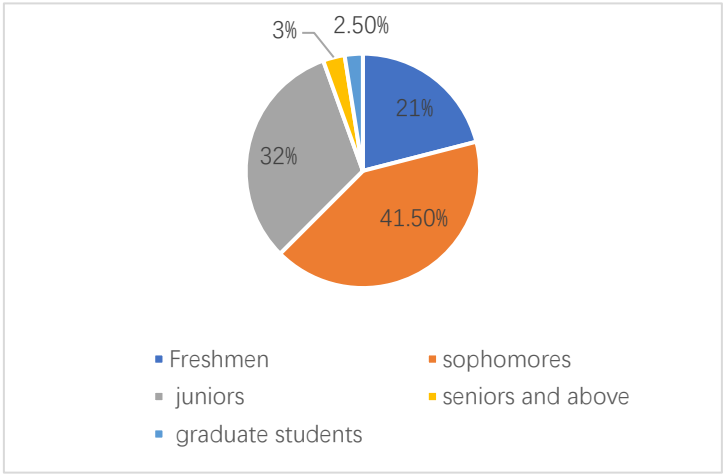

Figure 1. Number distribution by grade

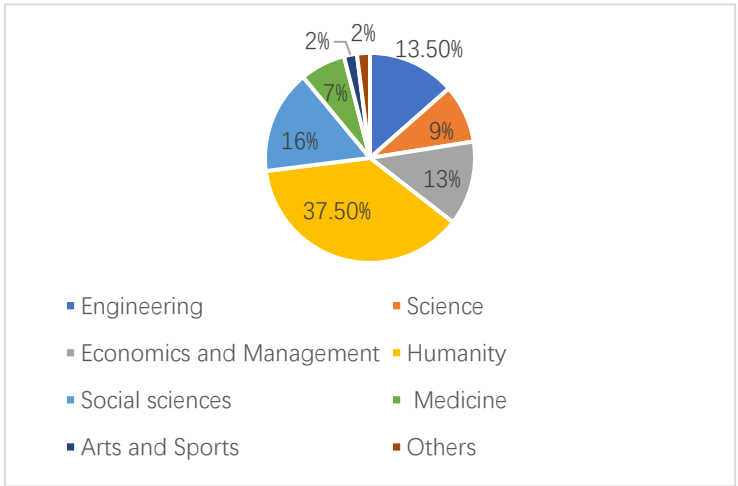

Figure 2. Number distribution by major

3.2. Questionnaire preparation

Based on the online learning situation of college students, we compiled the research literature on online learning of college students, grasped the key theories, developed and improved the questionnaire items, and finally formed a questionnaire on online learning of college students including 68 items after adapting, discussing and modifying, pre-testing and re-modifying. The questionnaire was designed with five dimensions and scored by Likert 5-point scale, the details of which are shown in Table 1. The questionnaire contains seven sections: basic information of subjects; evaluation of technology platform, 5 items; online learning environment, 5 items; learning behavior, 14 items; teacher teaching, 14 items; interactive learning, 18 items; and learning effectiveness, 11 items. The potential independent variables set in the research model constructed in this paper are platform technology, learning environment, learning strategies, teacher teaching, and interactive learning, with the aim of analyzing the relationships between them and the potential dependent variables of learning effectiveness of college students' online learning.

3.3. Data Collection

After the questionnaires were collected, the collected data were first pre-processed to improve the validity and correctness of the data analysis. The data were subdivided into six dimensions, and the data of the same dimensions were summed and averaged to form several dimensions, including platform technology, learning environment, learning duration, learning strategy, teacher teaching, teacher feedback, interactive learning purpose, student interactive learning behavior, teacher interactive learning behavior, interactive learning effect, and online learning effect, which were used for the subsequent data analysis. After pre-processing the data, spss modoler data analysis tool was used to analyze the collected data by correlation analysis, regression analysis and cluster analysis to investigate the online learning effect and its influencing factors.

4. Analysis Results

4.1. Descriptive statistics results

In this study, we analyzed the impact of platform technology, learning environment, learning strategies, teacher teaching, teacher feedback, and interactive learning on the effectiveness of online learning by analyzing their factors. For details, see Table 1 for the statistics of students' online learning platform types; Table 2 for the statistics of descriptive results of each dimension of the questionnaire.

Table 2 shows the descriptive statistics of students' online learning platforms. There are many online learning platforms, and different platforms focus on different online learning functions, which also have a certain influence on the learning effect. It can be seen that the most commonly used learning platform is the real-time live streaming type, represented by Tencent Meeting, through which teachers give real-time lectures to students, with better interactive learning conditions and higher requirements for the learning environment; followed by the resource sharing and exercise publishing platform, in which Rain Classroom, for example, is both real-time and time-delayed, and this type of platform can be used by teachers to publish courseware, homework, etc., and can also be used in the classroom to This type of platform focuses on online learning resource sharing and interactive learning. This type of platform focuses on sharing resources and interactive learning.

Table 1. Online Class Platform Type

Platform	Ding Talk	Chang Class	Rain Classroom	ZOOM	Tencent Meeting	Tencent Class	QQ	Wechat	Wisdom Tree	MOOC
Number	41	11	136	27	189	24	9	22	73	108

Table 2. Descriptive statistics results

Variable	Number of samples/pc	Min	Max	Mean	Standard deviation
Platform technology (PT)	200	1.00	5.00	3.66	0.78
Learning environment (LE)	200	1.00	5.00	3.69	0.79
Learning strategies (LS)	200	1.00	5.00	3.45	0.77
Teacher instruction (TI)	200	1.00	5.00	3.88	0.70
Teacher feedback (TF)	200	1.00	5.00	3.91	0.78
Interactive learning effectiveness (IE)	200	1.00	5.00	3.73	0.81
Interactive learning behavior (IB)	200	1.00	5.00	3.51	0.76
Learning effectiveness (LE)	200	1.00	5.00	3.34	0.71

4.2. Correlation analysis results

Data correlation analysis is to understand the correlation and influence degree between various types of behavioral data. Here, Pearson correlation coefficient is used to analyze the correlation between teachers' online teaching (including three dimensions of platform technology mastery, online teaching resources provision and online teaching process behavior), teachers' feedback (including attention to learning behavior, timeliness of feedback and attention to students' feedback) and students' online interactive learning data (including three dimensions of interactive learning purpose, interactive learning behavior and interactive learning effect). The correlation analysis was conducted to understand the impact of teachers' online teaching on students' online interactive learning. The results are shown in Table 3.

The correlation between teachers' teaching and students' interaction behavior was not high ($r=0.531$, $p<0.01$), but it was statistically significant with the interaction effect ($r=0.769$, $p<0.01$); the correlation between teachers' feedback and students' interaction behavior was not high ($r=0.492$, $p<0.01$), but it was statistically significant with the interaction effect ($r=0.75$). ($r=0.759$, $p<0.01$). In addition, there were different correlations between teacher feedback and students' different interactive learning purposes, with teacher feedback showing a high correlation with interactive purpose - interest ($r=0.673$, $p<0.01$) and interactive purpose - achievement ($r=0.658$, $p<0.01$), which reached statistical significance. Details are shown in Table 3.

The analysis of the data shows that teachers have difficulty in motivating students to engage in interactive behaviors on their own, but they can improve the effectiveness of students' online interactions by improving their own teaching quality. This is because through teachers' online clear explanation, it may enable students to stimulate deeper thinking and gain more inspiration when interacting with teachers and peers. And teachers' timely evaluation of students' interaction behaviors can make students gain interaction satisfaction and thus stimulate their interest in interaction.

Table 3. The effect of teachers' online teaching situation on students' online interactive learning

	IE	IB	IA-grades	IA-Compliment	IA-Interesting	IA-Senseof accomplish-ment	IA-Answer questions
TI	0.769**	0.531**	0.612*	0.478**	0.653*	0.662**	0.682
TB	0.759**	0.492**	0.547	0.467**	0.673**	0.658**	0.670

IA indicates Interactive aim, * indicates $p<0.05$, ** indicates $p<0.01$

Using this method, the correlation and influence between teacher specific online teaching process and interaction behaviors and student interaction behaviors data were further analyzed, and the results are shown in Table 4. where there was a high significance between student interaction behaviors and

teacher-student 1v1 interaction (r=0.602, p<0.05) and teacher-guided group discussion (r=0.674, p<0.05), and reached statistical significant in the sense of statistical significance. The correlations between student interaction behaviors and teacher attention to student response (r=0.506, p<0.05), attention to interaction (r=0.402, p<0.05), and attention to classroom fun (r=0.434, p<0.05) were low. Details are shown in Table 4.

Table 4. Effects of teacher-specific online teaching processes and interactive behaviors on interactive behaviors with students

	Focus on student response	Focus on Interaction	Focus on classroom fun	1v1interaction with students	Guid group discussions
IB	0.506*	0.402*	0.434*	0.602*	0.674*

* indicates p<0.05

4.3. Multivariate linear analysis results

The regression equation was established with the online learning effect as the dependent variable and the three dimensional factors of learning strategy, interactive learning behavior, and interactive learning effect as the independent variables, and the regression results are shown in Table 5. LE is the dependent variable and LS (Learning strategy), IE, and IB are the independent variables.

$$Y(LE)=0.35*LS+0.14*IE+0.33*IB+0.52 \quad (1)$$

The regression results show that: Online learning strategies have a significant positive effect on online learning effectiveness, which indicates that the more students can choose online learning strategies that are suitable for them, the better their online learning effectiveness will be. Therefore, students should try different learning strategies and choose the appropriate online learning strategy as one of the ways to improve their online learning effectiveness. Interaction learning dimension factor---interaction learning behavior has a significant positive impact on interaction learning effect, which means that the more frequent the interaction behavior is when learning online, the better the interaction effect is and the better the learning effect is. Therefore, teachers and students should interact more often in online courses, and ensure the quality of interaction and focus on feedback in order to improve the online learning effect.

Table 5. Results of regression analysis of online learning effects

Independent variable	Standard coefficient	t-value	Significance level
LS	0.375	5.563	0.000***
IB	0.376	6.566	0.028*
IE	0.154	2.209	0.000***
R^2: 0.631	Adjusted R^2: 0.625	F-value: 111.627	

* indicates p<0.05 *** indicates p<0.001

4.4. Clustering analysis results

To examine college students' learning strategies for online learning, this study used the K-means clustering algorithm to classify the types of college students' online learning strategies. The K-Means algorithm is an unsupervised learning and also a division-based clustering algorithm, which generally uses the Euclidean distance as a measure of similarity between data objects, where the similarity is inversely proportional to the distance between data objects, and the greater the similarity, the smaller the distance [10]. First, the strategy questions in the questionnaire were divided into five categories - place selection, resource utilization, emotion regulation, motivation and regulation strategies. Among them, emotion regulation strategy is the result of summing and averaging to maintain emotional stability and reduce negative emotion; regulation strategy is the result of summing and averaging to develop plan, progress monitoring, content monitoring, plan adjustment, and time scheduling. Next, comparing the second, third, fourth, and fifth categories in turn, the detailed results of the categories

are shown in Table 6, taking into account the number of observations and nomenclature of each category. the mean and standard deviation results of each strategy for each category of students are shown in Table 7.

Table 6. Number of learners included in each cluster

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Number	62	77	12	17	32
Percentage	31%	38.5%	6%	8.5%	16%

Table 7. Analysis of college students' online learning strategy types on each dimension

	Cluster 1: M±SD	Cluster2: M±SD	Cluster3: M±SD	Cluster 4: M±SD	Cluster 5: M±SD	F-value
Motivation	3.18±0.50	4.22±0.50	1.58±0.52	2.24±0.66	2.69±0.54	121.75***
Place Selection	3.00±0.57	4.27±0.55	1.58±0.52	3.53±0.62	4.22±0.49	95.97***
Emotional Regulation	3.14±0.42	4.06±0.53	1.67±0.62	2.24±0.69	2.84±0.69	86.48***
Resource Utilization	3.26±0.51	4.29±0.54	1.83±0.84	2.65±0.70	4.16±0.51	83.85***
Moderating Strategies	3.32±0.39	4.14±0.55	1.87±0.85	2.56±0.38	3.61±0.51	76.76***

*** indicates $p<0.001$

Based on the mean scores of the five dimensions in each type, the performance of each type of students in terms of learning strategies is plotted in Figure 3. As seen in Figure 3, the trends of the mean scores of each dimension in different types are different. Clusters 1, 2, and 3 are named "medium strategy" learners, "strong strategy" learners, and "weak strategy" learners, respectively, according to whether they can actively adopt learning strategies. Cluster 4 is the one in which only place selection receives a high mean score. The mean scores of other dimensions are low, and these students pay more attention to the choice of learning environment in the process of online learning, so Cluster 4 is named "place-oriented" learners; Cluster 5 has low mean scores of motivation, emotion regulation and other related psychological strategy dimensions, and these students pay more attention to the use of hardware and facilities and resources in the process of online learning. In the process of online learning, these students pay more attention to the adoption of hardware and resource strategies and neglect the mobilization of psychological strategies, so Cluster 5 is named "hard strategy" learners.

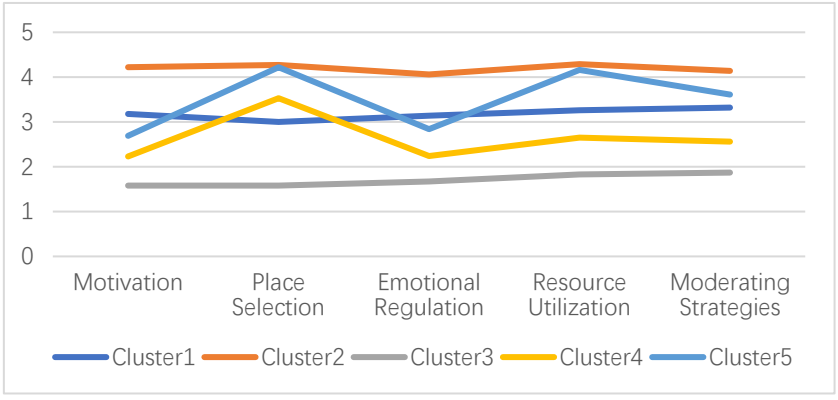

Figure 3. Performance of various clusters of students in terms of learning strategies

5. Conclusion

In this study, we used likert scale questionnaire to collect online learning data from college students, and used spss modoler to explore the degree of influence of online learning platform, teachers' behavior, learning strategies and interactive learning on the effect of online learning by using

correlation, multiple linear regression and k-means clustering models on the data, and came to the following conclusions.

There are various online learning platforms with different functionalities, and they should make full use of different functions and advantages for online teaching and learning. Teachers can fully combine timely interactive platforms, time-delayed interactive platforms, and resource sharing platforms to build a comprehensive online learning environment for students during and after class. Students can also make full use of different functional platforms such as live streaming, recording, and self-evaluation to conduct comprehensive learning strategies such as gap checking and expansion.

From the linear regression analysis of the data, interactive learning behaviors and interactive learning effects positively affect online learning effects. Therefore, when learning online courses, students should actively and high-quality participate in interactive learning, such as 1-to-1 communication with teachers in live courses, active participation in group activities, active questioning and Q&A questions, etc.; active interactive course discussions in recorded courses, etc., which can effectively improve the effect of online learning.

The correlation analysis of the data shows that there is a correlation between the data items of teacher and student behaviors. Therefore, in online courses, teachers should pay attention to feedback on students' learning behaviors, including giving timely feedback to students and adjusting teaching based on student feedback. In addition, teachers' teaching has obvious influence on students' interactive learning behaviors. Teachers should actively participate in online interactive learning, and specific behaviors may include guiding group activities and asking students to answer questions individually, which can effectively improve students' online interactive learning behaviors and thus ensure students' online learning effectiveness. In contrast to the traditional teaching model, teachers are not only "lecturers", but also "leaders" and "motivators". In order to meet the needs of modern learning, teachers must abandon the old concept of "teacher subject" and improve their ability to design and organize online teaching and learning to guide and promote learners toward common goals [11].

According to k-means cluster analysis, online learning students are divided into 5 clusters. For example, for "hard strategy learners", teachers should take care of students' emotions, motivate them to learn, and consciously teach methods to manage emotions and motivate them to learn, so that students can consciously use emotion management strategies to improve their learning effectiveness. For example, for "medium-strategy learners" and "weak-strategy learners", teachers should focus on teaching learning strategies such as progress testing and resource use.

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