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The examination of the relationship between learning motivation and learning effectiveness: a mediation model of learning engagement

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In the past decade, China has entered the process of universalization of higher education, however, with the popularization of higher education, the issue of education quality has become more important than ever. Therefore, the main objective of this study was to explore the relationship between learning motivation and learning effectiveness, the mediation effect of learning engagement on learning motivation and learning effectiveness, and the moderation effect of students' personality traits on the relationship between learning motivation and learning effectiveness. It was found that (1) Learning motivation had a significant positive impact on learning effectiveness; (2) Learning motivation had a significant positive effect on learning engagement; (3) Learning engagement had a significant positive impact on learning effectiveness; (4) Learning engagement had a partial mediation effect on learning motivation and learning effectiveness. (5) Personality traits had a moderation effect on the relationship between learning motivation and learning effectiveness. It was suggested that college students should stimulate their motivation for independent learning, enhance their motivation for learning, and cultivate the ability to learn independently in learning. At the same time, in the classroom, teachers should innovate teaching methods, mobilize students' interest in learning, and cultivate students' initiative. In addition, schools should actively carry out themed lectures to cultivate students' correct learning attitudes. In terms of the influence of personality traits on the relationship between learning motivation and learning effectiveness should not be ignored, and appropriate attention should be paid to improving learning effectiveness. Different personality traits should be further explored.

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Introduction

In 2010, China officially entered the process of universalization of higher education. With the popularization of higher education, the problem of education quality has become increasingly apparent. People paid great attention to the guarantee of the quality of higher education, and how to evaluate the quality of higher education has also become the focus of public discussion. Students were the main body of evaluation of the quality of higher education, from the perspective of students, students' final academic scores should be paid attention to, but what could not be ignored was the learning initiative and learning engagement of students in the learning process. Skinner & Belmont (1993) pointed out that in schools, students participated in more learning activities, the higher the score obtained, the stronger their identification with the school, and students should have the desire to participate actively, which was, motivation to learn. In college, undergraduate students are not pushed by teachers and parents like in high school, so this easily results in insufficient motivation to learn. Students did not spend much time on majors before and after class, the level of learning commitment was low, and the learning state was not optimistic (Peng et al., 2019). Before gaining admission into the university, most students were often indoctrinated in the high school learning stage that "if you go to college, you won't work hard", which was also one of the reasons why college students lacked enthusiasm for learning.

Learning motivation refers to improving an individual's learning behavior, directing the purpose of learning, and maintaining this learning activity, thereby adjusting and strengthening the student's inner journey or inner psychological state (Tollefson, 2000). Learning motivation was an intrinsic motivator that promoted students' learning behavior. When the motivation to learn was different, students' level of engagement with learning would also be different (Sánchenz-Bolívar & Martínez-Martínez, 2022). Learning engagement is an individual's positive and fulfilling mental state related to learning (Duan & Li, 2008). In the learning process, the mental state of students directly affects the learning process, and the higher the enthusiasm for learning, the greater the engagement in learning. Insufficient academic commitment makes it difficult to achieve the desired academic performance. At the same time, researchers have also conducted relevant research on the relationship between achievement motivation, personality traits, and college students' academic performance. Liu & Chang (2022) pointed out that differences in personality traits will have a certain impact on students, and personality traits are closely related to students' academic performance. Yao & Ma (2021) found that achievement motivation moderates the mediating process of emotional creativity on high school students' academic performance through academic self-efficacy, and showed a moderating mediation effect. The above studies revealed that personality traits were related to academic performance, which was explored in this study. Learning effectiveness refers to the learning effect produced in the learning process, which depends not only on the student's final grade but also on the student's understanding and mastery of learning (Peng et al., 2019). If a student's level of motivation was at a high level, he could be more engaged in the learning process and achieve excellent academic results.

It could be seen that learning motivation and learning engagement were important factors affecting learning effectiveness. In the face of the fact that the learning status of most college students in Chinese universities was not optimistic, this study took undergraduate students as the research object and employed learning engagement as the mediating variable, and adopted personality traits as the moderating variable to explore and analyze the relationship among learning motivation, learning engagement, personality traits, and learning effectiveness. The above four variables have been studied by individuals with different objects and different relationships. However, there is a lack of research on university students that coordinates these four variables in the same research framework. The relationship between the four elements and the factors affecting learning effectiveness was analyzed in detail, and relevant suggestions were proposed. It aimed to promote the improvement of college students' learning motivation, to improve the level of learning participation of the majority of students, to promote the depth of learning, to examine the moderating effect of personality traits, and to improve learning effectiveness and academic performance.

Literature review and hypotheses establishment

The studies of learning motivation. Learning motivation stimulated and sustained students' learning behaviors and motivated them to achieve certain academic goals. It was the internal motivation of students to learn, and it was a psychological state that affected students' academic performance (Shi, 2000). Mao (1995) argued that learning motivation is a psychological tendency and attitude. Studies have found that learning motivation is not a single structure, but a complex with a series of dynamic factors, which include the desire to learn, the orientation of interest, and the willingness factor to learn (Sánchenz-Bolívar & Martínez-Martínez, 2022; Zheng & Jia, 2017). Studies found that there was a significant positive relationship between learning motivation and academic performance, and the stronger the motivation to learn, the better the academic performance (Liu & Geng, 2005).

From the perspective of psychology, there were two main aspects of students' motivation to learn: The first aspect was endogenous motivation, such as intrinsic interest, curiosity, or the need to achieve a goal ; The second aspect was exogenous motivation, which referred to the motivation triggered by external rewards and punishments or the fear of failing exams (Pi, 2004). Fang (2007) categorized learning motivation into two types: intrinsic learning motivation and external learning motivation. According to Maslow's hierarchy of needs, Du (2008) divided learning motivation into material pursuits, fear of loss, group goals, personal achievements, and intellectual progress. Learning motivation is a complex mental process, and researchers have classified learning motivation from different perspectives. This study divided learning motivation into internal and external learning motivation. Combined with the findings of the above-related studies and reasonings, the following hypotheses were thus established.

Hypothesis 1 (H1): Learning motivation in terms of (a) (Hypothesis 1.1, H1.1) internal learning motivation, and (b) (Hypothesis 1.2, H1.2) external learning motivation has a significant positive impact on learning effectiveness.

The studies of learning engagement. Learning engagement refers to students' commitment to learning, including behavioral, emotional, and cognitive engagement (Fredricks et al., 2004). It plays an important role in students' learning process and learning engagement can be used as an indicator to predict academic performance (Zhang, 2012). Qiao & Zhao (2010) divided learning engagement into three aspects: behavioral engagement, cognitive engagement, and emotional engagement. These are the effort made by students in learning, the learning methods and strategies adopted in learning and the level of interest and positive feedback in the learning process, respectively.

External factors affecting learning input included family, community, culture, and educational environment. Internal factors such as students' initiative, personality traits, motivation,

self-efficacy, and cooperation would also have a significant impact on students' learning engagement (Shang, 2021). Accordingly, the following hypotheses were established.

Hypothesis 2 (H2): Learning motivation in terms of (a) (Hypothesis 2.1, H2.1) internal learning motivation, and (b) (Hypothesis 2.2, H2.2) external learning motivation has a significant positive impact on learning engagement.

The studies of moderation effect of personality traits. The Big-Five personality traits widely accepted were proposed by Costa and McCrae (1986), which were *agreeableness, conscientiousness, extraversion, neuroticism, and openness to experience*. Chen et al. (2023) employed the Big-Five personality traits of employees to examine the moderation effect on job satisfaction in a high-tech industry. Goldsmith (2016) conducted a study regarding consumer behavior by using the Big-Five personality traits, it was found that consumers with different personality traits showed different levels of happiness regarding shopping activities. The Big-Five Personality Theory is important because different personality traits lead to different behavioral outcomes. Wang et al. (2019) and Shen & Wang (2023) pointed out that people with different personality traits showed different levels of self-efficacy and rely on social expectations differently. In addition, in the study of organizational behavior, it was found that there was a significant positive relationship between the Big-Five personality traits and the behavior performance of individual organizations. Personality traits play an immeasurably important role in an individual's growth. According to the research conducted by Chinese psychologists on the learning effects of adolescent students and the influence of various factors, it was found that adolescent students with normal intelligence had different learning effects due to different personality factors. Personality is manifested by individuals in stable attitudes and customary behaviors. The core psychological characteristics of personality reflect the comprehensive quality of the individual and have a lifelong impact on the learners. Different learners have their own unique learning performance, that is, the individualization of learning behavior (Young, 2012). Therefore, the following hypothesis was thus established.

Hypothesis 4 (H4): Personality traits have a significant positive moderation effect on the relationship between learning motivation in terms of (a) (Hypothesis 4.1, H4.1) internal learning motivation, and (b) (Hypothesis 4.2, H4.2) external learning motivation and learning effectiveness.

The studies of learning effectiveness. Learning effectiveness refers to the results of a student's participation in a specific teaching activity over a certain period of time. This was not only the purpose of education, but also the expectations of parents, teachers, and enterprises for students (Zhao, 2021). Mao et al., (2020) pointed out that learning effectiveness includes students' learning achievements, learning performance, and learning progress, such as conceptual knowledge, scientific attitude, problem-solving ability, learning quality, experimental skills, and values.

Chang (2019) found that the factors affecting the learning effectiveness of college students mainly included personal factors, family background factors, school teaching management level factors, and social environment factors. Personal factors mainly included students' motivation and interest in learning. By setting achievable goals, students' learning direction was clearer, and learning motivation became a learning force, which had a positive impact on students' learning attitudes and diligence. Cultivated students' sense of responsibility and mission in learning, thereby having a positive impact on students' learning outcomes. In the classroom, students were more willing to take the initiative to learn their favorite subjects ; After class, students were more active in reviewing their favorite subjects, learning independently and expanding relevant knowledge, so that the learning effect would be better. In terms of family factors, educational attainment and financial status had a certain impact on academic achievement. The education level of parents determines the method and content of their teaching, which plays a very significant role in the physical and mental development of students (Chang, 2019). Regarding the level of school teaching management, it mainly included the school's teaching and cultural and sports activities arrangement, the school's teacher level and the school's teaching assessment methods. Regarding the impact of the social environment on learning effectiveness, the employment environment was directly related to the learning effectiveness of university graduates (Chang, 2019). Under the increasing pressure of employment, college students must constantly improve their professional skills and practical ability, continuously improve their learning efficiency, and transform the pressure of employment into motivation to achieve better learning results (Chang, 2019).

The studies on the relationship among learning motivation, learning engagement, and learning effectiveness. Liu & Geng (2005) found that academic performance was affected by learning motivation, which presented a positive correlation between motivation to learn and academic performance. This meant that when a student's own motivation increased, his/her learning performance would also be better. Yu et al. (2020) pointed out that many factors affected academic achievement, among which motivation and engagement were important. Kuh (2009) believed that the time and energy spent by students in the learning process had a great relationship with their academic performance. Wang (2015) also found that learning engagement could have a certain impact on students' academic achievement and personal development, and different factors affecting learning engagement had different impacts on learning outcomes. Therefore, according to the above various studies, this study proposed the following hypotheses:

Hypothesis 3 (H3): Learning engagement in terms of (a) behavioral engagement (Hypothesis 3.1, H3.1), and (b) emotional engagement (Hypothesis 3.2, H3.2) has a significant positive impact on learning effectiveness.

Hypothesis 5 (H5): Learning engagement has a significant positive mediation effect on the relationship between learning motivation and learning effectiveness.

Research methods and research design

Methodology. The relationship among independent variables (learning motivation), mediation variables (learning engagement), and dependent variables (learning effectiveness), will be analyzed by using Pearson product-moment correlation method. The effects among independent variables, mediation variables, and dependent variables will be analyzed by multiple regression methods (stepwise regression and hierarchical regression). The methods and concepts proposed by Baron and Kenny (1986), Mackinnon, Warsi, and Dwyer (1995), and Mackinnon (2008) were also used to test the mediation effect. Regarding the test of the moderation effect, a centralization variable approach developed by Fang et al. (2022) was employed.

Research framework. The research framework is shown in Fig. 1. This model consisted of four parts, the independent variable was learning motivation, including two variables of internal learning motivation and external learning motivation; The dependent variable was learning effectiveness; Learning engagement was the

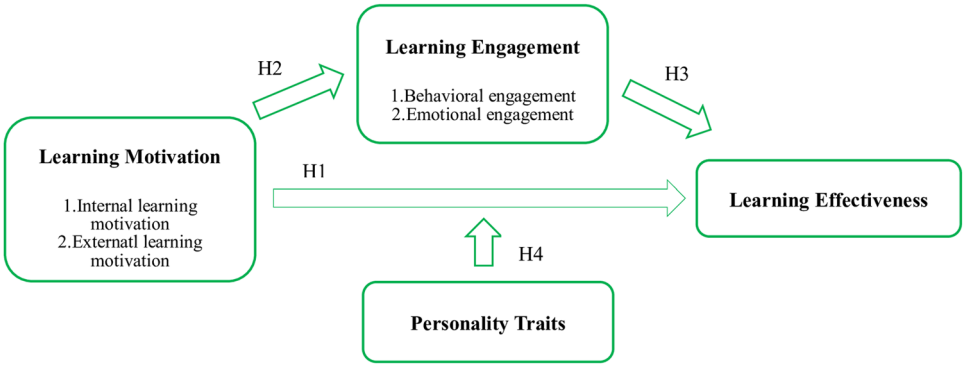

Fig. 1 The research framework of a mediation model of learning engagement on learning motivation and learning effectiveness. Learning motivation was first tested with learning effectiveness whether the relationship was significant. Subsequently, learning engagement was tested whether it had a mediation effect on learning effectiveness. Finally, personality traits variable was tested whether it had a moderation effect on learning effectiveness.

mediating variable, and learning engagement included two variables, namely behavioral engagement and emotional engagement; Personality traits variable was tested for examining the moderation effect on the relationship between learning motivation and learning effectiveness.

Questionnaire design. The first part of the questionnaire design of this study was the collection of basic personal information, including gender, grade, major, and place of origin, with a total of four questions. The second part was the measurement of the learning motivation scale, including two parts, namely internal learning motivation and external learning motivation, with a total of ten questions. The third part was the measurement of the learning engagement scale, which was divided into behavioral engagement and emotional engagement, a total of eight questions. The fourth part was the measurement of personality traits, which included a short form of ten question items. The fifth part was the measurement of the learning effectiveness scale, which consisted of nine questions. The Likert five-point scoring method was employed in this study.

With the help of the Questionnaire Star platform which was widely used in China, the questionnaires were completed by undergraduate students of various colleges and universities in the form of online answers. A total of 280 questionnaires were collected in this survey, and the final number of valid questionnaires was 251, with an effective rate of 89.6%. The collected data were analyzed by using SPSS21 and Amos24 software.

1. Measurement of variables
   In this study, some questions of the scale were adjusted and modified to be more in line with the actual situation.
   The Learning Motivation Scale in this study divided learning motivation into two dimensions, internal learning motivation and external learning motivation (Qin, 2021). After adjustment and modification, ten questions measuring learning motivation were formed, of which there were five question items each for internal learning motivation and external learning motivation.
   This study divided learning engagement into two dimensions, behavioral engagement and emotional engagement (Dong, 2021). To be more in line with the actual situation of this study, the reference scale was adjusted and modified, and the learning input scale of this study set up eight question items, of which there were three questions for behavioral engagement measurement and five questions for emotional engagement measurement.
   The measurement scale of personality traits adopted the short form used by Goldsmith (2016), which was arranged into one dimension. In order to be more in line with the actual situation of this study, the reference scale was adjusted and modified, and the personality traits scale of this study contained ten question items.
   Learning effectiveness in this study was divided into only one dimension (Feng, 2021). To be more in line with the actual situation of this study, the reference scale was also adjusted and modified, and the learning effectiveness scale of this study set up nine question items.
2. The reliability analysis of the measurement scale

Table 1 Reliability analysis of measurement scale.

Dimension	Cronbach's Alpha value	Question items
Internal learning motivation	0.835	5
External learning motivation	0.791	5
Behavioral engagement	0.766	3
Emotional engagement	0.824	5
Personality traits	0.944	10
Learning effectiveness	0.932	9

In this study, the reliability of the questionnaire scale was tested by a reliability analysis of SPSS21 software, using Cronbach's α values. The larger the α coefficient, the higher the credibility of the questionnaire, and it was generally believed that an α > of 0.7 indicated that the questionnaire was trustworthy. The results are shown in Table 1, and the α coefficients for each dimension of each scale in the questionnaire were greater than 0.7, between 0.766–0.944, indicating that the questionnaire reliability of this study was high.

3. The validity analysis of measurement scale

The Kaiser-Meyer-Olkin (KMO) test and Bartlett's sphericity test were performed on the data of the learning motivation and learning effectiveness of the survey subjects. The results are shown in Table 2, with a KMO measure of 0.841 and a Sig. value of 0.000, which met the conditions of factor analysis.

The principal components extraction of the learning motivation is shown in Table 3.

In Table 3, there are two numbers greater than 1 in the initial eigenvalues: 4.443 and 1.383. These two numbers were the initial eigenvalue factors, that was, the two factors were extracted, and the explained variances were 44.431% and 13.829%, respectively.

According to Table 4, the five-question items of internal learning motivation 1 (ILM1), ILM2, ILM3, ILM4, and ILM5 belong to factor 1, and the factor loadings were all greater than

0.5; The five-question items of external learning motivation 1 (ELM1), ELM2, ELM3, ELM4, and ELM5 belong to factor 2, and the factor loadings were all greater than 0.5, indicating that the questionnaire had convergent validity and discriminate validity, so it had constructive validity.

In order to perform the validity analysis of the learning engagement scale, KMO test and Bartlett's sphericity test on data from respondents' learning engagement were conducted and the results showed that the KMO measurement was 0.836, the Sig. value was 0.000, which met the conditions of factor analysis.

The principal components extraction of the learning engagement of the survey subjects is shown in Table 5.

In Table 5, there are two numbers greater than 1 in the initial eigenvalues: 3.869 and 1.171. These two numbers were the initial eigenvalue factors, which are the two factors extracted, and the explained variances are 48.360% and 14.636%, respectively.

According to Table 6, three measurement items, namely behavior 1 (BLE1), BLE2, and BLE3 belong to factor 2, and the factor loading was greater than 0.5; emotion 1 (ELE1), ELE2, and ELE3, ELE4, and ELE5, belong to factor 1, and the factor loading was greater than 0.5; It showed that the questionnaire had discriminate validity and convergent validity, so it had constructive validity.

For the purpose of verifying the validity of the learning effectiveness scale, KMO test and Bartlett's sphericity test were conducted on the data of the subjects' learning effectiveness, and the results showed that the KMO measure was 0.916 and the Sig. value was 0.000, which met the conditions for factor analysis.

The principal components extraction of the learning effectiveness is shown in Table 7.

As could be seen from Table 7, there was only one number greater than 1 in the initial eigenvalue: 5.831. This number was the initial eigenvalue factor, that was, a factor was extracted with an explained variance of 64.785%.

According to Table 8, it was reasonable to extract a factor from the learning effectiveness. Effectiveness 1 (EFF1) to EFF9, a total of nine questions, the factor loadings were all greater than 0.5, indicating that the questionnaire had a convergence validity and discriminate validity, constructive validity was thus withheld.

Table 2 KMO and Bartlett tests for learning motivation scales.

The Kaiser-Meyer-Olkin metric of sample adequacy		**0.841**
Bartlett's sphericity test	Approximate Chi-Square	1006.72
	df	45
	Sig.	0.000

For testing the validity of the personality traits scale, KMO test and Bartlett's sphericity test were also conducted on the data of the personality traits, and the results showed that the KMO measure was 0.964 and the Sig. value was 0.000, which met the conditions for factor analysis.

In Table 9, the composite reliability (CR) is 0.935, the convergent validity is 0.590 (AVE), and the discriminant validity is 0.768. These above values all indicate within an acceptable range. AVE and discriminant validity thus confirmed construct validity.

Data analysis

This section performed basic statistical analysis, correlation analysis, and regression analysis of the sample data.

Basic statistics of the sample. The descriptive statistical results are shown in Table 10.

As shown in Table 10, men (76) accounted for 30.28%, women (175) accounted for 69.72%, and men were less than women; Distribution of grades: juniors (140) accounted for the most, 55.78%, freshmen (31), sophomores (39) and seniors (41) accounted for 12.35%, 15.54% and 16.33% respectively; In the type of major, Science and Engineering (168) and Literature and History (73) accounted for more, 66.93% and 29.08% respectively, and Art and Sports (10) accounted for the least, 3.98%; Distribution of students' origins: rural distribution (170) was more, accounting for 67.73%, urban distribution (81) was less, accounting for 32.27%.

Correlation analysis. In this study, Pearson product-moment correlation analysis was employed to explore the correlation

Table 4 Learning motivation rotation component matrix.

Question items	Factor	
	1	2
ILM[a]1	0.744	
ILM2	0.705	
ILM3	0.734	
ILM4	0.715	
ILM5	0.844	
ELM[a]1		0.717
ELM2		0.790
ELM3		0.665
ELM4		0.602
ELM5		0.738

Note: ILM, Internal learning motivation; ELM, External learning motivation.

Table 3 Extraction of the principal components of the Learning Motivation Scale.

Factor	Initial eigenvalue			Extracted square loadings			Rotated square loadings	
	Total	Variance %	Accumulate %	Total	Variance %	Accumulate %	Total	Variance %
1	4.443	44.431	44.431	44.431	44.431	44.431	3.107	31.074
2	1.383	13.829	58.259	13.829	13.829	58.259	2.719	27.186
3	0.969	9.690	67.950					
4	0.748	7.484	75.434					
5	0.611	6.105	81.539					
6	0.472	4.724	86.264					
7	0.424	4.238	90.502					
8	0.373	3.733	94.235					
9	0.323	3.228	97.463					
10	0.254	2.537	100.000					

Table 5 Extraction of the principal components of the Learning Engagement Scale.

Factor	Initial eigenvalue			Extracted square loadings			Rotated square loadings	
	Total	Variance %	Accumulate %	Total	Variance %	Accumulate %	Total	Variance %
1	3.869	48.360	48.360	3.869	48.360	48.360	2.866	35.824
2	1.171	14.636	62.996	1.171	14.636	62.996	2.174	27.172
3	0.689	8.612	71.608					
4	0.611	7.634	79.242					
5	0.519	6.487	85.729					
6	0.445	5.566	91.295					
7	0.416	5.206	96.501					
8	0.280	3.499	100.000					

Table 6 Learning engagement rotation component matrix.

Question items	Factor	
	1	2
BLE[a]1		0.780
BLE2		0.895
BLE3		0.703
ELE[a]1	0.677	
ELE2	0.729	
ELE3	0.794	
ELE4	0.716	
ELE5	0.751	

Note[a]: BLE, Behavioral learning engagement; ELE, Emotional learning engagement.

among the four variables of learning motivation, learning engagement, personality traits, and learning effectiveness.

A correlation analysis of the two dimensions of learning motivation and learning effectiveness was carried out to determine whether and to what extent there was a correlation between learning motivation and learning effectiveness, and the results are shown in Table 11. The results showed that there was a significant positive correlation between learning motivation and learning effectiveness (0.582 and 0.494, respectively).

Regarding the results of the correlation analysis of learning motivation and learning engagement are also shown in Table 11. Internal learning motivation, external learning motivation, and learning engagement all showed significant positive correlations at the 0.01 level. This indicated a significant positive correlation between learning motivation and learning engagement (including behavioral engagement and emotional engagement).

Also, according to the results of Table 11, behavioral engagement, emotional engagement, personality traits, and learning effectiveness, all showed significant positive correlations at the level of 0.01, and the correlation coefficients were 0.533, 0.766, and 0.724, respectively. This showed that there was a significant positive correlation between learning engagement, personality traits, and learning effectiveness. These above results were also in line with the findings of Chang (2019), Mao (1995), Shang (2021), Shi (2000), Wang (2015), and Young (2012), which indicated that these four variables were close-related.

Regression analysis. The regression analysis in this study was based on correlation analysis to determine variable relationships that depended on each other. Correlation analysis could determine whether and to what extent variables were correlated, but it could not determine ***causality*** between variables. This section used regression analysis to test the hypotheses proposed in this study.

The results of the correlation analysis showed that there was a significant positive correlation between the two dimensions of learning motivation and learning effectiveness. The SPSS software was used to perform regression analysis on the variables, and the internal learning motivation and external learning motivation were taken as the independent variables, and the learning effectiveness was used as the dependent variable for regression analysis, and the results are shown in Table 12.

The analysis showed that two dimensions of learning motivation, namely internal learning motivation and external learning motivation, had a significant positive impact on learning effectiveness ($\beta = 0.410$, $P < 0.001$; $\beta = 0.255$, $P < 0.001$). The above results were in line with the findings of Lin & Geng (2005). H1 was thus supported.

The results of regression analysis using internal learning motivation and external learning motivation as independent variables and learning engagement as dependent variables are shown in Table 13.

The analysis results showed that the two dimensions of learning motivation, namely internal learning motivation and external learning motivation, had a significant positive impact on learning engagement ($\beta = 0.435$, $P < 0.001$; $\beta = 0.186$, $P < 0.001$). These results were in line with the findings of Shang (2021). Therefore, H2 was supported.

For testing the relationship between learning engagement and learning effectiveness, behavioral engagement and emotional engagement were served as independent variables and learning effectiveness was employed as the dependent variable for regression analysis, and the results are shown in Table 14.

The analysis results showed that the two dimensions of learning engagement, namely behavioral engagement and emotional engagement, had significant positive effects on learning effectiveness ($\beta = 0.145$, $P < 0.001$; $\beta = 0.629$, $P < 0.001$). These results were in line with findings of Yu et al. (2020). Therefore, H3 was thus supported.

The results of testing the mediation effect of learning engagement between learning motivation and learning effectiveness are shown in Table 15. A hierarchical regression analysis was conducted.

According to the results of Table 15, from Model 2 to Model 3, when Model 3 controlled for learning engagement ($\beta = 0.616$, $P < 0.001$), the regression coefficients of internal learning motivation and external learning motivation decreased ($\beta = 0.414 \rightarrow \beta = 0.146$; $\beta = 0.259 \rightarrow \beta = 0.140$). At the same time, from Model 3, it could also be seen that both internal learning motivation and external learning motivation were still in a significant state ($p < 0.01$; $p < 0.01$). Therefore, learning engagement had a partial mediation effect on learning motivation and learning effectiveness. Thus, **H5 was partially supported**. In other words, the learning engagement just transferred certain effects of learning motivation to learning effectiveness, not all of

Table 7 Extraction of the principal components of the Learning Effectiveness Scale.

Factor	Initial eigenvalue			Extracted square loadings		
	Total	Variance %	Accumulate %	Total	Variance %	Accumulate %
1	5.831	64.785	64.785	5.831	64.785	64.785
2	0.865	9.610	74.395			
3	0.491	5.460	79.855			
4	0.443	4.923	84.778			
5	0.359	3.993	88.771			
6	0.300	3.338	92.109			
7	0.273	3.031	95.141			
8	0.235	2.613	97.754			
9	0.202	2.246	100.000			

Table 8 Learning effectiveness component matrix.

Question items	Factor1
EFF[a]1	0.834
EFF2	0.809
EFF3	0.843
EFF4	0.808
EFF5	0.836
EFF6	0.809
EFF7	0.807
EFF8	0.738
EFF9	0.753

Note[a]: EFF, effectiveness.

the effects. There are some other mediation factors existed that needed to be explored.

In this study, the moderation approach proposed by Fang et al. (2022) was adopted and the hierarchical regression method was also employed for moderation analysis. First, the independent variable (internal and external learning motivation) and the moderation variable (personality trait) were centralized, and then the interaction terms of the independent variable (internal and external learning motivation) and the moderation variable (personality trait) were calculated, and finally, the hierarchical regression was performed respectively, and the analysis results are shown in Tables 16 and 17, respectively.

It was found in Table 16 that the significance level of the interaction coefficient between the independent variable (internal learning motivation) and the moderation variable (personality traits) after centralization was $0.000 < 0.01$, indicating that the coefficient was significant and the moderation effect was significant. The result showed that **Hypothesis 4.1 was supported**.

It was found in Table 17 that the significance level of the interaction coefficient between the independent variable (external learning motivation) and the moderation variable (personality traits) after centralization was $0.000 < 0.01$, indicating that the coefficient was significant and the moderation effect was significant. It was found that **Hypothesis 4.2 was supported**. Therefore, **Hypothesis 4 was thus supported**. The above findings were in line with the research results of Young (2012). In deeded, personality traits variable is an important factor that interferes the relationship between the learning motivation and learning effectiveness. Maybe some other factors are currently existed and needed to be explored.

Discussion

The results of this study supported the hypothesis that learning motivation has a significant positive impact on learning effectiveness. The average learning motivation of college students in the respondents was 3.802, of which internal learning motivation was slightly higher than external learning motivation, 3.868 and 3.736, respectively; The learning effectiveness of college students in the respondents was at the upper middle level, with an average of 3.740. Both dimensions of learning motivation were significantly positively correlated with learning effectiveness, that was, the stronger the student's motivation to learn, the better the learning effectiveness. This result was in line with Liang's (2020) study on the relationship among undergraduate students' learning motivation, learning engagement, and academic performance. In their daily study life, college students need to stimulate their intrinsic motivation to learn, improve their interest in their majors, and improve the effectiveness of learning through the study of knowledge and corresponding course training.

The test results also supported the hypothesis that learning motivation has a significant positive effect on learning engagement. The average learning engagement of college students among the respondents was 3.484. Exploring the aspects of internal learning motivation and external learning motivation, whether it was students' internal spontaneous interest in learning or the influence of the external environment, would stimulate students' learning motivation, thereby affecting the degree of learning engagement. Through the results of this study, it was found that the stronger the students' own learning motivation, the deeper the degree of learning engagement, which was in line with the result obtained by Dong (2021) in his study on the impact of freshman students' learning motivation on learning engagement.

The results also supported the hypothesis that learning engagement has a significant positive impact on learning effectiveness. From the aspects of behavioral engagement and emotional engagement, the effect of learning would be different depending on the degree of learning engagement, and the behavioral engagement and emotional engagement in learning engagement were significantly positively correlated with learning effectiveness. It showed that the more learning engagement, the higher the learning effect, and the influence of emotional engagement on learning effectiveness was greater than the influence of behavioral engagement on learning effectiveness. This result was in line with the results obtained by Peng et al. (2019) in their study on the relationship between learning engagement and learning effectiveness.

The results of the mediation effect partially supported the hypothesis that learning engagement mediates the relationship between learning motivation and learning effectiveness. Learning motivation affected learning effectiveness through partial mediation effects of learning engagement, which was partially in line with Liang (2020) in studying the relationship between undergraduate learning motivation, learning engagement, and academic performance. College students could only achieve good learning results if they convert their intrinsic learning motivation into practical actions into learning practice, that was, the degree of dedication to learning.

Table 9 The composite reliability (CR), convergent validity[a], and discriminant validity[b].

Variable	Measurement items	Standardized factor loadings	CR	AVE[a]	Discriminant validity
Personality Traits (PR)	PR1	0.711	0.935	0.590	0.768
	PR1	0.728			
	PR1	0.755			
	PR1	0.719			
	PR1	0.796			
	PR1	0.785			
	PR1	0.771			
	PR1	0.762			
	PR1	0.786			
	PR1	0.788			

Note[a]: Convergent validity was evaluated by AVE (average variance extracted).
Note[b]: Discriminant validity was evaluated by comparing the AVE value and square value of correlation coefficient.

Table 10 Demographic information of the total sample (*N* = *251*).

Category	Group	Number of people	Percentage
Gender	Male	76	30.28%
	Female	175	69.72%
Grade	Freshman	31	12.35%
	Sophomore	39	15.54%
	Junior	140	55.78%
	Senior	41	16.33%
Type of major	Science & Engineering	168	66.93%
	Literature & History	73	29.08&
	Art & Sports	10	3.98%
Origin	Rural	170	67.73%
	Urban	81	32.27%

The results of the moderation effect examination supported the hypothesis that personality traits moderated the relationship between learning motivation and learning effectiveness, which was in line with Young's (2012) study that different learners had their own unique learning performance. In other words, college students with different personality traits will have an interference effect on the relationship between learning motivation and learning effectiveness. Therefore, it is necessary to initiate an in-depth investigation of different personality traits.

Conclusions, management implications, and future study

The summary of result analyses. Internal learning motivation had a significant positive impact on learning effectiveness, therefore Hypothesis 1.1 (H1.1) was supported. While external learning motivation also had a significant positive impact on learning effectiveness, thus Hypothesis 1.2 (H1.2) was supported. It could be concluded that Hypothesis 1 (H1) was supported.

The test results also found that internal learning motivation had a significant positive impact on all dimensions of learning engagement, therefore Hypothesis 2.1 (H2.1) was supported. Meanwhile, external learning motivation also had a significant positive impact on all dimensions of learning engagement, Hypothesis 2.2 (H2.2) was thus supported. It also is concluded that Hypothesis 2 (H2) was fully supported.

Behavioral engagement was found to have a significant positive impact on learning effectiveness, Hypothesis 3.1 (H3.1) was thus supported. At the same time, emotional engagement was also found to have a significant positive impact on learning effectiveness, therefore Hypothesis 3.2 (H3.2) was supported. Thus, Hypothesis 3 was fully supported.

From the hierarchical regression analysis, it was found that the direct effect between learning motivation and learning effectiveness was partially transferred by learning engagement, therefore Hypothesis 5 (H5) was partially supported.

By using the centralized independent and moderation variables (Fang et al., 2022) and hierarchical regression analysis, it was found that personality traits had a significant moderation effect on the relationship between learning motivation and learning effectiveness. Therefore, the results showed that Hypothesis 4.1(H4.1) and Hypothesis 4.2(H4.2) were supported. Thus, Hypothesis 4(H4) was supported.

Management implications, suggestions, and future study. College students should stimulate their motivation for independent learning, enhance their motivation for learning, and cultivate the ability to learn independently in learning. In universities, students should actively participate in thematic lectures, expand their thinking, and trigger students thinking about personal learning goals and future career development, to determine the correct learning goals and enhance learning motivation. Liang (2020) found that the university period was a critical period for students' growth, and the school's various theme lectures could play a good educational role. Most students were overwhelmed in their first year in the university and were faced with many choices in a more liberal atmosphere. Lingering because of fear of unknown territory, or blindly choosing multiple directions due to novelty, resulting in missed good development opportunities. These phenomena were all due to a lack of thinking about self and the future, and there would be no strong motivation to learn without clear goals.

At the same time, in the classroom, teachers should innovate teaching methods, mobilize students' interest in learning, and cultivate students' initiative. Learning tasks should be challenging, increase students' behavioral and emotional engagement, and pay attention to students' mastery of knowledge. A student's commitment to the classroom depends not only on personal interests but also on the teacher's teaching methods and attitudes. Only when teachers value their work and strive to break through the traditional boring teaching methods can they inject vitality into the classroom and ignite students' enthusiasm for learning. Then whether in or out of class, students can increase their engagement in learning. Peng et al. (2019) studied the relationship among learning motivation, learning engagement, and learning effectiveness of accounting students, they also recommended that in addition to class time, students should arrange a certain amount of time for themselves in professional classes, and at the same time collect more information related to the

Table 11 The correlation analysis of learning motivation, learning engagement, personality traits, and learning effectiveness.

		LM		LEG		PT	LEF
		LM1	LM2	LEG1	LEG2		
LM	LM1	(0.835)					
	LM2	0.122	(0.791)				
LEG	LEG1	0.574**	0.501**	(0.766)			
	LEG2	0.440**	0.392**	0.105	(0.824)		
PT		0.399**	0.312**	0.482**	0.425**	(0.944)	
LEF		0.582**	0.494**	0.533**	0.766**	0.724**	(0.932)

LM learning motivation, *LM1* internal learning motivation, *LM2* external learning motivation, *LEG* learning engagement, *LEG1* behavioral engagement, *LEG2* emotional engagement, *PT* personality traits, *LEF* learning effectiveness; Numbers in parenthesis indicate Cronbach's alpha value; $^{**}P < 0.01$.

Table 12 The regression analysis of learning motivation on learning effectiveness.

Dependent variable →		Learning effectiveness
Independent variable	Internal learning motivation	**0.410*** **
	External learning motivation	**0.255*** **
Model	F value	77.994
summary	P value	**0.000**
	R^2	0.386

Note: $^{***}P < 0.001$.

Table 13 The regression analysis of learning motivation on learning engagement.

Dependent variable →		Learning engagement
Independent variable	Internal learning motivation	**0.435*** **
	External learning motivation	**0.186*** **
Model	F value	68.162
Summary	P value	**0.000**
	R^2	0.355

Note: $^{***}P < 0.001$.

Table 14 Regression analysis of learning effectiveness by learning engagement.

Dependent variable→		Learning effectiveness
Independent variable	Behavioral engagement	**0.145*** **
	Emotional engagement	**0.629*** **
Model	F value	194.528
Summary	P value	**0.000**
	R^2	0.611

Note: $^{***}P < 0.001$.

Table 15 The mediation effect of learning engagement on learning motivation and learning effectiveness.

Dependent variable→	Learning effectiveness		
Independent variable↓	**Model 1**	**Model 2**	**Model 3**
Gender	−0.008	−0.089	−0.009
Origin	−0.004	0.021	0.047
Internal learning motivation		**0.414*** **	**0.146** **
External learning motivation		**0.259*** **	**0.140** **
Learning engagement			**0.616*** **
F value	0.006	39.522	83.247
P value	0.994	**0.000**	**0.000**
R^2	0.000	0.391	0.629
ΔR^2	−0.008	0.381	0.622

Note: $^{**}P < 0.01$; $^{***}P < 0.001$.

major. Teachers could use checks and questions to motivate students to do a good job of pre-lesson and after-class consolidation.

In addition, schools should actively carry out themed lectures to cultivate students' correct learning attitude when they have just finished their high school career and entered a new stage. Keynote lectures could bring new knowledge to students, and could also provide some direction for confused students. Schools should enrich the library's collection of books so that students can make full use of the school's learning resources and update books promptly. At the same time, it actively held activities to enrich the forms of activities, created a learning platform for students, and created a good learning atmosphere. Before college students enter society, the university should serve as a platform to explore themselves and show themselves and should play an important role, provide rich resources, and cultivate outstanding talents for society and the country.

This study also found that personality traits had a moderating effect on the relationship between learning motivation and learning effectiveness. Therefore, it is necessary to explore using the long form of the Big-Five personality traits questionnaire in the future to deeply analyze the interfering effect of the personality traits of students on the relationship between learning

Table 16 The moderating effect of personality traits on internal learning motivation and learning effectiveness.

	Unstandardized coefficient[a]		Standardized coefficient	t	Sig.
	β	Std. error	β		
Centralized internal learning motivation	0.551	0.045	0.528**	12.311	0.000
Centralized internal learning motivation	0.405	0.045	0.388**	8.957	0.000
Centralized personality traits	0.380	0.047	0.350**	8.078	0.000
Centralized internal learning motivation	0.375	0.045	0.360**	8.405	0.000
Centralized personality traits	0.341	0.047	0.315**	7.308	0.000
Interaction of internal learning motivation and personality traits	0.203	0.045	0.183**	4.516	0.000

Note[a]: Dependent variable: Learning effectiveness; ** indicates $p < 0.01$.

Table 17 The moderating effect of personality traits on external learning motivation and learning effectiveness.

	Unstandardized coefficient[a]		Standardized coefficient	t	Sig.
	β	Std. error	β		
Centralized external learning motivation	0.510	0.048	0.473**	10.631	0.000
Centralized external learning motivation	0.322	0.051	0.299**	6.304	0.000
Centralized personality traits	0.392	0.051	0.361**	7.608	0.000
Centralized external learning motivation	0.287	0.049	0.266**	5.819	0.000
Centralized personality traits	0.368	0.049	0.339**	7.448	0.000
Interaction of external learning motivation and personality traits	0.270	0.044	0.247**	6.103	0.000

Note[a]: Dependent variable: Learning effectiveness; ** indicates $p < 0.01$.

motivation and learning effectiveness, to help students learn more effectively under the condition of better understanding of students' personality traits.

Data availability

The dataset is available on the Humanities and Social Sciences Communications Dataverse repository: https://doi.org/10.7910/DVN/MB7OH8.

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References

Baron RM, Kenny DA (1986) The moderator-mediator variable distinction in psychology research: Conceptual, strategic, and statistical consideration. J Personal Soc Psychol 51(6):1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173

Chang J (2019) Research on the influencing factors of college students' learning effectiveness. Chin Foreign Entrepreneurs 34:133. https://doi.org/10.1037/0022-0663.85.4.571

Chen C, Zhang K, Chen CM, Pao L (2023) The impact between motivational potential characteristics of job and job satisfaction: a moderation model of personality traits in a high-tech industry. Int J Asian Bus Inf Manag 14(1):1–19. https://doi.org/10.4018/IJABIM.325650

Costa PT, McCrae RR (1986) Cross-sectional studies of personality in a national sample: I. Development and validation of survey measures. Psychol Aging 1(2):140–143. https://doi.org/10.1037/0882-7974.1.2.140PMID:3267390

Dong, G (2021) *A study on the influence of freshman students' learning motivation on learning engagement* [Master's thesis, Harbin Industrial University]

Duan L, Li Y (2008) The relationship among professional commitment, burnout, and learning engagement in college students. Chin J Health Psychol 16(4):407–409

Du Y (2008) Investigation and analysis of the current situation of college students' learning motivation. J Cult Educ 30:188–190

Fang J (2007) The correlation studies on motivation, attribution, self-efficacy, and sports learning effects. J Beijing Sport Univ 12:112–113

Fang J, Wen Z, Ouyang J, Cai B (2022) Methodological research on moderation effects in China's Mainland. Adv Psychological Sci 30(8):1703–1714. https://doi.org/10.3724/SP.J.1042.2022.01703

Feng, J (2021) *Interdisciplinary background: Research on the influencing factors of master students' learning effectiveness* [Master's thesis, Guangxi Normal University]. https://doi.org/10.27036/d.cnki.ggxsu.2021.000554

Fredricks JA, Blumenfeld PC, Paris AH (2004) School engagement: Potential of the concept, state of the evidence. Rev Educ Res 74(1):59–109. https://doi.org/10.3102/00346543074001059

Goldsmith R (2016) The Big-Five, happiness, and shopping. J Retail Consum Serv 31(C):52–61

Kuh GD (2009) What student affairs professionals need to know about student engagement. J Coll Stud Dev 50(06):683–706. https://doi.org/10.1353/csd.0.0099

Liang, Y (2020). *A study on the relationship among learning motivation, learning engagement, and academic performance of undergraduate students of University* [Doctoral dissertation, Hebei University]. https://doi.org/10.27103/d.cnki.ghebu.2020.000401

Liu X, Geng D (2005) A study on the correlation between college students' learning motivation and academic performance. J Xichang Univ 17(2):75–77

Liu, Z, Chang, J (2022). Research on the learning autonomy of college English via internet from the perspective of personality traits, *Jiangsu Foreign Language Teaching and Research*, 28-32

Mackinnon DP (2008) Introduction to statistical mediation analysis. Erlbaum, Mahwah, NJ

Mackinnon DP, Warsi G, Dwyer JH (1995) A simulation study of mediated effect measures. Multivar Behav Res 30:41–62. https://doi.org/10.1207/s15327906mbr3001_3

Mao J (1995) Reflections on the characteristics of current learning motivation of college students in China. Res High Teach Educ 01:47–51

Mao Z, Li B, Qian M, Li Y (2020) Evidence-based analysis of college student learning effectiveness. Chin Adult Educ 11:28–31

Peng X, Tang Y, Guan M (2019) An empirical study on the relationship among learning motivation, learning engagement, and learning effectiveness. Sci Technol 29:63–65

Pi, L (2004). *Educational Psychology*. Shanghai, Shanghai Education Publisher

Qiao X, Zhao J (2010) A survey of secondary school students' participation in mathematics learning. China Electr Power Educ 35:83–85

Qin, J (2021) *The influence of master students' learning motivation on their scientific research and innovation ability* [Master's thesis, Shangxi Finance and Economic University]. https://doi.org/10.27283/d.cnki.gsxcc.2021.000359

Sánchenz-Bolívar, L, Martínez-Martínez, A (2022). Factors related to university students' motivation and instruments for its evaluations: a systematic review. *Revista Electronica Educare* (May-August), *26*(2). https://doi.org/10.15359/ree.26-2.26

Shang W (2021) A study on the relationship between motivation, self-efficacy, and learning engagement of finance college students in online learning. Guangxi Qual Superv Guide 04:48–52
Shen L, Wang Z (2023) Research on the influence of preschool teachers' personality traits on teaching effectiveness. J Wuyi Univ 42(4):91–96
Shi Y (2000) Survey report on college students' motivation for English learning. Theory Pract Foreign Lang Teach 04:8–11
Skinner EA, Belmont MJ (1993) Motivation in the classroom: reciprocal effects of teacher behavior and student engagement across the school year. J Educ Psychol 85(4):571–581
Tollefson N (2000) Classroom applications of cognitive theories of motivation. Educ Psychol Rev 12(1):63–83. http://jstor.org/stable/23363507
Wang Y (2015) An empirical study on the influence of college students' learning engagement on learning gain: Analysis results based on multi-layer linear model. J Natl Acad Educ Adm 07:76–81
Wang Z, Dong S, Li S (2019) A study on the differences in college students' self-presentation and social expectations. J Sci Technol Trends 33:234
Yao H, Ma L (2021) The influence of challenge-obstacle scientific research stress on postgraduate psychological anxiety: The mediating role of achievement motivation and self-efficacy. J Chin High Educ Res 5:79–85. https://doi.org/10.16298/j.cnki.1004-3667.2021.05.11
Young, W (2012) *A preliminary study on the relationship between college students' personality and academic performance* [Master's thesis, Yunnan University]
Yu X, Li Y, Dong B, Yang X (2020) A study on the relationship among medical students' learning motivation, learning engagement, and academic achievement from the perspective of teaching reform. Sanxi Youth 13:11–13
Zhang N (2012) A review of domestic and foreign learning engagement and its influencing factors in schools. Psychol Res 5(2):83–92
Zhao M (2021) The constituent elements of the learning effectiveness of accounting students: based on the five-year higher vocational modern apprenticeship training model. Contemp Enterp 02:136–137
Zheng F, Jia S (2017) The relationship between college students' learning motivation and learning engagement: The mediating effect of Time Psychological Accounts. J Cult Educ 23:146–147

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Author contributions

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Ethical approval

This study has been ethically reviewed and approved by the Zhaoqing University, China, Research (Ethics) Committee (ethics approval number: EA0003/2023). All procedures in this study were in accordance with the institutional research and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

The informed consent was obtained from all participants and/or their legal guardians. The participants were made to sign an informed consent form to validate their voluntary participation in this study.

Competing interests

The authors declare no competing interests.

Additional information

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