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Exploring the Influence of Chinese College Students' Self-regulated Learning Behavior on Academic Achievement in Online Education: A Study on the Mediating Role of Online Course Perceptions

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Abstract: - Online education offers students a more diverse learning approach. Students can choose courses that suit their learning pace and schedule, without being limited by time and space. Online education provides a self-regulated learning environment where there is no one to supervise them. Self-regulated learning training, along with prompts, activities and supporting tools, can effectively promote the academic achievement of online learning goals. In online learning environments with low levels of support and guidance, it is worth observing and summarizing university students' self-regulated learning (SRL) behaviors, and further proposing corresponding key strategies to effectively enhance students' learning outcomes. This study found that SRL behavior has a positive impact on learning outcomes, indicating that training in self-regulated learning significantly contributes to improved learning effectiveness. These findings offer valuable insights for the instructional design and management of online education.

Keywords: Online Education, Self-regulation Learning (SRL), Online Course Perceptions, Academic Performance, Online Learning.

I. INTRODUCTION

With the continuous development and popularization of Internet technology, an increasing number of people are choosing to acquire knowledge and skills through online education platforms. Online education has become a prevalent learning method, widely applied in both school education and vocational training.

The sudden novel coronavirus pneumonia epidemic in early 2020 disrupted everyone's life. More than 2,900 colleges and universities in China have postponed the opening of the school year and adjusted their teaching plans for the new semester in time to ensure "teaching, learning and research" during the period. In the context of the pandemic, innovative online education has become the mainstream teaching method due to the continuous breakthroughs in big data combined with the internet.[1].

For colleges and universities, whether it is the limitation of network technical conditions or the influence of online classroom on teaching effect and whether it is university teachers who are not familiar with new technical means or university students who have limited learning self-control, such adjustment was undoubtedly a great challenge. Traditional classes can hardly attract students' attention, let alone such non-binding live classes. In this regard, it has become an important topic for college students to enhance their self-discipline ability, adjust their mentality in due course and form good study habits.

In such a sudden change, learners of online learning have changed from the previous autonomous choice to the current passive participation, how should college students adjust their life and learning pace to adapt to online new learning? This is closely related to the ability of college students to adjust themselves. Promoting the achievement of learning goals through Self-Regulated Learning (SRL) training, prompts, activities, and supporting tools [2] is a strategy worth emphasizing. After years of research accumulation, SRL is a suitable evaluation concept [3]. SRL in the learning environment featuring low-level support and low-level guidance should be further observed and summarized, and the relevant key strategies should be put forward to promote the effective improvement of college students' learning results.

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To enhance the comprehension of the correlation between Chinese college students' learning behavior and academic performance in online learning environments, and to uncover the mechanism linking self-regulated learning behavior and perceptions of online courses to academic performance. This research aims to offer a theoretical foundation and practical recommendations for enhancing teaching effectiveness and student learning experiences in online education. This study employs Structural Equation Modeling (SEM) to examine the influence of Chinese college students' self-regulated learning behavior on academic performance in online education. Additionally, the study utilizes the Bootstrap method to assess the mediating role of online course perception. The findings aim to enhance the understanding of students' learning experiences in online education among educational administrators and practitioners. This understanding can help optimize instructional design and management, improve teaching quality and student satisfaction in online education, and foster the sustainable development of online education.

II.   LITERATURE REVIEW

A.   Online Education

Extensive research indicates that students engaged in online education achieve academic outcomes on par with, and in some instances, surpass those of traditional education. These findings underscore the potential of online education to enhance student academic performance and serve as an effective educational approach. As science and technology rapidly advance, the Internet is becoming increasingly prevalent, leading to a gradual rise in the proportion of online learning. Some scholars regard online learning as a way to deliver learning content through e-learning tools [4]. Rosenberg [5] proposed three criteria for online learning: 1.online learning is characterized by a real-time update, assessment, transmission and sharing of learning content; 2. distance learners can use the Internet to obtain learning content; 3. long-distance learning is emphasized and solutions superior to traditional training models are explored. The increasingly mature online learning allows more and more foreign students to use online courses to obtain degrees [6].

The two most commonly referenced types of online learning are synchronous online learning and asynchronous online learning. Hrastinski [7] pointed out that the most common tools for synchronous online learning are videoconferencing and chat. Synchronous online learning can make learners feel more involved and more socially and avoid frustration when seeking answers and asking questions. The most common tools for asynchronous online learning are e-mail and discussion boards. These tools can help teachers and students to observe other people's thoughts when they cannot have online discussions and interactions together at the same time. They can also respond to each other with clear and meaningful words [8]. Students' perceptions of online courses can significantly influence their learning outcomes. Positive perceptions often correlate with better grades, whereas negative perceptions can hinder academic achievement.

The rapid advancement of science and technology, coupled with the diverse demands for effective learning, has led to the emergence of blended learning as a timely and pivotal approach. Some emergent forms of online educational tools support the formation of a nonhierarchically distributed communication [9]. Online education can enhance student engagement. Through interactive online platforms and diverse learning methods, students are more likely to participate in the learning process, thereby improving learning effectiveness. Peking University published in KKnews: Peking University started classes online as scheduled in the spring of 2020, with multiple online teaching modes such as live broadcast, recording and broadcasting, massive open online courses, video conference, exclusive customization, etc. Students needed to learn independently in advance before class. Teachers asked questions to be discussed and considered in the WeChat group before class for online interaction. Autonomous learning and online activities not only enhance learning outcomes but also foster interaction among students and between students and teachers.

B.   Academic Achievemen (AA) of Online Learning

The main purpose of academic achievement measurement is to understand teachers' teaching effectiveness and learners' learning status, including learning benefits (test results, completion time) and learning benefits (learning satisfaction, achievements) [10]. Learning satisfaction refers to the sense of happiness and accomplishment that can be felt in the learning environment [11]. In this regard, students' satisfaction is a pleasant and successful experience [12]. Tough [13] deemed that learning satisfaction refers to students' learning attitude and feeling in the learning process. If they feel happy and have a positive attitude, they are satisfied. On the contrary, if they feel unhappy and have a negative attitude, they are not satisfied. When one's feelings in learning are equal to or exceed

expectations, one will feel satisfied. On the contrary, when the feeling is less than the expectation, one will feel dissatisfied.

Several studies have explored the academic achievements of students using online learning. The findings indicate that online learning offers greater flexibility compared to traditional methods, enabling learners to study anytime and anywhere, thereby overcoming the constraints of physical location and time. [14] Some also pointed out that there are many factors that affect the academic achievement of online learning, including the support given, the environment, and the interaction between users and the online learning community, of which the times of interactions is more often considered as an important factor affecting the effectiveness [15].

Collating evaluations of online learning effectiveness by multiple scholars [16-18], the following criteria are proposed:

1)   Achievement of learning objectives: Assessing whether students have met the learning objectives set by the course or training.

2)   Academic performance: Evaluating students' performance in the course through exams, quizzes, or assignments.

3)   Participation: Assessing the level of student engagement in the course, including discussions, questions, and assignment submissions.

4)   Satisfaction: Evaluating students' satisfaction with the course content, teaching methods, etc.

5)   Learning outcomes: Assessing the actual improvement in skills or knowledge level achieved by students after completing the course.

C.   Self-regulated Learning (SRL)

Recent research findings strongly support the notion that empowering students with control over the entire learning process is crucial. [18]. SRL views learning as an active process in which students engage, rather than a passive event that results from teaching alone. The central aspect of defining learning as self-regulation lies in whether learners demonstrate personal initiative, perseverance, and adaptability in their learning endeavors, rather than whether learning is socially isolated. Furthermore, researchers concur that SRL is not an inherent trait but a skill that can be cultivated and improved through personal experiences and practice in applying SRL strategies. [19].

The representation of personal behavior emphasizes personal motivation and belief, and SRL ability emphasizes self-management ability and ability to address unexpected situations, making the knowledge of personal skill operation more complete. Therefore, implicit behavior is the focus of SRL. From observing one's posterior cognition, action time and activity participation, it can be known that whether one carries out self-regulation. Zimmernan [20] argued that among the many abilities developed by human beings, SRL ability is a key ability that enables people to adapt to the environment quickly. Self-regulated learning behavior significantly influences students' academic performance in online courses. Students with strong self-regulated learning behavior are more likely to achieve good grades.

Learning ability is the comprehensive quality that learners show in the learning process, is an effective way to complete learning tasks, and is also a positive force that affects individual development and academic performance. SRL refers to students' spontaneous thoughts and behaviors, which are systematically related to their learning objectives. Whether online or face-to-face, self-regulation can be regarded as a compulsory course in the personal learning process. Self-regulation behavior is highly context-dependent [21]. Without the support and guidance of teachers, how to adjust one's learning ability to achieve one's goals in an online learning environment is the key factor. Michinov et al. [22] pointed out that procrastination has an important impact on the online learning environment. Especially, it will affect the learning effectiveness of online learning and the degree of participation in the discussion. Hence, online learners should actively engage in the learning process, which necessitates students to possess a high level of confidence in their own abilities and their capacity to manage their learning independently.

D.   Research Questions

Whether the effectiveness can promote improvement? when college students carry out online learning, whether their SRL behavior will affect their online course perceptions, how will further online course perceptions affect academic achievement, and what role online course perceptions plays in academic achievement of online learning. The aim of establishing the conceptual framework in this study is to elucidate the interplay between SRL behavior, perceptions of online courses, and academic achievement. Additionally, the study seeks to investigate the mediating role of online course perceptions. The conceptual framework is illustrated in Figure1. The research hypothesis is as follows:

H1: SRL behavior has a positive impact on academic achievement.

H2: SRL behavior has a positive impact on online course perceptions.

H3: online course perceptions has a positive impact on academic achievement.

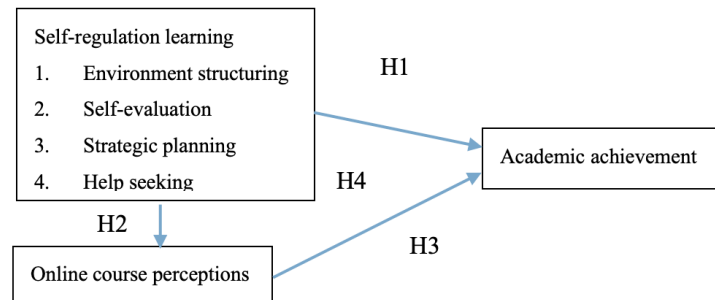H4: online course perceptions has a mediating effect between SRL behavior and academic achievement.

Figure 1: Conceptual Framework

III. METHODS

A. Participants

This study utilized wjx.cn software to select online courses from a private university in Guangzhou, China as the sampling range. The questionnaire was distributed from April 20, 2020, to June 15, 2020. The two-dimensional code of the questionnaire was sent to 1400 students, and 562 copies were finally recovered. IP is registered in Guangdong, Guangxi, Hubei, Hunan, Henan, Hebei, Zhejiang, Jiangsu, Hainan, Xinjiang respectively. Male participants (n = 222), accounting for 39.5%; students of School of Economics and Management (n = 351), accounting for 62.5%.

B. Measures

This study employed Likert's five-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was divided into three parts, each measuring variables such as online course perception, self-regulation in online learning, and learning effectiveness.

To gauge students' perceptions of online courses, an 11-item scale was developed. A higher total score on this scale indicates a positive view of online course perceptions, while a lower score suggests a negative view. Positive perceptions entail individuals' willingness to actively and frequently engage in online communication and collaboration. The scale comes from Barnard, Paton and Rose [23] 11-item scale. The internal consistency was checked by CFA and the results of exploratory factor analysis were revised to five items. Nunnally [24] proposed that it is acceptable to use a score reliability of 0.70 or higher in basic social science research.

In order to measure SRL in online learning, a second-order scale was constructed. The concept of the second-order scale originates from Zimmerman's research and reflects the multi-dimensional concept of SRL. There are four important structural components, namely: (1) environmental structure; (2) self-evaluation; (3) mission strategy; (4) and asking for help. The original second-order scale comprised 27 items, which were later reduced to 13 items through Confirmatory CFA to ensure internal consistency and explore factor analysis results. Higher scores on the scale indicate strong self-regulation abilities in online learning, while lower scores indicate weaker self-regulation abilities.

To assess students' perspectives on learning effectiveness, a three-item scale was developed as the outcome variable for academic achievement. On this basis, those with higher total scores indicate higher positive recognition of academic achievement. The main purpose is to understand the teaching effect of teachers and the learning status of learners, including test results, learning satisfaction and sense of achievement.

C. Procedure

The measurement process involved collecting and integrating the original data using wjx.cn software to create Word files and Microsoft Excel data files. For this study, Full Information Maximum Likelihood (FIML) in Amos (v.26) was employed as the estimation method. Confirmatory factor analysis and path analysis were then conducted to assess the reliability, validity, and fitness of the structural model.

D. Analysis

This study utilized Amos (v.26) as a tool and employed the Bootstrap method to test the mediating effect, with 2000 bootstrap samples, a 95% confidence level for PC confidence, and a 95% confidence level for BC confidence.

The coefficient product and Bootstrap methods were used to examine whether online course perceptions mediate the relationship between self-regulation behavior in online learning and academic achievement. Apart from calculating the direct, indirect, and total effects, it was necessary to determine whether the mediating effect was partial or complete. The structural model is depicted in detail in Figure 2.
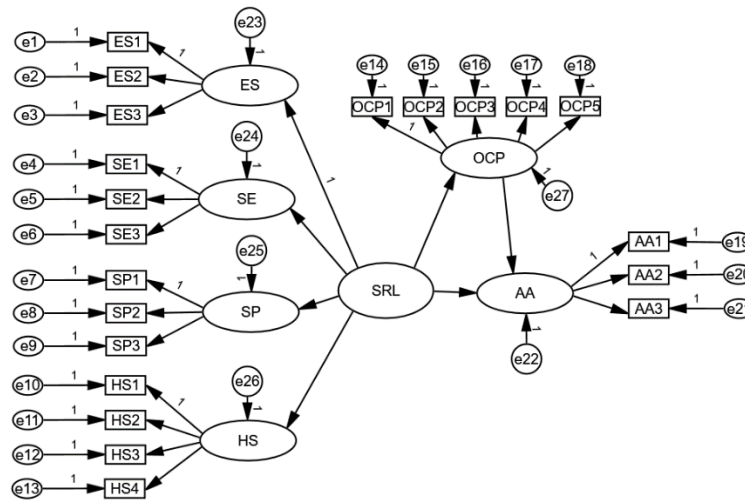

Figure 2: The Structural Model

IV. RESULTS

A. Confirmatory Factor Analysis (CFA)

We conducted first-order and second-order CFA separately. All sample coefficients in this study are significant, with standardized coefficients ranging from 0.7 to 0.9, which aligns with the suggestion. The reliability, as indicated by the CR values, falls between 0.826 and 0.945, indicating good internal consistency. Additionally, the factor loadings of each observed variable in the study were all statistically significant (p-value < 0.001), with t-values exceeding 1.96 and normalization coefficients above 0.7. The AVE values were also above 0.5, ranging from 0.606 to 0.812. For detailed verification values of each construct, please refer to Table 1.

Table 1: Verification Value of Each Aspect

			UNSTD	S.E.	t-value	P	STD	SMC	1-SMC	CR	AVE
E S	<---	SRL	1				0.870	0.757	0.243		
S P	<---	SRL	1.071	0.075	14.308	***	0.845	0.714	0.286	0.945	0.812
S E	<---	SRL	1.258	0.079	15.996	***	0.944	0.891	0.109		
H S	<---	SRL	1.193	0.077	15.420	***	0.941	0.885	0.115		
ES1	<---	E S	1				0.718	0.516	0.484		
ES2	<---	E S	1.097	0.061	17.931	***	0.828	0.686	0.314	0.826	0.613
ES3	<---	E S	1.072	0.062	17.387	***	0.798	0.637	0.363		
SP1	<---	S P	1				0.813	0.661	0.339		
SP2	<---	S P	0.991	0.048	20.459	***	0.800	0.640	0.360	0.857	0.667
SP3	<---	S P	0.980	0.045	21.559	***	0.837	0.701	0.299		
SE1	<---	S E	1				0.860	0.740	0.260		
SE2	<---	S E	1.027	0.040	25.897	***	0.863	0.745	0.255	0.870	0.692
SE3	<---	S E	0.927	0.043	21.610	***	0.769	0.591	0.409		
HS1	<---	H S	1				0.818	0.669	0.331		
HS2	<---	H H S	0.998	0.047	21.121	***	0.794	0.630	0.370	0.860	0.606
HS3	<---	H S	0.994	0.046	21.730	***	0.811	0.658	0.342		
HS4	<---	H S	0.822	0.047	17.378	***	0.684	0.468	0.532		
OCP1	<---	OCP	1				0.779	0.607	0.393		
OCP2	<---	OCP	0.986	0.056	17.660	***	0.713	0.508	0.492		
OCP3	<---	OCP	1.127	0.049	23.045	***	0.888	0.789	0.211	0.909	0.668
OCP5	<---	OCP	1.086	0.051	21.403	***	0.835	0.697	0.303		
OCP4	<---	OCP	1.099	0.050	22.153	***	0.859	0.738	0.262		
AA1	<---	AA	1				0.771	0.594	0.406		
AA2	<---	AA	1.124	0.050	22.590	***	0.909	0.826	0.174	0.897	0.744
AA3	<---	AA	1.110	0.049	22.522	***	0.901	0.812	0.188		

*** p-value<0.01, ** p-value<0.05, * p-value<0.1

B. The Model Fit Test of Second-order Verification Factors

The model fit of the second-order SRL verification factors, with relevant recommended values: a smaller χ^2 is better, a larger df is better, $\chi^2/df < 5$, GFI > 0.8, AGFI > 0.8, CFI > 0.9, and RMSEA < 0.08. The observed indicators

corresponding to the fit indices in this study all meet the criteria, as detailed in Table 2, indicating a good model fit.

Table 2: SRL Model Fit Index for Second-order Verification Factors

SRL second-order verification factors	χ2	df		χ2/df	GFI	AGFI	CFI	RMSEA
1. Null Model	4798.496	78		61.519	0.217	0.087	0	0.328
2. First order one factor	554.046	65		8.524	0.854	0.796	0.896	0.116
3. First-order four factors (No relevant)	1569.972	65		24.153	0.672	0.548	0.681	0.203
4.First-order four factors (Related)	155.583	59		2.637	0.960	0.939	0.980	0.054
5.Second-order factor mode	169.801	61		2.784	0.957	0.936	0.977	0.056

C. Model Adaptation Analysis

SEM analysis employs several fitness test indices to assess the consistency between the hypothetical model and actual observation data. The observation indicators of correspondence in this study are summarized in Table 3. They all meet the test indicators and show a good degree of adaptation.

Table 3: Model Adaptation Table

Adaptation index	Adaptation criteria	Data from this study
1. Basiccadaptation criteria		
Factor loading	>0.5	0.72~0.90
(Standardized Error)	>0.0	t-value >1.96
	significant	0.1~0.4
2.Overall mode adaptation		
χ2 or χ2/df	χ2 not significant	χ2＝390.652; df=182
	or χ2/df <5	χ2/df = 2.146
GFI	>0.8	0.940
RMR	<0.05	0.026
3.Other mode adaptation		
AGFI	>0.8	0.924
NFI	>0.9	0.954
CFI	>0.9	0.975
RMSEA	<0.1	0.045

D. Verification of the Mediating Effect

In this study, two new verification methods were employed. Firstly, the Bootstrap technique was used to estimate the standard error and non-standardized coefficient of the indirect effect. The Bootstrap method was conducted with 2000 bootstrap samples and a 95% confidence level for both percentile and bias-corrected (BC) methods. In Table 4, the analysis shows a significant indirect effect (z = 2.212 > 1.96) of students' self-regulated learning (SRL) behavior on their online course perceptions and learning outcomes, indicating a complete mediating effect as the direct effect (z = 1.73 > 1.96) is also significant. Secondly, the Bootstrap technique was used with Bias-Corrected and Percentile calculation methods to re-estimate the standard error and confidence interval of the mediating effect. In Table 4, the indirect effect of online course perceptions on SRL behavior and academic achievement is significant, with confidence intervals of 0.256 to 0.529 and 0.437 to 0.613, respectively, excluding 0. This suggests the presence of a mediating effect. However, the direct effect has confidence intervals of -0.1 to 0.29 and -0.022 to 0.281, including 0, indicating the absence of a direct effect and suggesting a partial mediating effect.

Table 4: The Mediating Effect Report

variable	Point estimate Valuation			Bootstrapping			
				Bias-Corrected 95% CI		Percentile 95% CI	
		Product of Coefficients		Lower	Upper	Lower	Upper
		SE	Z				
Total Effects							
SRL→AA	0.682	0.067	10.179	0.548	0.813	0.552	0.819
Indirect Effects							
SRL→AA	0.134	0.059	2.271	0.022	0.252	0.021	0.251
Direct Effects							
SRL→AA	0.549	0.092	5.967	0.376	0.738	0.377	0.740

V. DISCUSSION AND CONCLUSION

A. Discussion

The research framework of this study comprises seven potential variables and 21 observed variables, as illustrated in Figure 3. The collected samples were analyzed using a linear structural model to investigate the path relationship between college students' SRL behavior and academic achievement. The comprehensive data analysis from the previous section indicates that college students' SRL behavior significantly influences their perceptions

of online courses. Both college students' SRL behavior and their OCP affect AA in online learning, with OCP partially mediating the relationship between college students' SRL behavior and AA. All four hypotheses (H1-H4) were supported by the study's findings, as detailed in Table 5.

Table 5: Summary of Research Hypothesis Analysis Results

Hypothesis	Analysis result
H1: SRL behavior has a positive impact on academic achievement.	establish
H2: SRL behavior has a positive impact on online course perceptions.	establish
H3: online course perceptions has a positive impact on academic achievement.	establish
H4: online course perceptions has a mediating effect between SRL behavior and academic achievement.	establish

In Figure 3, the impact of college students' SRL behavior on OCP is significant, with a standard path coefficient value of 0.77. This indicates that students with a higher level of self-regulation in online courses tend to have a better understanding of the course material. Conversely, students with lower levels of self-regulation exhibit poorer perceptions of online courses.

Furthermore, SRL behavior significantly influences academic achievement, with a standard path coefficient value of 0.51. This suggests that a higher level of self-regulation positively impacts academic performance. These findings underscore the importance of SRL behavior and highlight its significant role in online teaching and curriculum design.
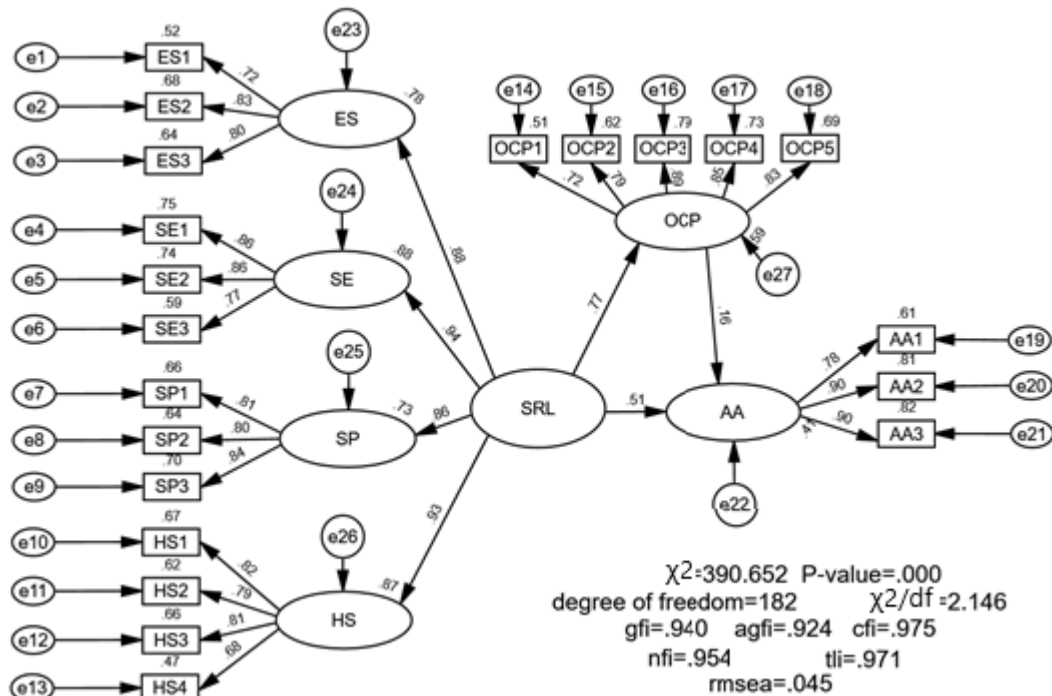

Figure 3: Path Analysis Diagram

The relationship between college students' OCP and AA appears relatively weak, as indicated by the standard path coefficient value of 0.16. This observation may be attributed to the fact that most students were exposed to online courses for the first time, and the questionnaires were distributed among sophomores. The transition to online learning has shifted students from autonomous choice to more passive participation. Many students have limited prior experience with online courses, leading to a less nuanced understanding of online course perceptions.

In the future, college students will encounter an increasing number of online courses. It would be beneficial to conduct further verification to determine if there are any conclusions different from those drawn in this study. Therefore, it is advisable for college students to actively engage with and comprehend online course materials to enhance the flexibility of online SRL, thus improving academic performance, enjoying learning, and fostering a sense of achievement. Furthermore, educators and course designers should focus on creating an online learning environment that promotes a positive perception of online courses, facilitating students' understanding and engagement.

Future research should revisit the mediating role of online course perceptions in online learning and further investigate the relationship between college students' SRL behavior and academic achievement. This exploration can lead to the development of more effective strategies to support students in their studies and enhance learning outcomes. Additionally, due to limitations in sample size, multi-modeling was not feasible for the mediating model.

Incorporating multi-group models in SEM can help examine gender differences and other relevant variables in the mediating relationship, providing valuable insights for future studies.

B. Conclusion

Online education plays a pivotal role in schools and educational institutions by enhancing the utilization and efficiency of educational resources. It offers students convenient access to high-quality educational materials worldwide, saving them time and money while providing a flexible learning experience. Our study focused on how Chinese college students' self-regulated learning behavior and their perception of online courses influence their academic achievement, revealing the mediating role of online course perception.

The findings indicated a significant positive relationship between SRL behavior and AA, with OCP acting as a moderator in this relationship. This underscores the critical role of students' SRL behavior in achieving high academic performance in online education, with OCP playing a positive role in this regard. These results contribute to the advancement of SRL theories and online education research, providing deeper insights into how SRL behavior and OCP influence AA.

Furthermore, the results provide valuable insights for the instructional design and management of online education. Educational administrators and practitioners can use these findings to optimize the instructional models and content of online education, thereby improving teaching effectiveness and student satisfaction. Compared to traditional learning methods, online education typically incurs lower learning costs, which is one of the reasons for its widespread adoption.

For future research, we can further explore the following directions: 1. In-depth analysis of the impact of different types of online courses on student academic achievement: Future studies can further investigate whether there are differences in the impact of different types of online courses (such as MOOCs, SPOCs, etc.) on student performance, and explore the reasons behind these differences. 2. Exploring other possible mediating variables: In addition to online course perception, other possible mediating variables such as learning motivation and learning strategies can be explored to further reveal the mechanism through which self-regulated learning behavior affects academic achievement.

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