Civic Engagement for Education Equity in Kyrgyzstan:

the Republican Olympiad on Mathematics

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Executive Summary

This case study aims to understand the equality in education and performance trends in the Republican Olympiad on Mathematics (ROM), a national competition in Kyrgyzstan. Using the latest data from the ROM, the study compared participation and achievement based on gender, region, and school type. Female participants outperformed males both in representation and performance. Bishkek, the capital, had a lot of participants, but the Osh region also showed high participation and strong results. No significant performance differences were observed between public and private schools. These results are similar to but also different from the general trends in mathematical education in Kyrgyzstan, which shows that civic initiatives might have a special impact on education in the country. These findings suggest many policy recommendations, especially the need to help regions with fewer resources and support female success in mathematics. This study also opens the door for more research to explore the reasons, challenges, and social-economic factors affecting these trends in Kyrgyzstan. Through the lens of Kaiyrkul, a young woman from Naryn who secured second place in the ROM, we will explore how personal resilience, family support, and mentorship contribute to success in STEM for girls in Kyrgyzstan.

The case includes the following elements:

- Video Case Study
- Written Case Study: This Document

Introduction

In today's world, Science, Technology, Engineering, and Mathematics (STEM) fields play an essential role in driving progress and innovation. A strong STEM education equips individuals with the skills to think critically, solve problems creatively, and contribute meaningfully to economic and social development. However, access to quality education in STEM is not equally distributed worldwide.

In Kyrgyzstan, many students face significant barriers to accessing quality STEM education. These challenges are particularly pronounced in rural areas, where underfunded schools often lack basic resources like laboratory equipment, reliable internet access, or up-to-date textbooks. Students in such regions are at a disadvantage compared to their urban peers, who are more likely to attend better-equipped schools with trained educators and opportunities for extracurricular STEM activities.

Moreover, social inequalities compound these educational challenges. Children from low-income families often have fewer opportunities to pursue STEM education due to financial constraints, such as an inability to afford private tutoring or supplementary materials. In many cases, students from disadvantaged backgrounds must prioritize work over education to support their families, leaving little time or energy to focus on demanding subjects like mathematics or engineering.

Gender inequality further exacerbates the situation. While education is officially accessible to both boys and girls in Kyrgyzstan, cultural and societal norms in some regions discourage girls from pursuing advanced studies, particularly in STEM fields. Traditional expectations often limit girls to roles perceived as "domestic," sidelining their academic and professional ambitions.

The intersection of regional, social, and gender inequalities creates a layered problem that limits Kyrgyzstan's ability to fully harness its human potential in STEM.

This case study looks at one attempt to tackle the education equity issue in Kyrgyzstan through a   civic engagement initiative.

Literature Review

Education equality is a cornerstone in global policy dialogues, forming the foundation for both sustainable development and individual progress. The UNESCO Global Education Monitoring Report emphasized the significance of equitable education as an agent of change, offering pathways for individuals from diverse socio-economic backgrounds to uplift their socio-economic conditions. Disparities in education access and achievement, however, continue to persist worldwide, with factors such as geography, income, and gender playing significant roles.[1]

Mathematics Olympiads, as part of broader STEM initiatives, have gained prominence over the years. These competitions not only recognize outstanding talents but also benchmark national educational standards in mathematical disciplines. Countries often see these achievements as a reflection of their educational quality and rigor.[2] Yet, participation in such elite competitions can often be influenced by access to specialized training and resources, potentially leading to representational disparities.[3]

A longstanding concern in STEM education has been the underrepresentation of women. Although girls often perform at part or even outshine boys in school-level assessments, gender disparities become more pronounced at higher levels of education and in STEM professions.[4]

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[1] "Global Education Monitoring Report 2020: Inclusion and education.'' Paris: UNESCO. (2020). https://doi.org/10.54676/JJNK6989
[2] PISA 2018 Results (Volume I). "What students know and can do." PISA: OECD Publishing (2019). https://doi.org/10.1787/5f07c754-en
[3] "What students know and can do." ,
[4] "Cracking the code: Girls' and women's education in STEM." Paris: UNESCO. (2017) https://unesdoc.unesco.org/permalink/PN-2c5d63c3-b6ec-4011-a3e2-92ffd1e336c4

Societal norms, biases, and a lack of female role models in STEM are often cited as contributing factors.[5]

Kyrgyzstan, like many other nations, faces its own unique set of challenges and opportunities in education. While specific studies focusing on Kyrgyzstan's mathematical education landscape might be sparse, global trends and findings offer valuable insights, guiding research and policy in the region.[6]

It is essential, now more than ever, to understand the intricacies of platforms like mathematics competitions within varied cultural and national contexts. Evaluating their role in enhancing or perpetuating educational inequalities is pivotal, especially given the broader concerns about gender disparities in STEM fields.[7]

There remains an undeniable obligation to explore and understand the role and impact of platforms like mathematics Olympiads within the Kyrgyz context. Identifying their efficacy in addressing or perpetuating deep-rooted inequalities is crucial for shaping future educational policies and initiatives.[8]

Although current literature provides valuable insights into educational equity, the intricacies of STEM and mathematics Olympiads, and gender disparities, there is a clear gap in understanding these dynamics specific to Kyrgyzstan.[9] This case study aims to bridge this gap, emphasizing its relevance and urgency.

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[5] Hyde, J. S., & Mertz, J. E. "Gender, culture, and mathematics performance." Proceedings of the National Academy of Sciences, no. 106(22) (July 2009): 8801-8807.

[6] "World Development Report 2018: Learning to realize education's promise." Washington, DC: World Bank (2018).

[7] "Cracking the code: Girls' and women's education in STEM." Paris: UNESCO. (2017)

[8] PISA 2018 Results (Volume I). "What students know and can do." PISA: OECD Publishing (2019). https://doi.org/10.1787/5f07c754-en

[9] Hyde, J. S., & Mertz, J. E. "Gender, culture, and mathematics performance." *Proceedings of the National Academy of Sciences*, no. 106(22) (July 2009): 8801-8807.

History of the ROM

The ROM began in 2020 as a civic initiative led by the Kyrgyz-Swedish Mathematical School (KSMS). It aims to inspire students in grades 6 through 11 (ages 11–17) across the Kyrgyz Republic to engage deeply with mathematics through competition. Participants are challenged with original mathematical problems designed by the Olympiad Committee specifically for this event. The competition is conducted in two stages:

1. **First Stage (Online)**: Open to all schoolchildren nationwide, this stage allows participants to compete synchronously from their respective locations.
2. **Second Stage (In-Person)**: The top 20 students from grades 9 through 11 are invited to the KSMS to solve advanced mathematical problems in-person.

The Olympiad is open to all and entirely free, ensuring accessibility for students from diverse backgrounds. Participation does not require prior qualification, making it an inclusive platform for mathematical exploration. Winners from grades 9 through 11 become eligible to compete in the Republican Olympiad organized by the Ministry of Education of the Kyrgyz Republic.

Success at this higher-level competition is highly prestigious, as top-performing students receive up to 100% tuition scholarships to study at leading higher educational institutions in the country. Thanks to   the Republican Olympiad's status, the leading universities and colleges are confident about the objectivity and high-quality evaluation standards of the ROM. The competition results are accepted as a criterion for admissions and scholarship decisions. Since its inception, the Olympiad has experienced continuous growth in both the number of participants and the availability of grants for higher education.

The ROM is not just for students in cities or from wealthy families—its main goal was to give every student in Kyrgyzstan a chance to participate and compete. The first ROM in the 2020-21 academic year had only about 9,000 participants, but it has grown every year. The number of participants in the 2021-   22 academic year was about 11,000. In the 2022-   23 academic year, more than 17,000 students took part in the Olympiad.

This growth shows how much the Olympiad has resonated with students and teachers across the country. It is not just about the competition; it is about encouraging students to develop a love for mathematics. Over time, the Olympiad has become a major event in the country's academic calendar. Schools, both public and private, encourage their students to participate, knowing that doing well can open doors to scholarships and further education.

Data Collection

The main source of the data for this study comes from the Organizing Committee of the ROM. This is an important group that organizes the ROM every year and keeps statistics of the Olympiad, such as   participant information and performance. For this case study, we will focus on the ROM conducted in the 2022 -   23 academic year. This will give a more recent and relevant view of the state of mathematical education in Kyrgyzstan. The dataset includes important metrics, such as   scores, names, emails, regions, schools, and more. The ROM data is mostly in Russian. We translated it into English to make it easier to understand for a bigger audience. After translation, meticulous data cleaning was performed to ensure the integrity and reliability of the analysis. Approximately 5% of the dataset contained missing or incomplete entries, particularly in fields such as region and school type. For missing categorical variables, such as   gender and school type, we imputed values using the mode the most frequent category in the dataset to minimize bias introduced by missing data. For instance, if a participant's gender was missing, and the majority of participants were female, we assigned the missing gender as female. This approach was justified given the data's distribution and helped maintain the dataset's overall representativeness.

For missing numerical values such as scores, which were rare (less than 0.5% of entries), we used the median score to fill in the gaps. The median is less sensitive to outliers and provides a central tendency measure suitable for skewed distributions, ensuring that imputed values did not artificially inflate or deflate performance metrics.

Entries with significant inconsistencies or errors, such as mismatched region and school data, or duplicate entries, comprised less than 6% of the dataset. These entries were carefully reviewed,

and when verification was not possible through cross-referencing with official records or contacting the organizing committee, they were removed to prevent distortion of the results.

In total, the data cleaning process involved modifying approximately 5% of the entries through imputation and removing about 6% of entries due to irreparable inconsistencies, resulting in a robust and reliable dataset for analysis.

2022-   23 Results

The dataset reveals a significant female representation in the ROM, with 6,809 females (approximately 65%) out of 10,540 participants. This trend aligns with broader educational patterns in Kyrgyzstan, where women constitute a substantial portion of higher education enrollments. Notably, the country exhibits a female-to-male ratio of 1.61 in tertiary education, indicating that for every male student, there are approximately 1.61 female students[10]. One theoretical   reading of this rate of participation could   be that girls in Kyrgyzstan might be receiving stronger encouragement at the high school level to pursue academic achievements, particularly in STEM, as a pathway to upward mobility. Alternatively, sociocultural factors might foster a deeper sense of academic diligence among girls, while boys may face early workforce pressures or different societal expectations. Future qualitative research could examine motivational factors, parental influences, and broader cultural norms that shape these enrollment decisions.

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[10] Marchenko, Larisa Y., and Mirlan Chynybaev. Overview of the Higher Education System in Kyrgyzstan. Bishkek: National Erasmus+ Office in Kyrgyzstan, 2023.

Gender Dististribution
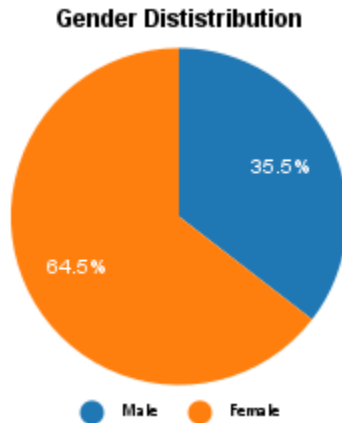
Regionally, the participation is diverse. Bishkek, being the capital, naturally recorded 1,109 participants. Yet, Osh surpassed this with 2,114 participants, making it the region with the highest participation. This prominence may be linked to Osh's status as a major urban center and its significant population, which comprises 14.2% of Kyrgyzstan's demographic. This elevated representation from areas like Talas, with only 387 participants, might require more attention and resources to enhance competition involvement. The participation from regions such as Naryn, Jalal-Abad, Issyk-Kul, Chui, and Batken display their own unique dynamics; their low participation can reflect underlying disparities in educational access, funding, or teacher availability, signaling areas for policy intervention. For instance, some regions might have more active civic organizations promoting math competitions, or they may benefit from stronger local government initiatives or philanthropic efforts that support teacher training and resource distribution. Further data collection on funding structures, teacher qualifications, and other socio-economic indicators could help clarify why certain regions do better at attracting participants. Whereas a significant chunk of the dataset (1,997 participants) remains unspecified in terms of region, suggesting a potential data collection gap that might need addressing in future research.

Region Dististribution
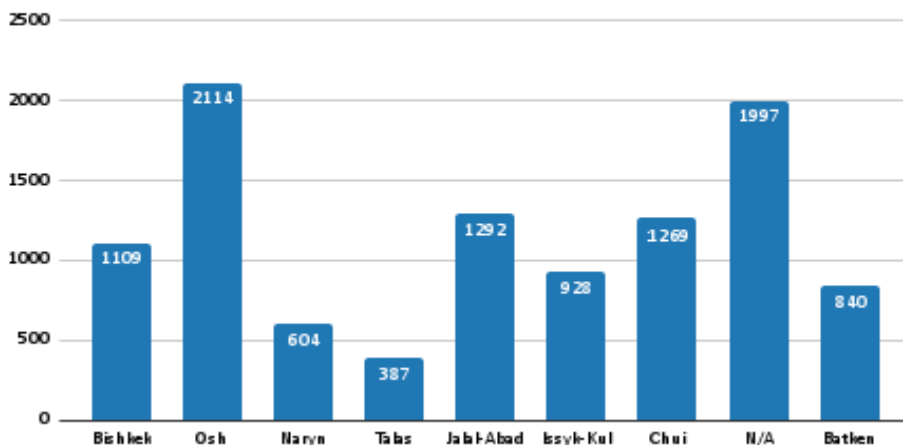
In terms of school types, the low participation from private schools (556 participants out of 10,540) compared to public schools can be contextualized by examining enrollment data: public schools in Kyrgyzstan cater to approximately 1,374,689 students, compared to only 43,381 students in private schools[11]. Public school students represent around 96.9% of all schoolchildren, with private school students accounting for just 3.1%. Given this demographic, private school participation in the ROM aligns closely with national enrollment figures. However, one possibility is that some private schools focus on specialized curricula or extracurricular activities, perhaps prioritizing language proficiency or arts, causing the ROM to receive less emphasis from school administrators. Additionally, some private institutions may not view public competitions as integral to their academic strategy or marketing. On the other hand, public schools might treat the ROM as a valuable chance to gain recognition and scholarships for their students, thus boosting participation.

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[11] National Statistical Committee of the Kyrgyz Republic. "Education Statistics for School Children, 2023." Bishkek, Kyrgyzstan: NSC KR, 2023.

School Type Distribution
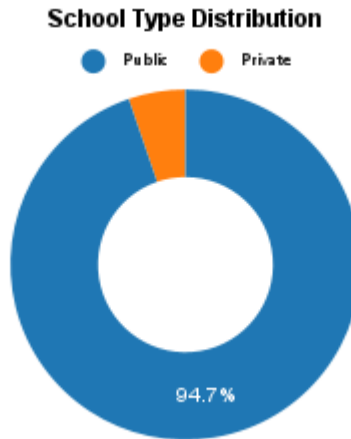

2022-   23 ROM Performance

In analyzing the academic performance of participants within the ROM, focusing on the top 30% score distribution offers a more reliable and meaningful insight into regional competencies. The top 30% was chosen for analysis as it better represents the overall merit of ROM participants, given that much of the data in the lower 30% was incomplete or lacked critical attributes, such as regional identifiers.

Bishkek, the capital city, accounted for 18.9% of the top scores. While notable, this figure highlights that being a capital does not inherently ensure dominance in academic performance. Several factors, such as the volume of participants, disparities in educational quality, or other socio-economic influences, may contribute to this outcome. These aspects warrant further investigation to fully understand the dynamics at play.

The standout performer is Osh, with a commanding 22.3% of top scores, overtaking even the capital. Jalal-Abad and Chui   both secured 15.2% and 13.4% of top scores. Regions like Batken and Issyk-Kul, with 10.9% and 9.2%, respectively, show commendable performances, reinforcing the notion that academic prowess is not solely confined to larger or more urban areas. On the other hand, Naryn, with a 6.4% top score distribution, and particularly Talas, trailing at 3.6%, bring forth concerns.

Distribution of Regions in Top 30% Scores - All Classes Combined
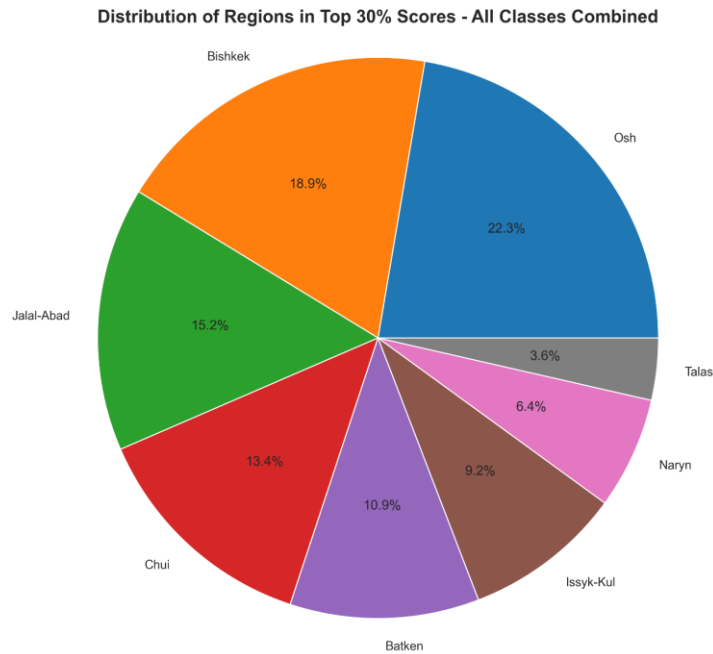
The disparity in public versus private school performance, where public school students dominate both participation and top scoring, is consistent with their overwhelming numerical representation. Although private schools are proportionally overrepresented in the top scores (accounting for 4.7% of top scorers despite being only 3.1% of total participants) , their overall low participation rate suggests that only a subset of highly motivated or well-prepared students from private institutions take part. It is possible that some private schools, especially those with international curricula, emphasize other competitions or standardized tests, thus directing fewer students toward the ROM. Alternatively, private school students who do participate may receive more individualized attention, tutoring, or specialized resources, factors that could enhance their likelihood of reaching the top score bracket.

Score Distribution in Top 30% for School Type (All Classes)
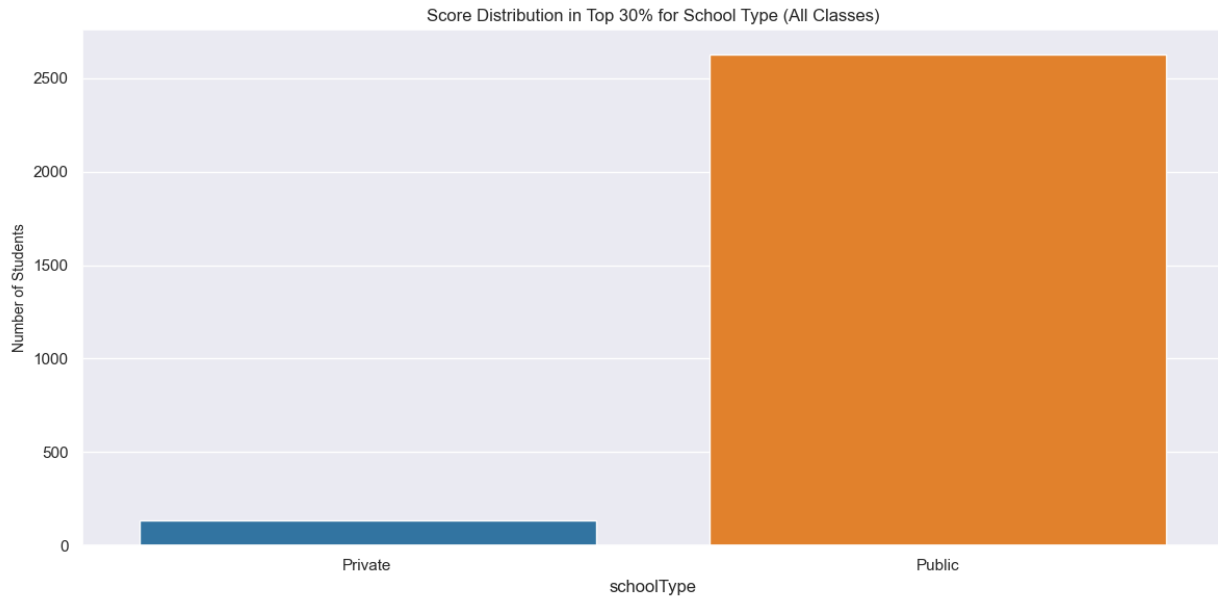
For gender-based scoring, females' leading 70% representation in the top 30% scorers suggests they not only participate more but also outperform males. This could be tied to motivational factors, teaching methods, or societal influences encouraging academic diligence among girls. Further study could illuminate whether this trend persists in other academic domains.

Distribution of Genders Across All Classes and Regions
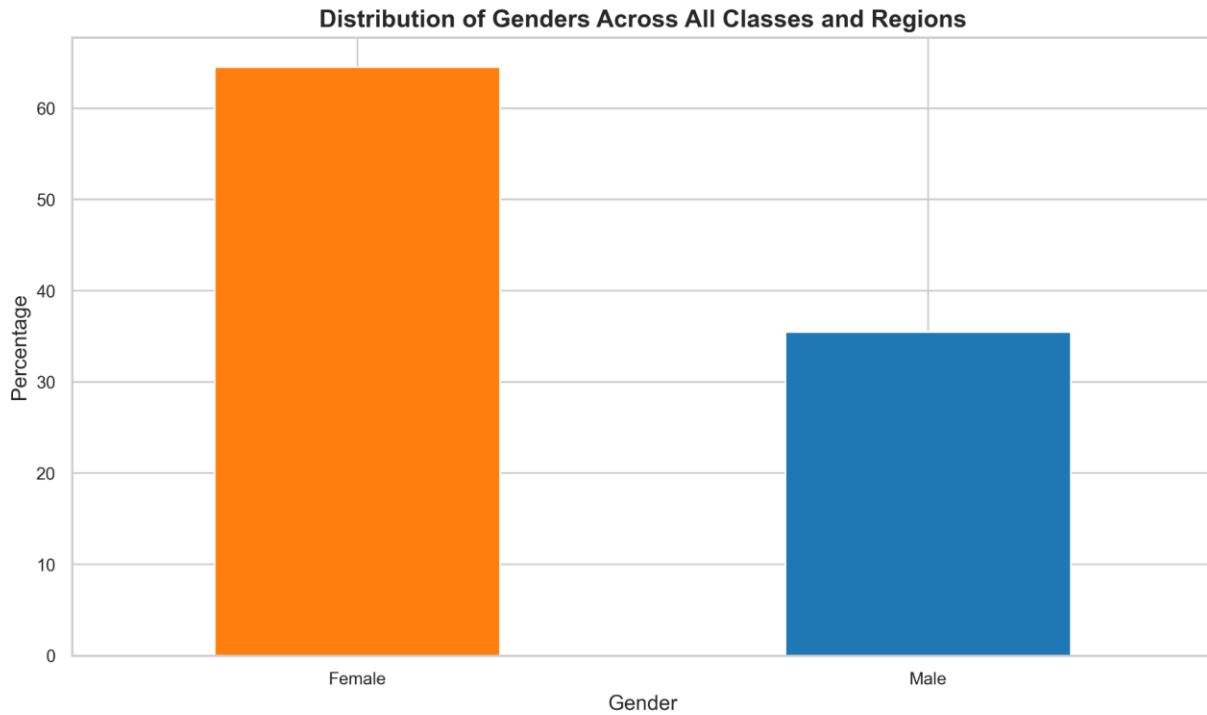
Digging deeper into regional specifics, for instance, in the Osh region, females lead with a score distribution being ⅔ of the top 30%. This can be attributed to both higher participation of female students and the fact that female students are more likely to to score high when given the opportunity.

Gender Distribution in Top 30% - All Classes, Osh

Interviews: A Qualitative Insight

In the qualitative component of our study, we focused on interviews with a remarkable individual, Kaiyrkul, a young woman from Naryn, a remote region of Kyrgyzstan, who secured the second position in the ROM. Now a student at the American University of Central Asia (AUCA) in the Applied Mathematics and Informatics Department, Kaiyrkul shared her aspirations and the challenges she faced pursuing a STEM career in a predominantly male-dominated society. Her narrative underscores a journey of resilience and determination, mirroring the broader struggle for gender equality in STEM fields within Kyrgyzstan.

Kaiyrkul's mother provided a parental perspective, emphasizing the family's unwavering support for her ambitions despite societal and financial hurdles. This familial support system is critical in nurturing the talents of young women in STEM, offering a foundation of encouragement and belief in their potential. Her teacher highlighted Kaiyrkul's blend of innate talent and relentless hard work, a combination that propelled her to excel in competitive environments like the Olympiad. This perspective sheds light on the importance of mentorship and the role educators play in recognizing and fostering potential.

The organizers of the Olympiad articulated their blueprint for the event as a civic initiative with the potential to transform Kyrgyzstan's educational landscape, especially for the youth hailing from the country's far-flung areas. By integrating these young minds into a global educational and competitive sphere, the initiative aims not only to spotlight the latent talents within these regions but also to forge a pathway toward their full realization. The focus on STEM education is particularly noteworthy, as it seeks to democratize access to quality education, ensuring that every child, irrespective of their geographical or socio-economic background, has a fair chance at excelling in these critical fields. The organizers believe that through such initiatives, the barriers that have traditionally hindered the participation of remote regions in national educational dialogues can be dismantled, fostering a more inclusive and equitable educational ecosystem.

In line with this vision, the Ministry of Education and Science's representative underscored the Kyrgyz government's unwavering support for civic initiatives aimed at educational advancement. The mention of the increasing participation and triumphs of girls in the ROM is particularly heartening, marking a significant stride toward rectifying gender imbalances within STEM disciplines in Kyrgyzstan. This evolution not only speaks to the efficacy of targeted government policies and civic interventions in nurturing a culture of inclusivity but also underscores the pivotal role such initiatives play in challenging and ultimately reshaping societal norms. By highlighting these successes, the Ministry aims to inspire further investment in civic initiatives that address educational disparities, thereby fueling a virtuous cycle of empowerment, innovation, and development. Through qualitative research, the profound impact of these initiatives on individual participants and the broader community can be meticulously documented, providing invaluable insights into the mechanisms through which education can serve as a catalyst for societal transformation. This body of research will not only reinforce the argument for the centrality of civic engagement in educational reform but also offer a roadmap for other nations looking to leverage education as a tool for inclusive growth and development.

Conclusion

The insights gleaned from our case study, augmented by the qualitative depth of interviews, illuminate the intricate dynamics of educational equality and performance at the ROM. These findings reveal several areas where improvements can be made to promote fairness and boost performance in mathematical education.

The dataset from the ROM reveals a significant female participation rate of approximately 65%, with females also comprising 70% of the top 30% scorers. This indicates that, at the high school level, girls are not only participating more but also excelling in mathematics competitions. However, national statistics show that women constitute only 31.1% of STEM graduates in higher education.[12] This discrepancy suggests that, despite their strong performance in secondary education, many high-achieving female students do not continue into STEM fields at the university level. To address this issue, it is crucial to implement strategies that sustain and nurture girls' interest in STEM beyond high school. Mentorship programs, such as the "TechWomen Program" initiative, have been effective in providing guidance and support to young women pursuing STEM careers. Additionally, increasing public awareness of STEM opportunities and addressing gender stereotypes can play a significant role in encouraging more women to enter and remain in these fields. By focusing on retaining and supporting female students who demonstrate aptitude and interest in STEM during their secondary education, we can work towards closing the gender gap in higher education and the STEM workforce.

Moreover, the ROM itself raises questions about its effectiveness as a proxy measure for educational equality. While the Olympiad provides a platform that appears to level the playing field by offering all students the chance to compete, does it fully capture the nuances of access to quality education, resources, and ongoing support necessary for sustained academic success?

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[12] Marchenko, Larisa Y., and Mirlan Chynybaev. Overview of the Higher Education System in Kyrgyzstan. Bishkek: National Erasmus+ Office in Kyrgyzstan, 2023.

Can the success in a mathematics competition be extrapolated to infer broader educational equity, or are there underlying disparities that such competitions do not reveal?

These questions highlight the need for deeper exploration into the factors contributing to the observed trends. Future research could investigate:

- **The Quality of STEM Education Across Regions and School Types**: Are there differences in curriculum, teacher qualifications, or resource availability that contribute to the performance disparities observed?
- **Socioeconomic and Cultural Influences**: How do socioeconomic status, cultural attitudes towards education, and gender norms influence students' participation and performance in STEM fields?
- **Longitudinal Outcomes**: Do high-performing students in the ROM continue to excel in higher education and pursue careers in STEM? What barriers might prevent them from doing so?
- **Role of Civic Initiatives**: How effective are competitions like the ROM in promoting educational equity? Could they be enhanced or complemented by other programs to have a more substantial impact?

In conclusion, while the ROM has shed light on promising trends in participation and performance, it also underscores the complexity of educational equality in Kyrgyzstan. The Olympiad serves as a valuable, albeit partial, proxy for measuring educational equity. It highlights areas of success and potential but also points to the need for a more comprehensive understanding of the systemic factors at play. By posing these larger questions and pursuing further research, stakeholders can better understand how to harness the potential revealed by the ROM and work towards an education system that truly offers equal opportunities for all students, regardless of gender, region, or school type.

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GitHub Repository: [Analyzing Education Equality and Performance Trends in a Kyrgyz STEM Olympiad](#).