The Antecedents of Olympiad Success for Science Olympiad Competitors: Analysis of High School Students in Kazakhstan

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AUTHOR AGREEMENT

Author’s signature: Date: 22.04.2024

DECLARATION

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Madiyar Abdilradov

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Yours sincerely,

Aliya Kuzhabekova

On behalf of:

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ABSTRACT

The Antecedents of Olympiad Success for Science Olympiad Competitors: Analysis of High School Students in Kazakhstan

This thesis investigates the relationship between academic and demographic factors and the success of high school students in Science Olympiads in Kazakhstan. This study uses a quantitative secondary data analysis approach to analyze data from a specialized school in Astana to identify key predictors of Olympiad performance. The research is grounded in the hypothesis that specific, quantifiable factors such as GPA, standardized test scores, and the number of advanced courses taken are closely linked to students' success in these rigorous academic competitions. The methodology involves a thorough statistical examination of the data set, ensuring anonymity and ethical consideration throughout the process. Descriptive statistics provide a detailed account of the student's academic and demographic profiles, while an independent samples t-test was used to compare the difference between the two groups; inferential statistics reveal the strength and nature of the relationships between these profiles and Olympiad outcomes. The results indicate that some academic indicators are significant predictors of Olympiad success, with implications for educators, policymakers, and stakeholders in the realm of gifted education. The discussion contextualizes these findings within the broader educational landscape of Kazakhstan, considering the implications for enhancing academic support structures and policies to foster talent effectively. By delineating the academic and demographic characteristics that contribute to Olympiad success, this thesis contributes to a more nuanced understanding of educational excellence. It offers strategic insights for the development of future educational initiatives and programs in Kazakhstan.

Аңдатпа

Жаратылыстану Пәндері Бойынша Олимпиада Қатысушылары Үшін Олимпиада Жетістіктерінің Алғышарттары: Қазақстандағы Жоғары Сынып Оқушыларының Талдауы

Тезис академиялық және демографиялық факторлардың жоғары сынып оқушыларының Қазақстандағы пәндік олимпиадалардағы жетістіктеріне байланысын қарастыруға арналған зерттеу еңбегі болып табылады. Бұл зерттеу олимпиада нәтижелерінің негізгі болжаушыларын анықтау үшін Астана қаласындағы мамандандырылған мектептің деректерін талдау үшін сандық деректерді талдау тәсілін пайдаланады. Зерттеу GPA, стандартталған сынақ ұпайлары және қатысқан қосымша курстардың саны сияқты нақты, сандық факторлар студенттердің күрделі академиялық жарыстардағы жетістіктерімен тығыз байланысты деген гипотезаға негізделген. Әдістеме бүкіл процесс барысында құпиялық пен этикалық нормаларды қамтамасыз ете отырып, деректер жиынтығын мұқият статистикалық талдаудан тұрады. Сипаттамалық статистика оқушылардың академиялық және демографиялық профильдері туралы егжей-тегжейлі есеп береді, ал екі топ арасындағы айырмашылықты салыстыру үшін t-тесті қолданылды; қорытынды статистика осы профильдер мен олимпиада нәтижелері арасындағы қатынастардың сипатын ашады. Зерттеу нәтижелері бойынша кейбір академиялық көрсеткіштер олимпиада жетістіктерінің маңызды болжаушылары болып табылады. Қорыта келе бұл тұжырымдар академиялық қолдау құрылымдары мен таланттарды тиімді дамыту саясатын жетілдірудің салдарын ескере отырып, Қазақстанның кең

білім беру ландшафтында, бұл тезис білім берудегі жетістіктерді тереңірек түсінуге ықпал етеді.

Аннотация

Предпосылки Успеха Участников Олимпиады по Естественным наукам: Анализ Старшеклассников Казахстана

В данной работе исследуется взаимосвязь между академическими и демографическими факторами и успехами старшеклассников на олимпиадах по естественным наукам в Казахстане. В этом исследовании используется подход количественного вторичного анализа данных для анализа данных специализированной школы в Астане с целью выявления ключевых факторов, влияющих на результаты олимпиады. Исследование основано на гипотезе о том, что конкретные, поддающиеся количественной оценке факторы, такие как средний балл, результаты стандартизированных тестов и количество пройденных курсов повышения квалификации, тесно связаны с успехом студентов в этих сложных академических конкурсах. Методология предполагает тщательную статистическую проверку набора данных, обеспечивая анонимность и соблюдение этических норм на протяжении всего процесса. Описательная статистика дает подробный отчет об академических и демографических характеристиках учащихся, в то время как для сравнения различий между двумя группами использовался независимый выборочный t-критерий; логическая статистика показывает силу и характер взаимосвязи между этими характеристиками и результатами олимпиады. Результаты показывают, что некоторые академические показатели являются важными предикторами успеха олимпиады, что имеет значение для педагогов, политиков и заинтересованных сторон в сфере образования одаренных детей. В ходе обсуждения эти выводы рассматриваются в контексте более широкого образовательного

ландшафта Казахстана, а также их значение для совершенствования структур академической поддержки и политики эффективного поощрения талантов. Описывая академические и демографические характеристики, которые способствуют успеху на олимпиадах, этот тезис способствует более глубокому пониманию качества образования. Он предлагает стратегическую информацию для разработки будущих образовательных инициатив и программ в Казахстане.

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1. Introduction

Background

In the arena of global education, academic competitions such as Science Olympiads have emerged as significant platforms that not only challenge and celebrate students' intellectual abilities but also contribute substantially to their personal growth and future academic trajectories. These competitions transcend mere tests of knowledge; they are instrumental in fostering innovation, critical thinking, and problem-solving skills that are crucial in today's increasingly complex and technology-driven world.

While the laurels won in these Olympiads are a matter of national pride, underscoring a country's educational standards and intellectual capital, the individual triumphs of students are pivotal in shaping their educational pathways and professional futures. For high-achieving students, particularly in countries like Kazakhstan, where educational rigor is married to a strong cultural ethos of excellence, the stakes and rewards of such competitions are indeed high.

However, despite their importance, there is a noticeable gap in our understanding of what exactly contributes to success in these high-stakes academic contests. A multitude of factors ranging from personal motivation, study habits, socio-economic background, school resources, and support systems are often speculated to interplay in determining the outcomes. Yet, the lack of concrete research leaves educators, policymakers, and students navigating a field rife with assumptions rather than evidence-based strategies.

This research seeks to fill that gap by systematically examining the antecedents of Olympiad success among high school students in Kazakhstan. By dissecting the varied and complex components that contribute to academic success in the competitive context of Science Olympiads, this study will provide valuable insights into the educational processes that best prepare students for excellence not only in competitions but in their academic and professional lives ahead.

Academic Olympiads stand at the crossroads of personal achievement and national progress, catalyzing the development of young talents into future innovators. The participation in such competitions offers more than academic accolades; it sets students on a trajectory towards impactful careers in science and technology, contributing significantly to the advancement of their fields and the knowledge-based economies of their nations. Studies have illuminated this trajectory, revealing how Olympiad winners are more likely to pursue specialized higher education and aspire to graduate degrees. Wu and Chen (2000) demonstrated that all participants from Taiwan in the Physics and Chemistry Olympiads attended top universities and remained committed to their scientific fields. Similarly, participation in the astronomy Olympiads has positively influenced career choices in astronomy and related sciences (Yim et al., 2011).

As Kazakhstan ventures further into the 21st century, fostering a STEM-proficient workforce is paramount for national development and prosperity. This urgency echoes the global trend towards STEM education, as witnessed in nations with robust STEM-based economies like Finland and the United States, where education policies actively nurture the school-to-industry pipeline (Erbolovna et al., 2019). These countries recognize the critical role that equitable access to education and opportunity plays in driving innovation and progress.

However, the question of equity in educational opportunities, particularly in the preparation for Olympiads, remains a pressing concern. Inequities in access can stem from varied socio-economic backgrounds, and without comprehensive knowledge of the antecedents of Olympiad success, talented students may not realize their full potential. The pursuit of understanding these antecedents transcends academic interest; it is a proactive step toward democratizing excellence in education. By identifying the strategies that lead to Olympiad success, we can ensure a more level playing field where every aspiring student can excel regardless of financial or social constraints. This study aims to dissect these antecedents to enhance Kazakhstan's intellectual capital and contribute to the global dialogue on fostering equity in education for all.

Kazakhstan's active engagement in international academic competitions, such as the International Biology Olympiad (IBO), exemplifies the nation's commitment to promoting excellence in science and education on a global platform. The government's support for Olympiad participants is part of a larger effort to continue a tradition of educational excellence that dates to the Soviet era.

During the Soviet period, a strong emphasis was placed on identifying and nurturing talent through academic competitions, which continues to influence educational policies in Kazakhstan today (Kukushkin, 1996). Current initiatives by the Kazakhstani government, as highlighted by the Vice-Minister of Education, underscore the importance of these competitions. Winners of these Olympiads are often awarded substantial recognition, including financial incentives, which surpasses the level of support provided in many other countries where rewards might be limited to books or university entrance (Morelis Hans, 2014).

This investment in intellectual competition aligns with Kazakhstan's broader educational policy narratives, which have been focusing on reforming and internationalizing education to adapt to a global context while preserving national values

(Fimyar & Kurakbayev, 2016). Meanwhile, top universities in the world are increasingly seeking talent and willfully provide large financial grants and scholarships to top universities for Olympiad winners. So, Kazakhstan will likely continue supporting students' participation in the movement.

Despite Kazakhstan's substantial investment in nurturing young talent through international academic competitions, a gap exists in understanding the specific mechanisms that lead to student success in these arenas. The nation has demonstrated a robust commitment to academic excellence, leveraging these competitions as a strategic element of a long-standing Soviet educational tradition of rigorous talent development (Fimyar & Kurakbayev, 2016; Sagyntay, 2022). However, uncharted territory remains in decoding the success formula that propels these students onto the international stage.

Kazakhstan's participation and success in Olympiads like the IBO are emblematic of the nation’s prowess in producing high-caliber talent. Yet, these students' specific pathways from local classrooms to international podiums are not clearly mapped. The lack of clarity on this journey hinders the ability to replicate success across the board, especially within regular schools that may not have access to the same resources or information as specialized educational institutions.

The core of the problem lies not only in identifying the talent but also in fostering it equitably across diverse socio-economic strata. By demystifying the antecedents of Olympiad success, we can offer actionable insights and strategies that regular schools can implement, ensuring all students can excel. This approach significantly improves equitability, as it empowers educators everywhere with the knowledge and tools necessary to support budding talent, irrespective of their background (Jumakulov & Ashirbekov, 2016).

The present study aims to fill this critical gap by investigating the variables that influence students' performance in Science Olympiads in Kazakhstan. By systematically analyzing these factors, this research will contribute to a more equitable distribution of opportunities and resources, allowing for a broader section of the student population to partake in and benefit from the nation's rigorous academic programs. The findings of this study will not only shed light on the nuances of academic coaching and preparation but also potentially inform policymaking to integrate effective practices across the country's educational landscape.

Research problem

While Kazakhstan actively supports its students in preparing for international academic Olympiads, a crucial question remains: How can this support be optimized for effectiveness? Understanding the antecedents of Olympiad success is not merely an academic pursuit; it is a strategy essential for national development in the realms of science, technology, engineering, and mathematics (STEM). Despite the significant role Olympiad winners play in advancing their fields and bolstering the nation's intellectual capital, there is a notable lack of comprehensive research on the factors that underlie their achievements (Sagyntay, 2022).

Internationally, studies have suggested that a confluence of individual, educational, and systemic factors contribute to academic success in Olympiads (Naumov, 2007). However, the specific interplay of these factors within the context of Kazakhstan remains underexplored. The historical legacy of the Soviet educational system, known for its rigorous talent cultivation, has transitioned into Kazakhstan's current educational policies. Yet, how this legacy translates into tangible outcomes in the post-Soviet era is a subject ripe for exploration (Fimyar & Kurakbayev, 2016).

The present research problem, therefore, is twofold: to identify and analyze the antecedents of Olympiad success among Kazakhstani students and to determine how these antecedents can be replicated across the nation's educational landscape to support equitable access to high-level competition preparation. Addressing this issue is vital for fostering a more inclusive environment where every talented student, regardless of their socio-economic background, can excel and contribute to the nation's scientific and innovative endeavors.

Purpose of the study

This study investigates the factors or predictors that influence the success of students participating in the Science Olympiad in Kazakhstan, particularly among high school students. This research intends to identify what contributes to their success in this prestigious competition.

By understanding these antecedents or factors, this study can potentially provide insights that can be used to support and improve students' preparation and performance in Science Olympiads. It can also contribute to the broader field of gifted education and STEM (Science, Technology, Engineering, and Mathematics) education in Kazakhstan, helping policymakers, educators, students, and parents understand how to optimize students' performance in science competitions.

Research Question

What are the key antecedents, among variable academic and demographic factors, that significantly predict success in the Science Olympiad among high school students in Kazakhstan?

To answer the question the research employed a quantitative methodology using secondary data analysis. Data on high school students' performance in Science Olympiads was collected from a school report, focusing on variables such as special preparation, math GPA, and teacher qualifications. Statistical analysis included descriptive statistics to characterize the data, t-tests to compare group means, ANOVA to examine between-group differences, and simple linear regression to investigate predictive relationships between the variables. Jamovi software was used for the analysis. The methods were chosen for their robustness in analyzing educational data and their ability to elucidate relationships between variables and outcomes.

Significance

The significance of this research lies in its multifaceted contribution to the educational community at both national and international levels. This study will fill a critical gap in scholarly knowledge by delving into the antecedents of success in Science Olympiads. Existing literature has not yet thoroughly articulated the pathways to success in these high-caliber academic competitions, especially within the context of Kazakhstan's educational system, which has been influenced by its Soviet legacy and recent policy reforms (Fimyar & Kurakbayev, 2016; Sagyntay, 2022).

This study will provide a detailed understanding of the factors that contribute to students' performance in Biology Olympiads. With a focus on Kazakhstan, the insights gained will apply to other countries seeking to enhance their educational strategies. The practical implications of the findings are extensive and diverse:

1. **Students** will gain insights into effective study strategies, critical thinking, and problem-solving techniques that have been proven to enhance performance in Olympiads.

2. **Educators** will benefit from a better understanding of identifying and nurturing potential, tailoring teaching methodologies, and providing resources aligned with the antecedents of Olympiad success.

3. **Policymakers** will be equipped with evidence-based recommendations that can guide the allocation of resources, the development of support programs, and the implementation of educational reforms to bolster the national talent pool.

4. **Parents** will be informed of the support and encouragement needed to foster their children's talents, which can help them make informed decisions regarding their educational investments.

5. Studies suggest that participating in Science Olympiads and educational competitions like the World Robot Olympiad can reinforce students' intentions to pursue STEM majors and careers and help them develop important skills (Sahin et al., 2015)

By charting the educational factors and practices that contribute to Olympiad success, this research will promote academic excellence within Kazakhstan and inspire other nations to adopt similar strategies, thereby enhancing the global academic community.

Outline of the thesis

This thesis unfolds over several chapters, each structured to provide a comprehensive analysis of the antecedents of Olympiad success for Science Olympiad competitors among high school students in Kazakhstan.

Chapter 1: Introduction - Sets the stage for the research, outlines the problem statement, and enumerates the study's objectives, research questions, and significance.

Chapter 2: Literature Review - Presents a thorough exploration of existing research, delving into the impact of Science Olympiads on students' STEM career aspirations and skill development and identifying gaps that this study aims to fill. Introduces the possible factors from literature that could influence students success in Science Olympiads.

Chapter 3: Methodology - Details the quantitative research design, describes the data collection from secondary sources and explains the statistical methods employed for analysis, including the justification for their use.

Chapter 4: Results - Reports the findings from the statistical tests, such as t-tests, ANOVA, and linear regression, offering a narrative of the data's implications and how they align with the hypotheses.

Chapter 5: Discussion - Interprets the results in the context of the reviewed literature, discussing the implications for educational practices and policy-making in Kazakhstan.

Chapter 6: Conclusions and Recommendations - Summarizes the study's key takeaways, acknowledges its limitations, and suggests directions for future research and practical applications in educational settings.

2. Literature review

Science Olympiads and Their Significance

As competitive events, science Olympiads have fostered an interest in STEM (Science, Technology, Engineering, and Mathematics) education among high school students. This paper defines Science Olympiads as academic competitions at various educational levels that aim to promote science, technology, engineering, and mathematics through individual and team challenges, fostering talent, critical thinking, and scientific literacy among international students (Baird et al., 1996; Swanson et al., 2023). These contests are designed to challenge and inspire students, promoting deeper engagement with scientific principles and problem-solving methodologies. Beyond the immediate competition, Olympiads catalyze long-term academic and career development in STEM fields.

Role in STEM Career Aspirations

Research has shown that participation in Science Olympiads can profoundly affect students' career aspirations. Olympiads help students identify their scientific interests and abilities, often guiding them toward STEM majors in college and eventual careers in related fields. The impact is not only on the individual level but also contributes to cultivating a new generation of scientists, engineers, and innovators essential for national development and global competitiveness (Sahin et al., 2015).

These competitive platforms allow students to explore and deepen their interest in various scientific disciplines and serve as a bridge to future educational and professional endeavors. Miller et al. (2018) found that students who participated in STEM competitions were likelier to express interest in STEM-related careers at the end of high school than those who did not participate. This suggests that competitions are an effective way to foster career interest in specific STEM careers.

Additionally, longitudinal research by (Miller et al., 2018) has provided insight into how participation in STEM competitions influences students' interest and their persistence in STEM. Qualitative data indicated that students accessed more STEM resources through competitions, gained STEM knowledge, improved STEM skills, and developed a positive feeling towards STEM, which promoted them to generate or maintain a STEM career interest.

These findings highlight the potential of Science Olympiads to spark initial interest in science and technology and cultivate the next generation of innovators and industry leaders. By highlighting the enduring influence of these early educational experiences, policymakers and educators can better appreciate the value of investing in and supporting Olympiad programs.

Educational and Policy Implications of Science Olympiads.

Science Olympiads play a pivotal role in shaping the educational landscape and policy development concerning STEM education. These competitions significantly influence students' STEM career aspirations and the development of twenty-first-century skills, with family, personal interests, and educators playing crucial roles in guiding these career paths. Notably, Science Olympiads encourage female participants to engage with projects in environmental or energy sciences, diversifying interests beyond traditional fields like engineering (Sahin et al., 2015).

The design of exams in competitions such as the International Biology Olympiad offers a template that can elevate science education practices, setting high benchmarks for students and informing curriculum design to cater to high-performing students (Opitz et al., 2020). Moreover, these Olympiads support the expansion of the talent pool in critical areas such as mathematics, addressing the pressing need for nurturing gifted students and broadening the curriculum in secondary education settings (Subotnik et al., 1996).

Coaching roles in these Olympiads enhance the self-confidence, knowledge, and pedagogical skills of teacher-coaches, with intrinsic motivation playing a significant part in their participation. This not only benefits the teachers but also improves the educational experiences of the students involved (Swanson et al., 2022). Furthermore, participation in Science Olympiads fosters increased interest in science and technology, encourages engagement in out-of-school scientific activities, and cultivates aspirations for pursuing science-related academic and career paths (Robinson et al., 2004).

Science Olympiads also serve as vital platforms for science communication, offering students insights into scientific careers and boosting scientific literacy among those who may not pursue science as a career (Lim et al., 2014). This is exemplified by initiatives like the European Science Olympiad, which promotes integrated teamwork across disciplines such as biology, physics, and chemistry, thereby potentially enhancing the overall interest and quality of science education (O'Kennedy et al., 2005).

Despite the benefits, challenges remain, particularly in specialized Olympiads for fields like medicine, where the costs sometimes outweigh the achievements, often exacerbated by a lack of support and low motivation among participants (Ghojazadeh et al., 2016). Nevertheless, the influence of Science Olympiads on educational and career choices is profound, with participation in state tournaments and exposure to new subjects having a notable impact on students' decisions regarding college and major selections (Smith et al., 2019). Ultimately, the Olympiad movement provides an alternative pathway for higher education entry, fostering early interest in scientific and technical creativity, which is crucial for developing the next generation of innovators and thought leaders in STEM fields (Gulov et al., 2023).

Therefore, Science Olympiads play a crucial role in shaping students' interests and competencies in STEM fields. They not only enhance career aspirations and skills development but also contribute to the quality of science education and the identification of talented students. The competitions provide valuable exposure to scientific careers and foster a deeper understanding of scientific concepts among participants. Additionally, they offer alternative pathways for gifted students to enter higher education and influence their academic and career trajectories. The educational and policy implications of studying Science Olympiads are significant, as they can inform strategies to attract more students, particularly females, into STEM fields and address the challenges of supporting and expanding the pool of gifted students.

Factors that influence students' success in Science Olympiads

Gender

The role of gender in Science Olympiad success is a multifaceted issue that encompasses perceptions of career aspirations, participation in competition categories, and the development of a science identity, particularly in the context of STEM (Science, Technology, Engineering, and Mathematics) fields.

For example, a study by Sahin et al. (2015) identified that female students are less likely to choose projects in the engineering category and more inclined towards environment or energy categories, suggesting a gendered pattern in subject interest within Science Olympiads. The study also noted that students are inclined towards pursuing

STEM majors, with teachers, personal interests, and parents being significant factors in shaping career aspirations.

Another important aspect is the underrepresentation of female students in Science Olympiads. A study by Castro-Manzano (2015) analyzed the data for the XIth Mexican Logic Olympiad and identified that there is a higher proportion of male participants, highlighting the need for targeted interventions to promote gender equity. Moreover an intervention designed to support young women's physics identity by creating an identity-safe learning environment resulted in increased interest and competence in physics among female participants, suggesting that gender-tailored approaches can enhance female engagement (Wulff et al., 2018)

Overall, gender plays a significant role in the Science Olympiad success, with female students showing distinct preferences for competition categories and facing underrepresentation. Interventions that create supportive environments tailored to young women can foster greater engagement and success in physics. Additionally, overcoming gender-science stereotypes and ensuring parental support are crucial for improving girls' performance and feelings of belonging in Science Olympiads.

Age

The impact of age on students' success in science education has been explored through various studies, focusing on different educational settings and age groups. This synthesis examines the relationship between age and cognitive achievements in science among younger and older students. For example, an observational study of children aged 4-6 by (Kallery & Loupidou, 2016) revealed that younger children in multi-age groups show improved cognitive achievements in science when they are in the presence of a greater number of older children, suggesting that age composition within groups can significantly influence learning outcomes. Other studies revealed that mathematical ability was a stronger predictor of science achievement than verbal ability or age, with no significant age-related differences in achievement for most science subjects (Lynch, n.d.) and that age and experience can be positive predictors of success in certain subjects.

The data suggests that age can have varying effects on science learning success. In early education, younger students benefit from interacting with older peers, while in the context of academically talented youth, age is less of a factor compared to mathematical ability. For mature students, age and experience may contribute positively to academic success in certain science-related fields. Overall, the relationship between age and success in science education is complex and influenced by the educational context and the nature of the subject matter.

GPA

The Grade Point Average (GPA) is a critical measure in educational research, serving as a quantifiable indicator of academic achievement. It is often used as a dependent variable in studies examining students' academic performance and is instrumental in decisions regarding student placement and selection.

As stated by Chansky (1965), GPA correlates with various aptitude and personality measures, indicating its adequacy as a metric for academic success in different college curricula. Also, higher GPA is associated with positive personality traits such as extraversion, agreeableness, and openness at the group level, suggesting that students with higher GPAs may be more socially adept and open to experience.

GPA serves as a significant indicator of various aspects of a student's academic and personal development. It is not only a reflection of academic ability but also correlates with positive personality development and social adjustment. High GPA is linked to better emotional stability, social skills, and motivation, which are important factors in the nomination for gifted studies. Additionally, GPA maintains a positive relationship with standardized test scores, reinforcing its role as a consistent measure of academic performance (Carey, 1997; Negru-Subtirica, 2020).

Individual-paced special courses

The relationship between specialized preparation or advanced courses and success in gifted programs is a topic of interest in educational research. This synthesis examines how such preparation may influence students' academic success in gifted programs.

Individually paced precalculus courses challenge academically talented students more than regular advanced math courses in school, and this type of preparation appears to enhance students' success in subsequent advanced coursework (Mills et al., 1992). Also, self-regulated learning skills, particularly in planning and strategy use, are positively correlated with academic success among trainee teachers preparing to teach gifted students, with the planning sub-dimension being a predictive factor for academic success (Marilena, 2016)

Therefore, specialized preparation, such as individually-paced courses, seems to prepare academically talented students effectively for advanced-level coursework by providing a greater challenge that aligns with their abilities. Additionally, for trainee teachers, possessing strong self-regulated learning skills, especially in planning, is important for academic success in programs designed for teaching gifted students.

Teachers' experience

The relationship between teacher qualifications and student success, particularly in gifted programs, is a topic of considerable interest in educational research. This synthesis examines the extent to which teacher qualifications may predict success in such specialized educational settings.

Exposure to a succession of highly qualified teachers has been linked to higher educational achievements and positive educational outcomes, indicating that teacher quality plays a crucial role in student success (Lee, 2018; Lee & Lee, 2020). Research also shows that teacher nominations for gifted programs, which assess gifted behaviors, are significantly correlated with students' later achievements in creativity, group skills, and language abilities (Hunsaker et al., 1997). Additionally, the qualifications of teachers, such as their degree type and the emphasis of their coursework, positively affect student achievement in reading, suggesting that the educational context and teacher preparedness are critical (Croninger et al., 2007). Contrary to some expectations, tests of general intelligence and achievement were not predictive of teaching success; instead, personality tests that emphasize mental health and teaching prognosis were found to be significant indicators (Seagoe et al., 1946). Educators' attitudes towards gifted education, influenced by their years of experience and in-service training, underscore the necessity for proper talent identification and the fostering of creative and effective skills in gifted students, highlighting the importance of specialized teacher training in these areas.

The research synthesis suggests that teacher qualifications, including their cumulative quality, experience, and specific training in gifted education, are important predictors of student success in gifted programs. While traditional measures of teacher ability, such as intelligence and achievement tests, may not indicate teaching success, the emphasis on mental health, teaching prognosis, and specialized training in identifying and nurturing gifted behaviors appears to be more relevant. Overall, the qualifications and preparedness of teachers play a significant role in fostering the educational attainment and specialized skill development of students in gifted programs.

Attendance of out of class activities

The relationship between extracurricular activities and academic success, particularly in the context of science Olympiads, is a topic of interest in educational research. This synthesis examines the impact of out-of-class science activities on students' performance and motivation in science competitions.

Participation in out-of-curriculum science communication activities is primarily driven by intrinsic motivation, which students believe is essential for achieving satisfactory results, and those with longer participation are more likely to favor such activities (Hasegawa et al., 2019). Involvement in the Science Olympiad boosts interest in science and technology and correlates with musical talent, engagement in out-of-school science activities, and aspirations for science-related college majors and careers (Robinson et al., 2004). Extracurricular science activities, including science fairs and Science Olympiads, are promoted by educators to enhance students' science content knowledge, process skills, and interest, potentially influencing their long-term career choices in the sciences (Abernathy et al., 2001).

The synthesis of the research suggests that participation in out-of-class activities, such as Science Olympiads, is positively linked to students' intrinsic motivation and success in science. These activities not only foster a deeper interest in science but also appear to contribute to the development of skills and knowledge that are beneficial for academic and career aspirations in scientific fields.

Previous participation in Science Olympiads

Research on the factors influencing success in science Olympiads has explored various aspects, including the role of previous participation, motivation, and the development of skills relevant to STEM careers.

An observational study of 52 International Chemistry Olympiad participants in Germany by Urhahne et al. (2012), revealed that previous participation in the International Chemistry Olympiad is a strong predictor of success in subsequent rounds, indicating that experience in the competition may enhance performance. This also adds one more important factor to analyze for this research.

Hypothesis from the literature review

The preceding review of the literature suggests a potential link between several factors and Olympiad scores, leading to the following hypothesis for empirical testing.

Hypothesis 1.

There is a difference in Olympiad scores between male and female students.

Hypothesis 2.

There is a difference in Olympiad scores between novice and experienced students participating in Science Olympiads.

Hypothesis 3.

There is a difference in Olympiad scores between students who participated in Science Projects and students who did not.

Hypothesis 4.

There is a difference in Olympiad scores between student who were exposed to individual training and students who did not.

Hypothesis 5.

There is a difference in Olympiad scores between students of different ages.

Hypothesis 6.

There is a difference in Olympiad scores between students of teachers with different categories.

Hypothesis 7.

There is a positive correlation between students' GPA and Olympiad scores.

Hypothesis 8.

There is a positive correlation between a number of out-of-class sections attended by a student and Olympiad scores.

Hypothesis 9.

There is a positive correlation between students' math GPA and Olympiad scores.

The subsequent sections will detail the methodology employed to rigorously test this hypothesis, including t-test, ANOVA, and linear regression analysis. These approaches will ensure a thorough examination of the proposed relationships, paving the way for significant contributions to both theory and practice in the field of Science Olympiads.

3. Methodology

Research design.

The selection of a quantitative secondary data analysis approach for this study is founded upon the need for objective measurement and analysis of relationships between variables. Quantitative research is essential when variables can be quantitatively assessed and when relationships between variables are expected to be predictive or causal (Creswell & Creswell, 2012). The use of existing data is efficient and allows for analysis within a shorter timeframe while still providing robust findings (Johnston, 2014).

Data Analysis Procedure

1. **Data Preparation**: Upon receiving the dataset, an initial data screening will be conducted. This process will involve checking for accuracy, missing values, outliers, and the participants' anonymity. Measures such as mean imputation or regression imputation will be considered for handling missing data, following recommendations by Tabachnick and Fidell (2013).

2. **Variable Operationalization**: Key variables will be operationalized as follows:

   - Cumulative GPA, math GPA, and number of out-of-class sections attended will indicate academic performance.

   - Demographic factors will include age and gender.

   - The only dependent variable, Olympiad performance, will be represented by students' rankings or scores in the competitions. All the other variables mentioned will be considered as independent variables.

- Other variables will be exposure to special individual courses, previous participation in Science Olympiads and involvement in Science Projects. Also, the dataset will have a category of a teacher of each student.

3. **Assumption checks:** Before starting the data analysis, all variables will be checked for several assumptions in Jamovi software. "Running an analysis is like driving a car—in order to do so, we make various assumptions about the road we're driving on" (Richardson, 2021, p.65).

   - The first assumption checked is the data's normal distribution. As stated in Richardson's book (2021), there are several methods to check for normality of distribution. First, we calculated the Shapiro-Wilk value for the data and then plotted the histogram and density graph of each variable. A Shapiro-Wilk value of $p > 0.5$ will indicate that the data is normally distributed (Richardson, 2021). In the visual representation of the graph, we expected to see a two-tailed bell curve (Richardson, 2021).

   - Next, we checked all variables for **outliers** in Jamovi software. Outliers could be easily detected by making a box plot of the data.

4. **Descriptive Statistics**: A comprehensive descriptive analysis will provide an overview of the dataset characteristics. All the nominal data will be represented by frequencies, these include gender (male vs. female), grade (9^{th} vs. 10^{th} vs. 11^{th}), previous participation in Olympiads, involvement in science projects and exposure to special preparation classes (yes vs. no). Continuous data of Olympiad scores will be reported with mean, median, standard deviation, and Shapiro-Wilk constant.

5. **Inferential statistics**: Several parametric tests are completed to test the effect of independent variables on the dependent variable.

    - The **independent samples t-test** will be used to test the effect of an independent variable with only two levels. As stated in Richardson's book (2021), the goal of an independent samples t-test is to “compare the means of two independent groups to determine whether there is statistical evidence that the associated population means are significantly different” (p. 152). Independent variables to be tested are: gender, previous participation in Olympiads, involvement in Science projects and exposure to special preparation.

    - The one-way **ANOVA** test will be used to test the effect of an independent variable with more than two levels. As stated in Richardson’s book (2021), the goal of one-way ANOVA is to “compare the means of three (or more) independent groups to determine whether there is statistical evidence that the associated population means are significantly different” (p.179). The independent variables to be tested are student grades and teacher categories.

    - The **simple linear regression** will be used to test the correlation between continuous independent variables and the dependent variable. As stated in Richardson’s book (2021), goal of linear regression is to “to model the linear relationship between the explanatory/predictor (independent) variables and an outcome (dependent) variable” (p. 275).

    -

- In the end, all the significant variables will be tested through **multiple linear regression** model to predict the best predictor for the dependent variable.

4. Results

This chapter provides the findings of the statistical analysis of the dataset. First, descriptive statistics provide an overall understanding of the nature of the dataset and assumption checks. Next, all the results of statistical tests mentioned in previous chapter will be introduced.

4.1 Descriptive statistics

The descriptive statistics for the dataset are provided here. Rather than giving only statistical data, descriptive statistics also help with the assumptions before running the tests (Richardson, 2021).

Table 1

Frequencies of Gender

Gender	Counts	% of Total	Cumulative %
1	76	49.7 %	49.7 %
2	77	50.3 %	100.0 %

Table 2

Frequencies of Grade

Grade	Counts	% of Total	Cumulative %
9	48	31.4 %	31.4 %
10	52	34.0 %	65.4 %
11	53	34.6 %	100.0 %

As shown in Table 1, of the 153 students, 76 (49.7%) were male and 77 (50.3%) were female, and in terms of grades 48 (31.4%) were students of 9th grade, 52 (34%) were students of 10th grade and 53 (34.6%) were students of 11th grade.

Table 3

Frequencies of Previous olympiad participation

Previous olympiad participation	Counts	% of Total	Cumulative %
No	85	55.6 %	55.6 %
Yes	68	44.4 %	100.0 %

Table 4

Frequencies of Involvement in science projects

Science projects	Counts	% of Total	Cumulative %
No	87	56.9 %	56.9 %
Yes	66	43.1 %	100.0 %

Table 5

Frequencies of Special preparation

Spec.preparation	Counts	% of Total	Cumulative %
No	79	51.6 %	51.6 %
Yes	74	48.4 %	100.0 %

Continuing with nominal data, as shown in the Tables above, out of 153 students, 85 (55.6%) had no previous experience of participating in olympiads, while the other half, 68 (44.4%), had previously participated in Science olympiads. In terms of involvement of students in science projects, 87 (56.9%) students had never participated in Science projects and only 66 (43.1%) students had experience of participating in Science projects. Lastly, students were divided into equal parts in regards to the use of special preparation classes for Science olympiads; 79 (51.6%) did not attend special preparation classes, and 74 (48.4%) had attended.

Table 6

					Skewness		Shapiro-Wilk	
	N	Mean	Median	SD	Skewness	SE	W	p
Olympiad scores	153	74.279	74.622	9.929	-0.154	0.196	0.993	0.720

Figure 1

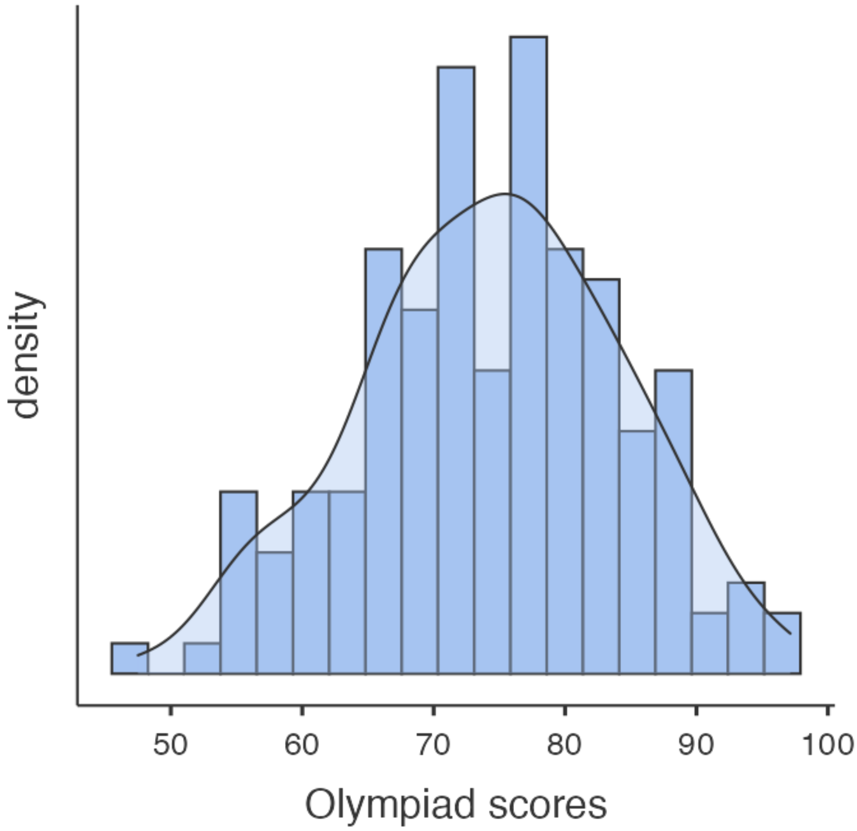

Table 6 shows that the mean Olympiad score was 74.279, indicating the average test results. The standard deviation was 9.929, indicating that 68% of participants are one standard deviation from the mean (Richardson, 2021). The skewness statistic of - 0.154 suggests that the distribution of the Olympiad scores is approximately symmetrical with a little bit of negative skew. The Shapiro-Wilk test yielded a value of 0.993, $p = 0.720$. This indicates that the data follows a normal distribution ($p > 0.05$) (Richardson, 2021). Upon visual inspection of the histogram and density plot for the Olympiad scores in Figure 1 , the histogram displays the bell curve, which is an indicator of normally distributed data (Richardson, 2021).

4.2 Hypothesis 1: Effect of Gender on Olympiad Scores

This section details the results of the independent samples t-test conducted to compare the means of male and female students with respect to Olympiad scores.

Table 7

	F	df	df2	p
Olympiad scores	0.289	1	151	0.592

Note. A low p-value suggests a violation of the assumption of equal variances

Table 8

Independent Samples T-Test

		Statistic	df	p
Olympiad scores	Student's t	0.213	151.000	0.832

Note. H_a $\mu_1 \neq \mu_2$

An independent samples t-test was conducted to investigate the hypothesis that there is a difference in the Olympiad scores depending on whether students are male or female. 76 participants were male, and 77 participants were female. The independent variable was gender, and the dependent variable was scores taken by students in the Science Olympiad. An independent samples t-test was deemed appropriate as all the relevant parametric assumptions were met. Levene's test for variance equality was statistically significant, suggesting the assumption regarding equality of variances was not violated (F = 0.289, p = 0.592).

The results showed no significant difference in Olympiad scores regarding the gender of the students, *t* (151) = 0.213, *p* = 0.832. On average, female participants (M = 74.109, SD = 10.209) scored similarly to male students (*M* = 74.451, *SD* = 9.709). The magnitude of the difference in these two means (*mean difference* = 0.342) was low (Cohen's *d* = 0.034).

4.3 Hypothesis 2: Effect of previous participation in Olympiads on Olympiad scores

This section details the results of the independent samples t-test conducted to compare the means of experienced and novice students with respect to Olympiad scores.

Table 9

Homogeneity of Variances Test (Levene's)

	F	**df**	**df2**	**p**
Olympiad scores	0.712	1	151	0.400

Note. A low p-value suggests a violation of the assumption of equal variances

An independent samples t-test was conducted to investigate the hypothesis that there is a difference in the Olympiad scores depending on whether students have previous experience of participating in Science Olympiad or do not. 85 students were novice to Science Olympiads, and 68 participants had previously participated in Science Olympiads.

Table 10

Independent Samples T-Test

		Statistic	df	p
Olympiad scores	Student's t	- 0.089	151.000	0.930

Note. H_a $\mu_{No} \neq \mu_{Yes}$

The independent variable was participation in Olympiads, and the dependent variable was scores taken by students in the Science Olympiad. An independent samples t-test was deemed appropriate as all the relevant parametric assumptions were met. Levene's test for variance equality was statistically significant, suggesting the assumption regarding equality of variances was not violated (F = 0.712, p = 0.400).

The results showed no significant difference in Olympiad scores regarding the experience of the students, t (151) = - 0.089, p = 0.930. On average, experienced participants (M = 74.358, SD = 4.24) scored similarly to novice students (*M* = 74.215, *SD* = 9.576). The magnitude of the difference in these two means (*mean difference* = 0.144) was low (Cohen's d = 0.014).

4.4 Hypothesis 3: Effect of Involvement in Science Projects on Olympiad scores.

This section details the results of the independent samples t-test conducted to compare the means of students involved in Science projects and those not involved concerning Olympiad scores.

Table 11

Independent Samples T-Test

		Statistic	df	p		Effect Size
Olympiad scores	Student's t	-2.436	151.000	0.016	Cohen's d	-0.398

Note. H_a $\mu_{No} \neq \mu_{Yes}$

An independent samples t-test was conducted to investigate the hypothesis that there is a difference in the Olympiad scores depending on whether students have previous experience of participating in Science Projects or do not. 87 students had never participated to Science Projects, and 66 students had previously participated in Science Projects. The independent variable was participation in Science Projects, and the dependent variable was scores taken by students in the Science Olympiad. An independent samples t-test was deemed appropriate as all the relevant parametric assumptions were met. Levene's test for variance equality was statistically significant, suggesting the assumption regarding equality of variances was not violated ($F = 0.223$, $p = 0.637$).

The results showed that there is a significant difference in Olympiad scores regarding students' participation in Science Projects, $t(151) = -2.436$, $p = 0.016$. On average, students with experience in Science Projects ($M = 76.488$, $SD = 10.419$) scored higher compared to students who were not involved in science projects ($M = 72.603$, $SD = 9.576$). The magnitude of the difference in these two means (*mean difference* = 3.885) was moderate (Cohen's $d = 0.398$).

4.5 Hypothesis 4: Effect of Special Preparation on Olympiad Scores

This section details the results of the independent samples t-test conducted to compare the means of students involved in special preparation classes and those not involved concerning Olympiad scores.

Table 12

Independent Samples T-Test

		Statistic	df	p		Effect Size
Olympiad scores	Student's t	-6.056	151.000	< .001	Cohen's d	-0.980

Note. H_a $\mu_{No} \neq \mu_{Yes}$

An independent samples t-test was conducted to investigate the hypothesis that there is a difference in the Olympiad scores depending on whether students have participated in special preparation classes or not. 79 students had never participated in special preparation classes, and 74 students had been involved in special preparation classes. The independent variable was participation in special preparatory classes, and the dependent variable was scores taken by students in the Science Olympiad. An independent samples t-test was deemed appropriate as all the relevant parametric assumptions were met. Levene's test for variance equality was statistically significant, suggesting the assumption regarding equality of variances was not violated (F = 0.165, p = 0.685).

The results showed that there is a significant difference in Olympiad scores regarding students' involvement in preparatory classes, t (151) = - 6.056, *p* < 0.001. On average, students who were involved in preparatory classes (*M* = 78.799, *SD* = 8.658) scored significantly higher than those who were not involved in preparatory classes (*M* = 70.045, *SD* = 9.188). The Cohen's *d* effect size was -0.980, which can be considered large (Richardson, 2021).

4.6 Hypothesis 5: Effect of students' age on Olympiad scores.

This section details the results of one-way ANOVA, which examines the effect of student age on Olympiad scores. This statistical test helps determine whether there are statistically significant differences between the means of three or more independent groups.

Table 13

One-Way ANOVA (Fisher's)

	F	df1	df2	p
Olympiad scores	0.806	2	150	0.449

Employing a between-subjects design, the effect of students' age (3 levels: 9th grade vs. 10th grade vs. 11th grade) on Olympiad scores was assessed. Levene's test indicated that the variance was equal (p = 0.511), and so a one way ANOVA was conducted. This indicated that there was no significant discrepancy between the groups' scores (F (2, 150) = 0.806, p = 0.449). No post hoc comparisons were conducted.

4.7 Hypothesis 6: Effect of teachers' category on Olympiad scores.

This section details the results of one-way ANOVA, which examines the effect of teachers' categories on Olympiad scores. This statistical test helps determine whether there are statistically significant differences between the means of three or more independent groups.

Table 14

ANOVA - Olympiad scores

	Sum of Squares	df	Mean Square	F	p	η^2
Teacher category	1015.320	4	253.830	2.689	0.033	0.068

ANOVA - Olympiad scores

	Sum of Squares	df	Mean Square	F	p	η^2
Residuals	13969.145	148	94.386			

Employing a between-subjects design, the effect of teachers' category (5 levels: novice vs. moderator vs. expert vs. researcher vs. master) on Olympiad scores was assessed. Levene's test indicated that the variance was equal (p = 0.244), so a one-way ANOVA was conducted. This indicated that there was a moderate and significant discrepancy between the groups' scores (F (4, 148) = 2.689, p = 0.033 η^2 = .068). However, post hoc pairwise comparisons were conducted using Bonferroni correction, revealing no significant differences between the groups of teachers' categories.

4.8 Hypothesis 7: Effect of GPA on Olympiad scores.

This section describes the results of a simple linear regression analysis to explore the relationship between GPA and Olympiad scores, to determine how well GPA can predict Olympiad scores.

Table 15

Model Coefficients - Olympiad scores

Predictor	Estimate	SE	t	p
Intercept	69.190	6.176	11.203	< .001
GPA	1.255	1.510	0.831	0.407

The amount of variation in the Olympiad scores explained by the student's GPA was assessed using linear regression analysis. Whilst the data distribution was within normal parameters (p = 0.817) the residual errors showed a degree of autocorrelation (DW = 2.013, p = 0.928) and so the analysis should be interpreted cautiously. The correlation between Olympiad scores and that predicted by GPA was low (R = 0.067), indicating that only 5% of the variation in Olympiad scores could be predicted (R^2). The analysis also showed that GPA can not significantly predict the Olympiad scores [F (1,151) = 0.698, p = 0.407]. The unstandardized regression coefficient suggested that each 1 point increase in students GPA would predict an increase of 1.255 points in Olympiad scores (t(151) = 0.831, p = 0.407), which is not statistically significant.

4.9 Hypothesis 8: The effect of the number of out-of-class sections attended on Olympiad scores.

This section describes the results of a simple linear regression analysis, which explored the relationship between the number of out-of-class sections attended and Olympiad scores to determine how well it can predict Olympiad scores.

Table 16

Model Coefficients - Olympiad scores

Predictor	Estimate	SE	t	p
Intercept	73.046	1.472	49.636	< .001
No. out of class	0.350	0.350	0.999	0.319

The amount of variation in the Olympiad scores explained by the student's attendance of out-of-class sections was assessed using linear regression analysis. Whilst the data distribution was within normal parameters (p = 0.864), the residual errors showed a degree of autocorrelation (DW = 2.034, p = 0.864) and so the analysis should be interpreted cautiously. The correlation between Olympiad scores and that predicted by the number of sections attended was low (*R* = 0.081), indicating that only 7% of the variation in Olympiad scores could be predicted (R^2). The analysis also showed that the number of sections attended can not significantly predict the Olympiad scores [F (1,151) = 0.999, *p* = 0.319]. The unstandardized regression coefficient suggested that each 1-point increase in students' GPA would predict an increase of 0.450 points in Olympiad scores (t(151) = 0.999, *p* = 0.319), which is not statistically significant.

4.10 Hypothesis 9: The effect of math GPA on Olympiad scores.

This section describes the results of a simple linear regression analysis, which explored the relationship between the math GPA and Olympiad scores to determine how well it can predict Olympiad scores.

Table 17

Model Fit Measures

			Overall Model Test			
Model	**R**	**R²**	**F**	**df1**	**df2**	**p**
1	0.364	0.133	23.121	1	151	< .001

Table 18

Model Coefficients - Olympiad scores

Predictor	Estimate	SE	t	p
Intercept	39.692	7.232	5.488	< .001
Math GPA	8.311	1.728	4.808	< .001

The amount of variation in the Olympiad scores explained by the student's math GPA was assessed using linear regression analysis. Whilst the data distribution was within normal parameters ($p = 0.080$), the residual errors showed a degree of autocorrelation ($DW = 2.016$, $p = 0.926$) and so the analysis should be interpreted cautiously. The correlation between Olympiad scores and that predicted by the number of sections attended was moderate ($R = 0.364$), indicating that 13% of the variation in Olympiad scores could be predicted (R^2). The analysis also showed that the math GPA can significantly predict the Olympiad scores [F (1,151) = 23.121, $p < 0.001$]. The unstandardized regression coefficient suggested that each 1-point increase in students' math GPA would predict an increase of 8.311 points in Olympiad scores (t(151) = 4.808, $p < 0.001$), which is also statistically significant.

4.11 Model of the linear relationship of several independent variables on Olympiad scores.

This section describes the results of multiple regression analysis used to understand the predictive force of several independent variables on Olympiad scores. Independent variables were chosen based on their statistical significance in previous tests and criteria for meeting assumptions for multiple regression analysis.

Table 19

Model Coefficients - Olympiad scores

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	42.000	7.250	5.793	< .001	
Math GPA	5.777	1.696	3.406	< .001	0.253
Spec.preparation	6.787	1.480	4.587	< .001	0.343
Teacher category	1.143	0.532	2.149	0.033	0.151
No. out of class	0.331	0.302	1.097	0.275	0.077

In a study on factors that influence students' scores in Science Olympiads with regard to the math GPA, involvement in special preparation classes, teacher's category, and the number of out-of-class sections attended were measured to see if they could predict students' Olympiad scores. This was analyzed with multiple linear regression analysis.

The correlation between predicted and actual Olympiad scores was $R = 0.527$, indicating that the model could predict approximately 27% of the variation in Olympiad scores. Analysis indicated that this was not due to chance error [F (4,148) = 14.200, $p <$ 0.001].

From the factors included in the model, math GPA (t (195) = 3.406, $p < 0.001$), special preparation (t (195) = 4.587, $p < 0.001$), and teacher category (t (195) = 2.149, $p =$ 0.033) could significantly predict the Olympiad scores of students.

Each additional point in math GPA increased Olympiad scores by 5.777 points, while involvement in special preparation classes added an extra 6.787 points to students' Olympiad scores. While increase in the category of students teacher increased Olympiad scores by 1.143 points. Overall, special preparation was a better covariate of Olympiad scores ($\beta = 0.343$, $p < 0.001$) compared to math GPA ($\beta = 0.253$, $p < 0.001$) and teachers category ($\beta = 0.151$, $p = 0.033$).

5. Discussion

The findings of this study offer a multifaceted view of the factors contributing to success in Science Olympiads among high school students. The lack of significant difference in Olympiad scores between genders challenges common perceptions of gender disparities in STEM fields (Castro-Manzano, 2015) and suggests that when given equal opportunities, male and female students are likely to perform equally well in academic competitions like Science Olympiads. This finding is consistent with the evolving landscape of gender roles in education and may reflect successful efforts to balance gender representation in STEM-related activities.

Previous participation in Olympiads (Urhahne, 2012) and involvement in out-of-school science projects did not significantly predict Olympiad success, indicating that prior experience is not necessarily a determinant of current performance. This could suggest that the innate aptitude for science and Olympiad-specific preparation may have a greater impact than past experiences, emphasizing the need for targeted educational strategies to optimize student performance. Also results may indicate decreasing motivation of students after several rounds of Science Olympiads. As the growing number of literature indicates, motivation plays a crucial role in the engagement and success of students in Science Olympiads, as it is a driving force for learning and participation in these competitive events (Glynn et al., 2011; Pintrich et al., 2003).

Notably, special preparation classes were a significant predictor of success, highlighting the importance of structured and intensive preparation in achieving higher scores (Mills et al., 1992). This result aligns with research advocating for the targeted support of high-achieving students and points towards the efficacy of dedicated preparatory programs that equip students with the necessary skills and knowledge to excel in high-stakes academic competitions. Additionally, our study found that teacher qualifications had a significant but small effect size, which, while consistent with some literature on the influence of teacher expertise on student outcomes (Lee, 2018), is less pronounced than expected. This might be due to the strong emphasis on self-study and external support structures, such as private tutoring, that are characteristic of the preparatory landscape for Olympiads in Kazakhstan, possibly overshadowing the in-classroom influence of teachers (Bray, 2015).

The role of teacher quality, as reflected in the teacher's category, was also a significant factor, although to a lesser extent. This finding underlines the influence of teacher expertise and underscores the importance of qualified educators in facilitating student learning and success. It supports the growing body of literature that emphasizes the critical role of teacher qualifications and their direct impact on student outcomes (Croninger et al., 2007).

The effect of math GPA on Olympiad scores was particularly noteworthy, with each additional GPA point predicting a significant increase in scores. This relationship underlines the importance of strong mathematical foundations for success in science competitions and reinforces the idea that competence in mathematics is integral to overall academic achievement in STEM disciplines.

The absence of a significant effect of the number of out-of-class sections attended on scores suggests that the quantity of supplementary educational activities alone does not guarantee success. Instead, the quality and relevance of these activities, along with their alignment with Olympiad objectives, may be more critical factors to consider.

These results have several implications for educational policy and practice. They suggest that policies and practices should ensure equal opportunities for both male and female students, emphasize the importance of specialized preparation for academic competitions, and highlight the need to support and further develop the skills of teachers. Additionally, the findings advocate for an educational focus on math proficiency and suggest reevaluating the emphasis placed on extracurricular and out-of-class activities to align them more closely with the aims of academic competitions.

By considering these factors, educational stakeholders can better support the development of gifted and talented students, fostering a generation of learners well-prepared for the rigors of Science Olympiads and, by extension, future STEM challenges.

6. Conclusion

This study set out with the purpose of unraveling the antecedents of success in Science Olympiads among high school students in Kazakhstan. Our research questions focused on identifying the educational and demographic factors that could predict such success. The conclusions drawn from this investigation provide meaningful insights into the factors that significantly impact students' achievements in these prestigious competitions.

The extent to which the research purpose was achieved is reflected in the detailed analysis of the relationship between student preparation, teacher quality, and academic prowess, particularly in mathematics, with Olympiad success. Contrary to expectations, prior experience in Olympiads and other science projects did not predict higher achievement, shifting the spotlight onto the quality of preparation and instruction. This study conclusively found that specialized preparation and higher math GPAs are strongly associated with better Olympiad outcomes, underscoring the necessity of focused academic support and robust mathematical grounding for participants.

Our research questions were addressed through a rigorous examination of the dataset, yielding answers that both align with and challenge existing literature. The lack of gender disparities in Olympiad scores aligns with global educational trends towards gender equality in STEM, while the pivotal role of teacher qualifications adds to a growing consensus on the influence of teacher efficacy on student achievement.

The importance of these conclusions cannot be overstressed. They not only contribute to the academic discourse on educational achievement in Science Olympiads but also bear practical implications for educational policy and classroom practice in Kazakhstan. By highlighting specific areas that contribute to student success, this research informs educational stakeholders on where to direct resources and support to cultivate a fertile ground for nurturing future STEM talents.

As an implication for future reseach, future studies should consider primary data collection to allow for more tailored data that directly addresses research questions and to have control over which variables are included and how they are measured. Another good follow up study would be a longitudinal study designed to track changes over time and better understand the causal relationships between preparation, educational practices, and Olympiad outcomes. Incorporating qualitative methods, such as interviews or focus groups with Olympiad participants, will help to gain deeper insights into personal experiences, educational pathways, and context-specific factors affecting performance.

The study's limitations, including its reliance on data from a single institution and the potential for unmeasured confounding variables, set the stage for future research. To build on the findings of this thesis, subsequent studies could employ longitudinal designs across multiple institutions and incorporate qualitative methods to capture a more nuanced picture of the factors influencing Olympiad success.

In conclusion, this thesis has illuminated several key pathways to success in Science Olympiads and has begun to fill the gap in the literature concerning the Kazakhstani context. It lays a foundation upon which future research can build and offers actionable recommendations for educators and policymakers to enhance the educational experiences and outcomes of students. This study demonstrates that with strategic support and high-quality teaching, students can not only excel in Science Olympiads but also be inspired towards long-term engagement with STEM disciplines. The research herein contributes to the overarching goal of nurturing the next generation of scientific leaders and innovators who will continue to drive progress in Kazakhstan and beyond.

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Appendices

Appendix A - Declaration of the Use of Generative AI

Thesis Title: **The Antecedents of Olympiad Success for Science Olympiad Competitors: Analysis of High School Students in Kazakhstan**

I hereby declare that I have read and understood NUGSE's policy concerning appropriate use of AI and composed this work independently (please check one):

☒ with the use of artificial intelligence tools, or
☐ without the use of artificial intelligence tools.

(If you have used AI tools as defined in the GSE policy document, please complete the rest of this form.)

During the preparation of this thesis/examination, I used ChatGPT to brainstorm ideas and help with academic English. Also I used Consensus AI to look for research papers and synthesize information in the papers.

I also declare that I

☒ am aware of the capabilities and limitations of AI tool(s),

☒ have verified that the content generated by AI systems and adopted by me is factually correct,

☒ am aware that as the author of this thesis I bear full responsibility for the statements and assertions made in it,

☒ have submitted complete and accurate information about my use of AI tools in this work, and

☒ acknowledge that there may be disciplinary consequences if I have not followed NUGSE's guidelines regarding AI appropriate use.

Name: Madiyar Abdilradov

Signature:

Date: 22.04.24