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Development and validation of an online academic resilience scale for college students

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Abstract: Given the increasing prevalence of online learning, understanding the online academic resilience of college students is essential for learning analytics and intervention. This study employed mixed methods to develop and validate a new instrument, the Online Academic Resilience Scale (OARS). By interviewing 12 college students who had experienced significant online learning challenges and adapted well, 77 items were compiled. Using the Delphi method, 16 items were retained, encompassing four factors: goal focus, learning motivation and efficacy, positive cognition, and course quality. A questionnaire survey was conducted among 317 college students from different cities in China to evaluate the scale's effectiveness. Results indicated that the scale demonstrated good item discrimination, reliability, and validity. Furthermore, confirmatory factor analysis supported the structural validity of the scale, with chi-square (χ^2) = 293, degrees of freedom (df) = 98, $\chi^2/df = 2.98 < 3$, root mean square error of approximation (RMSEA) = 0.079 < 0.08, comparative fit index (CFI) = 0.929 > 0.9, Tucker-Lewis index (TLI) = 0.913 > 0.9, and P-value = 0.0000 < 0.005. The scale is suitable for measuring college students' online academic resilience and provides a theoretical reference and tool support for related research.

Keywords: *College students, Learning, Online academic resilience, Online learning, Scale development.*

1. Introduction

Online and blended learning have become mainstream learning methods for college students. With the rapid development of online learning, some issues occur, including students' inattention, lack of presence, load imbalance, the gradual weakening of learning motivation and interest, and academic delay, eventually leading to academic failure [1]. Higher registration and lower completion rates have become bottlenecks that restrict the development of online learning, causing great concern.

College students' online academic resilience is crucial to their learning quality and study completion. A study highlighted that academic resilience is negatively related to academic burnout in online learning [2]. Online academic resilience enables students to navigate through challenges effectively, enhancing their learning quality and outcomes [3, 4]. Academic resilience can enhance students' engagement with online content, increasing their active participation in online learning [5]. Additionally, it plays a critical role in reducing student attrition rates [6]. Therefore, fostering strong academic resilience in students enables them to achieve tremendous success in their studies [7].

The online Academic Resilience Scale (OARS) is crucial for identifying students' strengths and weaknesses in resilience, which can inform targeted interventions that support their academic success and well-being, Ghanizadeh and Majidi Yazdi [8]. Chen et al. [9] highlight the importance of regular assessments to address specific resilience characteristics that can significantly impact students' academic performance, there are currently few related studies. The lack of OARS presents challenges to intervention and the improvement of online learning quality.

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On this basis, this study conducts the following research: (1) according to the scientific scale compilation procedure, an OARS for college students is developed, and (2) a four-factor model of college students' online academic resilience is proposed. The purpose is to provide theoretical reference and tool support for related research.

2. Literature Review

2.1. Concept of College Students' Online Academic Resilience

Resilience is a person's ability to survive adversity and respond positively to situations to easily resolve difficulties encountered [10]. The American Psychology Association [11] defines resilience as "the process and outcome of successfully adapting to difficult or challenging life experiences, especially through mental, emotional, and behavioral flexibility and adjustment to external and internal demands." With the development and deepening of psychological resilience research, scholars have begun to use restrictive terms, such as academic, programming, professional, and digital, to conduct resilience research in various fields [12-14].

Academic resilience has been developed based on psychological resilience research. Researchers typically use social, economic, and cultural status indicators to study academic resilience, such as parents' occupation, parents' education level, and family resources, as well as academic stress, including unsatisfactory grades and challenging learning tasks, as indicators of learning risks or adversity. For example, Masten [15], highlighting academic resilience as a fundamental social-psychological structure, aims to describe why some students achieve better results in painful or challenging situations. Martin and Marsh [16] highlighted that academic resilience includes overcoming learning difficulties, stressful deadlines, test stress, poor performance, and personal, family, and social challenges that lead to academic stress, which weakens students' learning motivation to achieve set goals and academic ambitions. Xu [17] highlighted that academic resilience is the ability of students to effectively cope with and actively adapt to pressure, difficulties, or adversity in the learning process. Most existing research simultaneously considers social and economic life and learning dilemmas as risk indicators. In this study, the risk indicators of academic resilience are limited to academic pressure in the learning field, excluding social and economic status dilemmas. Furthermore, due to various differences between online learning and offline learning, such as interaction, flexibility, feedback, collaboration [18, 19] and differences at various learning stages, such as teenagers, who are influenced by family and teacher support more significantly than college students [20], this study only focuses on the college students' online academic resilience. It defines the online academic resilience of college students as their ability to adapt to overcome learning difficulties or face various learning challenges in online learning environments, which is the ability to recover and grow from significant learning challenges.

2.2. Predictor of OARS

Understanding the factors influencing academic resilience is essential for developing an academic resilience scale.

Goal focus has been shown to have a positive and significant relationship with academic resilience. Goal focus encourages students to engage deeply with their studies and persist through difficulties, fostering a resilient mindset. Students with a firm goal focus tend to exhibit high levels of academic resilience, as their goal focus helps them navigate through academic challenges effectively, suggesting that goal focus is a critical predictor of academic resilience [21].

Positive correlations are found between academic self-efficacy and academic resilience [22]. Higher levels of self-efficacy are associated with greater academic resilience, enabling individuals to better cope with stress and academic demands [9]. Self-efficacy significantly predicts academic resilience, accounting for a substantial portion of the variance among resilience levels.

Learning motivation and academic resilience have a positive correlation. Learning motivation is a strong predictor of resilience. Online learning highlights the importance of motivation in maintaining

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resilience. A study on Iranian university students found that motivated students are more resilient in adapting to new learning environments [23].

Researchers found a significant positive relationship between positive cognition and academic resilience, indicating that students with positive expectations are more resilient to academic challenges [8]. Positive cognition significantly contributes to academic resilience, predicting academic achievement.

The quality of online courses plays a significant role in influencing students' academic resilience. High-quality courses support students in developing academic resilience, particularly during online learning. Studies show that the quality of online courses is a significant predictor of academic resilience [24].

Literature research shows that goal focus, self-efficacy, learning motivation, positive correlation, and course quality are the main predictors of academic resilience.

2.3. Present Study

Scholars have focused on the resilience scale for college students. Zhao and Li [25] developed an academic resilience scale for college students, including six factors: learning efficacy, learning persistence, self-acceptance, perceived social support, social support utilization, and learning goals. Baek et al. [26] constructed an academic resilience scale for college students, which includes five dimensions: self-efficacy, situational judgment, resource utilization, encouragement, and learning goals. Meanwhile, Xu [17] designed an academic resilience scale for college students, including 21 items, and Cassidy [12] developed ARS-30, aimed at measuring academic resilience in the same group.

Scholars have also focused on the resilience scale for primary and secondary school students. Cui and Chen [27] compiled an academic resilience scale for secondary vocational school students; Yang [28] compiled an academic resilience scale for middle school students. Ramdani et al. [29] developed an academic resilience scale for junior high school students that measures empathy, problem-solving, self-efficacy, self-awareness, and learning goals. Oh and Kim [30] designed an adolescent academic resilience scale that includes five factors: family support, peer relationships, problem-solving, ambition, and learning environment. Hee and Park [31] designed an academic resilience scale for primary school students that includes four factors: parental support, peer support, learning adjustment, and teacher support.

The domain-specific academic resilience scale has also attracted the attention of scholars. Li and Guo [32] developed an English academic resilience scale for college students, which includes four factors: positive cognition, personal perseverance, emotional regulation, and learning management. Zhan [33] developed a second-language academic resilience scale for college students. Ricketts et al. [34] designed a mathematics academic resilience scale. Han [35] revised the 11-factor academic resilience scale for Eugenics.

Existing research has shown the following: (1) Most of the achievements of the academic resilience scale are based on offline learning environments, which are unsuitable for evaluating online academic resilience. Students face more challenges, such as time management, maintaining motivation, and social interaction, in online learning [36]. With the digital transformation of education, developing a resilience scale suitable for online learning is urgent. (2) The focus of scale evaluation varies for different age groups. For example, teenagers have weak independence and are influenced by families and teachers, while the academic resilience scale for primary and secondary school students involves more dimensions, such as family and peer support. In contrast, college students have strong independence, which involves more dimensions, such as self-efficacy. Online learning has become a mainstream learning method for college students, and it is urgent to develop an appropriate OARS for them. (3) The scale for a particular domain or special group has domain characteristics and is only suitable for measuring academic resilience in related fields.

The online academic resilience level of college students determines whether they persist in learning when encountering difficulties and is an essential factor affecting learning outcomes. Measuring

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students' online academic resilience is crucial for learning analysis and intervention. Given the lack of existing scales, this study developed an OARS for college students to provide a tool for measuring and cultivating online academic resilience among college students.

3. Method

3.1. Procedure

The present study aimed to develop a scale for measuring college students' academic resilience in online learning environments. To this end, mixed methods were employed, and a scale was developed using the following three stages (Figure 1). The first stage was the compilation stage, in which the first draft items of OARS for college students were generated, including interviews, the arrangement of interview materials, and the compilation of scale items. The second stage was the revision stage, which included deleting repeated and unreasonable items and modifying inappropriate items using the Delphi method. The third stage was the analysis stage, which comprised a questionnaire survey and quality analysis, including data collection, item discrimination analysis, reliability analysis, structural validity analysis, content validity analysis, and the structure and item determination of the scale.

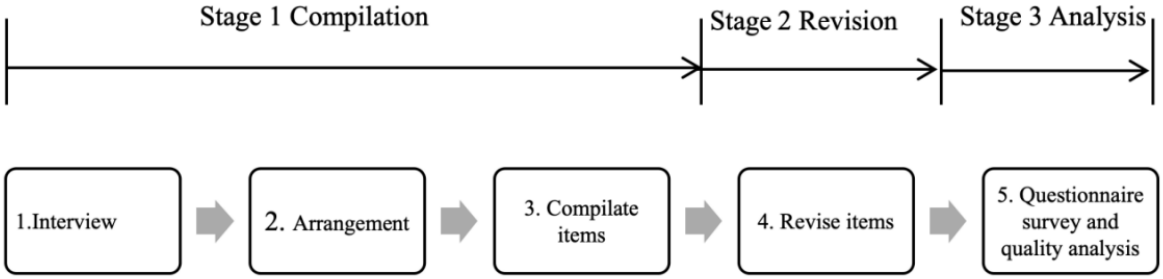

Figure 1.
Scale development procedure.

3.2. Respondents

3.2.1. Respondents in the Interview Stage

According to the connotation of online academic resilience for college students, the interviewees in this study were college students with online learning experience who had encountered significant learning difficulties or pressure in online learning but were well adapted. This research selected eligible college students from a university in Guangdong Province, China, to conduct interviews. After interviewing 12 respondents, data saturation was reached. Among the 12 respondents, 4 were male, 8 were female, 7 were sophomores, and 5 were juniors.

3.2.2 Respondents in the Questionnaire Stage

The participants came from universities in various cities throughout China and had prior experience with online learning. A total of 402 questionnaires were collected, and among them, 317 valid questionnaires were retained as research objects of the questionnaire survey. The basic information is shown in Table 1.

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Table 1.
Situation of questionnaire survey samples.

Type	Category	Number of people	Proportion (%)
Grade	Freshman year	33	10.41%
	Sophomore year	158	49.84%
	The third year of college	101	31.86%
	Senior year of college	25	7.89%
Gender	Boys	96	30.28%
	Girls	221	69.72%
Discipline	Liberal arts	150	47.32%
	Science	167	52.68%

3.3. Compilation of OARS for College Students

3.3.1. Interview on College Students' Online Academic Resilience

The research team conducted one-on-one interviews with interviewees, obtained their consent, and recorded the entire process. The interview adopted a structured approach. The outline is shown in Table 2. The first question guides the interviewee in reviewing learning difficulties or learning stress, and the other seven questions are used to extract the interviewee's memory.

Table 2.
Interview outline.

No.	Problem
1	Please tell us about the most significant or most impressive learning difficulty you encountered in online learning.
2	What do you think are the difficulties encountered in online learning? What are your views and attitudes toward the challenges of online learning?
3	What is your emotional state when you encounter difficulties in online learning? What are the ways to improve your emotional state?
4	What efforts or arrangements have you made to solve the difficulties in online learning?
5	How do you feel about overcoming the difficulties in online learning?
6	Who helped you at that time? How did they help you?
7	In addition, what other reasons motivated you to persist in overcoming difficulties, not give up, and strive to complete your studies at that time?
8	Please evaluate yourself in one word.

3.3.2. Arrangement of Interview Materials

The first step is coding. Using the automatic transcription function of the recording pen, the recorded audio is converted into a text manuscript, which is encoded according to the different interviewees. The second step is organization. Because there are many modal particles in the automatically transcribed manuscripts, most of which are colloquial expressions, it is necessary to sort out the manuscripts and extract useful information. The third step is confirmation. Feedback the sorted text to the corresponding interviewees, and ask them to confirm the written materials. If the interviewees think that the text truly reflects the interview content, the materials will be sorted out. If the interviewees report that the interview content is inconsistent with the materials, the materials will be modified according to the interviewees' opinions until they agree.

3.3.3. Compilation of Scale Items

Scale items were compiled based on written interview materials, which were confirmed by interviewees using the Delphi method. The specific method involves extracting the core expressions of interviewees' answers from the written manuscripts and organizing them into a complete, concise, and unambiguous set of sentences. Seventy-seven items were sorted and subsequently used as the first draft of scale items. According to the content of the items, they are classified into four categories: (1) attitudes

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toward online learning difficulties, (2) motivation and self-efficacy after overcoming learning difficulties, (3) self-evaluation, and (4) the quality and operation of online courses using the Delphi method.

3.3.4. Revision of Scale Items

This study invited 16 experts to revise scale items using the Delphi method and deleted items whose expressions are repeated or whose contents have little to do with the online academic resilience of college students. The process included (1) conducting three rounds of questionnaires, distributing questionnaires to experts with instructions to share opinions and insights based on personal experience, knowledge, or research, and revising the items round by round according to the experts' suggestions; (2) analyzing and revising collected and analyzed expert feedback as well as identifying commonalities and disagreements; and (3) performing surveys for consensus. For these surveys, sixteen experts reached a consensus: they retained 16 items, which were divided into four dimensions according to the content of the items. (1) Goal Focus: This refers to the quality and ability of college students to stick to their goals, not give up, and concentrate on solving problems when facing difficulties in online learning. (2) Learning Motivation and Efficacy: This refers to the drive that encourages students to engage in learning activities and persist in completing tasks, and the confidence they have in their capacity to succeed in learning tasks. (3) Positive Cognition: This refers to the optimistic attitude of college students when facing online learning difficulties. (4) Course Quality: This refers to the quality of educational resources and the operational level of online courses. The sixteen items are shown in Table 3.

Sixteen online academic resilience evaluation items for college students were measured using a 5-point Likert scale. In addition, four demographic characteristic questions were added to form a scale with 20 questions.

Table 3.
Scale Dimensions and Items.

No.	Items
	Factor 1: Goal Focus
A1	I think it is normal to encounter difficulties in online learning.
A2	I do not pay attention to difficulties encountered in online learning and will not take the initiative to solve them.
A3	I think when I encounter difficulties in my studies, I must solve them.
A4	The process of overcoming difficulties is a harvest.
	Factor 2: Learning Motivation and Efficacy
B1	I experience satisfaction when I overcome my learning difficulties.
B2	College is the golden stage of life, and I hope to learn more things in college.
B3	The teacher's praise increases my enthusiasm to learn.
B4	My classmates' affirmation motivates me to continue to work hard.
	Factor 3: Positive Cognition
C1	When learning online, I feel that I am a person who does not give up easily.
C2	I take the initiative in my study.
C3	I have a clear learning goal.
C4	I have the patience to overcome every difficulty.
C5	I think I have the ability to solve difficulties encountered in online learning.
	Factor 4: Course Quality
D1	My interest in what I learn makes me more persistent in overcoming my learning difficulties.
D2	In the online course, the teacher sets clearly phased learning goals, which will motivate me to complete the learning tasks step by step according to the pace of teacher.
D3	The quality of the course affects whether I continue to study.

4. Findings

4.1. Item Discrimination

Analyze the item discrimination degree of the survey data. This method involves dividing the sample into high and low groups according to the total score of all items on the scale. An independent sample t-test is used to compare the scores of each item in the high and low groups. The significance

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level is 0.05, and the calculation results of 16 items in the scale are significant ($p < 0.001$), indicating that the discrimination degree of all items is up to standard. The correlation analysis between 16 items and the total was used to test the discrimination degree of the items again. The results showed that the correlation coefficients of the 16 items were greater than 0.5; therefore, the 16 items had a good degree of item discrimination. See Table 4 for the discrimination test results for each item.

Table 4.
Results of item discrimination.

Factor	Item No.	Correlation between Item and Total	P-value of t-test Between High and Low Groups
Goal Focus	A1	0.554	<0.001
	A2	0.624	<0.001
	A3	0.650	<0.001
	A4	0.710	<0.001
Learning Motivation and Efficacy	B1	0.720	<0.001
	B2	0.710	<0.001
	B3	0.694	<0.001
	B4	0.697	<0.001
Positive Cognition	C1	0.605	<0.001
	C2	0.600	<0.001
	C3	0.596	<0.001
	C4	0.694	<0.001
	C5	0.712	<0.001
Course Quality	D1	0.722	<0.001
	D2	0.707	<0.001
	D3	0.547	<0.001

4.2. Constructional Validity

Investigate the correlation between the factors, as shown in Table 5. The correlations are significant, and the correlation coefficient ranges from 0.36 to 0.67, indicating a moderate positive correlation. This suggests that all factors are aligned in the same direction but are distinct, and none can replace each other. The correlation between the factors and the total score ranges from 0.78 to 0.82, representing a highly positive correlation. This indicates that each factor is consistent with the overall concept.

Table 5.
Correlation matrix between each factor score and the total score of the scale.

Factor name	Goal Focus	Learning Efficacy	Positive Cognition	Course quality	Total score
Goal Focus	1				
Learning Motivation and Efficacy	0.670**	1			
Positive Cognition	0.471**	0.355**	1		
Course Quality	0.631**	0.648**	0.449**	1	
Total score	0.822**	0.776**	0.808**	0.781**	1

The confirmatory factor analysis utilized 317 valid questionnaires collected through survey methods and analyzed with Mplus 8.3 software to evaluate the fit of the four-factor model for college students' online academic resilience. The results indicated a good model fit, with the following fit indices: $\chi 2 = 293$, $df = 98$, $\chi 2/df = 2.98 < 3$, RMSEA = 0.079 <0.08, CFI = 0.929 >0.9, TLI = 0.913 > 0.9, and P-value = 0.0000 <0.005. All fit indices met the established criteria, suggesting that the four-factor model adequately fits the data. The standard parameter estimation results are presented in Figure 2. The names and contents of the items are detailed in Table 3.

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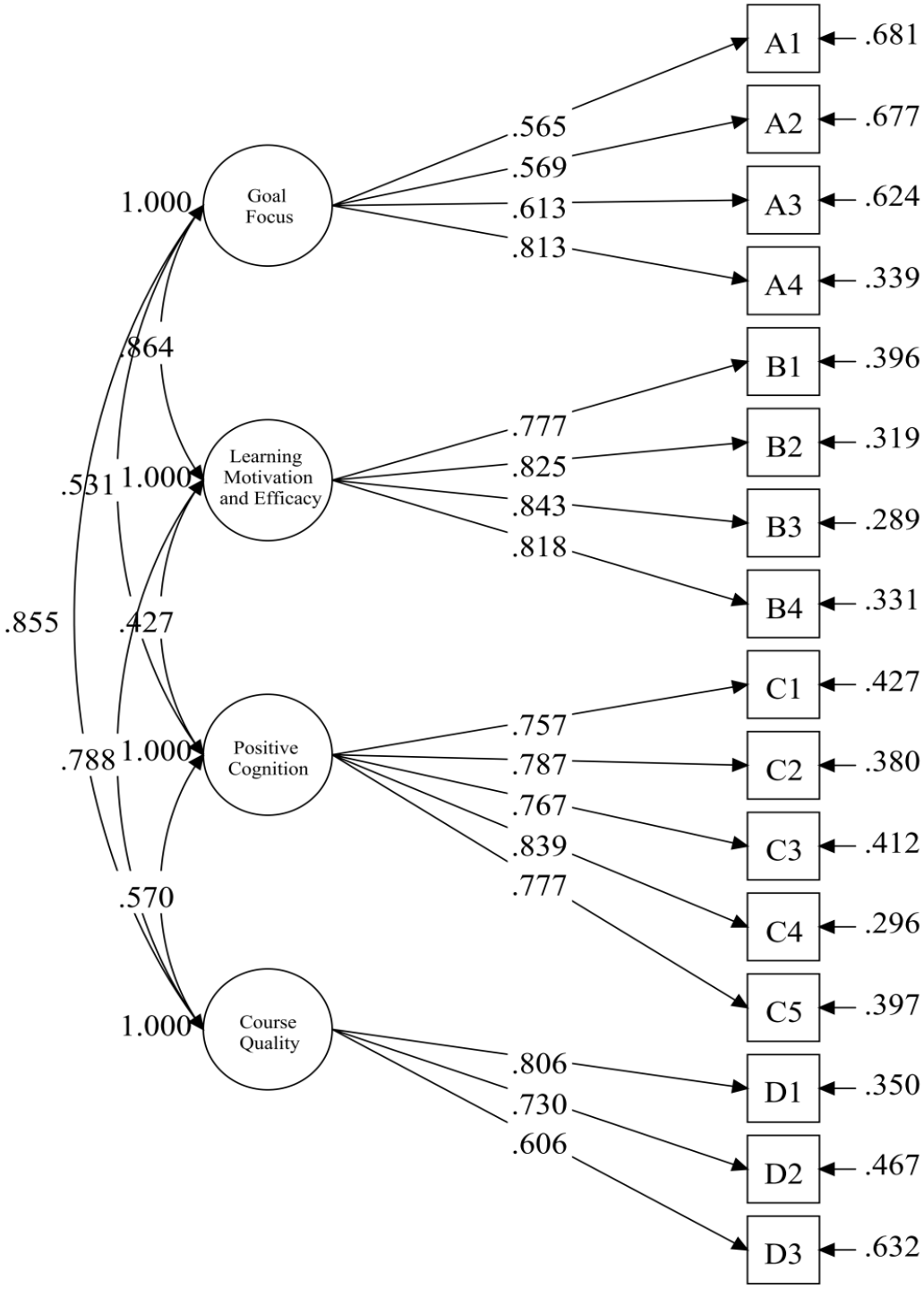

Figure 2.
Confirmatory Factor Analysis Results of Four-factor Model for College Students' Online Academic Resilience.

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4.3. Content Validity

Three experts were invited to test item-objective congruence (IOC). A total of 16 items exhibited IOC results between 0.67 and 1.00 and were approved by experts and retained.

4.4. Reliability Analysis

The reliability of the data was analyzed using SPSS. The Cronbach's alpha coefficients of the four scale factors are greater than 0.70, and the total Cronbach's coefficient of the scale is 0.911, as shown in Table 6. The results of the reliability analysis indicate that the reliability of the OARS for college students is excellent and meets the measurement requirements.

Table 6.
Reliability of the scale.

Factor	Mean value	Standard deviation	Cronbach's α
Goal Focus	3.93	0.60	0.733
Learning Motivation and Efficacy	4.19	0.65	0.887
Positive Cognition	3.43	0.66	0.889
Course Quality	3.85	0.61	0.755

5. Discussion

5.1. Key Findings

In this study, a scale to measure college students' online academic resilience was developed. Furthermore, the factor structure, reliability, and validity of the scale were tested. The scale consisted of 16 items, encompassing four factors: goal focus, learning motivation and efficacy, positive cognition, and course quality. The scale was administered to 317 college students in China. The correlation coefficients between the factors ranged from 0.36 to 0.67, and the correlation degrees between the factors and the total score ranged from 0.78 to 0.82. All factors aligned with the overall concept. The results of the confirmatory factor analysis indicated that all fit indices met the criteria for the four-factor model of OARS. The Cronbach's alpha coefficients for the four factors exceeded 0.70, and the overall Cronbach's alpha coefficient of the scale was 0.911. Based on these findings, the college students' OARS is a valid and reliable measurement tool.

5.2. Comparison with Literature

College students need to have academic resilience in the online learning environment. Students encounter various difficulties and academic stresses during online learning experiences. Online academic resilience reflects an increased likelihood of educational success despite adversity [37]. Furthermore, online learning and long-term isolation from teachers and classmates have exacerbated the symptoms of academic burnout; meanwhile, online academic resilience can play a protective role [2]. Thus, promoting academic resilience is an effective strategy for enhancing educational attainment in online classes [38].

This study builds on academic resilience literature by expanding the concept to the online learning context. Previous academic resilience scales have provided important insights into academic resilience in face-to-face learning [12, 25, 26]. However, OARS is specifically designed to address the needs of online learning environments, effectively bridging the gap.

5.3. Practical Implications

The scale can be used to measure the academic resilience of college students in online learning. The measurement results can be used for online learner analysis and learning intervention. The scale can be employed by educators and higher education administrators to identify students at risk of poor academic performance due to low academic resilience under online learning contexts. The early identification of students struggling to cope with online learning demands allows for timely interventions. OARS can

also be used to evaluate the effectiveness of interventions and make decisions regarding approaches to support students better in online learning.

The four factors of the scale provide insights into the development and operation of online courses. For example, course quality is a factor in college students' online academic resilience; thus, studying course construction and improving course quality are conducive to enhancing college students' online academic resilience.

Additionally, OARS is a valuable tool for researchers to examine the impact of online education on students' academic resilience, and educators can develop strategies that foster academic resilience and improve retention and success rates.

5.4. Limitations

The limitation of this study is that the sample size of the questionnaire survey was small. Furthermore, the study was restricted to college students in various cities in China and was not extended to other countries, which may limit its applicability to students in other countries. Cross-cultural validation of OARS could further enhance its utility. Therefore, the next step will be to conduct relevant research in other countries.

5.5. Future Study

A further study could explore specific strategies and interventions that most effectively build academic resilience in online learning contexts. Experimental studies testing the impact of resilience-building interventions could provide a more robust understanding of how academic resilience can be fostered in students who are struggling with course content.

6. Conclusion

With the development of network technology and the advancement of digital education, online learning has become an essential learning method for college students. Online academic resilience is a critical factor influencing learning outcomes. Measuring the level of online academic resilience is also a vital approach for learning analytics and intervention strategies. Studying the online academic resilience of college students holds significant importance. However, there is limited research on college students' online academic resilience, and no unified definition of related concepts and connotations exists, along with a lack of targeted scales. In this study, we define the concept of college students' online academic resilience, develop an Online Academic Resilience Scale (OARS), and propose a four-factor model comprising goal focus, learning motivation and efficacy, positive cognition, and course quality. Inspection results indicate that all items in the scale demonstrate good item discrimination. The correlation analysis between each factor score and the total score confirms that the scale's structure is reasonable. All fit indices meet the requirements for the four-factor model and data fitting. Reliability analysis results show that the reliability of the OARS for college students satisfies measurement standards.

The OARS for college students adheres strictly to survey requirements and has been revised and tested repeatedly. The scale compilation reflects the authors' understanding of the connotation and structure of online academic resilience. The scale provides a tool to support measuring college students' online academic resilience and related research, and the four-factor model offers a reference for related theoretical research.

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Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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