Received: 16 April 2025 | Revised: 6 June 2025 | Accepted: 15 August 2025 | Published online: 1 September 2025

RESEARCH ARTICLE

International Journal of Changes in Education
2025, Vol. 00(00) 1–9
DOI: 10.47852/bonviewIJCE52025942

BON VIEW PUBLISHING

The Professional Development of Gifted Students in Mathematics: A Follow-Up Study of the Winners of Mathematics Competitions

Peijie Jiang[1,*] and Wenqian Lin[1]

[1]*School of Mathematics and Statistics, Hunan Normal University, China*

Abstract: Mathematics competition winners are key subjects in research on mathematically gifted education. This study examined the career trajectories, academic achievements, and personal traits of 116 high school mathematics competition winners (graduating from 2008 to 2015) through the longitudinal questionnaire analysis. The key findings are as follows: (1) career clustering in STEM fields (technology, academia, finance) and advanced degree pursuits (81 participants); (2) high academic productivity, with 43 participants publishing as first authors and 13 holding patents; (3) income polarization (22.4% earning >¥40,000 vs. 12.1% earning <¥5,000 monthly); (4) elevated perfectionism (95.6%) and creativity (96.6%) in self-assessments; and (5) perceived benefits of competition experiences, including enhanced learning skills (87.9%) and academic growth (76.7%). The results highlight the strong correlation between mathematical talent and STEM-oriented careers, exceptional scholarly output, and the enduring impact of personal traits (e.g., perfectionism) and environmental factors on professional success. This work offers empirical insights into cultivating mathematically gifted individuals and assessing the long-term effectiveness of competition-based education.

Keywords: mathematical competition, gifted students, professional development, follow-up research, mathematical talent

1. Introduction

Any country's scientific and technological innovation requires a group of top-notch talents in basic disciplines. The discovery and cultivation of talented young people are closely tied to a country's future and destiny [1]. With the drastic changes in the world economy and political structure, there is an urgent need for outstanding scientists who can lead scientific and technological innovation. Cultivating top-notch talent in basic subjects, such as mathematics, is becoming increasingly urgent.

There have been numerous follow-up studies on gifted students, which often span decades, yielding valuable conclusions [2–6]. For example, Bernstein et al. [7] conducted a 35-year longitudinal follow-up study of gifted and ungifted students, revealing the effects of different forms of educational acceleration on gifted students' mental health. Lubinski and Benbow's [8] 35-year longitudinal study of mathematically gifted individuals found that the gifted students seemed satisfied with their life choices in their 30s. The authors pointed out that when people with mathematical talent choose careers other than engineering and the physical sciences, it should be seen as a contribution to society, not a brain drain.

As a way of selecting and training excellent students in mathematics, does mathematics competition make an essential contribution to science and society? How many of the winners of mathematics competitions later engaged in mathematics or research work closely related to mathematics? What role does the mathematics competition play in the professional development of the winners? Studying the professional development of mathematics competition winners has both essential theoretical and practical value. It helps explore the factors that affect the professional achievement and development of top-notch mathematics talents and understand how they grow. This research is also helpful in searching for ways to discover mathematically gifted students, create a suitable environment for their training, and help more excellent students truly develop into top-notch talents in mathematics. Based on the above analysis, building on China's consistent excellence in the International Mathematical Olympiad, the researcher conducted a follow-up study to address the following questions within the context of Chinese mathematical education and talent development.

1) How is the development of the winners of the mathematics competition?
2) What are the personal characteristics and growth environment of the winners of mathematics competitions?
3) What do the winners of the mathematics competitions think of the mathematics competitions?

2. Literature Review

2.1. Definition of mathematical talent

The concept of mathematical talent lacks a uniform definition and varies across cultures, though most focus on academic

***Corresponding author:** Peijie Jiang, School of Mathematics and Statistics, Hunan Normal University, China. Email: peijiejiang@hunnu.edu.cn

achievement and intelligence. Gifted students are understood as possessing both innate endowments and acquired abilities, as defined by Gagné [9], who describes them as individuals with exceptional ability and potential capable of achieving expert-level accomplishments. Mathematical talent is sometimes regarded as a hereditary-fixed intellectual trait that does not increase with study or practice [10] and is characterized by an inherent potential for a deeper understanding of mathematical concepts [11]. Assmus and Fritzlar [12] identify indicators such as reasoning, generalization, spatial imagination, and creative and flexible thinking. Pitta-Pantazi et al. [13] propose a structure encompassing both mathematical ability and creativity. Creativity, related to advanced mathematical thinking involving insight-based problem-solving, is also a critical component [14, 15].

2.2. Cognitive and non-cognitive factors

Identifying mathematically talented students involves assessing specific factors. Research indicates that these students often outperform their peers in cognitive aspects, such as information processing speed and working memory [8, 16, 17]. Beyond cognitive factors, such as high IQ and rapid learning, non-cognitive factors—including personality, motivation, and domain interest—are increasingly recognized as necessary conditions for realizing intellectual potential [18]. Heyd-Metzuyanim and Hess-Green [19] add social and cultural perspectives, emphasizing speed and ease of problem-solving, outstanding ideas, perseverance, response to challenges, and depth of engagement. While testing is a common identification method across countries, concerns about omissions still exist. A multifaceted approach is advocated, considering academic achievement, creativity, nonintellectual factors, and situational variables through a multichannel, multistep identification process, potentially supported by comprehensive diagnostic systems and consulting services [20, 21].

2.3. Educational models for gifted students

Gifted education is crucial for cultivating top-notch, innovative talent, especially given the global demand; yet, significant disparities exist in its development worldwide. Developing countries often prioritize universal primary education, and constrained funding has led to gifted education being a relatively recent and neglected area within their systems [22]. For instance, China faces challenges such as an imperfect talent training system, limited program participation, inadequate teacher capacity, weak support systems, and a lack of legal protection, with research often focusing on theory rather than empirical evaluation [23]. In contrast, developed countries like the United States have longer-established programs that are often supported by legislation and financial security at the national and state levels. Nevertheless, a key global research focus remains on enhancing gifted education models, particularly with regard to teacher roles. Leikin [24] outlines essential teacher qualities for gifted education, including creativity, passion for the subject, deep understanding of gifted psychology, effective teaching methods, and specific experience. However, research on developing these qualities in teachers is limited [25].

2.4. The role of technology in gifted education

Educational technology offers significant potential for improving gifted education. Several frameworks exist for its application. Pyryt [26] proposes five key dimensions for enhancement: learning speed, developing high-level process skills, fostering learning enthusiasm, product development, and peer interaction. Ng and Nicholas [27] emphasize the importance of dialogue and concept formation within online learning environments. The integration of such technology is seen as pivotal for creating new directions, possibilities, and enhancing the quality of gifted education [28].

3. Research Methodology

3.1. Research framework

There are many effective research frameworks for studying gifted students around the world. Milgram and Hong [29] propose a "4 × 4 gifted structure" model, which divides individual abilities into four performance levels and four performance types. It is noted that measuring creative thinking and leisure activities may be more effective in predicting life achievement than measuring intelligence and academic achievement. However, the model does not consider the stages of individual development. In a follow-up study on the scientific and technological creativity of gifted students, Hany [30] proposes a "hypothetical causality of scientific and technological creativity" model to explain the development of gifted students' creativity in these areas. Unfortunately, the results show that this model cannot effectively predict standard variables. Gagné [31] proposes a differentiated model of talent and ability development, distinguishing between these two concepts that are often confused. He considers the impact of their interaction, including opportunities, interpersonal relationships, and the environment, as well as the relationship between learning and practice on talent development [31]. The framework prioritizes opportunity as the most critical influencing factor and overemphasizes the value of opportunity.

It is worth noting that the educational productivity theory proposed by Walberg has been continuously refined in subsequent studies [32, 33]. The model describes the impact of synergy among multidimensional elements on complex human learning, which consists of nine factors organized into three dimensions: aptitude (ability, development, motivation), instruction (quality, quantity), and environment (home, classroom, peers, media) [34]. In the tracking study of gifted students, the above models are mainly used in two ways: (1) as an organizational model for collecting data and (2) as a reference for the tested path model. Based on these models, Campbell [35] developed a research framework to track the professional development of participants in transnational mathematics competitions. He designed detailed survey tools to determine which factors promoted the development of mathematical achievement in mathematics contestants through questionnaires and interviews. These factors involve three aspects: family, school, and mathematics competitions. Because the framework and its corresponding tools have been tested for reliability and validity, the framework can serve as a basis for modifying the tools to meet specific needs. These modified tools can then be directly applied to other research.

Although the educational productivity model has been developed over many years and forms the basis of some new frameworks, it was initially developed, and many of its variables are no longer applicable. The value of this framework lies in helping to build a framework for this study, in which the path model that the data have verified helps design a preliminary evaluation tool. Based on the purpose of this study and Walberg's educational productivity model, a questionnaire survey will be conducted on four variables related to winning the mathematics competition: personal characteristics (including personal traits), environmental characteristics, gifted teaching (i.e., mathematics competition training), and professional development achievements.

3.2. Research methods

This study is a follow-up investigation that examines the same group of objects at different time points to collect data. Then, through the statistical analysis of the data obtained before and after the survey, the changes in social phenomena and the causal relationships between different phenomena play an essential role in exploring complex social phenomena and answering all theoretical and practical questions. The researcher conducts a quantitative analysis based on the follow-up study and concludes from the questionnaire data.

In this study, professional development achievements are measured by the publication of high-level papers, published works, patents, awards, professional licenses, or certificates, serving as indicators to describe the current state of professional development among the winners of mathematics competitions. Six questions were designed to assess the satisfaction of gifted students with their studies, career, and income, categorized into five levels ranging from "very dissatisfied" to "very satisfied."

Personal traits are characterized by perfectionism, goal setting, commitment, creativity, and emotional response. Three items measure each variable, and the average score (retain the integer part) of the three items is taken as the item's score. Take perfectionism as an example, three measurement items were set up: "Whether it is a job I am good at or not, I will try my best to be perfect"; "If things don't turn out as expected, I will be very disappointed"; and "Even if I complete something, I will still be bothered by flaws in the process or details." Each item is assigned a score of 1 to 5, ranging from "very inconsistent" to "very consistent."

In this study, gifted teaching primarily refers to mathematics competition teaching, including the experience of participating in mathematics competitions and winning prizes, as well as individual perspectives on these activities. Based on the level of awards received and the degree of individual recognition for mathematics competition training and participation experience, the higher award level corresponds to the higher the assignment score. The higher the individual recognition of the mathematics competition experience, the higher the score, which ranges from 1 to 5. Among them, individual recognition of mathematics competitions refers to the acknowledgment that mathematics competitions have a positive impact on learning ability, achievement motivation, career choice, career achievement, and academic achievement, which is divided into 1 to 5 according to the degree of recognition of the mathematics competitions.

3.3. Participants and process

The participants are the winners of previous mathematics competitions who participated in the mathematics competition for Chinese middle school students about ten years ago and won more than the second prize in the provincial competition. The study utilized an online questionnaire for data collection, with participation being entirely voluntary. The researcher contacted some mathematics competition coaches in various provinces and cities, who then sent research invitations to the research participants. After contacting the participants, they were invited to fill in the questionnaire.

The basic process of this study is as follows: (1) to design research methods and tools according to the research purpose; (2) to select research samples for investigation; (3) to collect and organize data; and (4) to analyze the data, summarize the findings, and put forward suggestions. The statistical methods employed in this study primarily involved descriptive statistics, with SPSS and Excel utilized for data processing.

4. Research Results

4.1. Demographic data

A total of 153 questionnaires were collected in this study, of which 116 were valid. The winners of mathematics competitions in the sample graduated from high school between 2008 and 2015, with a main concentration between 2010 and 2014 (98). Among the 116 delegates were 106 boys, 9 girls, and 1 delegate of unspecified gender; the number of boys was significantly more than that of girls. Twenty-five winners were outside China when they filled out the questionnaire, including 21 in the United States, 3 in Canada, and 1 in France. Most of the winners within China's territory are currently based in Beijing (25), Shanghai (27), Changsha (8), and Shenzhen (7). The percentage of people living abroad is as high as 21.6%, and many of the winners of mathematics competitions are working or studying abroad.

4.2. The professional development of the winners of mathematics competitions

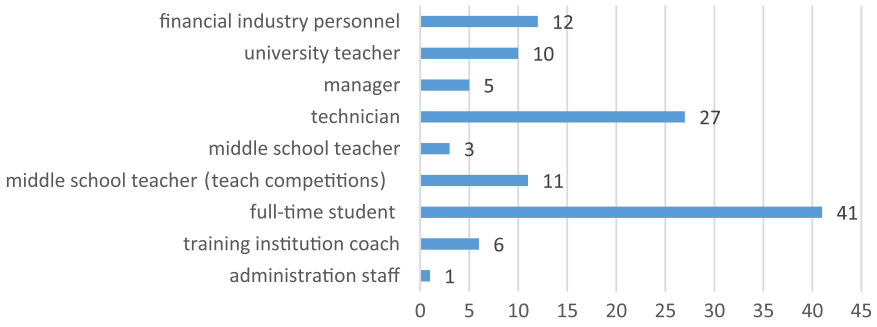
Among the participants, 35 held a bachelor's degree, 41 held a master's degree, and 40 held a doctoral degree. The percentage of people with a graduate degree was 69.8%. It can be observed that the winners of mathematics competitions tend to have a higher level of education. The percentage of mathematics majors with the highest academic qualifications of the winners of mathematics competitions is 49.4%, the percentage of majors in engineering and natural sciences is 39.7%, and a few are majors in economics and finance (9.5%) and education (2.6%) and other majors (0.9%). It can be seen that many winners of mathematics competitions still choose majors related to mathematics and technology, and the proportion of people who choose mathematics majors is the highest. This may be related to their interest in mathematics from an early age.

Figure 1 shows that when the winners filled out the questionnaire, 41 were still in the full-time study stage, 27 were engaged in technology research and development work, 12 were in the financial industry, and 14 were teaching middle school mathematics. Moreover, among them, 11 are part-time school mathematics competition coaches, 10 are university teachers, 6 are mathematics competition coaches in training institutions, 5 are managers, and 1 is the administrative staff. The above data indicate that more award-winning students pursue jobs in technology research and development, university (middle school) teaching, mathematics competition-related training, and financial industry. Nearly one-third of the winners choose to pursue higher degrees, and a similar proportion choose to work in education. It can be observed that most winners choose careers related to mathematics.

4.3. The achievements of the winners of mathematics competitions

To some extent, published papers included in the Web of Science and other critical scientific research databases reflect the academic ability of the winners of the mathematics competition. Nearly half of the winners have published high-level papers. Among them, 41 people participated in publishing 1–5 high-level papers, accounting for 35.3% of the total number of papers. Forty-three people published 1–5 high-level papers as the first author, accounting for 37.1%, and five people participated in publishing 6–10 high-level papers, accounting for 4.3%. Six people published 6–10 high-level papers as the first author, accounting for 5.2%, and seven people participated in publishing more than ten high-level

Figure 1
The occupation of the winners of mathematics competitions



papers, accounting for 6%. One person published over ten high-level papers and was listed as the first author, accounting for 0.9%. In terms of publishing high-level papers, the winners of mathematics competitions have achieved notable successes, with some winners publishing more than five articles.

Figure 2
Statistics on the certificates obtained by the winners of mathematics competitions

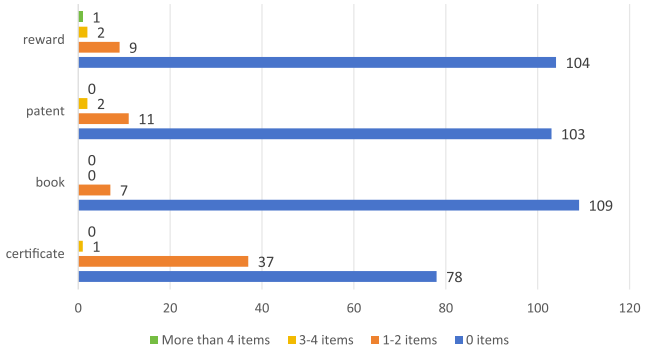


Figure 2 illustrates that outstanding award-winning students possessed specific characteristics in obtaining various vocational certificates, awards, patents, and works. The number of people with rewards accounted for 10.3%. Eleven people obtained 1–2 patents, and two obtained 3–4 patents, accounting for 11.2% of the total. The number of people who published books is 7, accounting for 6%. The majority of people hold professional certificates, accounting for 32.8%. In addition to professional certificates, the winners with the highest percentage held patents, while those with the lowest percentage had written books. Generally speaking, compared with ordinary students, the winners of mathematics competitions account for a high proportion of obtaining certificates and patents.

4.4. The income of the winners of mathematics competitions and their satisfaction with their careers

According to the income report of the China Household Financial Research and Research Center, the per capita income is classified into 11 grades. The number of people earning more than 5000 yuan shall not exceed 80 million. There is also a particular gap in income between different regions. Compared to the general population, the monthly income of math competition winners is significantly higher. As shown in Figure 3, 26 winners (22.4%) earn more than 40,000 yuan a month, 13 winners (11.2%) earn between 30,000 and 35,000 yuan, 8 winners (6.9%) earn between 25,000 and 30,000 yuan, and 10 winners (8.6%) earn between 20,000 and 25,000 yuan a month. Nearly 50% of the winners have a monthly salary above 20,000 yuan. Moreover, the proportion of people with a monthly salary of 40,000 yuan or more is the largest, far exceeding the income of the general population. At the same time, it is worth noting that there are 14 individuals with a monthly income of less than 5,000 yuan.

Figure 4 shows the income, academic, and career satisfaction of the mathematics competition winners. Regarding income, 74 respondents reported satisfaction, resulting in an overall satisfaction rate of 63.8%. Regarding schoolwork, 89 people were satisfied, resulting in a satisfaction rate of 76.7%. Regarding careers, 75 people were satisfied, with a satisfaction rate of 64.7%. There is little difference in satisfaction among the three aspects. Most mathematics competition winners are satisfied with their income, studies, and careers.

4.5. The personal characteristics of the winners of mathematical competitions

The reliability of the personal trait questionnaire is 0.797, which exceeds 0.6, indicating good reliability and validity. The 18

Figure 3
Monthly income of the winners of mathematics competitions (RMB)

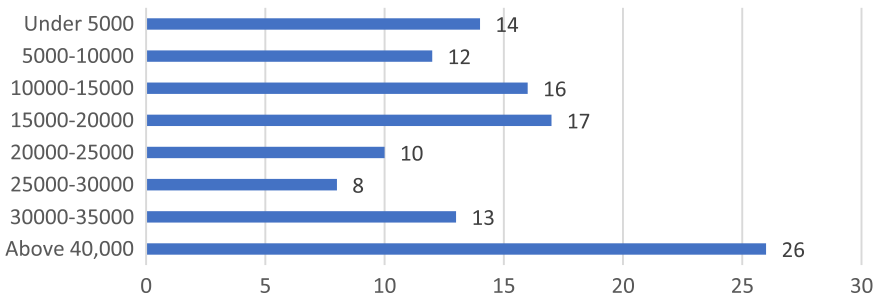
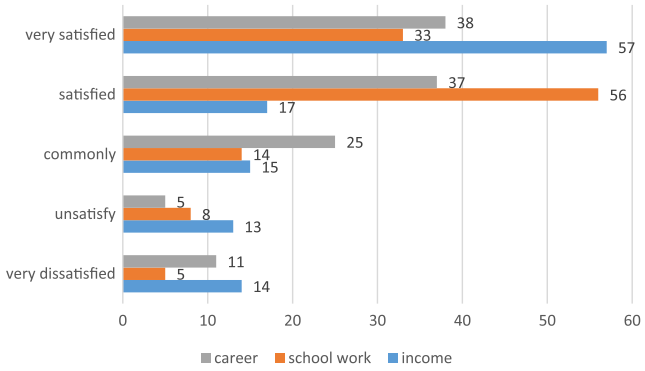


Figure 4
The satisfaction of the mathematics competition winners with their income, school work, and career



questions in the questionnaire involve six variables: perfectionism, goal setting, achievement motivation, commitment, creativity, and emotional response. Perfectionism includes the title Q1, Q2, and Q3; goal setting includes Q4, Q5, and Q6; achievement motivation includes Q7, Q8, and Q9; commitment includes Q10, Q11, and Q12; creativity includes Q13, Q14, and Q15; and emotional response includes topic Q16, Q17, and Q18.

The statistics of the number of scores in each item of personal characteristics are shown in Table 1. In terms of perfectionism, 95.6% of people scored three or higher, 96.6% scored three or higher in goal setting, 85.3% scored three or higher in achievement motivation, and 97.4% scored three or higher in terms of commitment. Regarding creativity, people with a score of 3 or higher accounted for 96.6%; 68.1% of people scored three or higher on the emotional response.

To sum up, the high-to-low scores are commitment, creativity, goal setting, perfectionism, achievement motivation, and emotional response. It can be seen that most of the winners of mathematics competitions are very devoted to mathematics learning and do not give up easily when they encounter problems.

4.6. The growth environment of the winners of mathematical competitions

Environmental characteristics were analyzed with a focus on the educational attainment and professions of the parents of mathematics competition winners, as well as the influences of teachers and peers. The parental occupational distribution reveals a predominance of intellectual professions: 10 winners had parents who were both employed as teachers, 28 had one teacher–parent, 21 had one engineer parent, and 18 had one civil servant parent. Other parental occupations included employees of state-owned enterprises, physicians, self-employed individuals, factory workers, and farmers, with only one case of both parents being farmers. Educational attainment data revealed that 36 winners had parents who both held bachelor's degrees, and 12 had parents who both held associate degrees. Among the remaining, 9 had one parent with a doctoral degree, 13 with a master's degree, 55 with a bachelor's degree, 24 with an associate degree, 15 with a technical secondary school diploma, 20 with a high school diploma, 11 with a junior high school education, and 5 with a primary school education. The parental population's high educational level—particularly bachelor's degrees, which were exceptional credentials during their era—suggests a correlation between parental academic achievement and their children's success in math competitions.

Additionally, the winners identified multiple influential figures in their competition journeys, with parents, coaches, teachers, and peer competitors during training being cited as the most impactful. Parents, high school math teachers, and graduate advisors were specifically named as critical contributors to their professional accomplishments.

4.7. The math competition winners' view on the mathematics competition

Participating in gifted mathematics training is significant. The mathematics competition winners ranked the learning attitudes, learning methods, subject/discipline ability improvement, career goals, making friends, expanding vision, understanding themselves, understanding others, and other meanings mentioned in the questionnaire to express the significance of participating in the excellent mathematics training. As can be seen in Table 2, the largest number of people put discipline ability in first place (34), making friends in second place (27), and subject ability in third place (27). Overall, the winners of mathematics competitions believe that the significance of participating in gifted mathematics training lies in improving their subject ability, making friends, and broadening their horizons.

Regarding the significance of participating in the mathematics competition, the questionnaire title is summarized into five aspects: learning ability, achievement motivation, career choice, career achievement, and academic achievement. The reliability of the questionnaire is 0.888, indicating a good level of reliability. As shown in Table 3, 102 people believe that participating in mathematics competitions significantly influences learning ability, accounting for 87.9%, and 88 people believe that participating in mathematics competitions significantly influences achievement motivation. Seventy-five people believe that participating in a mathematics competition has a significant influence on future career choices, accounting for 64.7%. In comparison, 79 people think that participating in a mathematics competition has a substantial influence on career achievement, accounting for 68.1%. Eighty-nine people believe that participating in mathematics competitions has a significant impact on academic achievement, accounting for 76.7%. In terms of the significance of participating in mathematics

Table 1
Personal trait scores of outstanding award-winning students

Score	Perfectionism	Goal setting	Achievement motivation	Commitment	Creativity	Emotional response
1	1	0	2	0	1	1
2	4	4	15	3	3	36
3	36	45	41	38	34	61
4	63	52	50	50	50	18
5	12	15	8	25	28	0

Table 2
The significance of participating in gifted mathematics training

Ranking	Attitude to learning	Learning method	Discipline ability	Career goals	Make friends	Broaden the horizon	Understand yourself	Know others	Other meaning
1	22	21	34	6	15	12	1	0	5
2	10	24	16	2	27	26	7	4	0
3	9	7	27	5	26	22	13	7	0

Table 3
The significance of participating in a mathematical competition

Level	Learning ability	Achievement motivation	Career choice	Career achievement	Scholastic achievement
Very low	1	2	11	5	5
Lower	1	3	5	11	8
Neutral	12	23	25	21	14
Higher	45	49	37	52	56
Very high	57	39	38	27	33

competitions, the winners believe that the influence of learning ability is the highest and that career choice is the lowest.

In addition, as many as 52 of the award-winning students believe they would not have achieved their current successes without participating in mathematics competitions, and 30 believe they could have achieved their current successes without them. Among them, 110 people think that mathematics competitions motivate them, and most think that mathematics competitions have no negative effects.

5. Conclusion and Discussion

Based on the educational productivity model, descriptive statistics were used to analyze the current situation of the mathematics competition winners, including professional and career development, outcomes and achievements, income status, and satisfaction with their studies and careers. It also examined the personal characteristics of mathematics competition winners, their educational environment, and their perspectives on gifted education.

Regarding professional and career development, most winners of mathematics competitions hold postgraduate degrees, and many continue to pursue further studies abroad [36]. Many people choose majors related to science and technology, and the proportion of students majoring in mathematics is also high. More people are choosing jobs in technology research and development, university teaching (including middle school), mathematics competition-related training, and careers in the financial industry. They choose jobs mainly considering their interests, sense of professional fulfillment, job satisfaction, and income potential. A longitudinal study of German schools reveals that 3–5 years after participating in mathematics competitions, students continue to experience a positive impact on their self-concept, learning interests, and learning habits [37]. Self-concept influences personal self-positioning, learning interests shape the direction of development, and study habits also impact work habits, all of which can significantly influence the choice of major and career.

In terms of income, many who have already worked have a high monthly income, much higher than that of ordinary people. However, it should also be noted that the monthly income of a small number of competition winners is not very high, which may be related to the regional disparity between the rich and the poor. It may also be that everyone's pursuit is different. Some people pursue a more comfortable life, while others strive for a higher quality of life. Income is affected by many factors and cannot fully reflect a person's ability.

Compared to ordinary students, most winners of mathematics competitions possess stronger scientific research abilities. They have published more high-level papers, some of which are very productive. Moreover, acquiring certificates, patents, and other intellectual property rights accounts for a high proportion. As a form of creative expression, patent is considered one of the most objective criteria [38]. To some extent, it reflects the individual's ability. Additionally, most winners are satisfied with their academic and career development, while only a few are dissatisfied.

This study examines the characteristics of outstanding winners in mathematics competitions through a questionnaire that assesses personal traits. Personal traits will also affect the future development of individuals. The study highlighted that individuals tend to adopt a consistent personality in both their personal and work environments [39]. Therefore, studying individual traits is essential for tracking the winners' development trajectory of the competitions. The six factors examined in this study are perfectionism, creativity, commitment, achievement motivation, goal setting, and emotional response. Ervynck [40] argues that creativity is a crucial component of problem-solving related to higher-level mathematical thinking. The tendency toward perfectionism among gifted students is higher than that of average students [41]. Their level of motivation, resilience to stress, or emotional responses may differ from those of the average students, especially if they have high expectations for a particular activity or are highly involved in it [42]. Thus, it is necessary to analyze the individual characteristics of the winning students. This study demonstrates that mathematics competition winners exhibit self-recognition in perfectionism, goal setting, achievement motivation, commitment, creativity, and emotional response. Most mathematics competition winners are perfectionists and creative. They possess flexible thinking, strong learning abilities, perseverance, self-confidence, diligence, talent, a love of thinking, and the capacity to calm down. Additionally, they are careful, patient, and self-controlled.

In gifted education, participating in mathematics competitions plays a crucial role in shaping learning attitudes, learning methods, and improving subject ability, as well as fostering friendships and broadening the vision of mathematics competition winners. In particular, research has shown that even brief encounters with peers who share similar interests, passions, and intelligence levels can have a positive impact on gifted teens' self-concept, peer status, and life goals. Gifted education provides an optimal learning environment [43]. Their learning and logical abilities can be enhanced after participating in mathematics competition tutoring. The mathematics learning competitions benefit their creative consciousness, improve their thinking ability, and develop their self-learning skills.

Regarding the environment, most winners' parents are intellectuals with higher education. Research shows that environmental factors undoubtedly influence an individual's performance, and there is evidence that genetic factors may also play a role [44]. These winners also cited their class teachers or coaches as greatly influencing them [45]. Mathematics competition training has higher requirements for teachers. Teachers and coaches play an important guiding role. Teachers with professional qualities in mathematics competitions should be encouraged to develop professionally.

This study focuses on an in-depth examination of the professional development trajectories exhibited by winners of mathematics competitions, whose distinctive domain-specific attributes inherently dictated the adoption of purposive sampling methodologies. Consequently, the research findings are predominantly relevant to specific cohorts of gifted students who have a track record of success in contests and similar elite educational settings. However, a systematic exploration remains imperative to delineate the developmental trajectories of a more expansive array of gifted students (e.g., noncompetitive mathematical specialists), as well as those students who do not fall within the gifted category.

Furthermore, the dataset underpinning this study predominantly draws upon self-reported perspectives from participants, thereby leaving other potential influential factors, such as early learning experiences, relatively underexplored. In light of these considerations, future research endeavors could be directed toward the following avenues: (1) constructing an early learning and growth profile for mathematically gifted students, to scrutinize the impact of early learning experiences on their developmental progression; (2) undertaking longitudinal follow-up case action research to elucidate the professional development pathways traversed by mathematically gifted students; and (3) investigating the distinctive features characterizing the professional development of the broader gifted student population and non-mathematically gifted students, while concurrently conducting comparative tracking studies across diverse gifted student categories.

Funding Support

This research was funded by a grant from the Hunan Provincial Department of Education (The Second Hunan Province Basic Education Teaching Reform Project: A Study on the Professional Development of the Winners of Middle School Students in Subject Competition), grant number Y2024906.

Ethical Statement

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of Hunan Normal University (Approval No. 2024321; Date: March 13, 2024).

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

Due to the involvement of participants' private data in this study, data sharing is not applicable to this article.

Author Contribution Statement

Peijie Jiang: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition. **Wenqian Lin:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization.

References

[1] Al-Ansari, A. M., Al-Hilal, A. J., & Alansari, A. E. (2025). Public school principals' role in supporting mathematically gifted students by equipping them with 21st-century skills. *Quality Assurance in Education.* Advance online publication. https://doi.org/10.1108/QAE-01-2025-0001

[2] Chang, C.-C., & Yu, H.-P. (2021). Gāozhōng kēxué bān bìyè shēng zhī zhuīzōng yánjiū: Dàxué xuéxí bià oxiàn yǔ shēngyá fāzhǎn zhī tàntǎo [Follow-up study on college learning performance and career development of science class graduates]. *Journal of Research in Education Sciences*, *66*(1), 173–202.

[3] Lakin, J. M., & Wai, J. (2020). Spatially gifted, academically inconvenienced: Spatially talented students experience less academic engagement and more behavioural issues than other talented students. *British Journal of Educational Psychology*, *90*(4), 1015–1038. https://doi.org/10.1111/bjep.12343

[4] Olton-Weber, S., Hess, R., & Ritchotte, J. A. (2020). Reducing levels of perfectionism in gifted and talented youth through a mindfulness intervention. *Gifted Child Quarterly*, *64*(4), 319–330. https://doi.org/10.1177/0016986220953392

[5] Wai, J., Bardach, L., & Tran, B. (2022). What longitudinal research and large-scale population representative studies can tell us about gifted students and education policy 50 years after the Marland Report. *Journal for the Education of the Gifted*, *45*(1), 46–63. https://doi.org/10.1177/01623532211063942

[6] Wai, J., Kell, H. J., & Worrell, F. C. (2024). Method considerations for school psychology from longitudinal research on gifted students. *Journal of School Psychology*, *103*, 101269. https://doi.org/10.1016/j.jsp.2023.101269

[7] Bernstein, B. O., Lubinski, D., & Benbow, C. P. (2021). Academic acceleration in gifted youth and fruitless concerns regarding psychological well-being: A 35-year longitudinal study. *Journal of Educational Psychology*, *113*(4), 830–845. https://psycnet.apa.org/doi/10.1037/edu0000500

[8] Lubinski, D., & Benbow, C. P. (2006). Study of mathematically precocious youth after 35 years: Uncovering antecedents for the development of math-science expertise. *Perspectives on Psychological Science*, *1*(4), 316–345. https://doi.org/10.1111/j.1745-6916.2006.00019.x

[9] Gagné, F. (2021). Implementing the DMGT's constructs of giftedness and talent: What, why, and how? In S. R. Smith (Ed.), *Handbook of giftedness and talent development in the*

Asia-Pacific (pp. 71–99). Springer Singapore. https://doi.org/10.1007/978-981-13-3041-4_3

[10] Erdogan, A., & Yemenli, E. (2019). Gifted students' attitudes towards mathematics: A qualitative multidimensional analysis. *Asia Pacific Education Review*, *20*(1), 37–52. https://doi.org/10.1007/s12564-018-9562-5

[11] Subotnik, R. F., Pillmeier, E., & Jarvin, L. (2009). The psychosocial dimensions of creativity in mathematics: Implications for gifted education policy. In A. Berman, B. Koichu, & R. Leikin (Eds.), *Creativity in mathematics and the education of gifted students* (pp. 165–179). Brill. https://doi.org/10.1163/9789087909352_012

[12] Assmus, D., & Fritzlar, T. (2022). Mathematical creativity and mathematical giftedness in the primary school age range: An interview study on creating figural patterns. *ZDM – Mathematics Education*, *54*(1), 113–131. https://doi.org/10.1007/s11858-022-01328-8

[13] Pitta-Pantazi, D., Christou, C., Kontoyianni, K., & Kattou, M. (2011). A model of mathematical giftedness: Integrating natural, creative, and mathematical abilities. *Canadian Journal of Science, Mathematics and Technology Education*, *11*(1), 39–54. https://doi.org/10.1080/14926156.2011.548900

[14] Kholid, M. N., Mahmudah, M. H., Ishartono, N., Putra, F. G., & Forthmann, B. (2024). Classification of students' creative thinking for non-routine mathematical problems. *Cogent Education*, *11*(1), 2394738. https://doi.org/10.1080/2331186X.2024.2394738

[15] Marsitin, R., Sa'dijah, C., Susiswo, S., & Chandra, T. D. (2022). Creative mathematical reasoning process of climber students in solving higher order thinking skills geometry problems. *TEM Journal*, *11*(4), 1877–1886.

[16] Berkowitz, M., Edelsbrunner, P., & Stern, E. (2022). The relation between working memory and mathematics performance among students in math-intensive STEM programs. *Intelligence*, *92*, 101649. https://doi.org/10.1016/j.intell.2022.101649

[17] Sugiman, S., Rızkıanto, I., & Pujıasti, E. (2020). Artistically talented students' perceptions of mathematics: View, interest, competence, and relevance. *Journal for the Education of Gifted Young Scientists*, *8*(3), 1247–1261. https://doi.org/10.17478/jegys.762677

[18] Savenkov, A. I. (2021). Cognitive and non-cognitive determinants of academic and life success. In *The 2nd International Scientific and Practical Online Conference "Psychology of Giftedness and Creativity" 2020, 117*, 01001. https://doi.org/10.1051/shsconf/202111701001

[19] Heyd-Metzuyanim, E., & Hess-Green, R. (2020). Valued actions and identities of giftedness in a mathematical camp. *International Journal of Science and Mathematics Education*, *18*(7), 1311–1331. https://doi.org/10.1007/s10763-019-10013-4

[20] Abdrakhmanov, R., Zhaxanova, A., Karatayeva, M., Niyazova, G. Z., Berkimbayev, K., & Tuimebayev, A. (2024). Development of a framework for predicting students' academic performance in STEM education using machine learning methods. *International Journal of Advanced Computer Science and Applications*, *15*(1), 38–46. https://doi.org/10.14569/IJACSA.2024.0150105

[21] Kaufman, S. B., & Sternberg, R. J. (2008). Conceptions of giftedness. In S. I. Pfeiffer (Ed.), *Handbook of giftedness in children: Psychoeducational theory, research, and best practices* (pp. 71–91). Springer US. https://doi.org/10.1007/978-0-387-74401-8_5

[22] Mhlolo, S. V., & Mhlolo, M. (2024). Support given to the gifted learner: Lessons from selected primary schools in South Africa and Zimbabwe. *Advances in Social Sciences and Management*, *2*(11), 28–46. https://doi.org/10.63002/assm.211.634

[23] Zhang, Z. (2017). Gifted education in China. *Cogent Education*, *4*(1), 1364881. https://doi.org/10.1080/2331186X.2017.1364881

[24] Leikin, R. (2021). When practice needs more research: The nature and nurture of mathematical giftedness. *ZDM – Mathematics Education*, *53*(7), 1579–1589. https://doi.org/10.1007/s11858-021-01276-9

[25] Karp, A. (2010). Teachers of the mathematically gifted tell about themselves and their profession. *Roeper Review*, *32*(4), 272–280. https://doi.org/10.1080/02783193.2010.485306

[26] Pyryt, M. C. (2009). Recent developments in technology: Implications for gifted education. In L. V. Shavinina (Ed.), *International handbook on giftedness* (pp. 1173–1180). Springer. https://doi.org/10.1007/978-1-4020-6162-2_60

[27] Ng, W., & Nicholas, H. (2007). Conceptualizing the use of online technologies for gifted secondary students. *Roeper Review*, *29*(3), 190–196. https://doi.org/10.1080/02783190709554408

[28] McCabe, K. O., Lubinski, D., & Benbow, C. P. (2020). Who shines most among the brightest?: A 25-year longitudinal study of elite STEM graduate students. *Journal of Personality and Social Psychology*, *119*(2), 390–416. https://psycnet.apa.org/doi/10.1037/pspp0000239

[29] Milgram, R. M., & Hong, E. (1993). Creative thinking and creative performance in adolescents as predictors of creative attainments in adults: A follow-up study after 18 years. *Roeper Review*, *15*(3), 135–139. https://doi.org/10.1080/02783199309553487

[30] Hany, E. A. (1994). The development of basic cognitive components of technical creativity: A longitudinal comparison of children and youth with high and average intelligence. In R. F. Subotnik & K. D. Arnold (Eds.), *Beyond Terman: Contemporary longitudinal studies of giftedness and talent* (pp. 115–154). Ablex.

[31] Gagné, F. (2004). Transforming gifts into talents: The DMGT as a developmental theory. *High Ability Studies*, *15*(2), 119–147. https://doi.org/10.1080/1359813042000314682

[32] Bentsi-Enchill, F. (2024). Teachers' role and factors hindering Ghanaian high school students' academic performance using Walberg's educational productivity. *Cogent Education*, *11*(1), 2393924. https://doi.org/10.1080/2331186X.2024.2393924

[33] Walberg, H. J. (1981). A psychological theory of educational productivity. In F. H. Farley & N. Gordon (Eds.), *Psychology and education* (pp. 81–110). McCutchan.

[34] Walberg, H. J. (1984). Improving the productivity of America's schools. *Educational Leadership*, *41*(8), 19–27.

[35] Campbell, J. R. (1994). Developing cross-cultural/cross-national instruments: Using cross-national methods and procedures. *International Journal of Educational Research*, *21*(7), 675–684. https://doi.org/10.1016/0883-0355(94)90040-X

[36] Yuret, T. (2024). Career paths of the International Mathematics Olympiad (IMO) medalists. *Scientometrics*, *129*(6), 3469–3491. https://doi.org/10.1007/s11192-024-05042-y

[37] Neber, H., & Heller, K. A. (2002). Evaluation of a summer-school program for highly gifted secondary-school students: The German Pupils Academy. *European Journal of*

Psychological Assessment, *18*(3), 214–228. https://psycnet.apa.org/buy/2002-06643-005

[38] Liu, J., Banda, L. O. L., Lyu, W., Shuang, M. S., & Chen, C. (2024). Assessing the relation between academic talent mobility and academic output. *Heliyon*, *10*(20), e39437. https://doi.org/10.1016/j.heliyon.2024.e39437

[39] Ones, D. S., Stanek, K. C., & Dilchert, S. (2025). Beyond change: Personality-environment alignment at work. *International Journal of Selection and Assessment*, *33*(1), e12507. https://doi.org/10.1111/ijsa.12507

[40] Ervynck, G. (2002). Mathematical creativity. In D. Tall (Ed.), *Advanced mathematical thinking* (pp. 42–53). Springer. https://doi.org/10.1007/0-306-47203-1_3

[41] Pyryt, M. C. (2010). Helping gifted students cope with perfectionism. In J. L. Jolly, D. J. Treffinger, & T. F. Inman (Eds.), *Parenting gifted children: The authoritative guide from the National Association for Gifted Children* (pp. 546–554). Routledge.

[42] Burkett-McKee, S., Knight, B. A., & Vanderburg, M. A. (2021). Psychological well-being of students with high abilities and their school's ecology: Is there a relationship? *Roeper Review*, *43*(3), 197–211. https://doi.org/10.1080/02783193.2021.1923593

[43] Townend, G., Jolly, J. L., & Chew, A. (2024). Professional development in gifted education: A systematic literature review. *Australian Journal of Teacher Education*, *49*(6), 76–104.

[44] Pezzuti, L., Farese, M., Dawe, J., & Lauriola, M. (2025). The role of parental education, intelligence, and personality on the cognitive abilities of gifted children. *Journal of Intelligence*, *13*(2), 12. https://doi.org/10.3390/jintelligence13020012

[45] Lv, S., He, Y., Xiong, B., & Wu, Y. (2024). Stress in Chinese teachers who teach the mathematically gifted: A qualitative perspective. *Frontiers in Psychology*, *15*, 1388236. https://doi.org/10.3389/fpsyg.2024.1388236

How to Cite: Jiang, P., & Lin, W. (2025). The Professional Development of Gifted Students in Mathematics: A Follow-Up Study of the Winners of Mathematics Competitions. *International Journal of Changes in Education*. https://doi.org/10.47852/bonviewIJCE52025942