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The impact of honors education on students' academic and innovative achievements: a longitudinal study in China (2011–2021)

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Honors education has ascended as an integral element within the sphere of global higher education, concentrating on fostering individuals who exhibit creativity and a history of innovative achievements. Despite its widespread adoption, there remains a scarcity of exhaustive longitudinal studies investigating its effects and associated variables. To address this shortcoming, this study deploys rigorous structural equation modeling (SEM) and linear regression analyses to meticulously examine a dataset comprising 319 students, who enrolled over a decade (2011–2021) in a prestigious honors college at a preeminent university in China. The primary objective is to discern the predictive efficacy of Chinese honors education selection criteria on students' creative and academic accomplishments. This endeavor strives to clarify the complex interplay among students' creative personalities, academic performance, creative achievements, and standardized college entrance exam scores. The findings emphasize that individuals who exhibit enhanced creative personality traits are predisposed to elevated levels of both innovation and academic attainment ($\beta=0.170$, $p=0.017$). Additionally, a significant inverse relationship is observed between general learning aptitude and subsequent academic performance ($\beta=-0.008$, $p=0.023$), while students pursuing science disciplines demonstrate superior innovation outcomes compared to their liberal arts counterparts ($\beta=0.125$, $p=0.048$). Interestingly, neither gender nor general academic prowess exerts significant predictive power over collegiate innovation ($\beta=-0.002$, $p=0.134$). These empirical insights equip policymakers and scholars with nuanced perspectives on the determinants shaping students' refined educational experiences, thereby inciting critical discourse concerning the refinement of selection criteria and the imperative of nurturing students' creative proclivities.

KEYWORDS

honors education, selection criteria, innovative achievement, academic achievement, creativity

1 Introduction

Honors programs, also known as Honors programs, have become an integral part of higher education systems worldwide, with an escalating number of students partaking in such programs (Long and Mullins, 2012). Countries such as China, Japan, South Korea, and Singapore have begun to weave educational policies and practices into a vital element of their national innovation strategies: the development of human capital. These programs are tailored to furnish high-achieving, motivated students with a rich learning experience through intimate class sizes, a more comprehensive purview of learning materials, and a deeper exploration of disciplinary content. This approach facilitates the overall enhancement of graduate student attributes, culminating in their contributions to science and society.

A century ago, in the 1920s, the United Kingdom and the United States embarked on an exploration of honors education, yielding remarkable results globally. Gaining admission into popular programs can be quite challenging. Selection is coordinated nationally and hinges on exam GPA (Denmark), a grading system predominantly based on grades (Norway), and a system rooted in grades, a national test, and other criteria (Sweden). The most creative minds do not necessarily excel in scoring. They require flexibility to fully harness their creativity. Honors programs can furnish the necessary challenges that they require (Wolfensberger, 2015). Honors education is fundamentally tailored for exceptional students, offering distinctive policies and high-quality resources in the selection, curriculum design, pedagogical approach, faculty, accommodation, scholarships, and more, all to nurture them into premier innovative talents.

Honors education, rooted in the West, is characterized by elite training. Commonalities exist between Chinese and international models in cultivating top talents, selecting students, and amassing quality educators. Globally, various forms of honors education exist, such as the Sirius programme in the Netherlands, the Honors College at Michigan State University, Honors degrees, and Degrees with Honors in Australia, among others (Izerda, 1958). Honors degrees denote a one-year program following a three-year bachelor's degree, necessitating high academic achievement for entry. They are accolades conferred upon students who have completed a degree of 4 years or more and have excelled in their academic pursuits (Shaw et al., 2013). China's modern cultivation of premier innovative talents, originating in the 1970s, has matured into a robust system for fostering top-tier innovative talents and honors education, bolstered by state support, university engagement, and student participation. This system proffers distinctive policies and resources to facilitate the growth of students into outstanding and innovative talents. The Chinese model for cultivating top talents has, to a degree, assimilated characteristics of international small-class mentorship and college management models, coupled with China's localized talent cultivation model. This includes naming honorary colleges or classes after distinguished alumni, concentrating on nurturing exceptional undergraduates in institutions such as Qian Xuesen Honors College of Xi'an Jiaotong University, Yuanpei College of Peking University, Kuang Yaming Honors School of Nanjing University, Chu Kozhen Honors College of Zhejiang University, and the School of the Gifted Young of the University of Sciences and Technology of China. There also exists a dispersal model that selects students from regular teaching classes into experimental classes. Diverse scholars hold varying perspectives on the recognition of top talent cultivation models in Chinese universities. However, a

comprehensive view reveals common characteristics: an emphasis on international exchanges, one-on-one guidance by tutors, granting students more freedom in course selection while emphasizing Individualized cultivation, and maintaining smaller class sizes. Research on honors education in China predominantly consists of phenomenal analysis and lacks empirical research. In terms of training objectives, domestic universities focus on fostering students' academic literacy and encouraging further educational pursuits, with the proportion of students pursuing doctoral degrees serving as a crucial indicator to assess educational effectiveness. Researchers adopt localized approaches to explore characteristics of honors students, such as waiting time during classes and well-being (Kumar et al., 2021; Hinterplattner et al., 2022).

The organizational framework proposed by Berger and Milem (2000) underpins this study as a theoretical foundation. Their model contends that the psychological, behavioral, and structural attributes of peer groups exert influence on students' formal and informal behaviors, as well as their perceptions in both academic and social realms. Consequently, these peer groups, behaviors, and perceptions collectively exert a distinctive and direct influence on students' academic performance. Inherently, honors programs and colleges establish a peer group distinguished by high academic achievement and motivation to engage in meaningful, often challenging, academic endeavors. Self-identifying as an honors student within this select peer group can amplify one's academic self-efficacy and self-esteem, traits linked with elevated college academic achievement rates and retention levels (Robbins et al., 2004; Richardson et al., 2012). Furthermore, the formal requirements and structures of honors programs (such as enrolling in honors courses or undertaking research/writing a senior thesis), coupled with the informal norms manifested through peers' study habits and intellectual contributions, are likely to contribute to the enhancement of both the quantity and quality of honors students' academic engagement (Seifert et al., 2007; Moon, 2012).

While there is an abundance of anecdotes and a generous amount of rhetoric concerning honors students, there is a conspicuous dearth of descriptive evidence, comparisons, or empirical data rooted in respectably-sized samples.

2 Literature review and hypothesis development

2.1 Honor education

Countries are equipping students with the skills necessary to compete in the 21st-century global economy, including fostering creativity, innovation, and technological competency. Cultivating top-tier innovators is a crucial objective of university talent development. Miller and Dumford (2018) scrutinized whether high-achieving students benefit from Honors College involvement by concentrating on student engagement as a predictor of a variety of positive outcomes. Analyzing a sample of 1,339 honors students and 7,191 general education students from 15 different universities, they examined data on a variety of indicators. The findings of their study revealed that participation in an honors college had a positive impact on various aspects of student learning, including reflective and integrative learning, utilization of effective learning strategies, engagement in collaborative learning activities, involvement in diverse discussions, interaction with faculty

members, and the quality of interactions among first-year students. These results remained consistent even after controlling for individual student characteristics and institutional factors. Additionally, senior students who participated in an honors college reported more frequent interactions with faculty members. Thus, participation in honors courses can be beneficial for many students, particularly those seeking enrichment and those who prefer to highlight their abilities.

Honors education refers to a personalized education model specifically designed for outstanding undergraduate students with high levels of ability. It also aims to cultivate elite talent in the era of mass education. Generally, honors education is a provision by universities and community colleges of a wide range of opportunities and experiences designed to meet the learning needs of the most capable students. The goals of honors education include selecting highly capable and ambitious honors students and providing these students with academic opportunities to challenge themselves and reach their maximum potential at the highest level (Friedman and Jenkins-Friedman, 1986). The Honors College is dedicated to cultivating an academically and socially enriching environment for its members and to fostering a proactive and innovative learning environment. The Honors College program emphasizes individualized academic programming over a rigid set of courses. Honors students are selected, meaning they are defined by selection criteria (Geiger, 2000, 2002). However, selection criteria vary significantly from institution to institution, and therefore, the composition of honors students also varies. The most commonly employed selection criteria are GPA and standardized test scores (SAT or ACT). In the 21st century, nurturing top-tier innovative talents is a crucial objective of talent development in universities. Many four-year universities and two-year community colleges in the United States offer honors education programs. Honors education is organized in a variety of forms, including Honors Program, Honors College, Honors and Experimental College, and Freshman Seminar Program.

Taking the Honors College at Michigan State University as an example, applications for the Honors College are divided into three categories: Incoming Freshmen, Current Students, and Transfer Students. For high school seniors who have received an offer of admission to Michigan State University, a completed application for MSU admission doubles as the application for Honors College membership; there is no separate application process. Selection criteria include the student's GPA or class rank in the top 5% of the class; substantial and rigorous AP (Advanced Placement), IB (International Baccalaureate), or dual-degree coursework within the range of courses offered by the school; and participation in community service, research interests, and leadership activities may also be considered as part of the overall examination. Students invited into the Honors College and providing test scores have an average SAT or ACT score of 1,440 or 32, respectively. It is at the student's discretion whether or not to include test scores as part of their application to MSU. Applicants are asked to demonstrate how they have uniquely spent their high school careers, and may submit an additional essay and arrange to have recent transcripts sent for further finalist status. For current and transfer students, the Honors College is by invitation only. Current students are reviewed for admission only during their first year of attendance at MSU. The process targets the top 10% of first-year freshmen in each college (based on cumulative GPA at the end of the fall semester). Students may also graduate with Honors (top 7–20%) or Senior Honors (top 6%) designation, as long as the cumulative GPA is met, independent of Honors College membership.

The Australian honors research degree plays a pivotal role as a prerequisite for direct entry into doctoral research programs. In 1995, the Australian Vice Chancellors Committee (AVCC) released a set of guidelines for good practice in Fourth Year Honours Programs, which defined Honors as an additional fourth year program following a three-year bachelor's degree. The thesis component of most programs was noted to range from 30 to 70%, with the primary objective being research training (Shaw et al., 2013). The training provided by the honors degree is particularly important to health disciplines where there is a growing recognition of the importance of research training to embed evidence-based approaches to practice (Barwick and Horstmanshof, 2023). There are several models of honors programs at the undergraduate level at Australian universities. The most common model comprises an additional fourth year of study in which students are selected based on their grade point average (GPA) in the first 2 or 3 years of study. Another model is the four-year degree, where students graduate with honors if their GPA is at or above the credit level, i.e., between 60 and 70 per cent (Kiley et al., 2009). The Australian Qualifications Framework (2013) stipulates that honors graduates should possess "a coherent and advanced knowledge of the fundamental principles and concepts of one or more disciplines and of research principles and methods." While the amount of coursework prescribed varies (Kiley et al., 2009; Martin et al., 2013; Backer and Benckendorff, 2018), the primary goal of the fourth-year honors year of the undergraduate program is research training. The honors year is an intensive phase that commences with the formulation of a research question and concludes with the submission of a research paper. The expected assessable outcome is usually at least a draft of a journal paper and also includes an extensive literature review (Kiley et al., 2009). Students who had published at least one peer-reviewed journal article outperformed those who had not published. Factors that affected honors performance included student gender, residential status, type of project undertaken, and whether a student had published a peer-reviewed journal article (Gnjidic et al., 2023).

As illustrated in literature, many universities offer students the opportunity to graduate with an honors degree, which is administered differently in different countries, at different institutions and in different subject areas. In general, honors degrees are seen as a bridge to transition from undergraduate to graduate and/or into a desired career. Dutch Higher Education has a reputation as being extremely egalitarian. In Dutch universities, honors programs are a fast-growing development, starting in 1993 (Ibata-Arens, 2012). In a college of higher education in the Netherlands, Honors are undertaken over nine months, during which academics supervise a student from the development of a research question to the submission of a written research thesis (Kappe and Van Der Flier, 2012). In the UK, for example, Honors is part of a degree classification system (Elton, 2004), while in many Australian universities, Honors is an adjunct to a standard undergraduate degree, although there is great variation in approach (Kiley et al., 2009). While there is some theoretical literature related to administrative and pedagogical aspects of Honors, students' perspectives were severely under-represented. In this paper, we collected 10-year longitudinal data to depict the whole picture about the students' entrance to the Honors College, their academic and innovative performance during the college and their further development after graduation. We also explored the predictors of general ability (i.e., college entrance examination scores), creative personality, big-five trait (i.e., openness), and demographic information (i.e., gender, major).

In this study, we choose academic achievement and college entrance exam scores as the main indicators of Honors education. Because academic achievement is required by general education, it should be positively correlated with college entrance examination scores. Aiming at cultivating innovative talents, the innovative achievement is characteristic of honors education and it should not be necessarily related to the college entrance examination scores. Therefore, the selection of academic ability and innovation ability can summarize the two main goals of current university education, and they have different meanings.

2.2 Academic achievement

In previous research, there has been a debate about what factors contribute to excellent educational outcomes: is it the student's motivation, talent, or social environment? It has been argued that intelligence is not the only reliable predictor of success (Furnham and Bachtar, 2008). Other predictors include personality traits such as perseverance, creative thinking, and problem-solving skills, as well as organizational talents and the ability to use ingenuity (Kappe and Van Der Flier, 2012). Wawrzynski et al. (2012) explored the importance of the environment such as family, school, and friends. It can be seen that honors programs produce outstanding students. In the case of the honors program, it can be argued that it is only appropriate or possible to decide who is gifted and talented after participation.

Kappe and Van Der Flier (2012) use GPA and time to graduation to measure student performance, as well as five specific performance indicators: regular exams, skills training, team projects, internships, and written papers. Jansen and Suhre (2015) chose to collect annual survey data on student motivation, perceptions of the instructional environment, participation in courses, and enrollment in course scores as indicators of the characteristics of the graduate experience. Among these predictors, we focus on college entrance examination scores (known as "Gaokao" score), because the honors program was developed specifically for the most capable students, and in China, high school entrance exam scores are an important indicator of general academic ability and educational outcomes (Wang et al., 2022), which differs from the student selection in the Swedish admission to higher education system which is based on two fundamentally different performance measures (Wikström and Wikström, 2017). Educators primarily perceive and achieve assessment quality through traditional criteria (Schellekens et al., 2023).

2.3 Innovative achievement

Cognitive flexibility mediates the association between dACC–mSFG connectivity and creative achievement (Chen et al., 2014). Empirical studies of gender differences in creative ability have had markedly inconsistent findings, but there is consensus on the disproportionate presence of males among figures widely recognized for outstanding creative achievement. Direct comparisons of male and female performance on a wide range of creativity measures have yielded a variety of unexpected results. Females showed significantly higher performance for measures of fluency and originality on the creativity test (Pesout and Nietfeld, 2021). However, males are more

likely to be perceived as more creative and receive greater benefits for engaging in creative behaviors (Luksyte et al., 2018). Similarly, Proudfoot et al. (2015) observed that stereotypically masculine behaviors enhance perceived creativity in males, while the same behaviors do not enhance perceived creativity in females. Elevated perceived creativity in males was mediated by identity attributions rather than ability attributes and predicted perceived reward desirability. Stoltzfus et al. (2011) found that androgynous individuals had significantly higher cognitive flexibility scores compared to those whose gender roles were described as female or undifferentiated. Luo et al. (2023) concluded that male students exhibited higher creative self-efficacy perceptions than female students. Males are generally considered to have higher creative self-efficacy and creativity due to biases associated with gender stereotypes (Charyton et al., 2008; Proudfoot et al., 2015; Luksyte et al., 2018; Luo et al., 2023). Due to the traditional gender division of labor, females have adaptive creativity, while males have both innovative and adaptive creativity (Stoltzfus et al., 2011). Males report greater support for creativity in the workplace than females, which in turn leads to more frequent creative workplace behaviors (Taylor et al., 2020).

Many studies have reported differences in creativity between liberal arts and science students as measured by performance on tests of divergent thinking (Lloyd-Bostock, 1979; Webster and Walker, 1981; Hartley and Greggs, 1997). The results of previous studies have shown that students in English and liberal arts generally outperform students in science and business in the area of divergent thinking. The general superiority of verbal creativity among students of humanities and social sciences, whereas business students had the highest scores on self-assessed creative traits and products (Cheung et al., 2003).

2.4 Creativity personality

Creative personality is an important predictor of an individual's creativity and an important component of creative qualities. The creative personality is a concept developed by Guilford that refers to the types of qualities and trait tendencies that highly creative individuals exhibit in their creative behavior. The traits of openness (inquisitiveness and imagination, among others) in personality traits are the variables most strongly associated with creativity (Batey and Furnham, 2006) and have been more widely and consistently validated (Kandler et al., 2016; Fürst and Grin, 2018). Feist (1998) conducted a meta-analysis of the relationship between creativity and five personality items and found that openness had the largest effect size on individual creativity predictions. Later studies have also found openness served as a common core of both creative potential (divergent thinking) and real-life creativity (creative activities and achievements) at almost all levels and domains (Guo et al., 2023). Soldz and Vaillant's (1999) ongoing 45-year follow-up study found that openness was significantly and positively related to creativity with temporal consistency. In recent years, the relationship between openness and creativity has been repeatedly mentioned in a series of studies (van Tilburg et al., 2015; Tan et al., 2019; Zhang et al., 2020). This is because, on the one hand, individuals with higher openness are curious and imaginative and therefore have a lower threshold for creative behavior; on the other hand, individuals with higher openness are more likely to have higher crystal intelligence, which leads to a more robust and richer knowledge base connected to the semantic system and therefore are more likely to

generate novel ideas (Benedek et al., 2012; Ziegler et al., 2012; Beaty et al., 2014; Christensen et al., 2018). Kaufman et al. (2016) found that openness to experience independently predicted creative achievement in the arts, while intelligence independently predicted creative achievement in the sciences. These results held even after controlling for the other Big Five personality traits.

The present study examines the relationships between participation in an honors program and several outcomes: college GPA, Gaokao score, academic achievement, innovative achievement and creative personality. The preceding consideration of Berger and Milem's (2000) theoretical framework suggests that honors participation may bolster each of these outcomes. This study improves upon previous research on honors programs by using a large and longitudinal sample; conducting analyses using a structural equation model (SEM); and exploring whether the potential impact of honors programs differs across student majors and gender.

Taken together, we come up with the hypotheses below:

Hypothesis 1. Students' creativity personality is positively related to their innovative performance (H1a), but not to their academic achievement (H1b).

Hypothesis 2. Students' Gaokao score is positively related to their academic achievement (H2a), but not to their innovative performance (H2b).

To reconcile the inconsistency in the current literature, we also explore the following research questions:

Research question 1. Whether and how do students' majors influence their innovative performance or academic achievement?

Research question 2. Whether and how students' gender influence their innovative performance or academic achievement?

3 Method and results

3.1 Research settings

We conducted our study in the Hanhong College of Southwest University, a leading university located in the southwest of China. Hanhong College is an interdisciplinary research and undergraduate teaching institution. Initial selection is based on students' high school entrance exam scores and the school's current year's admissions. Those qualified for enrollment will undergo a four-item aptitude test and a comprehensive interview. The aptitude tests include tests of physical fitness level, English level, psychological quality, and intelligence level. Currently, honors colleges in China use a mentorship, small class size, individualization, and internationalization model. This model outlines the features of the characteristics of honors education in China. Representative of this model is the Hanhong College, a specialized institution that implements the "Southwest University Undergraduate Talent Development Program." This cultivation model combines general and professional education in two stages. Like other honors

education, to prepare students to address complex issues, they need to be trained in inter- and transdisciplinarity (Horn et al., 2023). In the first 2 years, students receive a general education, while in the second 2 years, they take specialized courses according to their academic plans. In the process, students gain both accelerated learning opportunities and a rich learning experience. Because of the above characteristics of Hanhong College, we targeted it as a sample to explore the effectiveness of higher honors education in China.

3.2 Participants

All undergraduate students who studied at Hanhong College from 2011 to 2021 ($n=319$) were invited to participate in the survey. Among all participants, 141 were female (44.2%) and 178 were male (55.8%). Their ages ranged from 18 to 22 when they studied in the college as undergraduate students. About 62.4% of students majored in Science, Technology, Engineering and Math (STEM) ($n=199$), and others were in Humanities and Social Sciences ($n=120$).

3.3 Measures

3.3.1 Innovative achievement

To reflect students' innovative achievements, we collected their published papers, patents, competition awards, and completed academic projects during college. The number of students' articles, competitions and projects were used as indicators for the latent innovative achievement variable.

3.3.2 Academic achievement

Students' academic achievements were reflected with academic rewards. They were asked to list all the academic awards (i.e., scholarships, honors) they earned during their time in college.

3.3.3 Creative personality

We measured participants' openness with 2 items adapted from the Big Five scale (Gosling et al., 2003), and used it as the indicator of creativity personality as in the previous study. The sample item was "I was open to new experiences." Participants responded on a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree).

3.3.4 General learning ability

Students' general learning ability was measured by their scores on the National College Entrance Examination.

3.3.5 Gender and major

We collected and coded participants' gender and major. For gender, we coded 0 for female and 1 for male, and for major, 0 for Humanities and Social Sciences, and 1 for STEM.

3.4 Analysis strategy

Considering that we used different indicators for the constructs, we applied the structural equation model (SEM) and linear regression techniques to analyze the data, with the lavaan package (Rosseel, 2012) and lme4 package in R (Bates, 2011).

To have a general picture of students' innovative performance, we constructed the latent innovative performance with three indicators: students' number of academic papers and patents, competitions, and academic projects. In Models 1 and 2, we conducted SEM to explore the relationship between students' innovative performance and their gender, major, general learning ability and creative personality. Then, in Models 3 and 4, the interaction term of openness, gender and major were added to explore the possible interaction effect.

In Models 5, 6, 7, and 8, we used linear regression techniques to test our hypotheses. Model 5 investigated the effects of gender and major on students' academic achievement. For Model 6, we included creative personality and students' general learning ability. In Model 7 and 8, we added the interaction term between general learning ability and gender and major to test our hypotheses of interaction effects.

3.5 Results

3.5.1 Descriptive statistics

Table 1 shows the descriptive statistics and correlations for all the observed variables in the present study. Academic achievement was negatively correlated with students' national entrance examination scores ($r = -0.130, p < 0.05$), disproving H2a.

3.5.2 Structural equation model

Table 2 presents the results of SEM on students' innovative achievement. Model 1 suggested that innovative achievement was a function of students' majors. Students who studied STEM were more likely to achieve higher innovative outcomes ($\beta = 0.125, p = 0.048$) compared to those who studied Humanities and Social Sciences, providing support for Research question 1. After adding creative personality and general learning ability to the SEM (Model 2), results suggested that individuals with higher creative personality were more likely to achieve more innovative achievements ($\beta = 0.170, p = 0.017$), but not academic performance ($\beta = 0.170, p = 0.017$), providing support for H1a and H1b. Students' gender and general learning ability, however, were not significant predictors of their innovative performance in college ($\beta = -0.002, p = 0.134$), supporting

H2b and providing evidence for Research question 2. In Model 3 and 4, we aimed to investigate the moderating effects of gender and major on the relationship between creative personality and innovative performance, but no significant result was found ($ps > 0.05$).

3.5.3 Liner regression model

Table 3 shows the results of the linear regression model on students' academic achievement. As Model 5 suggested, gender and major were not significant predictors of students' academic achievements. After including creative personality and general learning ability, Model 6 showed that students' general learning ability could significantly predict their academic achievement after 4 years, but surprisingly in a negative direction ($\beta = -0.008, p = 0.023$). In other words, individuals who earned a higher score in their entrance exam were less likely to achieve academic honors in college. As predicted, creative personality was not a significant predictor of academic achievement ($\beta = -0.009, p = 0.972$), supporting H1b. Model 7 included the interaction term between general learning ability and gender, and Model 8 included the interaction term between general learning ability and major, but no significant result was found ($ps > 0.05$).

To summarize, under the education pattern of Hanhong, creative personality and general learning ability showed their unique contributions to students' innovative performance and academic achievement. To be specific, creative personality could positively affect students' innovative outcomes, but general learning ability showed a stable negative effect on students' academic performance.

4 Discussion

The current study provides an initial exploration into the longitudinal trends of academic and innovative achievements spanning a decade (2011–2021). The findings shed light on several critical aspects of honors education and its implications for student development.

Main findings:

Firstly, the results suggest a positive association between higher levels of creative personality traits and increased innovative

TABLE 1 Descriptive statistics and correlations among variables.

	M	SD	Major	Gender	Gaokao score	Creative personality	Publication	Competition	Project
Major	0.62	0.49							
Gender	0.44	0.5	0.217***						
Gaokao score	588.52	30.15	-0.059	-0.085					
Creative personality	4.06	0.49	-0.102	-0.115	0.094				
Publication	0.49	1.15	0.106	0.093	-0.023	0.088			
Competition	0.30	0.80	0.165**	0.111	-0.148*	0.070	0.264***		
Project	0.31	0.66	0.055	-0.003	-0.008	0.085	0.295***	0.171**	
Academic achievement	1.25	1.92	-0.001	-0.063	-0.130*	-0.007	0.245***	0.327***	0.372***

Computed correlation used Pearson-method with listwise-deletion.

N = 319, M = Means, SD = standard deviations.

Major: 0 = Humanities and Social Sciences, 1 = Science, Technology, Engineering and Math.

Gender: 0 = male, 1 = female.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

TABLE 2 SEM results on innovative achievement.

Variables	Innovative achievement			
	Model 1	Model 2	Model 3	Model 4
Independent variables				
Gender	0.075	0.092	-0.152	0.09
Major	0.125*	0.156*	0.152	-0.324
Gaokao score		-0.002	-0.001	-0.002
Creative personality		0.170*	0.14	0.095
Interaction terms				
Creative personality × gender			0.06	
Creative personality × major				0.118

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

TABLE 3 Linear regression results on academic achievement.

Variables	Academic achievement			
	Model 5	Model 6	Model 7	Model 8
Independent variables				
Gender	-0.255	-0.296	0.876	-0.293
Major	0.052	0.029	0.038	0.640
Gaokao score		-0.008*	-0.008*	-0.008*
Creative personality		-0.009	0.146	0.087
Moderator				
Creative personality × gender			-0.289	
Creative personality × major				-0.150

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

achievement, aligning with prior research (King et al., 1996; Furnham and Bachtari, 2008; Kandler et al., 2016). Notably, openness emerges as a significant predictor of creative performance, indicating its pivotal role in fostering innovation among students. However, the observed marginally significant relationship warrants further investigation to elucidate the intricate mechanisms underlying this association.

Secondly, the negative correlation between high scores on entrance exams and subsequent academic success in college challenges conventional selection criteria for honors programs. While high test scores traditionally serve as indicators of academic potential, the findings suggest a nuanced relationship, questioning the efficacy of solely relying on standardized testing for identifying innovative individuals (Scager et al., 2012). Future studies should delve deeper into alternative selection methods that prioritize creativity assessment to foster student excellence and innovation.

Moreover, disciplinary differences emerge as significant determinants of innovative outcomes, with science majors exhibiting a higher propensity for innovation compared to their counterparts in the liberal arts. This underscores the importance of disciplinary context in shaping creative achievement within higher education settings. However, it is crucial to recognize the multifaceted nature of creativity, which may manifest differently across diverse academic disciplines.

Furthermore, gender and general academic ability do not significantly predict innovative achievements in college, challenging stereotypes regarding gender differences in creativity (Stoltzfus et al., 2011). This highlights the need to move beyond traditional gender

roles and embrace inclusivity within educational environments, fostering an equitable platform for all students to thrive creatively.

4.1 Theoretical contributions and practical implications

4.1.1 Contributions to honors education

Utilizing a decade's worth of data, this study validated the relationship between creative personality and innovative achievement through an analysis of existing data sources, furnishing quantitative evidence for the efficacy of creative personality development in bolstering students' academic and innovative achievements. More significantly, this study discovered that students who achieved higher scores on the college entrance examination performed less creatively after commencing their college education. These findings critically challenge the selection criteria of current honors programs, wherein individuals with higher scores are assumed to be more creative. It may also be the case that in a group of higher-scoring students, there is very little variation in scores, at which point entrance exam scores cannot be used as a very discriminating indicator of innovative talent selection. The study also found that students majoring in science disciplines were more likely to yield innovative results. However, there were no significant differences in creative and academic achievements among students of different genders. These findings contradict the prevalent notion that men are more creative than women (Luksyte et al., 2018).

This study aligns with the three pillars of honors education as proposed by [Wolfensberger \(2012\)](#), underscoring the importance of providing students with bounded freedom and enhancing academic competence in fostering student development. As postulated in the theory of the three pillars of honors education ([Wolfensberger, 2012](#)), the evidence garnered in this study highlights the importance of offering students bounded freedom and enhancing their academic competence. [Rinn and Plucker's \(2019\)](#) systematic review demonstrated that various cognitive and psychosocial factors influence achievement among high-ability college students and that honors programming results in positive student outcomes. The effects of these pillars on creativity present an intriguing area for future research exploration. This study endorses the view of honors education as a multifaceted construct and offers an integrative model illustrating the potential interplay between its different facets.

4.1.2 Practical implication

Practically, the study calls for a re-evaluation of selection criteria for honors programs, advocating for the integration of creativity assessment to identify and nurture innovative individuals effectively. Additionally, insights into the impact of honors programs on student development provide valuable guidance for educators and policymakers in designing inclusive and effective educational initiatives.

As mentioned above, Hanhong College is characterized by mentorship, internationalization, individualization, and small class sizes. Both the merit-based admissions and the “student-centered” training philosophy share similarities with American and European honors education philosophies. While these results should be interpreted with caution, this may be a starting point for future research. In addition, honors programs may help prevent a decline in the academic ability of students who score high on entrance tests over time by providing a challenging education that matches students’ abilities. By using the results of empirical studies, more evidence-based decisions can be made about the role of the Honors College in undergraduate education. Recent scholarly work argues for more qualitative work in this area to develop a deeper understanding of the issue and to identify more effective ways to increase college success rates across these populations.

4.2 Limitations and future directions

This study does present several limitations. Firstly, the methodology, constrained by the nature of the survey, does not permit the inference of a causal relationship among constructs. Experimental studies are therefore recommended to rule out alternative explanations for the influence of creative personality on creative achievement in higher education. Another limitation stems from the insufficient focus on student competencies. Given the challenges presented by the age of artificial intelligence, greater emphasis should be placed on the development of students’ creative qualities in honors education, such as the incorporation of project-based learning (PBL), flipped classroom videos, and STEM courses ([Barak and Yuan, 2021](#); [Gomez et al., 2021](#); [Lee and Jung, 2021](#)). It is crucial to equip honors students with the visionary and critical thinking skills necessary for a comprehensive sustainability education ([Schweinsberg et al., 2013](#)).

Subsequent research could examine the quality of innovations students can achieve in their future careers through their 4 years of

study at Hanhong College, and which factors involved in the admissions process explain much of the variation in academic progress and performance, and to what extent these factors correlate with students’ differences.

Moreover, the Humanities play a crucial role in enhancing society and people’s well-being. Future research could explore whether honors program can provide academic training and support and exert cultural influence beyond academic enhancement, thus nurturing future scholars in the Humanities. The mental health of honors students is also a topic worthy of investigation. For instance, honors students face a trade-off between academic success and social engagement in maintaining their elite status ([Fang and Brown, 2024](#)).

4.3 Conclusion

Based on the 10-year longitudinal dataset, our study contributes substantively to the scholarly discourse on honors education by unraveling predictors of student development and innovative achievement. By elucidating the theoretical and practical implications of our findings, we empower educators and policymakers to make informed decisions aimed at enhancing the efficacy of honors programs in fostering student excellence and innovation within higher education settings.

Data availability statement

The original contributions presented in the study are included in the article/supplementary materials, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical approval was not required for the study involving humans in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants or the participants’ legal guardians/next of kin in accordance with the national legislation and the institutional requirements.

Author contributions

JY: Investigation, Writing – review & editing. DT: Writing – original draft, Conceptualization. ZW: Data curation, Writing – review & editing. YZ: Methodology, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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