The Development of an Online Study Adaptability Scale for Chinese College Students During the Global COVID-19 Pandemic

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Abstract. This study proposes a structural model for the online studying adaptability of college students during the global pandemic based on a questionnaire survey. A total of 1367 college students from H University in Fujian province participated in the study. Study items were evaluated and verified using item analysis, exploratory factor analysis, reliability analysis, confirmatory factor analysis, convergence validity analysis, and discriminant validity analysis. The scale that includes four dimensions namely: attitude towards study, auto-didactic ability, studying and communication, and the study environment, had a good reliability and validity. There was a significant difference between students' adaptability by grade and major but not by gender. Thus the scale can be used as a tool to evaluate the adaptability of college students to online studying in a global pandemic and to lay the foundation for future research in this area.

Keywords: on online study adaptability; scale; confirmatory factor analysis; reliability; validity

1. Introduction
Since January 2020, the rapid spread of COVID-19 forced the world into intense pandemic prevention and control strategies due to its high transmissibility and

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long incubation period. By July 2020, the pandemic had affected almost all countries and regions (Sintema, 2020) including 98.6% of students from preschool to higher education and a total of 1.725 billion children and youths from than 200 countries (Brief, 2020). The education system faced its greatest challenge in human history (Pokhrel & Chhetri, 2021).

According to China's Ministry of Education (2021), in the spring semester of 2020, all regular undergraduate universities in China implemented online teaching during the unprecedented pandemic with 1.08 million teachers conducting 1.1 million courses. A total of 22.59 million college students participated in online studying. Online studying therefore became a practical method within the teaching and learning processes, and students had to adapt to the sudden transition from offline studying to synchronous online studying (Besser et al., 2022; Razak et al., 2022). The outbreak transformed teaching models from simply offline teaching and "online + offline" blended teaching to "large-scale and long-term" full-time online studying (Zhai et al., 2020) with serious impacts on students, teachers, and educational organizations worldwide (Almanthari et al., 2020). For the first time, the online teaching platform that covered all subjects at all levels, exposed online education to many difficulties (Zhao et al., 2020).

Online studying enabled students pursue their studies during the school closures (Subedi et al., 2020). However, there were many problems in the implementation of online studying including a lack of study facilities and operational techniques in universities, and educators' negative attitudes (Alqudah et al., 2020). Furthermore, it took time for both students and teachers to adapt to the sudden changes from school to online learning and self-study for the students, and from classroom teaching to online teaching for the teachers (Zhao et al., 2020). In addition, some students failed effectively interact with their teachers and peers through the internet; a failure that troubled both the students and their teachers (Kurucay & Inan, 2017). Therefore, educators developed feasible solutions to online study problems (Kandri, 2020). Lyall and Mcnamara (2000) found that learning maladjustments are common in the network environment as online studying is suitable for students who are more mature, self-disciplined, and intrinsically motivated.

Although the technology is commonly used to support student learning at the tertiary level (Isssroff & Scanlon, 2002), during the pandemic teachers and students had to engage in exclusive online distance learning. Teachers and students were unable to quickly adapt to new teaching methods, learning approaches, course materials, and ways of thinking. As a result, both learners and teachers felt isolated, helpless, or anxious (Yang & Yang, 2021). Research studies on the adaptability of online learning not only aims to improve online study quality (Chen & Chen, 2021), but also to aide to students' survival and development. At present, measurement tools for college students' online studying adaptability in China only measure the unilateral study form of college students' online recording. The Student Adaptation to College Questionnaire (SACQ) compiled by Baker and Siryk (1984) are widely recognized by international scholars. The Test of Reaction and Adaptation in College (TRAC) designed by Simon and Rorand (1995) is also renown. However, due to differences between the Chinese higher education and training modes and the students' study style,

there are very few localized verifications of foreign adaptation questionnaires in China. Since the outbreak, college students' adaptation to studying has garnered more attention as the students are expected to maintain a high level of motivation and adapt to a virtual study environment (Bao, 2020).

Many scholars have developed learning adaptation scales (Feng & Li, 2002; Wang, 2006; Martin et al., 2012; Qin, 2019; Wu, 2020; Guo, 2021; Li, 2021; Liu, 2022). However, Feng and Li (2002), Wang (2006), Li (2021), and Liu (2022) only used exploratory factor analysis (EFA) and did not use confirmatory factor analysis (CFA) to validate the suitability of the scales. A measurement model constructed by confirmatory factor analysis has the following three characteristics. First, each observed variable can correctly measure the latent variable to which it belongs. Second, the standardized regression coefficient of each observed variable is only significant as pertains to the latent variable to which it belongs. Third, the overall fit of the measurement model is good (Kline, 1998). When conducting analyses of construct validity, EFA and CFA should be combined for cross-validation to ensure the certainty, stability, and reliability measured by the scale, and it will also be a trend developed in psychological scale research (Li & Huang, 2007). Therefore, exploratory factor analysis was performed followed by confirmatory factor analysis in constructing a scale. This paper evaluated contemporary college students' study adaptability to compile a set of suitable study adaptability questionnaires with good reliability and validity for examining contemporary college students' adaptability to online learning during the pandemic.

Thus, this study posed two questions: (a) How to construct an online study adaptability scale for university students; (b) How applicable is the scale in measuring university students' Online study adaptation in a pandemic context.

2. Literature Review
2.1 Definition of Online Studying Adaptability
Adaptability is the ability to change to different situations or behaviors of different people (Vandenbos, 2007). Martin et al. (2013) describe adaptability as the ability of individuals to adjust their own cognition, behavior, and emotions in the face of uncertain and novel internal and external situations. Students' adaptability is measured using both intrinsic values and external values. Intrinsic values refer to the motive, emotions, and spirit linked to the students' virtual study. Extrinsic values relate to how the students deal with the environment, such as the physical environment, and the way that they interact with others (Razak et al., 2021).

These researchers' definition of learning adaptation includes factors such as attitude, emotion, ability, and environment. Baker et al. (1985) believed that learning adaptability refers to an individual's positive attitude towards establishing learning goals and completing academic tasks, as well as the effectiveness of the efforts made in meeting said needs and adapting to the learning environment. Gerdes and Mallinckrodt (1994) pointed out that learning adaptability not only involves the students' potential for academic success, but also the students' ability to adjust their own psychological, emotional, and behavioral factors. Feng and Li (2002) believe that study adaptability refers to a behavioral process in which subjects strive to suitably adjust themselves to a state

of balance within the study environment. Martin et al. (2012) describe study adaptability as the achievement of balance between individuals and their study environment based on their constant self- adjustment.

Researchers proposed a novel definition of online studying adaptability in the context of the global pandemic. Online studying adaptability refers to a certain ability held by a subject to integrate his/her own psychology with the outside environment in the process of online studying because of an interaction between his/her personality factors and environmental factors (Guo, 2021). In this study, the adaptability to online studying is defined as the ability to appropriately adjust one's cognition, emotions, and behavior in the face of an online study environment.

2.2 Online Studying Adaptability Scale

Feng and Li (2002) pioneered the use of questionnaires to study the main dimensions of the college students' study adaptability including study motive, learning ability, environmental factors, teaching mode, and study attitude.

Wang (2006) states that college students' study adaptability consists of seven dimensions namely study attitude, learning ability, study technique, study autonomy, study environment, teaching method, and study content.

The Learning Adaptability Scale compiled by Martin et al. (2012) divides learning adaptability into four dimensions: a response to novelty, change, variability and/or uncertainty; cognitive, behavioral, or affective functions; regulation, adjustment, revision and/or a new way to access to these three functions; and a constructive purpose or outcome.

Qin (2019) compiled the Study Adaptability Scale based on a MOOC hybrid study. Qin's (2019) scale included the six dimensions of attitude, task, autonomy, communication, and the environment, as well as physical and mental health.

Wu (2020) denotes college students' study adaptability as consisting of nine dimensions, including attitudes to learning, motivation, approaches to learning, information literacy, teacher expertise, teacher emotional support, cognitive support, self-mastery, and the learning environment.

Guo (2021) developed the Online Learning Adaptation Questionnaire for College Students based on the characteristics of their online learning situation. The questionnaire had 24 questions on learning motivation, teaching mode, learning ability, learning attitude, and learning environment.

Li (2021) preliminarily proposed examining the English learning adaptability of college students using AI support. Li (2021) examined their study attitude adaptation, autonomy in study adaptation, study interaction adaptation, physical and mental health adaptation, and study environment adaptation.

Liu (2022) measured study adaptability using five commonly utilized dimensions: motives, teaching mode, learning ability, attitude, and environment.

Previous research studies on the study adaptability scale were not done in the context of a pandemic. Some scales have low reliability (Wu, 2020), a lack of factor loadings (Liu, 2022), and only use a single analysis method (Feng & Li, 2002; Wang,

2006; Li, 2021; Liu, 2022). In addition, researchers divided the content of the Learning Adaptability Scale into personal and environmental factors. Personal factors include learning attitudes, motivation, learning ability, learning autonomy, and learning communication, while environmental factors include learning environment, teacher support, and teaching methods. Researchers always prefer to study learning attitudes and motivation together because they are somewhat related (Oroujlou & Vahedi, 2011; Sengkey & Galag, 2018). The learning environment, which includes a teacher element as part of the classroom environment (Zhang, 2012), is particularly important in the adaptation to online learning in a pandemic context. This study divided the scale of online studying adaptability of college students during the global pandemic into four dimensions based on a combination online studying adaptability scales developed by previous researchers: study attitude, auto-didactic ability, study and communication, and the study environment.

2.3 Attitude Towards Studying

In psychology, studying attitude is the relatively stable inner psychological tendency of students toward studying. Studying attitude is mainly composed of affective, cognitive, and behavioral factors (Cheng & Zhang, 2011). For example, Zhang and Geng (2009) pointed out that study attitude refers to the students' views on study activities and their words and behavior during study activities including their positive or negative behavioral tendencies and reactions (Liu et al., 2014).

Online learning can influence students' behavior and attitudes (Male et al., 2020). A good study attitude can help the students quickly accept online learning (Liu, 2022). Students' attitudes towards learning significantly affects their willingness to learn and their learning processes (Aguilera-Hermida, 2020). Simonson et al. (2019) posit that attitude is one of the most important factors that affect learners' success within the online learning. This study posits that attitude is a lasting positive or negative behavioral tendency and students' reaction to distance learning.

2.4 Auto-didactic Ability

Holec (1981) first introduced the concept of "autonomous study" to foreign language teaching. Auto-didactic ability refers to students' ability to determine the study objectives, contents, materials, and methods, the time, place, and progress of learning, and the ability to evaluate their own study. It is believed that auto-didactic ability is the capability to control self-learning. For instance, Benson (2007) defined autonomous study as the ability to control one's own study, viz. their study management, their cognitive processes, and their study content, which mainly involves motives, concept, strategy, and so on.

Students are vulnerable to selective difficulties in the presence of abundant study resources. A strong auto-didactic ability is required to identify essential knowledge and make breakthroughs in the process of study (Liu, 2022). When undertaking online courses, studying is an active and meaningful activity and the students have more autonomy. The present study defined auto-didactic ability as

students' ability to control their study objectives, study management, study methods, and the study process during the pandemic.

2.5 Study and Communication

Education is essentially a process of dialogue; therefore communication plays an important role in the learning process (Liang, 2018). In a systematic discussion of adaptability, Abu Talib et al. (2021) argue that learning needs to address potentially serious problems such as poor quality of communication. Suboptimal learning and communication results from students' maladjustment: good communication and interaction is important in students' learning adaptation (Qin, 2019). Students share knowledge through social media and interact with their teachers and classmates in knowledge construction (Liu, 2022). Moore (1989) proposed that communication in online education includes communication between the students and teachers, students and their teaching resources, and among students themselves. Hong et al. (2000) emphasized that "humane exchange," that is, real-time interaction, communication, and exchange between teachers and students should occur in an online environment akin to that in the classroom teaching setting. Adnan and Anwar (2020) pointed out in underdeveloped countries like Pakistan where a vast majority of students are unable to access the internet due to technical as well as monetary issues that limit interaction with the instructor, rapid response time, and traditional classroom socialization, online learning cannot produce the desired results.

This study defined study and communication as the students' communication with their teachers and peers during online learning.

2.6 Study Environment

Yang (2000) describes the study environment as a combination of various study resources that support students in carrying out constructive learning and not only as information resources. Jonassen (2000) defined the study environment as a space where the students study together or support each other. Students control their study activities and use the information resources and knowledge construction tools in the study environment to solve problems.

The study environment plays an important role in study adaptation. Löf (2010) and Porter et al. (2010) described study adaptation the students' efforts to self-adjust to achieve harmony between the objective environment and self-learning. Di Pietro et al. (2020) pointed out that while emergency distance teaching was implemented for continuity of education during the pandemic, students were separated from their on-the-spot study environment during isolation or confinement, and this may have led to study damage. The design of the learning environment can have a considerable impact on learning outcomes (Bower, 2019).

In summary, this study adopted Jonassen's (2000) definition of the study environment.

In this study, the above four dimensions were extracted by fusing and organizing previous dimensions related to learning adaptability. The four dimensions of the scale can measure the learning adaptability of university students during the global pandemic and avoid censoring questions due to covariance issues.

3. Research Procedures and Methods

3.1 Research procedures

In this study, the research process consisted of five steps. The questionnaire, formulated on the basis an analysis of original literature, was used to collect secondary data. A purposive sampling method was used to collect accurate and reliable data and reduces non-response rates (Murairwa, 2015). The data collected in the pre-test was used for the item analysis, exploratory factor analysis, and reliability analysis. The data from the formal questionnaire was subjected to confirmatory factor analysis. Ultimately, the formal Online Learning Adaptation Scale was developed as shown in Table 1.

Table 1: Research process and results

Steps	Research process	Research results
1	Analysis literature	Formation of the first draft of the scale with 4 dimensions and 38 questions
2	Questionnaire survey	Pre-test analysis collected 300 valid questionnaires. A formal sample of 1367 valid questionnaires was collected.
3	Item analysis	Three categories with 6 judgment criteria; 2 questions were deleted and 36 questions were retained.
4	Exploratory factor analysis (EFA)	The four dimensional factor loadings ranged from .530 to .838. The eigenvalues were all greater than 1 with a cumulative explained variance of 68.903% and a KMO value of .950 (p=0.000). Finally, 12 questions deleted.
5	Confirmatory factor analysis (CFA)	Good model fit. For example: RMSEA=0.075, RMR=0.038, GFI=0.866, NFI=0.909, IFI=0.918, PNFI=0.810, PCFI=0.818, CN=191. Formation of the final scale with 4 dimensions and 24 questions.

3.2 Research Tools

The Scale of College Student Adaptability to Online Studying during the Global Pandemic is divided into four dimensions namely: study attitude, auto-didactic ability, study and communication, and study environment. The scale has 24 questions rated on a 5-point Likert score. Among them, the 3 questions on the study environment have reversing scores (Table 2). The basic data collected in this research study included participants' gender, grade, and major classification. The questionnaire had two questions that served as a lie-detector test: "I like to participate in online courses" and "I do not like to participate in online courses." If the same responses were provided to the two questions, the participant failed the lie detector test. When the questionnaires were collected, responses from

participants that failed to pass the lie detector test or completed the questionnaire in a very short of a period of time were regarded as invalid.

Table 2: The connotation and items of the online studying adaptability scale

Dimensions	Definition	Items
A. Study attitude	Study attitude refers to the students' persistent positive or negative behavioral tendencies or behavioral response to distance learning during the global pandemic (Liu et al., 2014)	A1 During online studying, I am able to maintain a high thirst for knowledge
		A2 During online studying, I am able to actively eliminate negative emotions
		A3 It's meaningful for me to participate in online studying during the pandemic
		A6 During online studying, I am proactive and willing to participate in relevant activities
		A7 During online studying, I am able to correct my attitude towards studying to be aggressive and hard-working
		A8 When faced with the temptation of the internet, I am able to concentrate on my studies
		A9 I am able to refrain from looking up irrelevant material on the internet
Auto-didactic ability	Auto-didactic ability refers to the ability of students to control the study objectives, study management, study methods, and study process during the global pandemic (Benson, 2007).	B1 During online studying, I am able to set corresponding goals based on the overall goals of the course
		B2 During online studying, I am able to make corresponding plans according to the overall goals of the course
		B3 During online studying, I am able to adjust my study plan according to the actual circumstances
		B4. During online studying, I am able to develop corresponding methods for myself according to the teachers' content of the courses
		B5 During online studying, I am able to make an objective evaluation of my study
		B9 During online studying, I am able to determine the type and scope of information required
		B10 During online studying, I am able to summarize the main ideas found from within the data
		B11 I am able to innovate on the basis of integrating information
Study and communication	A space for the students to learn together as a community where the students can use online information resources to solve problems	C1 During online studying, I am able to actively answer the questions raised by the course teachers
		C2 During online studying, I am able to take the initiative to consult the course teacher when I encounter problems beyond my ability

	(semantic citation of this study).	C3 During online studying, there is no obstacle in my communication with the course teachers
		C4 During online studying, when other students raise doubts, I will actively reply and participate in the discussion
		C5 During online studying, I am willing to share my experience with others
		C9 During online studying, there are no obstacles in my communication with my classmates
Study environment	A space where the students study together and/or support each other. The students control the study activities and implement information resources and kno wledge construction tools to solve problems (Jonassen, 2000).	D1 During online studying, there are always distracting information
		D2 During online studying, I don't always get feedback from others in time
		D3 I felt uncomfortable with the disconnect between online teaching and reality

3.3 Research Subjects

This study enrolled students from H University, a comprehensive university in Fujian Province, as its research object. The university has 26 colleges and 90 departments with 25,000 full-time undergraduate students undertaking various majors. H university is one of the largest universities in China with a high number of overseas students. During the pandemic, H university implemented relevant national pandemic prevention policies and its students were engaged in online studying for more than 300 days before the 2020 Chinese Lunar New Year. The students had to study online two weeks prior to the start of semester (October 14), with in-person classes beginning in the third week. Study questionnaires were administered during the first week of face-to-face teaching to facilitate the comparison between online studying adaptability and face-to face teaching. Study respondents volunteered to participate and has the advantages of good subject cooperation and high questionnaire recovery.

3.4 Pre-test Analysis

Item Analysis

The questionnaire initially had a total of 38 questions including 9 questions about study attitude, 11 questions about auto-didactic ability, 9 questions about study communication, and 9 questions about the study environment.

Item analysis was conducted to evaluate the relevance of the scale and to determine whether the topic of each scale was discriminative using various measurement indicators (Qiu, 2006). Item analysis was also done to enhance the scale by deleting unnecessary topics based on specific measurement indicators. The study adopted the item analysis criteria of Wu (2009). Item analysis was divided into three categories with six judgment criteria as the basis of item deletion: extreme group comparison (decision value ≥ 3.0), the correlation test (where the correlation between the item and total score is greater than or equal to

0.4 and the correlation between the correction item and total score is less than) and the homogeneity test (α value verification after item deletion, commonality greater than or equal to .20, factor load greater than or equal to.45). Item deletion proceeded if an item met more than 3 judgement criteria.

A total of 400 pre-test questionnaires were issued, 390 were collected of which 300 were valid. After the item analysis, question 6 of the auto-didactic ability dimension and question 4 of the study environment dimension were deleted and the other questions were retained.

Exploratory Factor Analysis
When conducting exploratory factor analysis index, the eigenvalue should be greater than 1, the cumulative explanatory variation should be more than 50%, the *KMO* value should be more than 8, and the *Bartley's spherical test* should be significant. Based on these indicators, questions 4 and 5 on the study attitude dimension, questions 7 and 8 on auto-didactic ability, questions 6, 7 and 8 on the study communication dimensions, and questions 4, 5, 6 and 7 on the study environment were deleted. The eigenvalues after these questions were deleted were all greater than 1, the cumulative explanatory variation was 68.903%, the *KMO* value was .950, and the *Bartley's spherical test* value was significant (5373.924; p=0.000). The common factors found in the correlation matrix are shown in Table 3.

Table 3: Factor analysis summary table

Item	Dimensions			
	Study attitude	Auto-didactic ability	Study & communication	Study environment
A1	.652			
A2	.610			
A3	.652			
A6	.714			
A7	.792			
A8	.728			
A9	.732			
B1		.730		
B2		.697		
B3		.631		
B4		.619		
B5		.595		
B9		.652		

B10		.580		
B11		.530		
C1			.683	
C2			.754	
C3			.646	
C4			.765	
C5			.634	
C9			.611	
D1				.749
D2				.838
D3				.781
eigenvalue	4.880	5.034	4.093	2.368
variance	26.406%	17.380%	14.520%	10.597%
Cumulative explanatory variation	68.903%			
KMO Quantity of sampling suitability	.950			
Bartlett Spherical verification	5373.924***			

Reliability Analysis

The *Cronbach's a* coefficient of the "study attitude" dimension was .918, the *Cronbach's a* coefficient of the "auto-didactic ability" dimension was .927, and the *Cronbach's a* coefficient of the "study and communication" dimension was .881. The *Cronbach's a* coefficient of the "study environment" dimension was .802 and the total *Cronbach's a* coefficient was .956 after the above-mentioned items in the exploratory factor analysis were deleted. The Cronbach's coefficients for the total scale and subscales of the four dimensions were high indicating the scale's internal consistency.

4. Research Results and Analysis

4.1 Formal Sampling

In this study, a total of 2000 questionnaires were distributed to the college students in a comprehensive university in Fujian Province. In total, 1897 questionnaires were collected with 1367 found to be valid. In the sample of this

study, there are 412 male students, accounting for 30.1% of the total number, and 955 female students, accounting for 69.9% of the total number. The number of freshmen was 411 (30.1%), followed by 728 sophomores (53.3%), 152 juniors (11.1%), and 76 seniors (5.6%). By major, 839 or 61.4% of students majored in literature and history, 305 or 22.3% of students majored in science and technology, and 223 or 16.3% of students majored in art and sports.

4.2 Confirmatory Factor Analysis

In this study, AMOS was used to conduct the confirmatory factor analysis using all of the data. First, a normality test was performed and the test results showed that the absolute value of the Skew coefficient was less than 3 (Kline, 1998). The Kurtosis absolute values were all less than 10 (Huang, 2015), indicating that the sample data was in line with normal distribution. Furthermore, there was no negative error variance (EV), a standardized regression weighting coefficient (SE) greater than 0.95, and a standard error (SE) greater than 0.95 in the check model index, therefore there were no violation estimation phenomenon found in the model. Finally, when the suitability index was used to judge the suitability of the mode, the standard was roughly as follows (Figure 1): RMSEA should be less than .080, while NFI, IFI, and CFI should be more than .900 (Qiu, 2006). Confirmatory factor analysis was conducted to test the fit of the model. In this study, the RMSEA value was .075, the RMR value was .038, the GFI value was .866, the NFI value was .909, and the IFI value was .918. PNFI and PCFI should be greater than .500 (Hair et al., 2006) where there is a PNFI value of .810, a PCFI value of .818, and a CN value of 191. The results of the confirmatory factor analysis show that all of the indexes were up to the adaptation standard which reflects that the model is basically suitable.
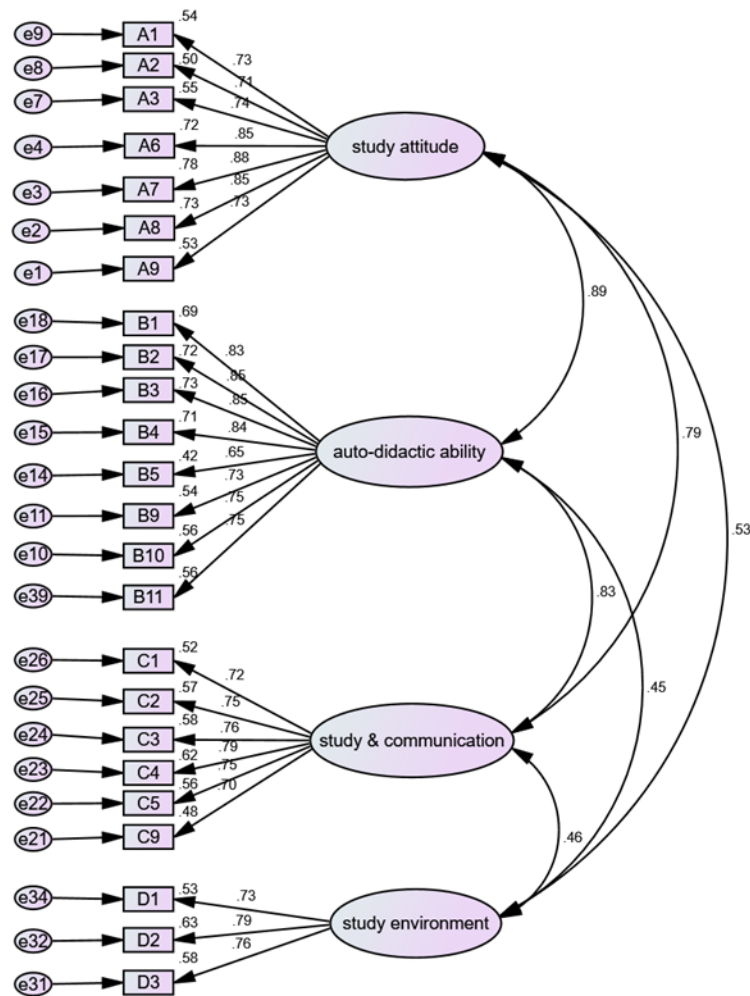
Figure 1: Measurement model

4.3 Convergent Validity

The factor loading of the latent variables in the scale of online studying adaptability - "study attitude," "auto-didactic ability," "study and communication," and "study environment" – ranged from .530 to.838, all of which are greater than .500. The combined reliability results were study attitude (.920), auto-didactic ability (.931), study and communication (.881), and the study environment (.780), all of which were higher than .600 (the standard of good constructed reliability). The mean variances were study attitude (.624), auto-didactic ability (.629), study and communication (.554), and the study environment (.544). According to Fornell and Larcker (1981), the combinatorial reliability should be greater than .600. Based on the constructed reliability alone, the researchers were able to determine that there was appropriate construct aggregation validity. However, considering the actual data orientation, an AVE higher than 0.36 can also be considered a reluctantly accepted standard. Therefore, this study believes that the scale has constructive validity.

4.4 Discriminant Validity

Hair et al. (2012) suggests a judgment criterion where the number of AVE square roots for each facet greater than the correlation coefficients must account for at least 75% of the total number of comparisons. Take Table 4 as an example. It can be judged that the scale has discriminant validity which again proves that the intrinsic quality of the measurement model is better.

After the preliminary test and formal questionnaire analysis, the Scale of College Students' Adaptability to Online Studying during the Global Pandemic compiled in this study was finished. It contains 24 questions within four dimensions: study attitude, auto-didactic ability, study and communication, and study environment as shown in the table below.

Table 4: Discriminant validity of on-line study adaptability

	M	SD	1	2	3	4
1. Study attitude	2.589	0.811	.790			
2. Auto-didactic ability	2.470	0.767	.834**	.793		
3. Study & communication	2.584	0.783	.716**	.767**	.744	
4. Study environment	3.058	0.890	.467**	.397**	.392**	.738

The diagonal line is the square root of AVE value of each variable, and the non-diagonal line is the correlation coefficient; Source: this research.

4.5 Difference Analysis

To explore the differences in the adaptability of online learning among the college students of different genders, an independent sample was adopted for the t-test analysis. The findings were as follows: different genders of the college students and network adaptability (t=0.201, p =.841), study attitude (t=-0.312, p =.755), auto-didactic ability (t=-0.015, p =.988), study and communication (t=-0.881, p =.379), and the study environment (t=1.674, p =.094).

In this study, single-factor independent sample ANOVA was used to analyze the differences in the adaptability of the students with different grades to online studying. The results showed that the variance was homogenous. The Scheffe method was used to test this, and it was found that there was no significant difference in the adaptability of students with different grades in relation to online studying (F=1.401, p=.241). However, there were significant differences among the different grades in the dimension of the study environment [Freshman year (M=2.996, SD=0.875); sophomore year (M=3.148, SD=0.875); junior year (M=2.969, SD=0.934); senior year (M=2.890, SD=0.774); junior year (M=2.969, SD=0.875); senior year (M=2.890, SD=0.774). p=.003]. Additionally, the adaptability to online

studying among freshmen was significantly lower than it was among sophomores.

In this study, a single factor independent sample ANOVA was used to analyze the differences in the adaptability of the students from different majors in relation to online studying. The results show that there were significant differences in the adaptability of the students from different majors in relation to online studying (F=16.088, p=.002). There were significant differences in study attitude, auto-didactic ability, study and communication, and the study environment. The art majors' results were significantly less for study attitude, auto-didactic ability, study and communication, and the study environment compared to the literature, history, and science and technology majors.

5. Discussion

This study constructed the Adaptation to Online Learning Scale for College Students to evaluate college students' adaptation to online learning in a global pandemic through item analysis, exploratory factor analysis, and confirmatory factor analysis. The scale, that has a total of 24 questions, is divided into four dimensions: learning attitude, independent learning ability, learning communication, and learning environment. Item analysis shows that the scale items are well-differentiated. The scale's cumulative explanatory variance indicates its ability to examine more than half of the students' adjustment problems. The factor loadings for the four dimensions range from .530 to .838. Confirmatory factor analysis confirms that the scale has good construct validity and meet psychometric requirements. Additionally, reliability analysis results that denotes that the scale's internal consistency coefficient of .956 demonstrates good measurement requirements. Therefore, the scale is an appropriate tool for evaluating college students' adaptation to online learning in a global pandemic context.

In contrast to the previous studies on scale construction, some scales have low reliability (Wu, 2020), a lack of factor loadings (Liu, 2022), and have adopted a single statistical validation for (Feng & Li, 2002; Wang, 2006; Li, 2021; Liu, 2022). In this study, exploratory factor analysis and confirmatory factor analysis were used to improve the scale's reliability and validity. The scale, which contains both personal and environmental factors, namely the students' attitude and learning abilities, their communication with both their peers and teachers, and their adaptation to the overall learning environment, are appropriate for measuring the learners' adaptation to learning in the specific context of online learning.

Gender did not influence the online studying adaptability of college students, because all students, regardless of gender, were suddenly faced with having to adapt to undertake online learning.

There was a relationship between a student's grade and his or her adaptability to online studying. Sophomores' adaptability to the online study environment exceeded that of freshmen. Freshmen were new to university life; an experience further challenged by sudden transition to online classes. On the other hand, sophomores had already adapted to the learning environment and may have found it easier to adapt to the internet than freshmen. Over time, the changes in

students' study methods and thinking ability gradually strengthens their study ability (Li & Gu, 2011).

There were significant differences in the college students' adaptability to online studying by university major. Students majoring in art were less adaptable to online learning when compared to students majoring in literature, history, science, and technology in all dimensions. It is possible that most art majors focused on practice, and their teachers were unable to directly guide them after offline teaching was suspended.

6. Conclusion

Generally speaking, scale development is a continuous process and additional verification procedures can enhance its reliability and validity. The scale had good reliability and validity based on the results of the exploratory and confirmatory factor analyses. The factor loadings also demonstrate the scale's good convergent validity and discriminant validity. The scale can therefore be used as a research tool to assess the online learning adaptability of university students.

But all questionnaires were administered to students at one university in Fujian Province and sampling deviation may have a certain impact on the research results. There were imbalances in the gender and proportion of majors in each grade. Thus, future research should expand the research's subjects and scope to include vocational students and postgraduate students to better understand the differences among the different subjects. Furthermore, interviews and participant observations would furnish more information regarding understanding adaptation to online learning. Despite some limitations, this study adds to the growing body of knowledge on the effectiveness of adaptive tools for online learning and sets the stage for future research in this area. It is anticipated that the results of this study will encourage educators to explore other online learning adaptive tools in their teaching practices and to continue developing innovative approaches to improve student learning and achievement.

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