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An empirical study on blended learning in higher education in "internet + " era

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Abstract

In order to investigate the overall cognition of blended learning, we made a questionnaire survey and interviews with students and teachers of 10 universities and colleges in Anhui Province. Based on this investigation, we design a Rain class blended learning model which fully utilizes the modern network technology and mobile terminals to closely link pre-class and after-class learning to classroom teaching by using Wechat terminal. In order to validate the application effect of the model, a quasi-experiment is conducted between two groups of students. We used SPSS 23.0 in recording and analyzing the data for inferential statistics, two independent samples T-test, variance analysis and descriptive statistical analysis. The difference was statistically significant with $P < 0.05$. The study found that students have higher interest and acceptance to blended learning, but miscellaneous online resources and excessive interference information have negative impacts on students' online learning participation behavior. The hypothesis about the influencing factors of blended learning has been verified empirically, that is, perceived ease of use, perceived usefulness, a learning atmosphere are important factors affecting learners' acceptance of blended learning. A teaching practice proved that the new learning model has achieved remarkable results in improving learning efficiency and quality of students in large classroom, cultivating students' learning initiative and stimulating their interest in learning.

Keywords Blended learning · Online learning; Traditional teaching · Teaching practice · Rain classroom

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1 Introduction

With the development of Internet information technology, lots of scientific and technological elements have been applied in the field of education. Educators have to think about the problem of educational informationization. The ultimate goal of education is always to promote the all-round development of talents. But by traditional face-to-face teaching, it is difficult to cultivate individualized learning and evaluate the whole learning process, this is due to the fact that the content of a course is fixed, the course duration and learning space are limited, and it is difficult to share high-quality learning resources. Traditional teaching ignores students' initiative and independence in learning, as such, it is not conducive to the cultivation of students' creativity. Online courses (such as MOOC and micro-courses) give learners time and place flexibility (Baturay, 2015), but video-based curriculum design is not conducive to the development of deep learning. Due to technical reasons and too many people online, it is impossible to carry out deep communication; learning integrity is difficult to guarantee, and the quality of MOOC education and the assessment of student work are also issues (Hew & Cheung, 2014). Blended learning, as a new teaching method, make the two teaching methods into an optimal combination. (Hubackova, 2015; Okaz, 2015)

Based on reflection and reconstruction of online learning, blended learning emerged, whose purpose is "optimizing all kinds of teaching elements in the teaching process with the help of information technology, realizing the teaching objectives or achieving the intended educational objectives in the most effective way" (Li, 2014). Aided by Internet and information technology, blended learning is not based on a certain learning theory, but integrates constructivism, connectionism, cognitivism, humanism, educational technology and other learning theories. The purpose of blended learning is to explore a way of maximizing the advantages of traditional teaching and online education, and to realize the "trinity" of value shaping, ability training and knowledge imparting. Many related researches (Bliuc et al., 2007; Selim, 2007; Ginns & Ellis, 2007; Graham et al., 2005; Garrison & Kanuka, 2004; Ugur et al, 2011; Carbonell et al., 2013; Keengwe & Kang, 2013; Asarta & Schmidt, 2017; Broadbent, 2017; Bouilheres et al., 2020; Asarta & Schmidt, 2020; Ustun et al., 2021) and teaching practice (Paechter et al., 2010; Lim and Morris, 2009; Christensen et al, 2013; Powerll and Watson, 2015; Porter et al., 2014; Matukhin and Zhitkova, 2015; Nazarenko, 2015; Bersin, 2004; Olivers, 2012; Driscoll and Barneveld, 2015; Lafrance and Blizzard, 2013; Asarta & Schmidt, 2017; Bazelais & Doleck, 2018; Han & Wang, 2019; Asarta & Schmidt, 2020; Monk et al., 2020; Al-Qatawneh et al, 2020; Müller & Mildenberger, 2021; Felipede et al., 2021) have shown that the quality of talent training can be enhanced through the application of blended learning. In this context, some intelligent blended learning platforms have been developed and applied in China, such as blue clouds classroom and Rain Classroom.

Wisdom teaching tools essentially provide data and intelligent information support for teaching, and apply the most advanced information technology such as mobile internet, cloud computing and data mining in the teaching process. But

how can we combine digital online education with offline teaching to maximize the learning effect of students? For this question, we made related research and carried out a teaching practice. The procedures are as follows: Firstly, we carried out a questionnaire survey and interviews with students and teachers of 10 universities and colleges in Anhui Province to investigate the overall cognition of blended learning. Secondly, we analyzed the influencing factors of the students' acceptance. Thirdly, we constructed a learning model: blended learning based on Rain Classroom, which integrated online learning and classroom teaching harmoniously, and carried out a teaching practice. Finally, the learning effect of the teaching practice was evaluated.

2 Empirical review: An investigation

A meaningful learning can only be achieved through learners' active and effective learning activities. Any mechanical and blind learning is considered nothing but a waste of learners' time and energy. The real purpose of learning can only be achieved when learners internalize knowledge. Therefore, before the teaching practice, we administered questionnaires and conducted interviews with students and teachers of 10 universities and colleges in Anhui Province in order to investigate the overall cognition of blended learning. The questionnaire mainly includes personal situation, the use and cognition of blended learning, and the evaluation and suggestion on blended learning. Excluding the incomplete and invalid questionnaires (those with the same answers), 1738 valid questionnaires were retrieved, achieving a 90.9% effective rate.

Through the survey, the following facts were found: 89% of the students have been surfing online for over 5 years, as Devlin (2013) has mentioned that lots young people under twenty interacted more using social media. 76.78% of the students have high interest and confidence in blended learning and consider it helpful. 92.8% of students like blended learning because of the large amount of online information and high abundance of learning resources. 76.5% of the students think that they definitely need the help and guidance of teachers in learning. 83.6% of the students have the willingness to study online courses recommended by teachers, while only 27.8% of them have continuous participation behavior. We found that most students had a high acceptance of blended learning and were eager to acquire more knowledge, but too much network interference (such as entertainment, shopping, games) hindered students' continuous participation in online courses. Students are unable to screen out the online courses corresponding to classroom teaching, so they need the assistance and guidance of teachers. The role of teachers has changed from knowledge inculcators to knowledge combers, learning guides and psychological counselors. More college students have realized that teachers still play an important role in blended learning (Du & Fu, 2016).

We also interviewed 30 teachers face-to-face about their thinking to blended learning during a break of ten minutes. Throughout the interview, we wrote down their age and educational level, then used voice recorders to record the content of the interview. 6 teachers with master degree who are 45 + years old confessed

that blended learning poses new challenges to them. 2 over-45 s teachers with master degree and 9 teachers of the same age with PhDs think wisdom teaching tools can provide more convenient teaching means, and believe in "the ability of technology to bring transformative change to education" (Brahimi & Sarirete, 2015). The rest 13 interviewees are younger teachers with PhDs. They all believe wisdom teaching tools can provide more convenient teaching means, when they have to deal with the problems of teaching information selection, organization and reconstruction, classroom design, organization and mastery, data collection, screening and analysis in the process of teaching. In the blended learning, all the teachers believe that students' online course study before class is very important, as it largely impacts students' classroom learning and directly affects the learning effect of blended learning; and their continuous participation in online courses is the premise of harmonious integration of online education resources and classroom teaching. Of course, teachers should constantly improve their information technology literacy, teaching design level and teaching data literacy to overcome the challenges posed by the new teaching tools. Both students and teachers should make efforts to achieve the best matching of various learning factors.

2.1 Influence factors

In blended learning embedded in information technology, students' acceptance directly affects the final effect of blended learning, which is an important basis for the construction and evaluation of a learning platform (WU & Liu, 2013). Through questionnaires and interviews, we find that students' perception and evaluation on blended learning often come from their perception, experience and evaluation of online learning platforms. Therefore, perceived ease of use and perceived usefulness are important determinants of the acceptance of blended learning.

Students' perception to the content, mode and operation process of blended learning and their dependence on learning atmosphere and interaction behavior determine the ultimate learning effect. Tennyson constructed a hierarchical analysis model of students' acceptance of blended learning, and stated that perceived ease of use, perceived usefulness and learning atmosphere were three key factors influencing students' acceptance. Perceived ease of use basically means that a product has a simple operation interface, is easy to understand, operate and remember. But users with different learning background have different sensibility on ease of use as they have different cognitive ability, learning ability and operational experience. He pointed out that "ease of use" was positively related to the acceptance of students in blended learning (Joo et al., 2011) because the digital learning platform had friendly interface, clear understandable knowledge, easy operation and autonomy, and was easy to be accepted by students.

Perceived usefulness is a subjective understanding that blended learning is meaningful and effective. Ertmer and colleges carried out a study and discovered that students' perceived usefulness played a positive role in promoting positive learning and participating in interaction (Liaw et al., 2007; Ertmer et al., 2008). Learning atmosphere is a learning environment established to meet the needs of students' physical and mental development, which can influence students' thinking and behavioral

habits imperceptibly. A good learning atmosphere can stimulate students to work hard, improve the efficiency of "teaching" and "learning". Aided by Internet and information technology, blended learning makes it possible for learners to learn autonomously and instantly.

The learning climate, as one comprehensive informal facilitator, can facilitate learning capability (Revilla, 2006). Trust, cooperation, sharing, discussion and encouragement among students, between teachers and students could stimulate students' potential interest in learning. In e-learning or traditional learning, a healthy and harmonious learning atmosphere is helpful to exchange ideas, information and knowledge. There is a significant positive correlation between knowledge exchange and learning atmosphere on students' acceptance. Small regarded teachers as the soul of the teaching process and experts with authority (Small et al., 2012). The interaction between teachers and students enhances the students' acceptance. Roca's research has proved that acceptance was an important factor, which influences the learning efficiency (Roca & Gagne, 2008).

2.2 The model of blended learning based on rain classroom

In April 2016, Tsinghua University launched a wisdom teaching tool–Rain Classroom. Compared with the traditional network teaching system (such as Sakai), Rain Classroom actively uses mobile internet technology such as information push and real-time interaction to bring teachers and students closer to the courses, make the interaction more humane, convenient and accurate, and has the capacity to track, monitor and real-time evaluate the whole learning process. Compared with other classroom interactive tools, Rain Classroom uses BYOD (Bring Your Own Device) as the response system. It makes full use of students' own smartphones instead of being limited to public teaching aids, and is capable of adding more personalized learning guidance and context teaching design in learning.

Teachers can use Rain Classroom and students' mobile phones to link their pre-class and after-class learning with classroom teaching. Before class, teachers can arrange pre-class learning tasks by mobile phone push so that students can form a certain learning support for the high-level interaction in the classroom. After class, mobile phone push can help the students in reviewing and expanding related knowledge. The function of "mobile phone push" is not only to improve the students' self-learning ability, but also to get students into the habit of self-learning; and to enable the teachers to capture the dynamic learning state of students before and after classes. Bullet screen, one of functions of Rain Classroom, is very popular among students who are influenced by ACG (Animation, Comic, Game). The transplantation of this function into the classroom environment of Rain Classroom can make students express their opinions more enthusiastically and make it possible for the whole class to discuss concurrently.

In addition, Rain Classroom also has the functions of "slide synchronization", "incomprehension" feedback, and "classroom exercise response system". With these functions, Rain Classroom can automatically collect the data of students' learning behavior, analyze and quantify their learning effect in an objective way, which is conducive for teachers to evaluate the teaching quality and adjust their teaching strategies, so that the teaching is data-driven instead of experience-driven. Blended learning

based on Rain Classroom can enable students to learn independently and fragmentally through their smartphones at anytime and anywhere. It can enable teachers to carry out "Dual-channel teaching" calmly and flexibly. It can record teaching data panoramically, analyze the teaching process and teaching status individually, and provide a scientific decision-making basis for teaching and learning. Figure 1 below, shows the model of blended learning based on Rain Classroom.

3 Method

We conducted a quasi-experiment to validate the application effect of blended learning based on Rain Classroom (Fig. 1). The subjects were 275 students from eight classes of English majors in a university of Anhui Province, China. By using a group sampling method, four classes (136 students) were selected as the experimental group to carry out blended teaching based on Rain Classroom, and Fig. 1. Blended Learning based on Rain class four classes (139 students) were taught with traditional classroom teaching in the control group.Lectures, classroom hours and teacher of the two groups were the same. The experiment lasted for a duration of one semester (18 weeks), the course taught was "extensive reading" commencing from 08:00 a.m. to 09:40 a.m. on every Wednesday. For the experimental group, the procedures are as follows:

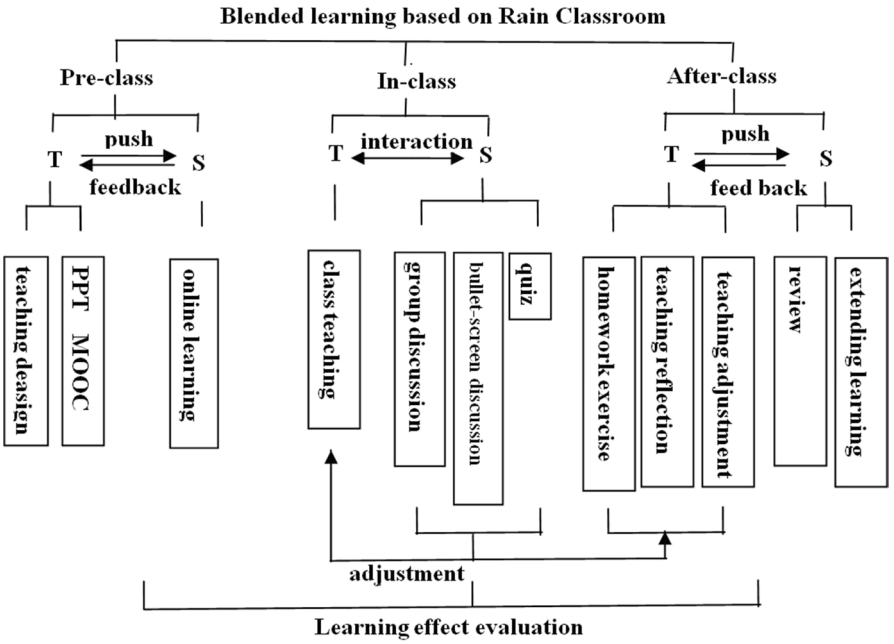

Fig. 1 T = teachers S = students

3.1 Preview before class

Teachers click on Rain Classroom (Wechat subscription), select "I want to start class" and establish a course and a class. Students log in to Rain Classroom by sweeping the two-dimensional code of Wechat, and click "Start Class". In the first class, students must fill in their personal information, including class, name, student number, etc., in order to facilitate the observation of learning effect and the record of students' scores. The learner's subjective initiative and self-discipline determine the effect of blended learning. But the undergraduates of the post-2000s generation are smartphone aborigines, and their learning has been disturbed by more and more online interference information, such as shopping, games films and so on. Consequently, the first step in our learning model is to insulate students from the disturbing information and enable them to effectively study the relevant teaching resources (MOOC, micro-courses, excellent online courses) pushed by teachers.

Before class, teachers refine the main points of one lecture, send them to the students in the form of PPT through "Rain Classroom" and set a time limit to preview. Teachers can insert micro-videos (within 2 minutes) or voice explanations (one minute or so) into the PPT to make the courseware more vivid and understandable. If there is something which students don't understand, they can make a mark online which will appear on teachers' phones at the same time. Teachers will give more explanation in class according to students' feedback. Teachers also can recommend related MOOC for students, such as some extensive reading related resources in "MOOC - National Excellent Course Online Learning Platform of China University", to deepen and expand their professional knowledge. In blended learning, teachers are learners, extractors, integrators and providers of online resources before class.

3.2 Classroom teaching

In the blended learning, Rain Classroom software generated a two-dimensional code for each course automatically. Students scanned the code with their phones and entered "the classroom". In class, teachers are designers, instructors, facilitators and collaborators in learning. In Rain Classroom, teachers can organize a quiz in class to test the teaching effect, and can organize students to participate in classroom discussions by bullet screen and off-line groups. If there is anything which students don't understand or are confused, they can click a button to indicate their incomprehension. The feedback will appear on the teacher's computer or mobile phone at the same time, and be recorded by Rain Classroom. It is convenient for teachers to evaluate the level at which students master a unit. And it is also helps the students in reviewing their confused knowledge.

An interaction between a teacher and his/her students, and a good learning atmosphere can stimulate students' potential to the greatest extent, cultivate a sense of team work, and deepen a trust between a teacher and his students. Also, it is regarded as truancy if a student has not scan the two-dimensional code into Rain Classroom,

which is convenient for teachers to manage the order of classroom teaching, improve students' classroom engagement (He, 2020; Lima et al., 2021).

3.3 Review after class

After class, the Rain Classroom system will send the data of the whole classroom teaching process to the teacher's mailbox, this includes the number of students who have questions regarding what they have learned, who have made mistakes in the quiz, which can be specific to which students have answered the wrong questions. It is convenient for teachers to adjust his/her teaching plan, and more conducive to the final formative evaluation as an objective indicator of reference. Teachers can give students homework to check and consolidate the new knowledge and recommend some relevant MOOC for students to study by themselves as a second classroom.

3.4 Evaluation

The evaluation to the teaching effect of the two groups mainly comprises of two parts, academic records and questionnaire. (1) academic records. The objective part of the evaluation includes 30% after-class quizzes, 30% after-class exercises and 40% final exams. There is no difference in teachers, paper, scoring criteria and invigilation between the experiment group and the control group. (2) Questionnaire. We investigated the teaching satisfaction of the two groups and the evaluation of the experimental group to the blended learning based on Rain Classroom. The questionnaires contain four sections with the first section requesting the demographics of the respondents. The second part elicited data on the respondents' experiences in blended learning. Respondents were asked questions related to the predictor variables (SysQual, iQual, servQual, and uSat) in part three. Lastly, the fourth part catered for question-related to the dependent variable. All items were adapted from past studies (Hsu et al., 2010; Mayeh et al., 2014; Venkatesh et al., 2003) and measured on a 5-point Likert Scale with "1 = Strongly Disagree" and "5 = Strongly Agree".

In this paper, we use SPSS 23.0 in recording and analyzing the data for inferential statistics using descriptive statistics and multiple regression analysis. The Content validity of the survey instrument was carried out by two academic experts whose critical reviews and recommendation led to the removal of items deemed ambiguous. All the emerging Cronbach Alphas were above the 0.7 thresholds denoting the instruments measuring the constructs were reliably acceptable.

4 Results

For this model, this paper uses a closed questionnaire design, and measure variables on a Likerts scale. The standard factor load of each variable ranged from 0.637 to 0.869, the T value was significantly bigger than the critical value, the load

factor was significant, the cumulative variance contribution rate reached 78.63%, and the maximum one-way variance contribution rate was up to 23.12%. The correlation coefficients of each variable in the discriminant validity test fall within the range of 0.368 to 0.862, and each correlation coefficient (+2) deviation did not contain 1. The main effect test of influence factors shows that perceived ease of use, perceived usefulness, and good learning atmosphere positively influence the students'acceptance ($p < 0.05$), which supports that perceived ease of use, perceived usefulness, a good learning atmosphere have noticeable positive effects on learners' acceptance.

Table 1 shows the socio-demographic characteristics of the respondents. A total of 10.5% of the respondents were male, and 89.5% of the respondents were female. This implies that majority of the respondents were female. Similarly, the age distribution of the respondents revealed that 99.1% of the respondents were below the age 30 years, 0.5% of the respondents were within the age range of 31–40 years, where 0.5% of the respondents were above the age range of 41 years. The implication is that the age preference of students is less than 30 years. Table 1 further shows the educational level of the respondents, 97.7% of the respondents are having lower degrees, 1.8% have Bachelor degrees, while the 0.5% are having higher degree. This implies that most of the respondents are currently undergoing their tutelage as in higher degrees. This shows that the school diversity can satisfactorily give the accurate information on the topic examined.

Before the teaching practice, test scores of the two groups in comprehensive English were 76.968 ± 8.145 (the experimental group) and 75.682 ± 8.356 (the control group). After the teaching practice, academic records, students' satisfaction rate and the subjective evaluation were determined and shown in Tables 2, 3 and 4 below.

Table 1 Sociodemographic Characteristics of Respondents

Socio-demographic Characteristics	Frequency	Percentage (%)
Gender:		
Male	23	10.5
Female	196	89.5
Total	219	**100**
Age:		
less than 30 years	217	99.1
31-40 years	1	0.5
41-and above	1	0.5
Total	219	**100**
Education:		
Secondary School	214	97.7
Diploma	4	1.8
Bachelor	1	0.5
Total	219	**100**

Table 2 The Comparison of test scores of the two groups (x ± s)

Group	number of students	academic record
the control group	139	78.632±8.756
the experimental group	136	82.368±6.387

$P < 0.01$

Table 3 The Comparison of satisfaction rate of the two groups

Group	Students	Satisfaction	General	Dissatisfaction	Rate
the control group	139	87	20	29	62.58%
the experimental group	136	112	22	5	82.35%

$P < 0.05$

5 Test of hypothesis

The result presented in the model summary Table 5 indicates that students' acceptance and blended learning in higher education variable were jointly explained at 57.6% variance of attitude towards blended learning, good learning atmosphere, perceived usefulness and perceived ease of use, while the remaining 42.4% could be due to the effect of extraneous variables not accounted by the model. The adjusted R-square (0.319) which is a value just so close to R-square (0.332) shows that if the model is sampled from the population rather than the sample it will account for a negligible difference of 0.8% variance in the outcome. Therefore, the model fitness is good. R = 0.576 implies that the relationship between students' acceptance (SA) and blended learning (BLENDL) is fairly high because the correlation coefficient is close to 1.

Table 6 presents the overall diagnostic test of significance computed using Analysis of Variance (ANOVA) between joint relations of students' acceptance (SA) and Blended learning in higher education (BLENDEDL). The ANOVA results for regression coefficients indicate that the significance of the F = 26.587 > F-table = 11.128

Table 4 Student' subjective evaluation of the aided teaching effect of "Rain Classroom" (n = 136) students (%)

questionnaires	satisfactory	good	poor
learning interests	106(77.9)	24(17.7)	6(4.4)
learning initiative	102(74.3)	29(21.3)	6(4.4)
learner autonomy	120(88.2)	14(10.3)	2(1.5)
English language competence	85(62.5)	11(8.1)	40(29.4)
problem analysis ability	89(65.4)	30(22.1)	17(12.5)
fragment learning	121(89.0)	15(11.0)	0(0.0)
preview	118(86.8)	18(13.2)	0(0.0)
classroom teaching	115(84.6)	15(11.0)	6(4.4)
review	104(76.5)	29(21.3)	3(2.2)
teacher-student communication	109(80.1)	20(14.7)	7(5.2)
learning atmosphere	102(75.0)	31(22.8)	3(2.2)
teamwork spirit	107(78.7)	23(16.9)	6(4.4)
to lighten the learning load	86(63.2)	20(14.7)	30(22.1)

Table 5 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.576[a]	0.332	0.319	3.33589

[a]Predictors: (Constant), ATTBLEND, GLE, PU, PEOU

at a degree of freedom of (2, 83); i.e. P-value = 0.00 is less than 0.05. This indicates that the students' acceptance significantly predicts the effectiveness of blended learning in higher education in internet + era (meaning it is a good fit for the model). Therefore, a significant relationship between joints effect of students' acceptance and blended learning in higher education in Internet + era exists at 95% confidence level.

From regression Table 7, it can be deduced that attitude towards blended learning, good learning atmosphere, perceived usefulness and perceived ease of use has the least beta (β = 0.205; 0.138; 0.149 and 0.208 respectively) and this implies that blended learning has a positive impact on students' acceptance in the higher education in internet + era. Students' acceptance (SA) has direct positive effect on blended learning and it makes a noticeable positive change in learning in higher education at 5% level. This result implies that both students' acceptance (SA) and blended learning (BLENDL). has significant impact on higher education performance which the incorporated results of model summary in Table 5 and ANOVA Table 6 failed to indicate the direction of the impact because of insensitivity of statistical power. The constant of regression further shows that if SA = BLENDL = 0, then the higher learning increases by 26.4% and it is significant at 5% level. Therefore, it seems the removal of students' acceptance and blended learning can be used for inference. Hence, the null hypothesis is rejected and the alternative hypothesis is accepted by the fact that there is significant impact of students' acceptance and blended learning on higher education in internet + era at 5% level of significance.

6 Discussion

The blended learning based on Rain Classroom fully utilizes the modern network technology and mobile terminals to closely link pre-class and after-class learning to classroom teaching by using Wechat terminal. The results of the teaching practice

Table 6 ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig
1	Regression	1183.457	4	295.864	26.587	0.000[b]
	Residual	2381.429	214	11.128		
	Total	3564.886	218			

[a]Dependent Variable: SA

[b]Predictors: (Constant), ATTBLEND, GLE, PU, PEOU

Table 7 Regression Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig	Correlations
		B	Std. Error	Beta			Zero-order
1	(Constant)	14.624	2.090		6.997	0.000	
	PU	0.288	0.134	0.205	2.153	0.032	0.496
	GLE	0.220	0.114	0.138	1.932	0.055	0.397
	PEOU	0.204	0.149	0.149	1.368	0.173	0.503
	ATTBLEND	0.319	0.134	0.208	2.387	0.018	0.483

[a]Dependent Variable: SA

proved that, students' study interest and enthusiasm are obviously aroused, their academic performance is significantly improved and the needs for fragmented learning has been met. It can be seen that new technologies and means are more attractive to undergraduates nowadays. To some extent, different teaching modes of the same course can impact students' learning interest and enthusiasm. Blended teaching based on Rain Classroom extends effectively classroom teaching to pre-class and after-class, which can promote students' deep learning and independent learning capacity. The push function of Rain Classroom before and after class is convenient for students to preview and review, while the background record of students' learning in Rain Classroom is convenient for teachers to grasp students' learning situation real-timely and objectively. The continuous participation behavior in MOOC of the experimental group shows that Rain Classroom can improve students' learning enthusiasm before and after class, and is the extension and complement of classroom teaching. Blended learning based on Rain Classroom can give room for a more convenient and efficient communication between teachers and students more convenient and efficient. Also, a good interaction between students and their teachers can further internalize what they learn. In the experimental group, the teaching practice proves that 80.1% of students see it as a way of promoting communication between teachers and students. 75% of them think that Rain Classroom can activate the classroom atmosphere and 78.7% of them think that it is conducive to the cultivation of team work spirit. Our blended learning models no longer take grades as the sole criterion for evaluating students' learning effect but lays on stress on monitoring students' learning attitude in online and offline learning, tapping and expanding their potential abilities. While the objective records of the whole learning situation, including before and after class, will become one of the reference basis of a formative evaluation and help to establish formative indicators.

The students of the experimental group highly evaluate Rain Classroom while their teachers have a complicated emotion about it. Teachers admit that Rain Classroom is a great adjunct to teaching and learning, but teachers should play a leading role in the whole process. While the new teaching tool has brought new challenges and pressures to teachers too. Under the background of Internet, teachers have to always explore new knowledge, as well as select, organize and reconstruct the information so that this cloud-based knowledge can most effectively influence students'

learning. Blended learning based on Rain Classroom aims at providing students with a new learning experience beyond simply applying it in teaching. Therefore, teachers need to design teaching, organize and control the whole class according to different students, courses and their own teaching style.

The data provided by Rain Classroom can provide important information for teaching decisions. Teachers should pay attention to excavate the rich value hidden in the data so as to make better teaching decisions and improve teaching practice. Rain Classroom has collected the data of students' learning process, in a way that teaching has transited from experience-driven to data-driven. However, some data (such as that of students' emotion) also need to be collected, screened and analyzed by teachers themselves instead of intelligent tools. In addition, teachers also need to worry about students' excessive non-learning use of mobile phones. In the blended learning based on Rain Classroom, students need to use their phones, but some students inevitably engage in online activities unrelated to learning. According to such phenomenon, teachers must emphasize that students need to follow the screen to study, phones only can be used in quizzes or bullet screen discussions.

7 Conclusion

Through questionnaires and interviews, we have understood the current situation and problems of blended learning in China. With such a logical starting point, we analyzed the influencing factors of blended learning and constructed a blended learning model based on Rain Classroom, then conducted a teaching practice. In this paper, the main conclusions drawn are as follows: Firstly, according to our survey, Chinese undergraduates have many problems in learning through the internet. Students cannot have deep learning to the related MOOC because they lack teachers' guidance and their participation behavior is difficult to sustain. Miscellaneous online resources and the excessive disturbing information are the main negative factors affecting blended learning. Therefore, through the blended learning, teachers supervise and monitor students' online learning before and after class through the background of Rain Classroom, then check the learning effect in classroom teaching, so as to integrate online and offline learning deeply and improve its efficiency and quality.

Teachers carefully design the class teaching and online learning resources for their students; Rain Classroom is handy for students to use with their phones; students think the PPT or related MOOC pushed by teachers are very useful; online bullet-screen discussions and class group discussions make learning atmosphere highly active and feedback functions make communication between teachers and students accessible. All of these will have a significant positive impact on the acceptance of blended learning and students' acceptance has a significant positive impact on learning. Blended learning based on Rain Classroom integrates online learning and class teaching deeply, which can greatly optimize teaching effect, greatly improve students' participation and flexibility in learning. It also provides teachers with an opportunity to reframe teaching methods and optimize teaching practice. Finally, by quantitative and qualitative analysis, the teaching practice

proves that blended learning based on Rain classroom can significantly improve students' learning efficiency and quality.

By the close combination of information technology, internet resources and education, blended learning based on Rain Classroom harmoniously integrated the advantages of online learning and classroom learning, which is truly learner-centered and gives students a new learning experience. In blended learning, students can autonomously control their learning progress, learning content and learning time under the guidance of their teachers who have become the designers of learning activities and the promoters of learning process. Rain Classroom uses big data to track students' learning, record their learning status, progress and effect, and analyze their learning behavior and condition in the shortest time. It will help teachers to monitor the time at which students finish the scheduled learning tasks, target their problems and provide clear goals for later education and intervention. Furthermore, it serves as an important reference for learning evaluation.

7.1 Limitations and prospects

In this paper, we constructed a blended learning based on Rain Classroom and carried out a teaching practice. Further study should be conducted in the following areas: (1) Strengthening the applicability study of blended learning based on Rain Classroom. This is because there are differences between students, which leads to a different applicability to each of the students but same for all courses. This paper only validated the applicability of blended learning based on Rain Classroom to liberal arts courses, science and engineering courses are more inclined to computational process and formula deduction exercise, and its applicability needs to be verified. (2) The understanding of blended learning based on Rain Classroom needs to be further deepened; this is because the application and practice of blended learning is not only limited to students and teachers, the recognition and policy support of the school leadership and the education authorities are more conducive to its development (Moskal et al., 2013; Taylor & Newton, 2013; Graham et al., 2013). (3) The evaluation system of the new learning model needs to be further improved; In this paper, the evaluation of the effect of blended learning based on Rain Classroom comprises of both objective and subjective parts. But learning effectiveness evaluation is a complex process, which mainly includes summative evaluation, formative evaluation and self-evaluation.

Blended learning is based on the concept of Internet education, and the continuous progress of information technology will surely provide new impetus for its development. For example, virtual reality technology makes full use of entity behavior system simulation technology and interactive 3D dynamic scene technology, students can completely immerse themselves in the simulation teaching situation. VR environments may aid students' efforts to be active learners through consciously attending to, and reflecting on, critique leveraging reflexivity and novel meaning-making most likely to lead to a conceptual change (Philippe et al., 2020). Another typical example is the application of artificial intelligence in education.

AI has applied the technology of speech semantics recognition, image recognition, knowledge atlas and in-depth learning to educational scenarios such as teaching and evaluation, and has begun to reconstruct the relationship between all parties in education and teaching. The development trend of AIEd has been developing to empower learner agency and personalization, enable learners to reflect on learning and inform AI systems to adapt accordingly, and lead to an iterative development of the learner-centered, data-driven, personalized learning (Ouyanga & Jiaob, 2021). Education is a complex system that requires multiple perspectives and levels of analysis to understand its contexts, dynamics, and actors' interactions, particularly concerning thechnological innovations(Castro, 2019). In the foreseeable future, with the development of science and technology, the content and mode of blended learning will become more and more exciting, and its research will also present new trends and development directions.

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Declarations

Conflicts of interest/competing interests The authors do not have any possible conflicts of interest.

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