



## Research article

# Harmonious passion and academic achievement in higher education: The mediating influence of exploratory and exploitative learning strategies

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## ABSTRACT

Harmonious passion refers to engaging in an activity out of personal volition and sense of meaning, which motivates individuals to devote substantial time and energy while internalizing the activity as part of their identity, and it underpins the promotion of sustainable behaviors and mindsets. The present study aimed to investigate the relationship between harmonious passion and academic achievement among university students in higher education, as well as the mediating role of exploratory and exploitative learning behaviors in this association. Exploratory learning involves seeking new knowledge and skills, whereas exploitative learning involves refining and applying existing knowledge and skills. Data were collected from 528 university students across multiple institutions in China. Using structural equation modeling and multiple regression analysis, results revealed that harmonious passion had a significant positive effect on academic achievement. Furthermore, exploratory and exploitative learning played a chain-mediated role in the relationship. These findings provide insights into how harmonious passion could promote students' academic success in the context of innovation-driven and socially sustainable development, via the facilitation of sustainable learning strategies. Therefore, this study has broader implications for personal and societal sustainability, by emphasizing the role of harmonious passion and sustainable learning strategies in enhancing academic achievement and, ultimately, contributing to a more sustainable society.

## 1. Introduction

Recent studies have explored various aspects of harmonious passion and its impact on different areas of life, including education, work, and psychological well-being. Passion for learning can affect sustainable learning and ultimately affect academic achievement in university [1]. These studies collectively highlight the importance of harmonious passion in various aspects of life, from academic performance and engagement in educational factors to innovative work behavior. They underscore the need for fostering harmonious passion to enhance positive outcomes in both educational and work contexts [2]. University education plays a crucial role in developing the innovative talents demanded in the new global economic era [3]. Many talented innovators laid the foundations of their careers during university, and universities themselves can be strengthened by understanding how to nurture such talents by focusing on sustainable innovation [4]. Harmonious passion is a type of passion towards activities that individuals love, value, and invest time and energy in Ref. [5]. This study views harmonious passion as a multidimensional, self-sustaining process in which learners commit

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sufficient time and energy to achieve their learning goals by enhancing their autonomous motivation, positive emotions, and sense of identity [6], thereby stimulating harmonious passion [7]. Introduced by March in 1991, the concept of ambidextrous learning comprises two synergistic dimensions: exploratory learning (ERL) and exploitative learning (EVL), each offering unique, interconnected benefits to the educational process. This study posits a framework for understanding student academic success in Chinese universities, highlighting the roles of harmonious passion and ambidextrous learning. It aims to explore the influence of harmonious passion on academic achievement within higher education and examine how exploratory and exploitative learning behaviors mediate this relationship. This nuanced approach provides a comprehensive analysis of the factors contributing to educational outcomes, underscoring the importance of balancing diverse learning strategies to foster academic excellence.

Until now, most research into harmonious passion has focused on enterprises and other organizations rather than the educational domain, despite its potential for improving our understanding of academic learning processes. While past research has acknowledged the influence of harmonious passion and personal emotions on performance and achievement [7], the precise pathway of this impact has not been thoroughly elucidated. This study endeavors to examine the interplay between university students' harmonious passion, ambidextrous learning, and academic achievement within the context of Chinese higher education, and proposes pertinent theoretical models, thereby filling a significant research gap and offering substantial value. Drawing from the findings and pedagogical practices, this study advances targeted recommendations to furnish both theoretical underpinnings and a practical foundation for enhancing university students' academic outcomes. Appropriate supplement is also made in the article. Accordingly, this study considers how the three dimensions of harmonious passion (autonomous motivation, positive emotion, and identity) drive university learners to invest enough time and energy to achieve their learning goals [7]. In addition, we deliberately incorporate the concept of ambidextrous learning. Using Bloom's cognitive taxonomy, this study considers how the two modes of ambidextrous learning, namely exploratory learning (ERL) and exploitative learning (EVL), impact the relationship between harmonious passion and academic achievement.

In summary, this study employs a quantitative approach to investigate the interplay between harmonious passion, ambidextrous learning, and academic achievement among university students, ensuring reliability and validity of the results, and subsequently proposing and validating key hypotheses. The results reveal that 'harmonious passion' markedly elevates academic achievements by promoting both exploratory and exploitative learning activities. Building on the teaching exploration and practice of the teaching team [1], this study delineates strategic recommendations and methodologies to enhance university students' harmonious passion. The contributions of this article are threefold. Firstly, it integrates passion theory into university teaching contexts, thereby broadening the research's spatial dimension. It examines how each dimension of harmonious innovation passion collaboratively stimulates learners' harmonious passion. Secondly, while existing ambidextrous learning studies [8,9] seldom explore the mediating variables in the relationship between learning behavior and academic performance from an educational and university student perspective, this article employs quantitative analysis to elucidate the internal mechanisms linking the two. It provides a comprehensive analysis of how different ambidextrous learning approaches impact university students' academic achievement, thereby addressing a gap in the current literature and offering valuable insights. Lastly, this article contributes to the literature by proposing a chain-mediated effect model that elucidates the relationship between harmonious passion and academic achievement, accounting for the roles of exploratory and exploitative learning.

## 2. Literature review and hypotheses

### 2.1. Definition of key core concepts

Harmonious passion is a term that emerged as positive psychologists started to conduct theoretical and empirical research into passion at the turn of the 21st century. Hoffman (1991) [10] initially defined passion as a high-priority goal that encourages individuals to invest significant time and energy and yields important results. Vallerand et al. (2003) [5] utilized self-determination theory [11] to differentiate between compulsive and harmonious. The former arises from external factors such as coercion or pressure, while the latter originates from an individual's independent internalization of an activity or role as part of their self-identity. Harmonious passion, therefore, is a potent motivator for people to willingly pursue an activity. Individuals who experience this form of passion for an activity love it unconditionally and willingly devote considerable time and energy to it [12], generating positive experiences in the process [5,13].

Empirical studies have shown that harmonious passion positively impacts individuals' emotions, cognition, behavior, and so on [14], making them more focused on their activities, more satisfied with their work [15], and more adaptable to their environment. Additionally, harmonious passion facilitates the experience of cognitive "flow" (i.e., immersion in an activity [16]) and aids adaptability to other cognitive tasks [5,15]. It also fosters a strong sense of identity and value and is associated with adaptability and positive emotional and behavioral outcomes in other domains of activity. A stable and durable internal self-structure and harmonious passion do not arise from external pressures but from the persons strong focus on learning and work [17]. Individuals with harmonious passion view learning and work engagement as crucial aspects of realizing their self-worth, exhibit a sense of responsibility, are more adaptable, and can learn more effectively [18]. Conversely, self-initiative stems from a strong interest in learning, a powerful desire for knowledge, and various self-reward factors, all of which are associated with students' academic achievement [19]. Self-determination theory suggests that the happy experiences and experiences of individuals in the process of school and work will meet their psychological needs, and the positive internal psychological state is a key factor affecting individual behavior [11].

The second key concept in this research is ambidextrous learning, first proposed by March (1991) [20], and includes two dimensions: exploratory learning (ERL) and exploitative learning (EVL). Exploratory learning involves acquiring external knowledge and skills in a process characterized by exploration, change, development, experiment, risk-taking, strain, flexibility, and innovation [21],

while exploitative learning is described in terms of refining, screening, efficiency, implementation, and execution and consists of the use and development of an organizations existing skills. Specifically, exploratory learning is the development or replacement of new knowledge already existing in organizational memory, whereas exploitative learning focuses on the discussion, refinement, and reuse of old knowledge [22]. Many scholars later analyzed the characteristics, relationships, antecedents, and consequences of these two learning methods from organizational and innovation strategies [9], using many similar concepts to explain them, such as breakthrough and progressive innovations and exploratory and mining learning. Although they originated from studies of organizations, ERL and EVL also apply to individuals, teams, inter-organizational relationships, and entire industries [8].

The third key term mobilized in this study is academic achievement, which refers to the all-round development and success of people engaged in learning. Good academic performance facilitates a virtuous circle in the development of learners [23], leading to higher levels of academic achievement. Academic achievement should not only be assessed by traditional content-based tests but also by measurements of general cognitive level, learning ability, self-evaluation, and even subsequent achievements in the professional field [24]. The overall importance of academic achievement means that the factors involved should be identified and studied carefully.

Achievement goal theorists believe that students' pursuit of academic goals relates closely to their learning efforts, internal and external motivation, self-efficacy beliefs, and learning habits (among other factors). It is therefore implicated in students' choices of academic tasks and, ultimately, their achievement [25,26]. Academic success depends on students' ability, skills, desire, and confidence to succeed. Good individual study habits and readiness for academic input are also likely to affect this process [27,28]. Many students invest their time and energy into learning which they genuinely love, find meaningful, and feel internally driven to do [14]. Research shows that students' ability to self-regulate their positive emotions has significant and positive effects on their levels of academic achievement [29]. Positive emotions can enhance learners' curiosity, transforming it into behavior that aims at understand learning content, improve self-efficacy, and actively meet challenges [30], stimulating the determination of learners to master skills and knowledge.

## 2.2. Harmonious passion and its characteristics

Most research into harmonious passion and achievement has been conducted in the workplace rather than in educational settings. Nonetheless, harmonious passion was significantly and positively related to members' learning and the work performance [31]. Krishan (2016) [32] studied emotional intelligence and found that emotion was a key aspect of personal achievement, while Salovey and Mayer (1990) [33] concluded that 80 % of success was linked to emotion. People with positive emotions are better able to practice emotional self-regulation, maintain good interpersonal relationships, work under pressure, and live happier lives overall. Emotional intelligence exerts an important influence on personal achievement and is an effective indicator of personal success. Individuals with high levels of harmonious passion are willing to push their cognitive limits and are driven to achieve greater self-realization [34]. In complex environments, harmonious passion drives individuals to work harder, address complex factors creatively, and achieve innovative solutions. Cross-cultural and gender-focused research shows that harmonious passion often accompanies adaptive outputs, such as satisfaction and happiness [12,35].

Harmonious passion has three main characteristics. First, it is related to positive emotions [7], enabling individuals to participate fully in activities and perceive the world flexibly and openly [15,36]. The second characteristic of harmonious passion is identifying an activity or role as significant or meaningful. Third, harmonious passion is self-sustaining [37]. This is because people whose needs for autonomy, competence, and affiliation are met will experience a sense of self-determination that allows them to continue engaging in certain activities autonomously and automatically rather than as a result of external pressure [6]. The present study views harmonious passion as a multidimensional, self-sustaining process in which learners commit sufficient time and energy to achieve their learning goals by enhancing their autonomous motivation, positive emotions, and sense of identity, thereby stimulating harmonious passion [7].

## 2.3. Harmonious passion and academic achievement

Research indicates that students' academic achievement is significantly influenced by their emotional states and intelligence levels, with positive emotions and higher intelligence correlating with improved learning attitudes and performances [38]. Using the "Baron Emotional Consultation Table", they identified "A", "B", and "C" grade students and found that academic achievement was significantly and positively correlated with overall and multidimensional emotional intelligence. Harmonious passion may affect individual performance and achievement through simultaneous emotional, cognitive, and motivational mechanisms via inhibitive emotional regulation, cognitive reappraisal, and goal orientations [6]. The emotional feedback that individuals gain from learning motivates further investment in new activities, which is enjoyable and thus generate further innovation and higher levels of achievement [39]. Luh and Lu (2012) [40] found preliminary evidence of the relationship between harmonious passion and personal academic achievement. Zhao et al. (2023) [41] showed that passion for work and learning could positively impact individuals through aspects of self-cognition such as role identity, self-efficacy, and willingness to innovate. Student cognitive and emotional engagement is key to academic achievement and are driven by motivational traits such as learning self-concept [42]. Based on the research presented above, the first hypothesis is expressed as follows.

**H1a.** Positive emotion has a positive impact on academic achievement

**H1b.** Identity has a positive impact on academic achievement

**H1c.** Autonomous motivation has a positive impact on academic achievement

#### 2.4. *Ambidextrous learning and its relationships*

Learning is a core capability that enterprises must develop to achieve high-level performance. Some scholars have studied the relationship between ambidextrous learning and performance at the team level: Lee and Huang (2012) [43] emphasized that enterprises engaging in both exploratory and exploitative learning are more likely to perform well. To recap, ambidextrous learning includes exploratory and exploitative types, the first focusing on areas such as external influences, environmental changes, and risk-taking. However, exploitative learning results in less uncertainty, faster speeds, clear feedback, and more emphasis on improving and implementing current capabilities and technologies. In organizational or business studies, exploratory learning focuses on bringing new value to the development of enterprises through the research of novel information and technology, and exploitative learning refers to the full development of current knowledge by enterprises to realize the expansion of value [44].

While these results are derived from organizational studies, they may also be relevant to education and university learning in particular. Here, ambidextrous learning is organized around learning goals, participation in social exchanges [31], integrating external environmental resources with internal knowledge, and demonstrating autonomous motivation and learning ability [45]. Exploratory learning can stimulate students' innovative thinking, producing diverse learning outcomes (such as academic papers, competition awards, etc.). Exploratory learning includes open, interdisciplinary, and cross-platform cooperation and exchange as disciplines advance continuously with the addition of new knowledge and resources, resulting in advances in academic achievement. However, in addition to constantly acquiring new knowledge from the outside world, university students must engage in exploitative learning, maintaining and extending their existing knowledge and skills [46]. Exploitative learning emphasizes the collation, direct use, and improvement of existing knowledge systems, significantly impacting quantifiable academic achievements such as final exams, quality of assignments, and test scores [40]. By choosing the appropriate form and method of ambidextrous learning, university students can improve their ability to learn and academic achievement.

One opportunity for ambidextrous learning is online course videos that use internet technology [47], carefully designed to integrate learning points from the course. University students can study anytime, anywhere, even at fragmented times, acquiring knowledge and information through communication and sharing within the class or through social media [48,49]. Offline classroom learning involves efficient interaction between teachers and students, with students obtaining knowledge from all participants. However, because certain skills and knowledge cannot be obtained solely from teachers, classmates, and textbooks, alternative means of exploratory learning must be developed, including projects, speeches and debates, enterprise investigations, research and evaluation, entrepreneurial practice, and themed competitions.

Previous research into ambidextrous learning has seldom considered the variables mediating the link between learning behavior and academic achievement from the perspective of university students. However, this gap can be filled by considering how ambidextrous learning methods impact university students' academic achievement. Accordingly, we formulated our second hypothesis as follows.

**H2a.** Exploratory learning mediates the relationship between positive emotion and academic achievement.

**H2b.** Exploitative learning mediates the relationship between positive emotion and academic achievement.

**H3a.** Exploratory learning mediates the relationship between identity and academic achievement.

**H3b.** Exploitative learning mediates the relationship between identity and academic achievement.

**H4a.** Exploratory learning mediates the relationship between autonomous motivation and academic achievement.

**H4b.** Exploitative learning mediates the relationship between autonomous motivation and academic achievement.

#### 2.5. *Ambidextrous learning and its mediating role*

March (1991) [20] pointed out that organizations can grasp the main characteristics of their internal and external environments through exploratory and exploitative learning. Exploratory learning denotes new knowledge and abilities developed outside the learning organization; exploitative learning is the learning that utilizes and expands on the knowledge inside the organization to various extents. Knowledge transfer, i.e., the application of existing knowledge to new ideas, will occur between exploratory and exploitative learning. Knowledge transfer is about applying existing knowledge to new ideas after it has been acquired or promoting ideas so they play their due role better, faster, or safer [50]. Knowledge transfer concerns the full use of existing resources and the acquisition and absorption of knowledge for efficient operations and to achieve the best results [50]. Exploratory learning can improve performance by absorbing knowledge external to the organization.

Further research has clarified that ambidextrous learning applies to the four levels of individuals, teams, organizations, and industries, rather than solely the third [8]. Exploratory learning allows organizations or individuals to master new external knowledge and capabilities and obtain a more secure grasp of the external environment [20]. New knowledge acquired through exploratory learning will become existing knowledge after being internalized and can then be exploited by individuals who can expand its value into different areas. Organizations or individuals can strengthen their knowledge management pathways through exploitative learning, making it difficult for competitors to emulate them for competitive advantage [51]. In the educational context, some university students may eventually receive scholarships and enter higher education through active learning, where they adopt feasible

ideas and execute them with great efficiency. These fast learners can effectively use gradual improvements in organizational knowledge to improve the effectiveness of exploitative organizational learning [52].

Knowledge acquisition and learning are closely linked. Learning is one of the core capabilities for enterprises to develop and achieve high-level performance. This view has been widely accepted in academic circles, and exploratory learning and exploitative learning as its two dimensions is no exception. Lee and Huang (2012) [43] emphasized that organizations and individuals that engage in both exploratory and exploitative learning are more likely to perform significantly. In the process of exploratory learning, we pay more attention to external influences, environmental changes, risk-taking, etc. Exploitative learning results in less uncertainty, faster speed, clear feedback, and more emphasis on the purification and implementation of existing capabilities and technologies.

Gibson and Birkinshaw (2004) [53] argue that contextual factors can help individuals allocate exploration and exploitative time in their studies and work in a reasonable way to ensure that organizations are able to address exploration and exploitative learning behaviors within a unit simultaneously. The organizations and individuals that simultaneously carry out ambidextrous learning can achieve higher performance than those that only rely on one of the learning mechanisms of exploratory learning or exploitative learning [54,55]. Paul and Stephen (2018) [56] found that the combination of exploratory and exploitative learning activities can enhance the viability of individuality, improve performance, and promote the improvement of learning and innovation ability. Exploratory learning emphasizes acquiring new knowledge through extensive search and flexible attempts, which will affect internal knowledge creation [44], urge them to use new knowledge to deal with existing problems, and finally improve performance and achievement. The study found that individual passion can improve their efficacy, and the perception of individual self-efficacy will affect their self-learning ability to a certain extent [57]. With the increase of exploratory learning, the knowledge base of learners has been expanded and the knowledge system has been updated [58], so as to obtain the ability and achievements beyond the original knowledge. Exploitative learning is to build on existing knowledge, strengthen existing technologies and capabilities, and thus improve performance [59]. Under the exploratory training mode of networking, opening, cross specialty and cross platform cooperation and communication, the university students who are passionate about learning can continuously acquire new knowledge and resources through exploratory learning, and at the same time, they can improve their learning performance and academic achievements by carrying out utilization learning on their existing knowledge and skills.

Combined with the previous hypothesis, we anticipated that exploratory and exploitative learning act as a chain-mediated effect of the relationship between harmonious passion and academic achievement, with the path proceeding as follows: harmonious passion → exploratory learning → exploitative learning → academic achievement. Accordingly, the following hypotheses are proposed.

**H5a.** Exploratory and exploitative learning have a chain mediated effect between positive emotion and academic achievement.

**H5b.** Exploratory and exploitative learning have a chain mediated effect between identity and academic achievement.

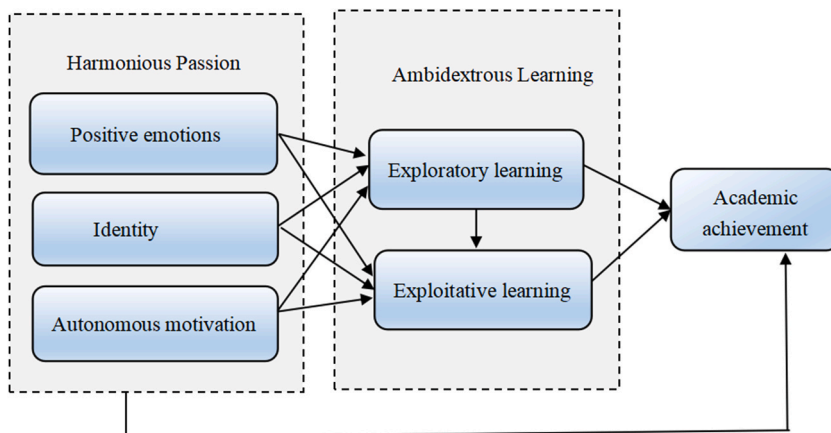
**H5c.** Exploratory and exploitative learning have a chain mediated effect between autonomous motivation and academic achievement.

Therefore, the theoretical model of this study is shown in Fig. 1.

**3. Methods**

*3.1. Ethical considerations*

Before initiating the study, approval was sought from the Scientific Research Ethics Committee of Qianjiang College, Hangzhou Normal University (The ethical approval number is 20220520093). All participants were informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality of their responses. Written informed consent was obtained from each



**Fig. 1.** Theoretical model of harmonious passion affecting academic achievement.

participant before they took part in the survey. Anonymity was ensured by not collecting any personally identifiable information, and all data were stored securely, accessible only to the primary researchers.

### 3.2. Questionnaire survey and data collection

To enhance the methodological rigor of our study, the questionnaire development process included a thorough review and validation phase before its pilot testing with 50 university students. Initially, the questionnaire was meticulously developed based on relevant literature and then subjected to a preliminary validation by a panel of experts in educational psychology and assessment methodologies. This step ensured the content's relevance and alignment with our study's objectives. Following the pilot study, the feedback received was carefully analyzed, leading to specific revisions aimed at refining the questionnaire's clarity and effectiveness. Crucially, these revisions were vetted by both lecturers, for their academic expertise, and experienced teachers, for their practical insights into student learning behaviors and motivations. The involvement of teachers was particularly valued for their direct engagement with students and their unique perspective on the dynamics of learning processes. This collaborative approach between lecturers and teachers in refining the questionnaire served to enhance its validity, ensuring a robust tool for assessing the relationships between harmonious passion, learning behaviors, and academic achievement. This process was instrumental in mitigating potential biases and enhancing the reliability of our data collection instrument, as advised by Podsakoff et al. (2003) [60] to counteract common method variance.

Once the final version of the questionnaire was ready, it was distributed in both online and paper-based formats to 600 participants between May and October 2022. Students from various departments across five universities in different regions of China were selected to participate, ensuring a diverse sample representative of the broader student population.

Of the 600 distributed questionnaires, 558 were returned, yielding a response rate of 93 %. After filtering out incomplete responses, 528 valid questionnaires remained, resulting in an effective response rate of 88 %. The breakdown of responses was as follows: 419 online questionnaires (79 %) and 109 paper-based questionnaires (21 %). An independent sample T-test was conducted using the source of the questionnaire (online vs. paper) as the grouping variable. The p-values for each tested variable were greater than 0.05, indicating no significant difference in responses based on the source of the questionnaire. The demographic details of the respondents are presented in Table 1.

### 3.3. Preparation of scale and design of variables

Our research utilized various instruments to measure key variables. For the measurement of harmonious passion (HP), we employed a modified version of Karagozoglu and Brown's (1998) [61] scale, which encompasses the three subdimensions: positive emotion (PE), identity (ID), and autonomous motivation (AM), with a total of 9 items.

Ambidextrous learning behavior (AL) was measured through the questionnaires developed by Holcomb et al. (2009) [62]. This instrument bifurcates into two subdimensions: exploratory learning (ERL) and exploitative learning (EVL), each containing three items. For academic achievement (AA), we adopted Bao and Zhang's (2012) [63] scale, comprised of six items that effectively assess students' competencies and academic achievements.

All variables were evaluated using seven-point Likert-type scales, ranging from 1 ("totally disagree") to 7 ("totally agree"). During our instrument development process, our team combined mature scales with insights from prior interviews and preliminary research, ultimately selecting three apt items to measure each variable. As control variables, we incorporated educational level, age, gender, and academic discipline, drawing on findings from previous research.

**Table 1**  
Demographic information of the samples.

	N	Percentage
<b>Gender</b>		
Female	238	45.1 %
Male	290	54.9 %
<b>Age</b>		
18–21 years old	273	51.7 %
22–25years old	98	18.6 %
26–30 years old	84	15.9 %
31–40 years old	73	13.8 %
<b>Education level</b>		
Freshman	181	34.3 %
Sophomore	159	30.1 %
Junior	103	19.5 %
Senior	85	16.1 %
<b>Subject categories</b>		
Humanities and Social	308	58.3 %
Natural Science	146	27.7 %
The others	74	14.0 %



### 3.4. Descriptive statistics

In this study, a 7-level scale was used in the survey, so when filling in the questionnaire, the minimum value was 1 and the maximum value was 7. Before carrying out regression analysis on the obtained data to verify the hypothesis proposed in this study, it is necessary to judge whether the received data is subject to normal distribution according to the skewness coefficient and kurtosis coefficient. If the absolute value of the kurtosis coefficient of each question item is less than 10 and the absolute value of the skewness coefficient is less than 3, the data basically conforms to the normal distribution. The descriptive statistical analysis results of each variable in this study are shown in Table 2.

The analysis results show that the mean values of all the questions are distributed in the range of 4.61–6.03, which is relatively average, and the standard deviation distribution of the mean values is relatively reasonable, meeting the conditions for further analysis. The absolute values of all question skewness coefficients and kurtosis coefficients are also within the required range, which proves that the data used in this study basically obey the normal distribution and can be analyzed in the next step.

### 3.5. Data analyses

This study focused on constructive validity, assessing the capability of scales to represent theoretical constructs. Using convergence and discriminant validity [64,65], the study employed factor analysis and the AVE index for validation. An AVE value above 0.50 suggests sufficient convergence validity. Discriminant validity requires item loads in a specific dimension to surpass those in other dimensions [66]. Reliability and validity analyses were conducted using SPSS22.0 and AMOS 22.0. Initial reliability tests using SPSS 22.0 confirmed that each variable’s Cronbach’s alpha exceeded 0.7. Subsequent confirmatory factor analyses in AMOS 22.0 evaluated the validity of each potential variable and the comprehensive model structure.

In our research, several significant findings were highlighted, as shown in Table 3. Firstly, the factor loads were observed to be greater than 0.7, a threshold indicative of solid factor consistency. Secondly, the composite reliability, denoted as CR, surpassed a value of 0.8, further bolstering the reliability of our model. Lastly, the Average Variance Extracted (AVE) values were found to exceed 0.5, reinforcing the construct’s validity. Further validation of our model’s robustness is evident in its fitting indices. Parameters such as  $\chi^2/df$ , RMSEA, GFI, IFI, TLI, and CFI consistently adhered to accepted standards. This adherence to recognized benchmarks, as outlined by Breckler (1990) [67] and Wen et al. (2004) [68], provides strong affirmation of the model’s effectiveness.

### 3.6. Correlation analysis

The descriptive statistics and correlation analysis of the main variables show that there is a significant positive correlation between the variables, and the maximum correlation coefficient is lower than the AVE value on the diagonal, indicating that the other variables have good discrimination validity, as shown in Table 4.

**Table 2**  
Descriptive statistical analysis results and normal distribution validation.

Items	Mean	Standard Deviation	Skewness	Bias standard error	Kurtosis	Kurtosis standard error
Positive Emotions (PE)						
PE1	5.75	0.902	−0.638	0.106	0.543	0.212
PE2	5.71	0.850	−0.544	0.106	0.744	0.212
PE3	5.78	0.882	−0.393	0.106	0.109	0.212
Identity (ID)						
ID1	5.85	0.912	−0.655	0.106	0.542	0.212
ID2	5.86	0.915	−0.509	0.106	−0.041	0.212
ID3	5.60	0.870	−0.270	0.106	0.221	0.212
Autonomous motivation (AM)						
AM1	5.69	0.815	−0.268	0.106	0.040	0.212
AM2	5.79	0.819	−0.370	0.106	0.122	0.212
AM3	5.74	0.783	−0.293	0.106	0.249	0.212
Exploratory learning (ERL)						
ERL1	5.87	0.850	−0.109	0.106	−0.859	0.212
ERL2	6.03	0.843	−0.481	0.106	−0.340	0.212
ERL3	6.02	0.928	−0.559	0.106	−0.596	0.212
exploitative learning (EVL)						
EVL1	5.67	0.894	0.050	0.106	−0.886	0.212
EVL2	5.62	0.930	0.021	0.106	−0.923	0.212
EVL3	5.59	0.879	0.012	0.106	−0.737	0.212
Academic achievement (AA)						
AA1	5.00	1.417	−0.620	0.106	0.394	0.212
AA2	4.98	1.313	−0.412	0.106	0.227	0.212
AA3	4.84	1.345	−0.514	0.106	0.411	0.212
AA4	4.81	1.369	−0.245	0.106	−0.150	0.212
AA5	4.61	1.520	−0.291	0.106	−0.383	0.212
AA6	5.09	1.349	−0.645	0.106	0.432	0.212

**Table 3**  
Comprehensive testing of sample data reliability and validity.

Constructs/ Measurement items	Cronbach's Alpha	Standardized loadings	CR	AVE	Constructs/ Measurement items	Cronbach's Alpha	Standardized loadings	CR	AVE
PE	0.822		0.822	0.607	AA	0.918		0.919	0.654
PE1		0.793			AA1		0.821		
PE2		0.774			AA2		0.817		
PE3		0.770			AA3		0.859		
ID	0.822		0.823	0.608	AA4		0.756		
ID1		0.810			AA5		0.796		
ID2		0.803			AA6		0.799		
ID3		0.723			AL	0.824			
AM	0.838		0.838	0.634	ERL	0.810		0.813	0.593
AM1		0.784			ERL1		0.813		
AM2		0.804			ERL2		0.754		
AM3		0.800			ERL3		0.740		
					EVL	0.803		0.806	0.580
					EVL1		0.723		
					EVL2		0.778		
					EVL3		0.783		
Variables	$\chi^2/df$	RMSEA		GFI	IFI	TLI	CFI		
	2.849	0.069		0.907	0.934	0.913	0.934		
Criteria	$2 < \chi^2/df < 5$	RMSEA < 0.1		GFI ≥ 0.9	NFI ≥ 0.9	TLI ≥ 0.9	CFI ≥ 0.9		

3.7. Homology deviation test and variable discrimination validity test

This study tries to reduce the potential common method variance (CMV) from two aspects: program control and statistical control. In terms of procedure control, we separated the independent variable (academic achievement) and intermediate variable (ambidextrous learning) from the dependent variable (harmonious passion) in the form of modules in the questionnaire design. We collected the objective data of the surveyed universities for the dependent variable to cross-verify the authenticity of the subjective evaluation data. At the same time, all proper terms in the questionnaire were explained, and it was emphasized that the questionnaire data were only used for academic research. In terms of statistical control, this study uses Harman's single factor confirmatory analysis to test whether there is a common method deviation [60]. The results of single factor confirmatory analysis showed that:  $c2//df = 5.078$ , greater than the judgment standard value 3,  $RMSEA = 0.088$ , greater than the judgment standard value 0.08,  $GFI = 0.857$ ,  $IFI = 0.895$ ,  $TLI = 0.863$ ,  $CFI = 0.894$ , all of which did not meet the judgment standard; In addition, the factor analysis method found that the first-factor rotation only explained 37.935 % of the total change, not 40 %, which indicates that there is no common method deviation in the data of this study.

4. Further empirical analysis

4.1. Mediation effect of exploratory learning and exploitative learning

The test results of the mediating effect of exploratory and exploitative learning are shown in Table 5. Among them, models (1), (2), and (3) test the mediating effect of exploratory learning between harmonious passion and academic achievement; Models (2), (4), and (5) test the mediating effect of exploratory learning between harmonious passion and exploratory learning; Models (1), (4) and (6) test the mediating effect of exploitative learning between harmonious passion and exploratory learning; The models (1), (3), (5), (6) and (7) test the mediated effect of exploratory learning and exploitative learning between harmonious passion and exploratory learning. This is to test the mediating effect of exploratory learning and exploitative learning on positive emotion, identity, autonomous motivation and academic achievement through model (8), (9), (10), (11). All the test procedures follow Baron et al. (1986) and Taylor et al. (2008) test methods. The bootstrap method is adopted, the sample size is 5000, and the confidence interval is 95 %. The variance inflation factor (VIF) results of each model showed no severe multidisciplinary in the regression of all models.

In the series of models analyzed, several key findings emerged. Model (1) critically examined the effect of harmonious passion (HP)

**Table 4**  
Correlation analysis and discrimination validity examination of principal variables.

Variable	PE	ID	AM	ERL	EVL	AA
PE	0.779					
ID	0.545**	0.780				
AM	0.149**	0.201**	0.796			
ERL	0.486**	0.521**	0.278**	0.770		
EVL	0.454**	0.519**	0.212**	0.476**	0.762	
AA	0.424**	0.433**	0.305**	0.417**	0.503**	0.809

Note: \*p < 0.1; \*\*p < 0.05; \*\*\*p < 0.01, the value on the diagonal is the square root of AVE.



**Table 5**  
Test results of the mediated effect of exploratory learning and exploitative learning.

Variables	AA	ERL	AA	EVL	EVL	AA	AA	AA	ERL	EVL	AA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
HP	0.530***	0.591***	0.435***	0.544***	0.405***	0.366***	0.321***				
ERL			0.160***		0.236*		0.094**				0.980*
EVL						0.301***	0.281***				0.290***
PE								0.253***	0.280***	0.237***	0.157***
ID								0.249***	0.332***	0.366***	0.111**
AM								0.218***	0.173***	0.103**	0.171***
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R <sup>2</sup>	0.285	0.356	0.301	0.3	0.336	0.348	0.354	0.285	0.363	0.322	0.356
F	41.576***	57.957***	37.457***	44.790***	43.969***	46.429***	40.672***	29.601***	42.399***	35.328***	31.775
N	528	528	528	528	528	528	528	528	528	528	528

Note: \*p < 0.1; \*\*p < 0.05; \*\*\*p < 0.01.

on academic achievement (AA). The results unequivocally revealed a significant positive linkage, thus corroborating Hypothesis H1. Delving deeper into the intricate relationships, Model (2) attested to the pronounced influence of HP on exploratory learning (ERL). Upon further scrutiny in Model (3) with the inclusion of HP and ERL in a unified regression framework, it was discerned that the impact of HP on AA was robustly positive when controlling for ERL. This finding underscores the pivotal mediating role that exploratory learning plays between HP and AA, consequently lending support to Hypothesis H2A. Model (4) was instrumental in illuminating the substantial positive impact of HP on exploitative learning (EVL). With the confluence of HP and ERL in Model (5), the effect of HP on EVL emerged as significantly positive when statistically controlling for ERL. This pivotal observation accentuates the mediating function of exploratory learning between HP and EVL, thus validating Hypothesis H3. In a comprehensive assessment using Model (6), which integrated both HP and EVL, the results evinced that, even under the stringent controls of EVL, the influence of HP on AA was profoundly positive. This pivotal observation accentuates the mediating function of exploitative learning between HP and AA, fortifying the claims of Hypothesis H2B.

In the subsequent Model (7), the data elucidated that, when considering the effects of ERL and EVL in tandem, both learning modalities emerged as partial mediators between HP and AA. Shifting the analytical lens to Models (8) through (11), the results were equally revealing. Models (8) underscored that positive emotion (PE), identity (ID), and autonomous motivation (am) all have a significant bearing on AA. Models (9) and (10) further extended this analysis to ERL and applied learning respectively, demonstrating the pervasive influence of PE, ID, and am. Most critically, the unified regression Model (11) encapsulated PE, ID, am, ERL, and EVL, and the findings were compelling. Even when introducing controls for ERL and EVL, PE, ID, and am maintained their significant imprint on AA. This intricate web of relationships emphasizes the pivotal mediating roles of both types of learning on the nexus between positive emotion, identity, autonomous motivation, and academic achievement, thereby validating Hypotheses H2a through H4b.

#### 4.2. Chain mediated effect of exploratory learning and exploitative learning

This study believes that there are multiple mediating effects in the process of independent variables positive emotion, identity, and autonomous motivation on academic achievement, and they are chain mediators. Therefore, in the analysis, according to the multiple mediating effect analysis method proposed by scholars, the bootstrap model is used to test them. If the 95 % confidence interval of the indirect effect does not include zero, it means that the mediated effect is significant; if it includes zero, it means that the mediated effect is not significant.

This study delves into the impact pathways and indirect effects of independent variables—positive emotion, identity, and autonomous motivation—on academic achievement, with a particular emphasis on the chain mediating effects of exploratory and exploitative learning. Adopting a multi-mediating effect analysis method proposed by scholars, it utilizes Structural Equation Modeling (SEM) combined with the Bootstrap approach for statistical analysis. Specifically, 5000 Bootstrap samples were conducted using AMOS software to bolster the robustness and significance of the estimations. An indirect effect’s 95 % confidence interval excluding zero indicates statistical significance of the mediation effect; inclusion of zero suggests it is not significant. This experiment methodically

**Table 6**  
Test results of chain mediated effect of exploratory learning and exploitative learning.

Effect type	Estimate	Bootstrap SE	95%Confidence interval	
			LLCI	ULCI
Direct effect				
PE→AA	0.1882	0.0433	0.1032	0.2733
Indirect effect				
PE→ERL→AA	0.0809	0.0200	0.0441	0.1245
PE→EVL→AA	0.0973	0.0197	0.0643	0.1435
PE→ERL→EVL→AA	0.0549	0.0122	0.0341	0.0810
Total Indirect effect	0.2331	0.0270	0.1875	0.2919
<b>Effect type</b>	<b>Estimate</b>	<b>Bootstrap SE</b>	<b>95%Confidence interval</b>	<b>95%Confidence interval</b>
			<b>LLCI</b>	<b>ULCI</b>
Direct effect				
ID→AA	0.1713	0.0456	0.0817	0.2609
Indirect effect				
ID→ERL→AA	0.0892	0.0235	0.0457	0.1381
ID→EVL→AA	0.1220	0.0244	0.0789	0.1739
ID→ERL→EVL→AA	0.0488	0.0132	0.0287	0.0806
Total Indirect effect	0.2600	0.0306	0.2041	0.3286
<b>Effect type</b>	<b>Estimate</b>	<b>Bootstrap SE</b>	<b>95%Confidence interval</b>	<b>95%Confidence interval</b>
			<b>LLCI</b>	<b>ULCI</b>
Direct effect				
AM→AA	0.1729	0.0378	0.0986	0.2472
Indirect effect				
AM→ERL→AA	0.0541	0.0140	0.0298	0.0848
AM→EVL→AA	0.0319	0.0177	0.0021	0.0713
AM→ERL→EVL→AA	0.0475	0.0110	0.0289	0.0725
Total Indirect effect	0.1335	0.0250	0.0851	0.1811

assesses how these variables influence academic achievement through different indirect pathways, revealing partial mediating effects and a chain transmission effect of exploratory and exploitative learning under the influence of positive emotions, identity, and autonomous motivation. The analysis of Bootstrap samples confirms the significant chain mediating effect of exploratory and exploitative learning, providing solid empirical evidence to support theoretical hypotheses and contributing to understanding the complex interactions between individual emotions, cognitive traits, and academic performance in educational contexts.

The condition of considering four control variables, this study uses the bootstrap model to verify the mediating effect of exploratory and exploitative learning on positive emotion and academic achievement. Model 7 was selected, with a sample size of 5000. Under the 95 % confidence interval, positive emotion was taken as the independent variable, academic achievement as the dependent variable, and exploratory learning and exploitative learning as the mediated variables. The test results are shown in Table 6. The results show that the total indirect effect is 0.2331, the 95 % confidence interval is [0.1875, 0.2919], and the confidence interval does not include 0, indicating that the total indirect effect is significant; The direct effect of positive emotion on academic achievement was 0.1882, and the 95 % confidence interval was [0.1032, 0.2733]. The confidence interval did not include 0, indicating that the direct effect was significant. The test results of mediating effects of exploratory learning and exploitative learning show that the mediating effect of exploratory learning is 0.0809, and the 95 % confidence interval is [0.0441, 0.1245], excluding 0, indicating that the mediating effect of exploratory learning is significant; The mediating effect of using type learning is 0.0973, and the 95 % confidence interval is [0.0643, 0.1435], excluding 0, indicating that the mediating effect of using type learning is significant. The chain-mediated test results of mediating variables are as follows: the chain-mediated effect size is 0.0549, and the 95 % confidence interval is [0.0341, 0.0810], excluding 0, indicating that the chain-mediated effect of exploratory learning and exploitative learning is significant. To sum up, the mediated variables exploratory learning and exploitative learning both partially mediate between positive emotion and academic achievement and are chain mediators. The hypothesis H5a is verified, as shown in Table 6.

This study has meticulously incorporated AMOS bootstrapping findings into our analysis for a robust assessment of the direct and indirect effects of exogenous variables on academic achievement. This enhanced approach entailed executing 5000 bootstrap samples within our structural equation modeling (SEM) framework, allowing for more precise estimates of effect significance. The analysis confirmed the robustness of our findings, with bias-corrected 95 % confidence intervals substantiating the significance of both direct and indirect pathways, thereby reinforcing the validity and reliability of our results.

On the other hand, the results of this study indicate that the confidence intervals for the mediating effects of exploratory learning and exploitative learning are relatively narrow, suggesting that the variability in effect estimates is small and the estimated values are relatively stable. This implies that the mediating effects are both stable and precise, exhibiting a high level of robustness. Furthermore, the distribution pattern of the bootstrap estimates for the indirect effects is characterized by concentration, low asymmetry, and a peak that is distant from zero, indicating that the estimates of the indirect effects possess a high degree of consistency and statistical significance.

It can be seen that the mediated variables exploratory learning and exploitative learning both play a partially mediated role between the sense of identity and academic achievement and are chain mediators. The hypothesis H5b is verified. Similarly, the hypothesis H5c is verified, as shown in Table 6. Expanding upon the initial explanation, we meticulously applied the PROCESS macro for SPSS, for our mediation analysis, chosen for its precision in bootstrapping methods. This choice aligns with our comprehensive approach to validating the mediated effects of exploratory and exploitative learning on the relationship between positive emotion and academic achievement.

#### 4.3. Robustness check

The robust test is carried out to ensure the reliability of the research results. In this study, the AMOSS 22.0 software is used to analyze the structural equation model of the sample data. The fitting indexes of the modified model are shown in Table 7. The C.R. values corresponding to the normalized path coefficients between all the significant and latent variables are greater than 1.96, which is statistically significant at least at the  $P = 0.05$ . It can be seen that the model is well corrected, and there is no need for further correction. The results of the structural equation model analysis are shown in Table 8 and Fig. 2, and the assumptions proposed above have been effectively verified.

According to the above hypothesis test results, as shown in Fig. 1, all the 15 research hypotheses proposed in this study have passed the empirical test, the results can be confirmed by the robustness check.

## 5. Discussion

The primary objective of this study was to delve into the influence of harmonious passion on academic achievement among Chinese university students. Our findings, consistent with the dualistic model of passion, indicate that harmonious passion can significantly bolster academic outcomes [69]. The passion is associated with sustained learning activities [70], and when students are driven by it,

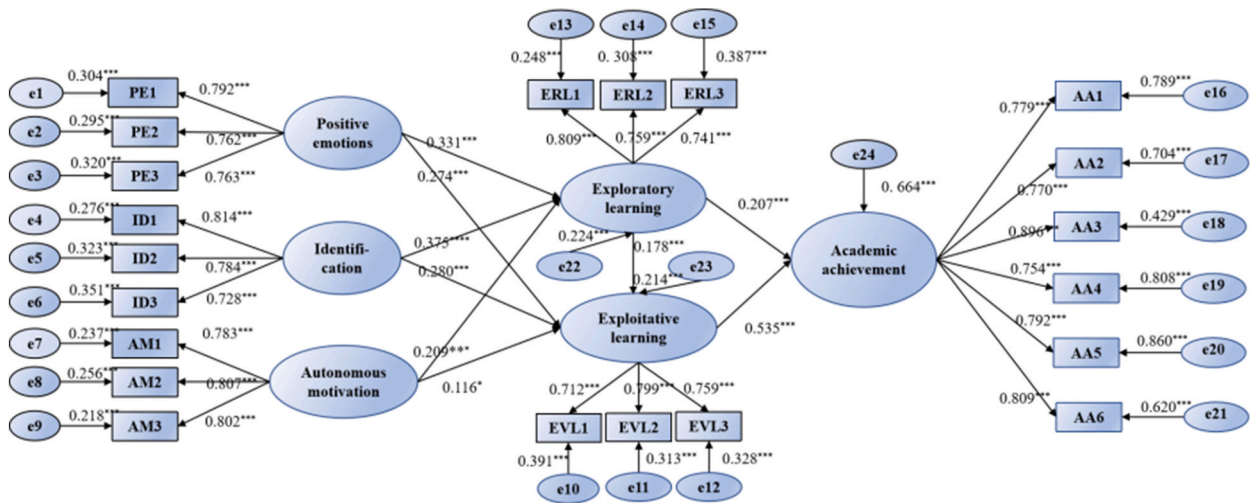
**Table 7**  
Validation and significance test results of modified model fitting indicators.

Fitting index	X2/df	GFI	RMR	RMSEA	NFI	IFI	TLI	CFI
Specific value	2.243	0.941	0.048	0.049	0.945	0.969	0.958	0.969

**Table 8**  
Analysis results of structural equation correction model.

Hypothetical path	Normalized path coefficient	CR	P
AA←PE	0.148	2.569	**
AA←ID	0.110	2.381	*
AA←AM	0.079	2.194	*
ERL←PE	0.331	4.922	***
ERL←ID	0.375	5.424	***
ERL←AM	0.209	4.822	***
EVL←PE	0.274	3.842	***
EVL←ID	0.280	3.781	***
EVL←AM	0.116	2.538	*
EVL←ERL	0.178	2.493	*
AA←ERL	0.207	3.534	***
AA←EVL	0.535	8.033	***

Note: \*\*\*P < 0.001; \*\*P < 0.01; \*P < 0.05.



**Fig. 2.** Corrected structural equation model with statistically significant path coefficients. Note: \*\*\*P < 0.001, \*\*P < 0.01; \*P < 0.05.

they exhibit enhanced motivation, actively engage in learning, and achieve superior outcomes. This relationship is further nuanced by the mediating roles of exploratory and exploitative learning.

Drawing from Blooms cognitive taxonomy, exploratory learning encompasses higher-level activities such as subject projects and debates, pushing students to embrace challenges and uncertainties [71]. Conversely, exploitative learning, foundational in nature, includes activities like online classes and group discussions, emphasizing efficiency and execution. These findings resonate with prior research on the interplay between harmonious passion, academic performance, and identity [72,73].

To further enrich the discussion based on the findings of this study, it is crucial to consider the broader implications for educational practice and policy. The significant impact of harmonious passion on academic achievement suggests that educators and policymakers should prioritize the development of educational environments that nurture students' intrinsic motivations and passions. Additionally, understanding the differential roles of exploratory and exploitative learning in this process highlights the importance of creating curricula that offer balanced opportunities for students to both explore new ideas and exploit existing knowledge. This approach not only facilitates academic success but also prepares students for lifelong learning and adaptability in their future careers. Further research should investigate the specific educational practices and policies that can most effectively cultivate such an environment, potentially transforming how education is approached in various cultural contexts.

**5.1. Theoretical implications**

This study extends the passion research domain into university education. Our findings align with prior studies, such as those by Santos and Cardon (2019), which identified a positive correlation between harmonious passion and academic achievements. Furthermore, our research delves into the three dimensions of harmonious passion, gauging their influence on academic performance, and aligns with studies emphasizing the role of autonomous motivation, positive emotions, and identity in the learning process [7,74]. By employing Bloom's cognitive taxonomy, we also broadened the application of ambidextrous learning theory, offering a comprehensive analysis of the impact of both exploratory and exploitative learning on academic achievement.

## 5.2. Practical implications

Educators should focus on fostering students' harmonious passion by designing diverse learning opportunities and promoting collaboration. Assessment strategies can be tailored to nurture harmonious passion, with multidimensional indicators providing a holistic view of student development. Leveraging technology, especially Information and Learning Technology (ILT), can further support harmonious passion by offering flexibility and enhancing the student engagement. Moreover, integrating findings from recent research, such as the role of passion in psychological responses and its impact during the COVID-19 pandemic, can provide valuable insights for educators [75,76].

## 5.3. Limitations and future research directions

In this study, we systematically described the whole process from questionnaire design and validation to data collection and complex statistical analysis, aiming to ensure the transparency and reliability of the study. However, there are inevitably some limitations. The results of the questionnaire survey may also be affected by some subjectivity, such as social expectations and memory bias. We seek to minimize such errors by carefully designing the questionnaire and applying statistical adjustments. At the same time, although we ensured the scientific validity of the questionnaire through expert review, there is a possibility that it may not be able to fully cover the deep-rooted psychological state and learning dynamics. In order to further deepen our understanding, we will also expand the channels and types of data collection in the follow-up study. In addition, the samples in this study were mainly from universities in five specific regions of China, and this specificity may have limited the sample representativeness and generalizability. Therefore, future studies should expand geographic and population coverage to enhance the ability to generalize the findings. In the statistical analysis, although the data were generally normally distributed, we also considered the impact of small sample size and atypical distribution on the model sensitivity, and therefore adopted the bootstrap method to enhance the robustness of the mediation effect estimation. However, sometimes the presence of incidental factors and uncontrolled variables may have a subtle impact on the findings. In interpreting the findings, we take these limitations as an important starting point for future work, aiming to promote a more comprehensive and in-depth understanding. By addressing these limitations, future research can pave the way for a more nuanced understanding of the impact of harmonious passion on academic achievements across varied contexts.

## 5.4. Comparison with previous research

Our findings are in line with the dualistic model of passion, emphasizing the positive influence of harmonious passion on academic achievement. This is consistent with the work of Bélanger & Ratelle (2021) [69], who explored the role of passion in university settings. Moreover, the positive correlation between harmonious passion and academic thriving, as highlighted by Zhou (2021) [70], further reinforces our results. The sport-to-school spillover effects, as discussed by Yukhymenko-Lescroart (2022) [71], provide an interesting perspective on the role of passion beyond academic settings. While our study did not delve into sports, the underlying principles of identity and performance in academic settings resonate with our findings.

Furthermore, the relationship between teaching quality, passion, and learning strategies, as explored by Ruiz-Alfonso & León (2019) [72], offers insights into the broader implications of our research. Their emphasis on the deep strategy to learn and epistemic curiosity aligns with our discussions on exploratory and exploitative learning.

## 5.5. Extensions and future directions

The nuanced relationship between passion and psychological responses, as underscored by Vallerand et al. (2022) [75], offers a richer dimension to our existing comprehension. Our research predominantly focuses on academic achievements, but it's pivotal to understand that passion's domain extends beyond just academic benchmarks. Passion, in its physiological and psychological manifestations, can profoundly influence students' adoption and effectiveness of sustainable learning strategies. When viewed together, these facets can paint a fuller picture of passion's broad-based impact on learners. The COVID-19 pandemic has dramatically accentuated the significance of passion in academic realms. The resilience and adaptability required during this period have highlighted the importance of sustainable learning strategies. Peixoto et al. (2021) [76] provide invaluable insights in this regard. Their exploration of passion's dynamics during the pandemic—especially its interplay with academic procrastination and mental well-being—lays down a foundational framework for future inquiries.

In conclusion, our study offers an expansive insight into harmonious passion's influence on academic landmarks. Still, the academic terrain is vast and continually shifting. Forthcoming research should delve into passion's physiological intricacies, address the multifaceted challenges posed by external disruptions like the pandemic, and align these insights with a wider range of studies. Integrating the role of sustainable learning strategies in this mix will be crucial.

## 6. Conclusions

This study has delved deep into the mechanism by which harmonious passion influences academic achievement, with particular attention to the role of sustainable learning strategies.

First and foremost, our research underscores that the harmonious passion of university students was positively correlated with their academic performance. This correlation is not just statistically significant but also practically relevant, suggesting that students with a

stronger harmonious passion are better positioned to leverage sustainable learning strategies, which in turn, can effectively promote their development throughout their degree courses. Secondly, our findings illuminate the pivotal role of ambidextrous learning in mediating the relationship between harmonious passion and academic achievement. Specifically, exploratory learning emerged as a significant mediator, underscoring the importance of open-mindedness and curiosity in academic contexts. However, it was exploitative learning that exerted a more pronounced effect, serving as the primary conduit linking harmonious passion to academic outcomes. This suggests that while sustainable learning strategies rooted in exploration are vital, those grounded in exploitation—leveraging existing knowledge and skills—are even more crucial in the academic setting.

Interestingly, while both types of learning strategies played a role, the chained mediation path, comprising both exploratory and exploitative learning, appeared to have a muted impact on academic achievement. This raises intriguing questions about the interplay between these strategies and suggests that the simple accumulation of mediators might dilute the effect of harmonious passion on academic outcomes. In light of these findings, as the academic landscape continues to evolve, it will be imperative for educators and policymakers to focus on cultivating both types of sustainable learning strategies, ensuring that students are equipped not just to explore new horizons but also to exploit existing knowledge reservoirs effectively. The findings highlight the study's strengths in linking passion with learning behaviors and academic success, making it particularly attractive to educators, policymakers, and scholars interested in promoting sustainable development and lifelong learning.

### Ethics declarations

This study was reviewed and approved by the Scientific Research Ethics Committee of Qianjiang College, Hangzhou Normal University, with the approval number: 20220520093.

### Data availability statement

The data that support the findings of this study are available on request from the corresponding author upon reasonable request.

### CRediT authorship contribution statement

**Yuyan Shen:** Writing – review & editing, Writing – original draft.

### Declaration of competing interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e29943>.

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