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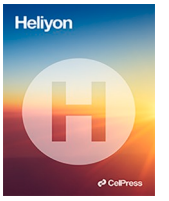

Research article

Doctoral students' academic performance: The mediating role of academic motivation, academic buoyancy, and academic self-efficacy

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ABSTRACT

Understanding influential factors for the academic performance of doctoral students is crucial for supporting their exploration of academic research opportunities and aiding their pursuit of careers in academic research. This study surveyed 659 doctoral students in China, utilizing scales to assess academic motivation, buoyancy, self-efficacy, self-concept, and performance. Based on a partial least squares structural equation modeling (PLS-SEM) analysis, a direct correlation between self-concept and performance was identified. Moreover, motivation, buoyancy, and self-efficacy were significant mediators in the relationship between self-concept and performance. To significantly enhance self-concept's impact on doctoral students' academic performance, educators should endeavor to enhance students' motivation, buoyancy, and self-efficacy. This endeavor will contribute to the discourse on academic performance and its underlying psychological mechanisms.

1. Introduction

This study explores the relationships between doctoral candidates' academic self-concept and their academic performance, while also identifying which variables moderate these relationships. The foundation of this research rests upon the self-determination theory. According to Coromina et al. (2020), the academic performance of doctoral candidates—including published articles and books, interpersonal skills, applied skills, and course work—differs from that of university students [1]. Students' views of their academic skills, especially compared with those of their peers, shape their academic self-concept. This includes how individuals assess their academic abilities and emotions, and their perceptions of others' opinions [2–4]. The close linkage between self-concept and performance is evident within scholarly discourse [5]. The direct impact of self-concept on achievement has been empirically established within scholarly research [6,7]. Ubago-Jimenez et al. (2024) also identified a direct relationship wherein self-concept positively influences performance [8]. Academic motivation drives learners' interest in the learning process itself [9,10]. Abdelrahman (2020) delved into a markedly significant association linking students' achievement with their motivation [11]. Wu et al. (2020) discovered that intrinsic motivation drives notably influences achievement [12]. Academic buoyancy, indicating the ability to navigate minor challenges [13], has been demonstrated to correlate with students' learning results [14]. Lei et al. (2022) demonstrated that academic buoyancy positively influences performance [15]. Academic self-efficacy, delineated as an individual's evaluation of their

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effectiveness and capability to execute particular learning tasks [16], encompasses perspectives and assessments regarding attaining academic goals [17]. Performance and academic self-efficacy have been demonstrated to possess a beneficial correlation [18].

Nonetheless, scant research has delved into the connections between doctoral students' academic performance and academic self-concept, particularly in constructing multiple mediation models that include academic motivation, buoyancy, and self-efficacy [19–21]. These frameworks are essential for examining their direct and indirect impacts on performance, thereby furnishing both theoretical and empirical support for boosting the academic performance of doctoral candidates. This study utilized multiple mediation analyses to examine how academic self-concept relates to academic performance, with mediation occurring through the partial or full mediation or support of motivation, self-efficacy, and buoyancy. It aimed to address this research gap and contribute both theoretical and empirical evidence. As follows were the research questions guiding this study:

RQ1. What is the correlation between doctoral students' academic self-concept and their performance?

RQ2. What is the relationship between doctoral students' academic self-concept and their motivation, self-efficacy, and buoyancy?

RQ3. How do motivation, buoyancy, and self-efficacy mediate the link between doctoral students' self-concept and performance?

2. Theoretical underpinning

Social cognitive theory, as proposed by Bandura in 1982 [22], and the self-determination theory developed by Ryan and Deci in 2000 [23]. Academic self-efficacy, which includes both social and academic dimensions, is influenced by environmental factors and interactions [24]. In accordance with the social cognitive theory by Bandura, it is posited that an individual shapes their self-efficacy through the experiences they undergo and their judgments of their competence. Successful academic outcomes and high scores tend to boost students' perceived capabilities [25], whereas negative experiences may lead to doubts about their ability to succeed, potentially leading them to discontinue their studies [26].

For doctoral students, academic self-efficacy is crucial for enhancing confidence and competence in scientific tasks and is posited to mediate performance. The self-determination theory provides an extensive structure for investigating motivation, stress, and self-directed learning. Motivation is classified into three types: intrinsic, extrinsic, and motivation, each reflecting a different level of self-determination. Research on self-determination theory extensively highlights the role of intrinsic motivation in promoting achievement [27]. Tisocco and Liporace (2023) also demonstrated a positive relationship linking motivation with students' performance [28].

3. Hypotheses development

3.1. Academic motivation: its mediating role in academic self-concept and performance

There is substantial evidence from numerous studies suggesting that performance is positively influenced by self-concept [29,30]. In their comprehensive analysis, Groenewald et al. (2021) not only validated the positive associations between performance at the tertiary level and both prior performance and self-concept but also elucidated the intricate interplay and nuanced relationships among these fundamental determinants [31]. Based on the empirical evidence from these studies, we propose the ensuing hypothesis:

H1a. Academic motivation is positively and significantly influenced directly by academic self-concept.

Abundant studies have proposed that the important variable impacting performance is motivation [32,33]. According to Radi (2013), students exhibiting elevated motivation and actively engaging in the learning process demonstrate superior performance and reduced attrition rates [34] than those who do not. Litalien et al. (2017) reported a positive correlation in university students, linking intrinsic motivation to performance, while noting negative impacts from external regulation and motivation [35]. Based on the empirical evidence from these studies, we propose the ensuing hypothesis:

H1b. Academic performance is positively and significantly influenced directly by academic motivation.

This study proposes that motivation acts as a mediator in the influence of self-concept on performance, consistent with self-determination theory's assertion of its mediating role in the link between self-concept and individual performance [36]. This mediating effect has been evidenced in several studies, especially concerning intrinsic/autonomous motivation [37–39]. Based on the empirical evidence from these studies, we propose the ensuing hypothesis:

H1c. Academic motivation serves as a positive mediator in the link of academic self-concept with academic performance.

3.2. Academic buoyancy: its mediating role in academic self-concept and performance

A widely accepted notion posits self-concept as a pivotal antecedent to buoyancy, with Colmar et al. (2019) highlighting a positive association between buoyancy and self-concept [40]. In the 2020 longitudinal analysis, Rhee and colleagues delineated a reciprocal negative prognostic association between self-concept and buoyancy, wherein each construct inversely predicted the temporal trajectory of the other [41]. These conflicting findings underscore the need to further explore whether self-concept significantly enhances buoyancy. Based on the empirical evidence from these studies, we propose the ensuing hypothesis:

H2a. Academic buoyancy is positively and significantly influenced directly by academic self-concept.

Numerous investigations have established a positive correlation between buoyancy and performance [13,42]. Lei's 2022 research with 860 Chinese secondary students investigated the mediating role of buoyancy in the relationship between self-efficacy and performance, demonstrating a significant enhancement in performance attributable to buoyancy [43]. Based on the empirical evidence from these studies, we propose the ensuing hypothesis:

H2b. Academic performance is positively and significantly influenced directly by Academic buoyancy.

It has been confirmed by prior studies that buoyancy acts as a mediating factor in the relationship between self-concept and performance [44,45]. This corresponds with Ursin et al.'s (2021) observation that buoyancy significantly mediates various positive learner outcomes [46]. Within the context of educational research, Fleischmann et al. (2023) have underscored the salience of self-concept, recognizing its contributory significance to individual well-being and its prognostic efficacy for scholastic endeavors, choices, and achievement [47]. Based on the empirical evidence from these studies, we propose the ensuing hypothesis:

H2c. Academic buoyancy serves as a positive mediator in the link of academic self-concept with academic performance.

3.3. Academic self-efficacy: its mediating role in academic self-concept and performance

Within the framework of social construction, self-concept demonstrates a robust correlation with self-efficacy beliefs [48,49]. Arens and colleagues' (2022) extensive research revealed a notably strong correlation between individuals' self-concept perceptions and their self-efficacy, underscoring a pivotal link in the longitudinal study [50]. The connection between initial self-concept and later self-efficacy has been positively validated by research, highlighting the progressive impact of self-perception on confidence in one's abilities [51]. Another study observed that in a learning context, students who possessed a heightened self-concept also exhibited increased self-efficacy and a more profound feeling of community [52]. Based on the empirical evidence from these studies, we propose the ensuing hypothesis:

H3a. Academic self-efficacy is positively and significantly influenced directly by academic self-concept.

Crucial for performance are high levels of self-efficacy [53], as highlighted by Høigaard et al. (2015), who found a positive relationship between self-efficacy and achievement, particularly in environments characterized by a task-oriented school climate perceived by students [54]. Further scholarly investigations have lent robust support to the positive correlation between self-efficacy beliefs and performance, as evidenced by the referenced studies [55,56]. Based on the empirical evidence from these studies, we propose the ensuing hypothesis:

H3b. Academic performance is positively and significantly influenced directly by Academic self-efficacy.

In the exploration of elements impacting performance, researchers have identified self-efficacy as a crucial mediating factor that bridges self-concept with the attainment of learning outcomes [51]. The research by Diseth et al. (2012) demonstrated that self-efficacy contributes positively to achievement, having a beneficial impact on academic outcomes both directly and indirectly [57]. Existing research substantiates self-efficacy's mediating function in performance and its direct effects, yet an additional investigation into its intermediary role remains justified [54,58]. Based on the empirical evidence from these studies, we propose the ensuing hypothesis:

H3c. Academic self-efficacy serves as a positive mediator in the link of academic self-concept with academic performance.

3.4. The linkage of academic self-concept with academic performance

An abundance of scholarly evidence suggests that performance can be anticipated by academic self-concept [59]. For instance, Wang and Yu (2023) determined that the augmentation of academic self-concept manifested a saliently affirmative impact, thereby engendering advancements in achievement, fostering heightened motivation levels, effectuating amelioration in performance metrics,

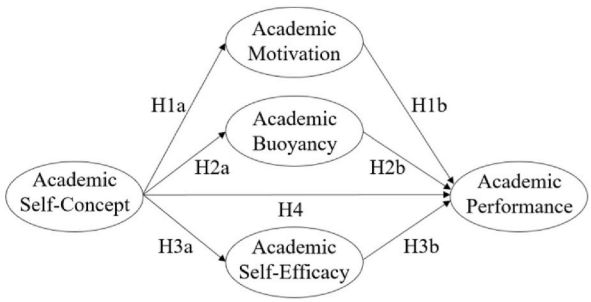

Fig. 1. Proposed hypothetical construct.

and fortifying self-efficacious tendencies [29]. Consequently, the robustness of self-concept serves as a formidable predictor of performance [51]. Based on the empirical evidence from these studies, we propose the ensuing hypothesis:

H4. Academic performance is positively and significantly influenced directly by academic self-concept.

The direct association between the variables and the mediated relationship is represented in Fig. 1 as an explanation of the hypothesis outlined earlier.

4. Methods

4.1. Measurement tool design and pilot study

The survey instrument employed in the research was bifurcated into two distinct segments, detailed inAppendix A, which also houses the ancillary content inclusive of the inquiry items. The first section included four questions concerning the demographic information of the doctoral candidates who participated in this survey. The second section contained 26 questions exploring the causal factors affecting the participants' academic performance. For the evaluation, the instrument measuring students' self-concept of their academic abilities [60], included six elements and yielded a high-reliability value of 0.945. The scale measuring academic performance encompassed five items ($\alpha = 0.945$). The instrument assessing academic motivation [61], was composed of five components and demonstrated a reliability coefficient (alpha) of 0.852. The assessment tool for academic buoyancy, developed by Martin and Marsh (2008b) [13], consisted of four distinct elements ($\alpha = 0.908$). The measure for gauging students' academic self-efficacy in their capabilities, based on the work of Midgley et al. (1998) [62], was comprised of six items and exhibited a high-reliability index ($\alpha = 0.900$). A pre-test was conducted with a sample of 139 participants. The Kaiser-Meyer-Olkin (KMO) metric evaluates the suitability of data for factor analysis by assessing the proportion of variance that variables share. Higher KMO values suggest better suitability for factor analysis, aiding validity assessment. Consistent with the initial test outcomes, Cronbach's α for all constructs demonstrated satisfactory reliability ($\alpha > 0.800$) and validity (KMO >0.7; $p < 0.05$) for further in-depth research.

Table 1
Assessment of measurement models.

Construct/Item	Indicator Weight	Factor Loadings/Cross Loadings				
		AM	AP	ASC	ASE	AB
Academic Motivation (CR = 0.950, AVE = 0.829).						
AM1	0.231	**0.902**	0.779	0.730	0.748	0.777
AM2	0.232	**0.916**	0.797	0.716	0.751	0.788
AM3	0.211	**0.903**	0.747	0.628	0.692	0.735
AM4	0.218	**0.922**	0.766	0.656	0.685	0.754
AM5	0.207	**0.909**	0.718	0.631	0.653	0.737
Academic Performance (CR = 0.953, AVE = 0.840).						
AP1	0.210	0.722	**0.897**	0.713	0.733	0.786
AP2	0.226	0.798	**0.933**	0.768	0.751	0.853
AP3	0.220	0.777	**0.920**	0.758	0.721	0.825
AP4	0.214	0.760	**0.908**	0.689	0.746	0.805
AP5	0.220	0.779	**0.925**	0.705	0.757	0.834
Academic Self-Concept (CR = 0.954, AVE = 0.797).						
ASC1	0.189	0.680	0.705	**0.922**	0.692	0.671
ASC2	0.189	0.663	0.719	**0.933**	0.688	0.668
ASC3	0.195	0.686	0.738	**0.939**	0.708	0.691
ASC4	0.196	0.680	0.749	**0.946**	0.705	0.716
ASC5	0.200	0.706	0.764	**0.947**	0.717	0.713
ASC6	0.148	0.529	0.545	**0.619**	0.552	0.516
Academic Self-Efficacy (CR = 0.939, AVE = 0.748).						
ASE1	0.203	0.723	0.738	0.694	**0.933**	0.680
ASE2	0.207	0.665	0.706	0.755	**0.857**	0.683
ASE3	0.201	0.714	0.716	0.698	**0.913**	0.667
ASE4	0.193	0.677	0.720	0.635	**0.905**	0.662
ASE5	0.146	0.542	0.547	0.476	**0.670**	0.569
ASE6	0.201	0.695	0.752	0.659	**0.884**	0.708
Academic Buoyancy (CR = 0.946, AVE = 0.859).						
AB1	0.264	0.790	0.820	0.668	0.694	**0.908**
AB2	0.257	0.744	0.796	0.650	0.685	**0.921**
AB3	0.280	0.774	0.856	0.725	0.720	**0.943**
AB4	0.278	0.782	0.846	0.722	0.740	**0.934**

Note: The bold values indicate the factor loadings.
CA, Cronbach's alpha; CR, Composite Reliability; AVE, Average Variance Extracted; AP, Academic Performance; ASC, Academic Self-concept; AM, Academic Motivation; AB, Academic Buoyancy; ASE, Academic Self-efficacy.

4.2. Partial least squares structural equation modeling (PLS-SEM)

PLS-SEM is known for its efficiency in structural equation modeling. It handles both reflective and formative constructs within complex models effectively [63]. Given the study's multifaceted and varied characteristics, we employed the Smart PLS software to carry out the PLS-SEM analysis, a decision informed by the software's robust capability to navigate the complexities inherent in such research. As Smart PLS 2.0 cannot directly compute mediating effects, we resorted to the Sobel Test for their estimation [64]. However, in Smart PLS 3.0 and above, it is possible to directly analyze the mediating effects using bootstrapping [65]. Bootstrapping is a non-parametric statistical technique wherein the original data is repeatedly sampled with replacement to create multiple bootstrap samples [66]. This method enables the direct analysis of the mediating effect. Using Smart PLS (v. 4.0) software, we analyzed the mediating effects using bootstrapping. The process involved two main steps. First, we assessed the measurement model using the PLS-SEM algorithm. Then, we examined the structural model with bootstrapping techniques [67].

4.3. Participants and procedure

To gather extensive data, we shared the updated questionnaire link on WeChat. This was done effectively using the Wenjuanxing (https://www.wjx.cn/) platform. Data were collected from March to May 2023 at six universities in two metropolitan cities (Guangzhou and Shenzhen) and three municipalities (Chongqing, Wuhan, and Kunming). If participants perceived any adverse effects on their performance, they retained the prerogative to decline participation. Of the 678 questionnaires collected, 659 were deemed valid (97.2 % response rate). Following the "ten times" rule, which recommends a minimum sample size of seventy for models with up to seven structural paths [66,68], our sample of 659 comfortably exceeded this recommended threshold.

5. Results

5.1. Demographic attributes of the participants

The 659 participants in our survey consisted of 61.15 % females and 38.85 % males. First-year students accounted for 65.40 % of the responses, second-year students for 27.47 %, third-year students for 5.16 %, fourth-year students for 1.21 %, and other students for 0.76 %. The distribution of participants by field of study was as follows: 47.34 % were studying in the field of education, 27.62 % in business administration, 13.20 % in water resources, and 11.84 % in statistics.

5.2. Measurement model assessment

Urbach and Ahlemann (2010) proposed the following threshold values for exploratory research: CA should be above 0.800, CR above 0.800, AVE exceed 0.500, indicator weight surpassing 0.100, and factor loadings surpass 0.700, thereby surpassing the cross-loadings [69]. The discriminant validity of the constructs is indicated when factor loadings exceed the cross-loadings. Table 1 presents the measurement model values. All CAs exceeded 0.800, CRs exceeded 0.800 for each construct, AVEs exceeded 0.500 for each construct, and all indicator weights were observed to exceed the prescribed threshold value of 0.100, while all factor loadings were found to surpass their corresponding cross-loadings, thus fulfilling the criterion for discriminant validity. These combined metrics meet all necessary criteria for evaluating the validity of the model comprehensively. Additionally, they guarantee its reliability.

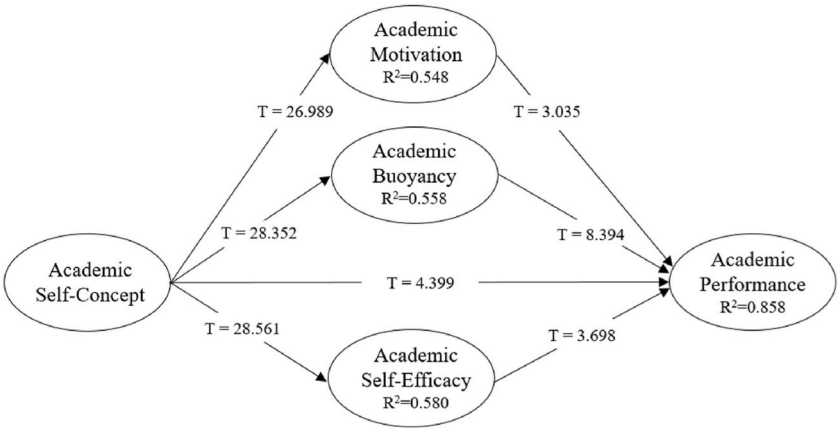

Fig. 2. Structural model.

5.3. Assessment of structural model

Within the framework of bootstrapping, we define parameters for assessing the significance of path coefficients, including subsamples of 1000, the percentile bootstrap method for confidence intervals, a two-tailed test type, and a fixed seed for the random number generator. Fig. 2 represents the structural model.

Hair et al. (2017) defined benchmarks for R^2 values and goodness of fit (GOF). They determined that R^2 values signify a small effect size if they are beyond 0.190, a medium effect size if above 0.330, and a large effect size if over 0.670 [54]. Regarding the goodness of fit (GOF), benchmarks are established at 0.100 for small, 0.250 for medium, and 0.360 for large effect sizes. For a model to be considered well-fitting, the normed fit index (NFI) must exceed 0.90. The standardized root mean square residual (SRMR) should ideally be low, with values below 0.080 or at most 0.100 indicating a preferable fit. In our study, SRMR showed improvement to 0.044, NFI approached 0.899, GOF reached 0.758 in the large category, and R^2 values for academic performance (AM: 0.548 $_{\text{medium}}$, AP: 0.858 $_{\text{large}}$, ASE: 0.580 $_{\text{medium}}$, AB: 0.558 $_{\text{medium}}$) demonstrated strong predictive capability. The omission distance, which is not divisible by the total sample size, was set to 7 in blindfolding settings due to our sample size of 659. The Q^2 statistic, which evaluates the predictive relevance of a group of manifest variables, should exceed 0.000. In our study, all Q^2 values exceeded this threshold. The hypothesis testing results are displayed in Table 2.

5.4. Assessment of mediating effects

While we have pinpointed indirect effects, whether these effects fully or partially mediate remains unverified. This section offers comprehensive mediation tests to clarify this aspect. We consider the unique and complex nature of our proposed multiple mediation models, including motivation, buoyancy, and self-efficacy, as mediators between self-concept and performance. Testing multiple mediation models is complicated due to unidentified collinearity issues, as noted by Preacher and Hayes (2008) [70]. We conducted a systematic examination of the potential mediation of the three models. Table 3 presents the three models as follows: Model 1: ASC → AM → AP (Mediation of Academic Motivation); Model 2: ASC → AB → AP (Mediation of Academic Buoyancy); and Model 3: ASC → ASE → AP (Mediation of Academic Self-Efficacy). This study, following Hair et al. (2013), categorizes VAF into three stages: full mediation (>80 %), partial mediation (20%–80 %), and no mediating effect (<20 %) [71,72].

6. Discussion

6.1. Exploring how academic self-concept affects academic performance

The research presents a notable discovery, indicating a substantial positive relationship between how students view their self-concept and their performance ($t = 32.490$, $p < 0.001$). This correlation, congruent with prior research [8,68,73,74], underscores the notion that students who harbor optimistic perceptions of their aptitude exhibit superior academic achievements compared to their counterparts whose self-perceptions within academic realms are less confident. The findings of our study highlight the pivotal influence that self-concept has on various crucial elements of students' learning journeys. Our research revealed that self-concept has a notable positive impact on students' motivation ($t = 26.989$, $p < 0.001$), buoyancy ($t = 28.352$, $p < 0.001$), and self-efficacy ($t = 28.561$, $p < 0.001$) in their academic abilities. This underscores the complex relationships among these factors in educational settings. The data suggests that students confident in their academic skills are more inclined to participate in learning activities. They also show greater buoyancy when confronted with difficulties and possess a stronger conviction in their academic success compared to their less confident peers.

Table 2
Hypothesis testing.

Hypotheses	O	STDEV	t-value	CI	f^2	Support
Total effects.						
H1a: ASC → AM	0.740	0.027	26.989***	0.685: 0.791	1.212 $^{\text{strong}}$	Yes
H1b: AM → AP	0.157	0.052	3.035**	0.052: 0.257	0.043 $^{\text{weak}}$	Yes
H2a: ASC → AB	0.747	0.026	28.352***	0.693: 0.797	1.262 $^{\text{strong}}$	Yes
H2b: AB → AP	0.512	0.061	8.394***	0.393: 0.630	0.470 $^{\text{strong}}$	Yes
H3a: ASC → ASE	0.762	0.027	28.561***	0.706: 0.815	1.383 $^{\text{strong}}$	Yes
H3b: ASE → AP	0.168	0.046	3.698***	0.092: 0.267	0.061 $^{\text{weak}}$	Yes
H4: ASC → AP	0.793	0.024	32.490***	0.743: 0.838	0.067 $^{\text{weak}}$	Yes
Specific Indirect Effects (bootstrapping).						
H1c: ASC → AM → AP	0.116	0.039	2.992**	0.039: 0.193		Yes
H2c: ASC → AB → AP	0.382	0.049	7.811***	0.284: 0.476		Yes
H3c: ASC → ASE → AP	0.128	0.036	3.550***	0.070: 0.208		Yes

Note: O, Original Sample; STDEV, Standard Deviation; t-value, T Statistics; CI, Confidence Intervals, f^2, Effect size.
AP, Academic Performance; ASC, Academic Self-concept; AM, Academic Motivation; AB, Academic Buoyancy; ASE, Academic Self-efficacy.
Effect size: 0.02 to 0.15 (weak); 0.15 to 0.35 (moderate); >0.35 (strong).
t-value >1.96 at p-value <0.05 (*), $^{(**)}$t-value >2.576 at p-value <0.01, and. $^{(***)}$t-value >3.29 at p-value <0.001.

Table 3
Multiple mediation analysis.

	O	STDEV	t-value	CI
Model 1: ASC → AM → AP (Mediation of Academic Motivation).				
ASC → AM (a1)	0.740	0.027	27.008***	0.684: 0.790
AM → AP (b1)	0.554	0.049	11.333***	0.455: 0.649
ASC → AP (c) without mediator	0.626	0.029	21.678***	0.573: 0.683
ASC → AP (c') with mediator	0.384	0.050	7.659***	0.283: 0.486
Model 2: ASC → AB → AP (Mediation of Academic Buoyancy).				
ASC → AB (a2)	0.747	0.026	28.410***	0.693: 0.796
AB → AP (b2)	0.281	0.045	15.202***	0.594: 0.772
ASC → AP (c) without mediator	0.626	0.029	21.678***	0.573: 0.683
ASC → AP (c') with mediator	0.686	0.045	6.214***	0.194: 0.369
Model 3: ASC → ASE → AP (Mediation of Academic Self-Efficacy).				
ASC → ASE (a3)	0.762	0.027	28.635***	0.707: 0.815
ASE → AP (b3)	0.421	0.067	6.245***	0.357: 0.630
ASC → AP (c) without mediator	0.626	0.029	21.678***	0.573: 0.683
ASC → AP (c') with mediator	0.488	0.069	7.065***	0.282: 0.550
Specific Indirect Effects (bootstrapping).				
Model 1: ASC → AM → AP	0.410	0.037	11.083***	0.337: 0.478
Model 2: ASC → AB → AP	0.512	0.036	14.153***	0.443: 0.584
Model 3: ASC → ASE → AP	0.372	0.055	6.744***	0.266: 0.488

Size of Mediation Effects

	IE (a * b)	VAF (a * b/a * b + c')	Decision
Model 1: ASC → AM → AP	0.410	51.6 %	partial mediation
Model 2: ASC → AB → AP	0.210	23.4 %	partial mediation
Model 3: ASC → ASE → AP	0.321	39.7 %	partial mediation

Note: O, Original Sample; STDEV, Standard Deviation; t-value, T Statistics; CI, Confidence Intervals.
AP: Academic performance; ASC: Academic self-concept; AM: Academic motivation; AB: Academic buoyancy; ASE: Academic self-efficacy; IE: Indirect Effects; VAF: Variance Accounted For.
t-value >1.96 at p-value <0.05 (*), t-value >2.576 at p-value <0.01 (**), and(***)t-value >3.29 at p-value <0.001.

6.2. Examining how academic motivation, self-efficacy, and buoyancy moderate performance

Our research provides empirical support for a mediated link between students' self-concept and their performance in school. It highlights how academic motivation, self-efficacy, and buoyancy are intermediary factors in this relationship. Our results indicate that students who view themselves positively in an educational context tend to perform better. This contrasts with students who do not hold such positive self-beliefs, as they often achieve lower academic results. We posit that students with a positive self-concept are more motivated and exhibit greater buoyancy and self-efficacy in their academic abilities during the learning process than those without such a positive self-view.

The effect size data revealed a substantial positive impact of self-concept on students' motivation (ASC → AM: 1.212). This indicates a high correlation between these two variables, aligning with previous research findings [36,75]. Conversely, the effect size between academic motivation and performance was weak (AM → AP: 0.043), suggesting that in practical educational settings, the relationship between the two is not robust. This underscores that improving students' academic performance in educational contexts cannot be achieved by focusing solely on one aspect; rather, it requires a multifaceted approach. Within the complex landscape of doctoral students' academic pursuits, the nuanced interplay between self-concept and performance was elucidated through the mediation of motivation, underscoring the intricacies inherent in their educational trajectory. Furthermore, the proactive cultivation of doctoral students' motivation emerged as a pivotal facilitator, exerting a transformative influence on their self-concept and subsequently fostering an enriched learning milieu conducive to heightened levels of performance.

The data showed that the effect size for self-concept had a considerable influence on the students' buoyancy (ASC → AB: 1.262). This is consistent with [72] and indicates that teachers can intervene in self-concept to bolster the capability of doctoral students to manage challenges. The effect size of buoyancy on performance exhibited a notable strength (AB → AP: 0.470), suggesting that teachers can improve doctoral students' performance by enhancing their ability to deal with learning difficulties. Additionally, amidst the intricate network of mediating variables, it was elucidated that the partial mediating efficacy of buoyancy manifested relatively modestly (AM: 51.6 %, AB: 23.4 %, ASE: 39.7 %), thereby underscoring the substantial direct impact of both self-concept and buoyancy on the scholarly achievement of doctoral students. This contention is bolstered by the corroborative evidence derived from effect size analyses.

The analysis of effect size has shown a robust positive link between one's self-concept and belief in self-efficacy (ASC → ASE: 1.383). This finding emphasizes the considerable sway that a student's self-concept holds over their confidence in succeeding academically. The study revealed a weak effect size (ASE → AP: 0.061). This was observed between students' self-efficacy and their performance. Essentially, the data suggests that self-efficacy in academic abilities has a limited impact on actual performance outcomes. This conclusion is congruent with the research findings of Komarraju and Nadler [76].

In the realm of performance, the impact engendered by self-concept revealed a discernibly positive trajectory ($t = 32.490, p < 0.01$,

[0.743: 0.838]). However, the effect size was weak (ASC → AP: 0.067). Upon a comparative analysis of effect sizes, it becomes evident that there exists a pronounced and robust interrelation, particularly among the constructs of self-concept, motivation, self-efficacy, and buoyancy. This interrelation not only substantiates but also accentuates a significant degree of strength within these associations. This particular phenomenon could likely stem from the complex web of factors that underpin the relationship between self-concept and performance. It's possible that within the practical milieu of educational settings, there are additional, yet unidentified, variables that have eluded capture, thus contributing to the multifaceted dynamics at play. The observed phenomenon might also be attributable to the intricacies inherent in our conceptualized framework. Within this framework, the interplay among various variables could potentially modulate the extent of the effect observed between self-concept and performance, thereby adding layers of complexity to the model's predictive capacity.

7. Implications

Empirical evidence sheds light on the fact that strategically crafted interventions, which aim to nurture and enhance self-concept, hold the promise of casting a favorable impact upon the sphere of performance. Educators may proactively employ a range of multifaceted strategies aimed at nurturing a healthy academic self-concept among doctoral candidates. This particular initiative, through its multifaceted approach, is poised to augment students' motivation, buoyancy, and self-concept in their academic competencies. In turn, this is anticipated to culminate in a discernible enhancement of their scholastic achievements. For instance, personalized feedback, goal-setting activities, and mentorship programs could facilitate the cultivation of heightened proficiency and assurance in their academic capabilities among doctoral students. Educators who carefully consider doctoral students' assessments of their academic skills and support their motivation, buoyancy, and self-efficacy in overcoming challenges can create a learning atmosphere that is both more supportive and more conducive to their development and success.

This dissection illuminates the multifaceted interplay between self-concept, motivation, buoyancy, and self-efficacy, all of which pivotally intertwine with performance, thereby enriching our understanding of the synergistic relationships that these elements foster within the educational landscape. This insight can inform the development of more comprehensive theoretical frameworks that capture the dynamic nature of academic success. Future models could integrate insights from psychology, sociology, and education, leading to a more nuanced understanding of academic achievement that accounts for the multifaceted nature of student experiences and outcomes.

8. Conclusion and limitations

In this research, a sophisticated multiple mediation model was meticulously constructed to probe into the nexus between self-concept and performance, while simultaneously delving into the intermediary roles played by academic motivation, buoyancy, and self-efficacy, thereby offering a nuanced exploration of these pivotal educational constructs. The empirical evidence has demonstrated that a robust self-concept not only positively influences students' performance but also bolsters their self-efficacy, ignites their motivation, and strengthens their buoyancy. Additionally, it has become apparent that buoyancy has a more substantial impact on performance than either motivation or self-efficacy, indicating that the capacity to persevere through educational challenges is a critical component of academic success. Each of the three mediating variables exerts a partial mediating effect on the relationship. Our findings augment the academic discourse by furnishing additional empirical substantiation for the significance of cultivating a favorable self-concept among doctoral candidates. Armed with this evidence, educators and policymakers are poised to craft targeted interventions and multifaceted strategies aimed at bolstering the self-concept among doctoral students, a move that is anticipated to culminate in the elevation of their performance.

Although this study addresses important research gaps, it is limited by focusing on a specific group of doctoral students, and despite efforts to ensure the findings' generalizability, the overall sample size remains small. Future research could investigate other groups (e.g., university students) in a larger sample to see if the findings hold across different student populations. Second, our model failed to account for external variables that may impact academic performance, such as the learning environment, parental support, and financial situations. In the future, we will consider these factors and incorporate them into our research.

Data availability statement

The authors are authorized to disseminate the data, which will be accessible upon reasonable inquiry directed to the first author (dora_guo@e.gzhu.edu.cn).

Ethical approval

The School of Education at Guangzhou University has provided ethical approval for this project through its Ethics Review Committee (GZHU202341). All study participants provided their informed consent.

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CRediT authorship contribution statement

Huifen Guo: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Zhen Zhou:** Writing – original draft, Funding acquisition, Data curation. **Fengqi Ma:** Software, Project administration, Funding acquisition. **Xieling Chen:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e32588.

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