[1,*]Xu Fang
[2] Xiuge Wang
[3] Wenying Ma

An Empirical Study on the Educational Application of ChatGPT

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Abstract: - At present, the digital transformation of education has become a national strategy, and ChatGPT is of great significance to the in-depth promotion of the digital transformation of education.Chatgpt has become a hot spot at home and abroad. The application of ChatGPT in daily education and study need to be deepened, but there is still a lack of attention to the current situation and effect of ChatGPT at home and abroad. Based on expectation confirmation theory, information system success theory and TAM model, this study constructs a model of the influencing factors of ChatGPT learners' use satisfaction. The results of structural equation analysis show that perceived usefulness, expectation confirmation and information quality have significant positive direct effects on learners' satisfaction; perceived ease of use, system quality and social influence have significant positive direct effects on learners' perceived usefulness; system quality and information quality have significant positive direct effects on learners' expectation confirmation; perceived usefulness has significant positive direct effects on behavior intention; system quality has significant positive direct effects on perceived ease of use. The results of qualitative comparative analysis of fuzzy sets show that there are six schemes to promote learners' satisfaction. The overall coverage of the six configurations is 0.974215, and the consistency is 0.71898. On the basis of the above research, some countermeasures and suggestions are put forward finally.

Keywords: ChatGPT; Satisfaction; Structural Equation; Qualitative Comparative Analysis of Fuzzy Sets.

I. INTRODUCTION

At present, the digital transformation of education has become an important strategy for the development of education in all countries in the world, and artificial intelligence is an important means for the digital transformation of education, which is of great significance to promote personalized learning and high-quality resource sharing [1].The rapid development of artificial intelligence has had a wide impact on education. The application of artificial intelligence promotes the birth of intelligent chat robots and virtual assistants. On November 30, 2022, American technology company OpenAI launched a new artificial intelligence chat robot ChatGPT. In just two months, the active users of ChatGPT reached 100 million. The application of ChatGPT has become a hot spot at home and abroad, and scholars have started research on ChatGPT in succession, mainly focusing on the significance and value[2], application mode[3] and practice path of ChatGPT. In the field of education, many scholars at home and abroad have carried out research on the educational application of ChatGPT, including the following aspects. Firstly, relevant scholars have discussed the basic theory of educational application of ChatGPT, including its characteristics, significance and influence. Generative artificial intelligence such as ChatGPT will make historic changes in education and provide new conditions for the development of human creativity. Secondly, relevant scholars discussed the potential and risks of the application of ChatGPT in the field of education, and put forward corresponding countermeasures. Thirdly, relevant scholars further discussed the challenges and influences brought by ChatGPT to schools[4], teachers[5] and students. At present, although ChatGPT has been applied in education, there is still a lack of in-depth analysis on this issue. Satisfaction is an important variable to measure the use effect[6]. Existing studies have used various research methods to analyze and discuss the current situation of ChatGPT and learners' learning and use, but there is still a lack of theoretical and empirical research on ChatGPT learners' use satisfaction. This study intends to analyze the following questions: (1) How satisfied are the learners with ChatGPT? (2) What are the influencing factors of learners' satisfaction with using ChatGPT? (3) How to improve learners' satisfaction in using ChatGPT in all aspects in the future? Based on the related theories, this study constructs a model of ChatGPT learners' satisfaction with the use, and makes an empirical study, which further makes up for the deficiency of ChatGPT related theoretical research, and provides educators and researchers with relevant suggestions and countermeasures on how to effectively use ChatGPT technology in the development of education application.

[1] School of Education Science, Nantong University, Nantong, Jiangsu, China;
[2] School of Education Science, Nantong University, Nantong, Jiangsu, China
[3] School of Education Science, Nantong University, Nantong, Jiangsu, China
*Corresponding author: Xu Fang

II. MODEL CONSTRUCTION

A. Basic Theoretical Model

First of all, Expectation Confirmation Model[7] is a common model to study the continuous adoption and satisfaction of users' information technology applications. Based on this model, a large number of scholars have studied the continuous adoption and satisfaction of information technology educational applications, and achieved good explanation. ChatGPT's educational application is a typical information technology educational application, and it can be explained by Expectation Confirmation Model. Secondly, the information system success model[8] is also a relatively common model, which mainly explains the influencing factors of information system use and is suitable for the study of the influencing factors of more complex information systems. ChatGPT is a general artificial intelligence product based on language model. It is a typical form of information system with certain complexity. It mainly interacts with the output information of the system through user access. Information quality and system quality are important or core factors to measure the quality of its products, so it is suitable to use the information system success model for research. Finally, TAM model is widely used and confirmed by scholars to study the influencing factors of personal use of computers, aiming at explaining personal attitudes and behaviors towards the adoption of specific technologies, and has a good explanation for the adoption of information technologies[9]. At present, TAM models are mostly used to study online teaching, application of new technologies and other fields. Learning with ChatGPT belongs to accepting new technologies, which can be explained by TAM series models. Generally speaking, the above models discuss the influencing factors of information technology adoption in the field of education from different aspects, and this study can better explain the generation of learners' satisfaction with ChatGPT by combining them.

B. Model Construction

The expection confirmation model indicates that satisfaction and perceived usefulness positively affect users' behavior intention. Through the study of college students' willingness to use online live courses and the behavior of MOOC users, relevant scholars find that users' satisfaction and perceived usefulness affect users' behavioral intentions.According to the expected confirmation model, user satisfaction will be positively influenced by both perceived usefulness and expectation confirmation. Relevant scholars have studied the continuous use behavior of information technology and the users' willingness to use academic WeChat official account, and found that users' perceived usefulness and expectation confirmation will affect users' satisfaction. The success model of information system points out that information quality will positively affect users' satisfaction. Through the study of e-learning, relevant scholars found that the information quality will affect the satisfaction of users. Building upon this, the study puts forward hypotheses H1, H2, H3, H4, and H5.

TAM model points out that perceived ease of use and external factors (including social influence) will positively affect users' perceived usefulness. Relevant scholars have studied the continuation intention of E-Learning 2.0 system and the continuous use intention of users of mobile fitness App, and found that usability awareness and external factors (including social influence) will affect users' perceived usefulness. The expected confirmation model indicates that expectation confirmation will positively affect users' perceived usefulness. Through the study of SNS users' persistent behavior[10], relevant scholars found that expectation confirmation would affect users' perceived usefulness.According to the success model of information systems, users' perceived usefulness is positively influenced by both information quality and system quality. Relevant scholars have studied the users' willingness to act[11] and the willingness to use personal cloud storage services[12] in university mobile libraries, and found that information quality and system quality will affect users' perceived usefulness. According to the above analysis, the study puts forward hypotheses H6, H7, H8, H9, H10 and H11.

Through the research of medical information system, relevant scholars found that the system quality has a positive impact on users' perceived ease of use . Relevant scholars have found that information quality and system quality have a positive impact on users' expectation confirmation through the research on their willingness to continue using online education. According to the above analysis, the study puts forward hypotheses H11, H12 and H13.

In summary, this study presents the following research hypotheses and establishes an initial research model, as depicted in Figure 1. The operational definitions of model-related influencing factor variables are shown in Table 1.

H1: Learners' satisfaction with the use of ChatGPT has a significant positive impact on behavior intention.

H2: Learners' awareness of ChatGPT's usefulness has a significant positive impact on behavior intention.

H3: Learners' awareness of ChatGPT's usefulness has a significant positive impact on satisfaction.

H4: Learners' expectation confirmation of ChatGPT has a significant positive impact on satisfaction.
H5: The information quality of ChatGPT has a significant positive impact on learners' satisfaction.
H6: Learners' perceived ease of use of ChatGPT has a significant positive impact on perceived usefulness.
H7: Learners' expectation confirmation of ChatGPT has a significant positive impact on perceived usefulness.
H8: The system quality of ChatGPT has a significant positive impact on perceived usefulness.
H9: The information quality of ChatGPT has a significant positive impact on perceived usefulness.
H10: ChatGPT's social influence has a significant positive impact on perceived usefulness.
H11: ChatGPT's system quality has a significant positive impact on perceived ease of use.
H12: The system quality of ChatGPT has a significant positive impact on expectation confirmation.
H13: ChatGPT's information quality has a significant positive impact on expectation confirmation.

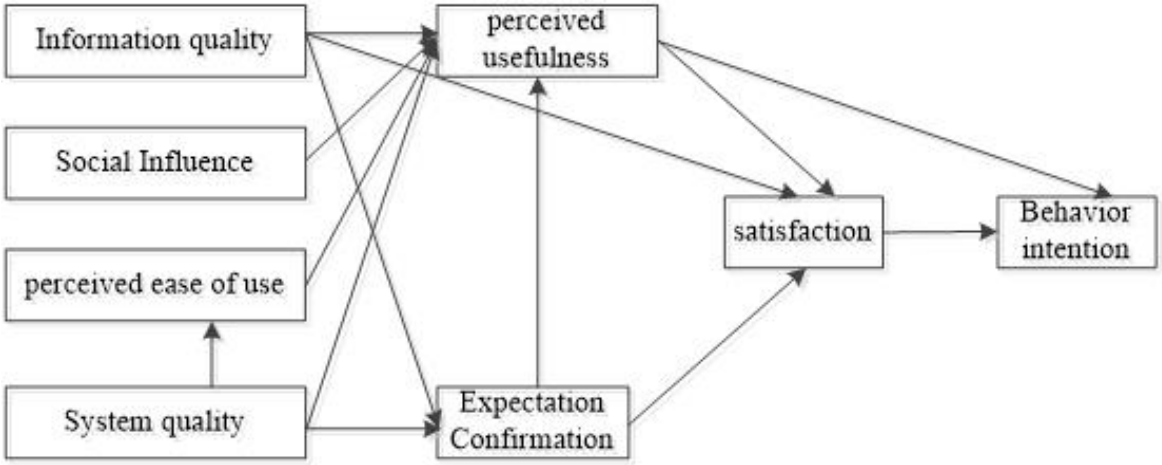

Figure 1: ChatGPT learners' use satisfaction model construction diagram

Table 1: Operational definitions of related variables

variable	operational definition
Behavior intention	Learners' willingness to continue to use ChatGPT to assist learning after using ChatGPT in the early stage.
Satisfaction	Learners' satisfaction with learning with ChatGPT.
Perceived usefulness	To what extent do learners think the use of ChatGPT can improve their learning?
Expectation Confirmation	After using ChatGPT, learners compare the actual learning effect level with their psychological expectations before using it, and get a subjective evaluation that is consistent with their expectations.
Perceived ease of use	Learners personally feel that using ChatGPT requires effort.
Information quality	When learners use ChatGPT, the quality of information exchanged between learners and ChatGPT is high or low, for example, the feedback information of ChatGPT meets the needs of learners.
System quality	The quality of ChatGPT system itself includes its ease of operation, flexibility of service, multilingual support, etc.
Social Influence	Learners' acceptance of ChatGPT is influenced by their social network groups and social environment.

III. Empirical Research Process

A. Questionnaire Design and Distribution

On the basis of ChatGPT learners' use satisfaction model and referring to relevant literature, a questionnaire is designed. Among them, the items related to system quality and information quality are derived from the research conducted by DeLone et al. The items related to perceived usefulness, perceived ease of use, social influence, and behavioral intention come from the studies conducted by Zhang et al. and Fang. The items about expectation confirmation and satisfaction comes from Yang et al.'s research, and the specific content is shown in Table 2. The questionnaire mainly includes three parts. The first part is the questionnaire description, which introduces the background, purpose and ChatGPT of the questionnaire. The second part is the relevant information of learners, including whether they have used ChatGPT, basic population information and ChatGPT-assisted learning experience; The third part is the main part of the questionnaire, including learners' information quality, system quality, behavior intention, satisfaction, perceived usefulness, perceived ease of use, social influence and expectation confirmation, etc. This part of the content is compiled according to Likert's five-point scale, which allows learners to score according to their own perception and actual situation. The scores of 1-5 indicate "very

disagree", "disagree", "general", "agree" and "very agree" respectively. Questionnaires are mainly distributed to learners online through the quiz star platform for answering. The questionnaire was distributed to students and on-the-job workers in schools in Jiangsu, Henan, Guangdong and Gansu province. The research set the question "Have you ever used ChatGPT?" The results show that 43.6% of the learners use ChatGPT to study. Taking learners who use ChatGPT as the research sample, a total of 731 questionnaires were collected. After filtering out 42 questionnaires with incomplete or invalid responses, a total of 689 valid questionnaires were used for analysis, resulting in a questionnaire efficiency of 87.3%.Among the learners who participated in the questionnaire survey, there were 306 boys (accounting for 44.4%) and 383 girls (accounting for 55.6%). In terms of the distribution of study periods, universities (accounting for 42.3%) are the most, junior high schools (accounting for 21.8%), graduate students and on-the-job workers account for the same proportion (both 13.1%), and primary schools (accounting for 5.5%) and high schools (accounting for 4.2%) are less.

Table 2: Questionnaire design

Variable name	number	Item content	frame of reference
Information quality	IQ1	chatgpt always gives me a satisfactory answer.	DeLone et al.[8]
	IQ2	chatgpt's answer to me is more in line with my expectation.	
	IQ3	chatgpt provides more accurate and reliable answers.	
	IQ4	chatgpt is rich in functions and can meet my needs.	
System quality	SQ1	chatgpt system has friendly interface and reasonable information organization.	
	SQ2	chatgpt system has fast speed and timely response.	
	SQ3	chatgpt can provide good interaction.	
Behavior intention	BI1	I am very willing to use chatgpt to solve the problems I encounter in my study.	Zhang et al.[13] Fangl[9]
	BI2	If I have the qualifications to use chatgpt, I will use chatgpt in my study.	
	BI3	In learning, I would like to recommend chatgpt to others.	
Perceived usefulness	PU1	chatgpt can solve the problems in my study.	
	PU2	chatgpt is very helpful to my study.	
	PU3	chatgpt can improve my learning effect	
	PU4	chatgpt is very helpful to realize personalized learning.	
	PU5	Using chatgpt has improved my learning efficiency	
	PU6	chatgpt has helped me with my study in many ways.	
	PU7	Generally speaking, chatgpt is very useful for my study.	
Perceived ease of use	PEOU1	It is easy to learn and operate chatgpt.	
	PEOU2	The interaction with chatgpt is clear and easy to understand.	
	PEOU3	It doesn't take much time and effort to use chatgpt.	
	PEOU4	Using chatgpt to achieve what I want to do is easy, and it doesn't take much effort.	
Social Influence	SI1	The leader wants us to use chatgpt in our study.	
	SI2	The teacher wants us to use chatgpt in our study.	
	SI3	My peers around me agree that I use chatgpt in my study.	
	SI4	Schools or units very much hope that we can use chatgpt in our study to assist our study.	
Expectation Confirmation	EC1	All my expectations of chatgpt have been realized.	Yang et al.[7]
	EC2	chatgpt's performance is in line with my expectation.	
	EC3	All the functions of chatgpt have been verified.	
Satisfaction	SAT1	I am satisfied with the application of chatgpt in learning.	
	SAT2	I am satisfied with the answer given by chatgpt.	
	SAT3	I had a great time interacting with chatgpt.	

B. Reliability and Validity Test

As shown in Table 3, all factors have Cronbach's α values higher than 0.7, indicating that the scale developed in this study exhibits high reliability and the variables in the questionnaire demonstrate good internal consistency.The combined reliability (CR) of each latent variable is greater than 0.8, that is, the questions in the same dimension have internal consistency, which shows that the measurement model is reliable. The factor load of each observed variable is greater than 0.5, which is much higher than the acceptable minimum level of 0.4. The average extraction variance (AVE) of each latent variable is greater than 0.5, which shows that the questionnaire has good convergence validity. After testing, the square root value of the average variance extracted (AVE) for each variable is higher than the correlation coefficient with other variables, indicating that the questionnaire demonstrates good discriminant validity.

Table 3: Reliability and Validity Analysis

Latent variable	Observation variable	Standardized factor load	Cronbach α	CR	AVE
Information quality	IQ1	0.910	0.923	0.923	0.813
	IQ2	0.920			
	IQ3	0.913			
	IQ4	0.861			
System quality	SQ1	0.919	0.909	0.910	0.845
	SQ2	0.910			
	SQ3	0.929			
Behavior intention	BI1	0.895	0.890	0.893	0.820
	BI2	0.930			
	BI3	0.891			
Perceived usefulness	PU1	0.889	0.961	0.961	0.810
	PU2	0.887			
	PU3	0.905			
	PU4	0.907			
	PU5	0.893			
	PU6	0.911			
	PU7	0.910			
Perceived ease of use	PEOU1	0.862	0.905	0.907	0.778
	PEOU2	0.908			
	PEOU3	0.902			
	PEOU4	0.856			
Social influence	SI1	0.927	0.921	0.924	0.809
	SI2	0.908			
	SI3	0.836			
	SI4	0.921			
Expectation confirmation	EC1	0.926	0.920	0.920	0.861
	EC2	0.932			
	EC3	0.927			
Satisfaction	SAT1	0.937	0.908	0.909	0.845
	SAT2	0.904			
	SAT3	0.917			

C. Fitting Degree Analysis

Based on the analysis of Smart PLS 4.0 software, Gof and SRMR are generally used to evaluate the model fitting degree. Gof value is calculated according to the method proposed by Tenenhaus and other scholars. The value of Gof is greater than 0.36, which indicates that the model has a good degree of fitting. According to the calculation, the GoF of this study is 0.76, which indicates that the model of this study has a good degree of fitting. In this study, the SRMR is 0.048, which is less than 0.08, indicating that the model basically passed the fitting test.

D. Path Analysis

For the study of small samples, it is a reasonable choice to use Smart PLS as an analysis tool. It can overcome the limitation of small sample data, provide robust and reliable analysis results, and help to make effective statistical inference and draw conclusions. Compared with other statistical software such as Amos, SmartPLS has advantages in small sample research, and at the same time, Smart PLS also has advantages in the analysis of complex structural models. When the number of latent variables set in the model is large, especially when there are many intermediate variables, the model is relatively complex, and PLS analysis can still estimate effectively. In this study, the path coefficient estimation and significance test of the research model are realized by PLS algorithm and Bootstrapping method in Smart PLS 4.0 software. In the process of Bootstrapping calculation, a two-tailed t test with significance level of 5% is set. A significant path is established in the model when the absolute t-value is greater than 1.96 and the p-value is less than 0.05 for the corresponding path coefficient. In this study, the paths in the model are analyzed by using SmartPLS 4.0, and the obtained results are sorted out as shown in Table 4. Among them, the path coefficient indicates the degree of influence of one variable on another. It can be known that H2, H3, H4, H5, H6, H8, H10, H11, H12 and H13 pass the inspection, while H1, H7 and H9 fail.

Based on the aforementioned analysis findings, the results of path coefficient estimation and significance test of structural model are shown in Figure 2. The thickness of lines between variables in the figure is related to the size of their corresponding path coefficients. The thicker the lines, the greater the influence.

(1) Satisfaction

The research shows that in the process of using ChatGPT, perceived usefulness, expectation confirmation and information quality have a significant positive and direct impact on learners' satisfaction, among which information quality is the key factor that directly affects learners' satisfaction. From the data analysis results, we can see that the path coefficients of perceived usefulness, expectation confirmation and information quality to satisfaction are 0.372, 0.184 and 0.423 respectively. That is to say, in the process of using ChatGPT, improving learners' perceived usefulness of ChatGPT system can promote their learning satisfaction; Satisfy the learners' expectations of ChatGPT, realize their pre-expectations, and the learners' satisfaction will be improved. The more high-quality information pushed by ChatGPT system, the higher the satisfaction of learners will be. The conclusion of this study is consistent with that of other related studies. From the analysis of its influencing factors, information quality has the greatest influence on learners' satisfaction, followed by perceived usefulness and expectation confirmation. Therefore, in the process of learners' use of ChatGPT, researchers and developers of ChatGPT should continue to pay attention to learners' needs and feedback, constantly improve and optimize its functions and contents, and ensure that ChatGPT provides learners with relatively accurate, comprehensive and timely information, so that learners can truly feel the practical value and help brought by ChatGPT, and ensure that learners' expectations are consistent with their actual experiences, thus providing learners with better learning experience and support[14]. It can be seen that learners' satisfaction with ChatGPT is influenced by many factors, but various measures can be taken to improve learners' satisfaction with ChatGPT.

Table 4: Path Coefficient and Significant Results of Research Model

suppose	path	Path coefficient	T value	P value	result
H1	Satisfaction-> behavior intention	0.128	1.601	0.109	Not significant
H2	Perceived usefulness-> behavior intention	0.717	10.736	0.000	outstanding
H3	Perceived usefulness-> satisfaction	0.372	4.026	0.000	outstanding
H4	Expectation confirmation-> satisfaction	0.184	2.241	0.025	outstanding
H5	Information quality-> satisfaction	0.423	4.655	0.000	outstanding
H6	Perceived ease of use-> Perceived usefulness	0.317	4.789	0.000	outstanding
H7	Expectation Confirmation-> Perceived usefulness	0.084	1.213	0.225	Not significant
H8	System quality-> Perceived usefulness	0.312	3.550	0.000	outstanding
H9	Information quality-> Perceived usefulness	0.109	1.577	0.115	Not significant
H10	Community influence-> Perceived usefulness	0.175	3.545	0.000	outstanding
H11	System quality-> Perceived ease of use	0.762	21.448	0.000	outstanding
H12	System quality-> Expectation Confirmation	0.283	3.300	0.001	outstanding
H13	Information quality-> Expectation Confirmation	0.598	7.398	0.000	outstanding

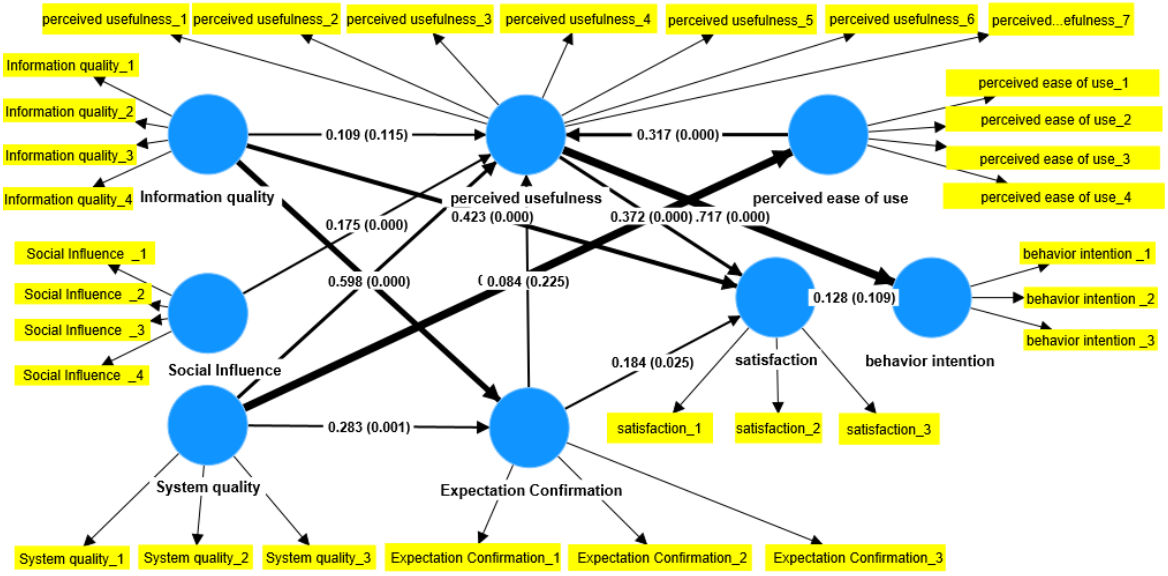

Figure 2: Path Inspection Diagram

(Note: The reported values are standardized path coefficient and P value)

(2) Perceived usefulness

The research shows that in the process of using ChatGPT, perceived ease of use, system quality and social influence all have a significant positive and direct impact on the perceived usefulness of learners, with the key

factor being the perceived ease of use, which directly influences the perceived usefulness of learners. From the data analysis results, we can see that the path coefficients of perceived ease of use , system quality and social influence affecting perceived usefulness are 0.317, 0.312 and 0.175 respectively. That is, in the process of using ChatGPT, learners' perceived ease of use, system quality and social influence have a significant impact on learners' perceived usefulness. That is to say, every unit increase of perceived ease of use, system quality and social influence will increase learners' satisfaction level by 0.317, 0.312 and 0.175 units respectively. The conclusion of this study is consistent with Wu and Zhang's research on the continuation intention of E-Learning 2.0 system[15]. Therefore, in the process of learners using ChatGPT, teachers or other guides can create a cooperative community environment to encourage learners to participate in discussions, share experiences and help each other. In addition, relevant researchers should simplify the interface design and operation process of ChatGPT, optimize the user interface, make it intuitive and clear, and provide easy-to-understand guidance and tips. At the same time, researchers can constantly optimize the performance and stability of ChatGPT[16] to ensure that it can quickly respond to learners' needs and provide accurate results. Based on this, the perceived ease of use, system quality and social influence are improved, and learners' perceived usefulness of ChatGPT is enhanced.

(3) Expectation confirmation

The research shows that in the process of using ChatGPT, system quality and information quality have a significant positive direct impact on learners' expectation confirmation, among which information quality is the key factor that directly affects learners' expectation confirmation. From the data analysis results, it can be seen that the path coefficients from system quality and information quality to expected confirmation are 0.283 and 0.598 respectively. That is, in the process of using ChatGPT, the higher the system quality and information quality of ChatGPT, the higher the learners' expectation confirmation will be. The conclusion of this study is consistent with that of other related studies. The main reason may be that ChatGPT has a good user interface and interactive design, which can usually provide learners with a faster and more efficient learning experience. When the system quality and information quality are high, learners are more confident to rely on and use ChatGPT, thus meeting their learning needs.

(4) Behavior intention

The research shows that perceived usefulness has a significant positive and direct impact on learners' behavior intention in the process of using ChatGPT. From the data analysis results, we can see that the path coefficient from perceived usefulness to behaviorl intention is 0.717. That is to say, in the process of using ChatGPT, the higher learners' awareness of usefulness, the more obvious their behavioral intention of using ChatGPT. The conclusion of this study is consistent with that of other related studies[17]. The main reason may be that when learners perceive that ChatGPT has practical value and help to their learning process, they are more motivated and willing to use ChatGPT[18]. If learners think that ChatGPT can meet their learning needs, provide accurate information or solve problems, they will be more inclined to continue to use and rely on ChatGPT.

(5) Perceived ease of use

Research shows that in the process of using ChatGPT, the system quality has a significant positive and direct impact on perceived ease of use. In the process of using ChatGPT, the higher the system quality of ChatGPT, the stronger the learners' perceived ease of use. The conclusion of this study is consistent with that of other related studies[19]. The main reason may be that when the system quality of ChatGPT is high, it often has better user interface design, interaction mode and functional performance. This makes it easier for learners to operate and navigate when using ChatGPT, and reduces the confusion and obstacles in the learning process.

IV. Qualitative Comparative Analysis of Fuzzy Sets

Structural equation focuses on analyzing the influence of a single variable on other variables; FsQCA focuses on the comprehensive influence of multiple variables on an observed variable at the same time, emphasizing the combination effect. Therefore, fsQCA is more suitable as a supplement to structural equations, and related studies have also confirmed that the two can complement each other[20]. By comparing the consistency and differences of several cases, QCA can understand the sufficient and necessary conditions that lead to the results, reveal the asymmetric relationship between dependent variables and independent variables, and form different combinations of conditions that describe specific results. FsQCA uses fuzzy scores to indicate the degree of results and conditions, and has a partial membership score for conditions that cannot be clearly coded, which can avoid the loss of information, and is suitable for the study of continuous variables, and has been adopted by many researchers[21]. Therefore, this study further uses the fsQCA method to carry out subsequent data analysis, in order to explore the specific path of achieving high satisfaction with a variety of combined factors.

A. Data Calibration

Before fsQCA inspection, the collected data should be calibrated first. Through calibration, all variable data are transformed into fuzzy membership values between 0 and 1, so that any variable can be measured by the same scale, effectively avoiding the influence of time, space, situation and other conditions[22]. The values corresponding to 95% quantile, 50% quantile and 5% quantile in the data are often selected as anchor points to calibrate Likert scale data. The three anchor points represent complete membership, fuzzy membership and no membership respectively, and the selection of anchor points is shown in Table 5. Then the anchor value of each antecedent variable is brought into the calibrate function to calibrate the data preliminarily. In order to improve the model effect, the calibrated value of 0.5 is uniformly added with 0.001 to avoid generating the fuzzy membership degree of 0.5, thus completing the data calibration.

B. Necessity Analysis

Through the "Analysis-Necessary Conditions" in fsQCA software, the necessity test is carried out. The purpose of this step is to judge whether a single variable is necessary to cause the result to occur. In fsQCA analysis, the necessity analysis of antecedents can provide necessary support for the subsequent adequacy analysis. The results of necessity condition analysis are measured by consistency and coverage, in which consistency measures the degree of conditional variables as a subset of the result variables, while coverage measures the degree of coverage (interpretation) of each condition variable to the result variables, and the values of consistency and coverage are between 0 and 1. Generally speaking, in fsQCA, if the consistency value is greater than 0.9, then the condition variable is the necessary condition of its result variable. Through calculation, it can be found that among the consistency coefficients of the existence and non-existence of the six variables included in the analysis, the consistency coefficients of perceived usefulness, perceived ease of use, information quality and system quality are greater than 0.9, and the others are all lower than 0.9. The results show that perceived usefulness, perceived ease of use, information quality and system quality are the necessary conditions for forming learners' satisfaction with ChatGPT. In addition, this study further analyzes the mechanism of conditional combination on learners' satisfaction with ChatGPT.

C. Adequacy Analysis

In this study, the configuration of 289 data samples is analyzed. First, the truth table is constructed. There are 6 antecedents in this study, and there are 26=64 possible configurations. That is to say, 689 valid sample cases are classified according to 64 configurations (some configurations may have multiple sample cases, and some configurations may not have sample cases), and after classification, we will get the truth table. Larkin suggested that the consistency threshold should be at least greater than 0.75, which was set at 0.8 in most studies. Frequency refers to the number of times that a certain configuration actually appears in the real sample, and the sample size should be not less than 80% of the total sample size after the frequency threshold is set. Therefore, in this study, the consistency threshold is set to 0.8 and the frequency threshold is set to 2.

After configuration analysis and calculation, three solutions will be generated: complex solution, reduced solution and intermediate solution. What is only included in the intermediate solution and not in the reduced solution is called the edge condition, which is considered to have an auxiliary contribution to the production of the result [10]. In this study, the results are presented in the form of a combination of intermediate solutions and reduced solutions. Referring to previous studies, big black circles (●) indicate that necessity or core condition exists (or is at a high level), small black circles (●) indicate that the edge condition exists (or is at a high level), inner circles (⊗) indicate that the core condition does not exist (or is at a low level), (⊗) indicates that the edge condition does not exist (or is at a low level), blanks indicate that the antecedent condition is "irrelevant" that is, whether it exists or not will not affect the results), and large circles indicate the core condition. In this study, the configuration of six different conditions that affect learners' satisfaction with ChatGPT is finally obtained, and the configuration table formed according to the rules is shown in Table 5.

Table 5 shows the evaluation of coverage and consistency of each configuration. Consistency in configuration analysis is similar to the concept of significance in statistical model, which indicates the possibility that the configuration will lead to the result (ChatGPT usage satisfaction). The results show that the consistency of each configuration is between 0.782281 and 0.94696, and the consistency of the overall scheme is 0.718898 (> 0.5), which indicates that the above six configurations are sufficient conditions for the results. Coverage reflects the explanatory power of configuration to the formation of results, which can be understood as R2 in statistical model. The coverage of the six configurations ranges from 0.400449 to 0.861757, and the overall coverage of the scheme

reaches 0.974215 (> 0.8), which shows that these six schemes can explain most of the situations that cause learners' satisfaction in using ChatGPT. Among the six configurations, configuration 3 has the highest coverage rate, which shows that the scheme has the best explanation for learners' satisfaction with ChatGPT.

Table 5: Summary of Conditional Configurations to Make Learners Satisfied with ChatGPT Use

Precondition	Configuration 1	Configuration 2	Configuration 3	Configuration 4	Configuration 5	Configuration 6
Perceived usefulness	●	●	●	●	●	●
Perceived ease of use	●	●	●	●	●	●
Social influence		⊗		●		⊗
Information quality	●	●	●	●	●	●
System quality	●	●	●	●	●	●
Expectation confirmation	⊗			●		⊗
Original coverage rate	0.51256	0.505582	0.861757	0.809938	0.81583	0.400449
Net coverage rate	0.113353	0.0168219	0.00768626	0.0166752	0.00225151	0.00355417
consistency	0.782881	0.791301	0.863963	0.816594	0.94696	0.927472
Overall programme coverage	0.974215					
Overall scheme consistency	0.718898					

D. Configuration Result Analysis

From the necessity analysis and adequacy analysis, we can know that the necessary conditions of this study. Based on this, the conditional configuration of learners' satisfaction with ChatGPT is formed, as shown in Figure 3. For learners' satisfaction with the use of ChatGPT, each configuration corresponds to a scheme (for example, configuration 1 corresponds to scheme 1), and six configurations reveal the schemes formed by different factors in different degrees. The preliminary analysis of the six configurations is as follows:

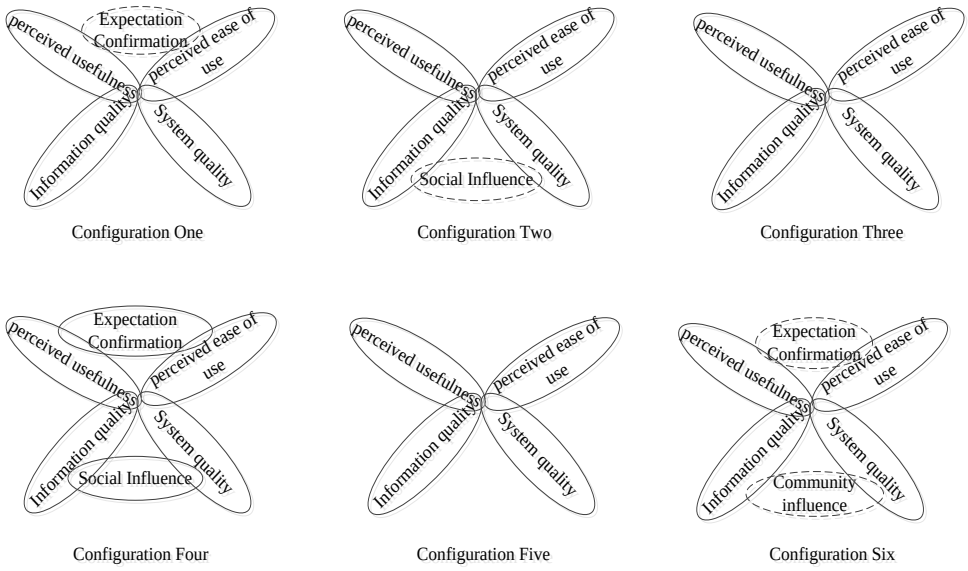

Figure 3: Conditional Configuration Schematic of Learners' Satisfaction with ChatGPT.

E. Configuration Analysis and Structural Equation Analysis

The results of fsQCA analysis show that among the six antecedents, perceived usefulness, perceived ease of use, information quality and system quality are the necessary conditions to make learners satisfied with using ChatGPT; perceived usefulness, information quality, system quality and expectation confirmation are the core conditions to make learners satisfied with using ChatGPT. perceived usefulness, information quality, perceived ease of use and system quality appear as necessary conditions, which shows that learners have a strong tendency to ChatGPT's perceived usefulness, information quality, perceived ease of use and system quality. The results of structural equation analysis also verify this point, that is, learners' perceived usefulness and information quality have a direct impact on ChatGPT use satisfaction and learners' perceived ease of use has an indirect impact on

satisfaction. In addition, expectation confirmation appears as the core condition, which shows that learners also have a strong tendency to expectation confirmation of ChatGPT. The results of structural equation analysis also verify this point, and learners' expectation confirmation has a significant positive impact on satisfaction. As far as this study is concerned, good perceived usefulness, expectation confirmation and information quality can be the "bright spots" to attract learners to use ChatGPT and improve their satisfaction. The influence degrees of the three factors are "information quality", "perceived usefulness" and "expectation confirmation" in turn. Combined with the results of fsQCA, perceived ease of use, system quality and perceived usefulness, and information quality all affect learners' satisfaction in using ChatGPT, and the pursuit of satisfaction should be based on these four conditions. In a word, the results of fsQCA provide further insights for learners' satisfaction with using ChatGPT, and form different configurations. It transforms the result of a single conditional variable into the result of multiple conditional variables, and realizes the final result based on the combined effect, which is helpful to understand the causal relationship between multiple conditional variables and satisfaction in detail. In the concrete practice process, we should develop together in many aspects to improve learners' satisfaction in using ChatGPT.

V. Countermeasures and Suggestions

Through the above discussion of the research results, we can find that learners' satisfaction with ChatGPT is influenced by many factors, including perceived usefulness, expectation confirmation, information quality, etc., and these factors are combined to predict satisfaction. This survey shows that the average use satisfaction of ChatGPT learners is only 3.68, which needs to be improved. Combined with the conclusion of this paper, in order to further improve the satisfaction of learners in using ChatGPT, this study puts forward some suggestions and measures from the following aspects.

A. Pay Attention to the Scenes and Services of ChatGPT to Improve Learners' Perceived Usefulness

The research shows that learners' perceived usefulness is positively related to their satisfaction with using ChatGPT, so learners' perceived usefulness should be improved. On the one hand, relevant researchers can provide personalized services and learning content according to learners' hobbies and learning characteristics[23], so that learners can truly feel the practicality of ChatGPT. In addition, researchers can also encourage learners to feedback and communicate in the process of using ChatGPT, so as to know their needs and problems in time, adjust and upgrade the functions and services of ChatGPT in time, meet the changing needs of learners and the overall learning effect, and also improve learners' perceived usefulness and satisfaction more effectively. On the other hand, schools or teachers can strengthen the introduction of ChatGPT application scenarios, so that learners can know more clearly the differences between ChatGPT and traditional tools and other intelligent tools, understand its advantages and disadvantages, and then use ChatGPT reasonably according to their own conditions. For example, in language learning, we can provide corresponding vocabulary, grammar and other contents for different contexts to help learners better master language knowledge.ChatGPT education automatic scoring system can automatically identify students' homework and answers according to their contents, grammar, semantics and syntax, and give corresponding scores[5]. On this basis, we will continuously improve learners' perceived usefulness of ChatGPT and improve their satisfaction.

B. Improve the Version and Function of ChatGPT, and strengthen Learners' Expectation Confirmation.

Research shows that learners' expectation confirmation knowledge is positively related to learners' satisfaction with using ChatGPT, and learners' expectation confirmation level should be improved. On the one hand, relevant researchers should first understand learners' needs and expectations, so as to take them into account when designing versions and functions of ChatGPT. Different versions of ChatGPT serve different learners, thus satisfying learners' expectations. For example, the student version of ChatGPT mainly serves the students, providing rich subject knowledge, homework answers, exam exercises and other functions; The language version of ChatGPT mainly serves language learners, providing multi-language translation, oral practice, grammar correction and other functions. The text provided by ChatGPT increases their contact with the target language[24]. On the other hand, researchers can set clear indicators and goals in various scenarios to help learners understand the capabilities and limitations of ChatGPT, so as to avoid unnecessary expectations or sense of loss caused by too high or too low expectations. At the same time, professionals can use appropriate guidance and training materials to help learners use ChatGPT better, and answer learners' questions and puzzles in time to enhance learners' confidence and satisfaction. On this basis, learners' expectations for ChatGPT are constantly improved and their satisfaction is improved.

C. Optimize the resources and Contents of ChatGPT to Improve the Information Quality of the System

Research shows that the content quality of ChatGPT is positively related to learners' satisfaction with using ChatGPT, and the information quality of ChatGPT system should be improved. ChatGPT can help students screen and integrate high-quality educational resources through the ability of language understanding and information retrieval, and provide richer content support for learning. On the one hand, it needs the participation of domain knowledge experts. ChatGPT may lack relevant knowledge base in some professional fields. At this time, we can consider inviting domain experts to participate in reviewing and supplementing the knowledge base to ensure the accuracy and practicability of the knowledge base. In the process of generating answers, we need to ensure that the input and output of the model are accurate and avoid low-quality answers or wrong answers. On the other hand, a user feedback mechanism can be adopted. This is an important way to optimize ChatGPT. Users' experience and opinions can be collected through user ratings, user feedback suggestions and error prompts, and the ChatGPT system can be optimized and improved according to user feedback. ChatGPT technology can provide more guidance and tips, and at the same time provide instructive feedback and suggestions in real time to help students complete their tasks more effectively[23]. In addition, the data in the knowledge base should be screened, classified and sorted to ensure that the contents in the knowledge base are accurate, comprehensive, timely and useful, and to optimize the contents and resources of ChatGPT, so as to provide learners with a high-quality knowledge base. On this basis, the information quality of ChatGPT for learners is continuously improved and their satisfaction is improved.

D. Continuously Update and Improve ChatGPT to Improve the Performance and Stability of the System

On the one hand, ChatGPT's learning ability is constantly evolving. Relevant researchers can monitor and analyze learners' feedback, evaluate the development of data and technology, and constantly optimize the version and function of ChatGPT. The previous version 2.0 to the current version 4.0 is the result of technical development and exploration. China needs to build an autonomous and controllable Chinese Chat GPT technology. From the hardware, software, Chinese resources, algorithms, engineering applications and other aspects, we will pragmatically promote the landing of China version of Chat GPT[25]. We should continue to optimize the version and function of ChatGPT in order to provide more accurate and comprehensive answers and information to learners. On the other hand, the performance and stability of ChatGPT are very important for improving learners' satisfaction. Technicians can respond quickly and answer accurately by increasing computing resources, improving model algorithm and optimizing system organization structure, and strive to achieve the goal of handling a large number of user requests at the same time to avoid system crash or delay. In addition, technicians can use learners' feedback data and combine related natural language processing technology to continuously train and iterate ChatGPT model. Through many iterations, the parameters and structure of the system are constantly adjusted and optimized, and the expression ability and answer accuracy of ChatGPT system are improved. Based on this, the system performance and stability of ChatGPT are improved, and the satisfaction of learners is improved.

VI. BRIEF SUMMARY

The application of ChatGPT in education is deepening, which is embodied in the aspects of ChatGPT assisting teachers' teaching and students' learning. In assisting teachers' teaching, ChatGPT plays an important role in providing teachers with richer resources for preparing lessons, optimizing teachers' teaching design and teaching evaluation. In terms of students' learning, ChatGPT can play an important role in counseling and answering questions, providing more abundant learning resources and realizing personalized learning. ChatGPT is of great significance in improving the teaching effect of teachers and the learning effect of students. ChatGPT can also be of great significance for promoting the development of educational equity. We should further promote the application of ChatGPT in education and teaching. The purpose of this study is to explore the satisfaction of ChatGPT learners and comprehensively analyze its influencing factors through structural equation and qualitative comparative analysis of fuzzy sets. The results of structural equation analysis show that perceived usefulness, expectation confirmation and information quality have significant positive and direct effects on learners' satisfaction; perceived ease of use, system quality and social influence have significant positive direct effects on learners' perceived usefulness; system quality and information quality have significant positive direct effects on learners' expectation confirmation; perceived usefulness has significant positive direct effects on behavior intention; system quality has significant positive direct effects on perceived ease of use.Through the fuzzy fixed set comparative analysis, we can see that there are 6 schemes to promote learner satisfaction. Among them,perceived usefulness, perceived ease of use, information quality and system quality are the necessary conditions for learners'

satisfaction with ChatGPT. The overall coverage of the six configurations is 0.974215, and the consistency is 0.71898. Due to the use of questionnaire survey for data collection, there may be a certain subjectivity. Future studies could use more diverse data collection methods and more comprehensive analytical methods to compensate for these shortcomings. In general, this study discusses the current situation of ChatGPT learners' satisfaction and puts forward suggestions for improvement and optimization based on the influencing factors. This is of great significance for further promoting the development and application of ChatGPT technology, and also provides a reference for the design and improvement of other AI learning tools..

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