Analyzing Education Equality and Performance Trends in the Republican Olympiad on Mathematics

An OSUN Case Study

Written By:

Abdullah Nazari and Fatima Fayazi

Supervised by:

Professor Pollina Dolmatova

Abstract

This research sought to understand education equality and performance trends within the Republican Olympiad on Mathematics (ROM). Drawing from the most recent ROM data, the study revealed significant disparities in participation and achievement across gender, regional, and school-type categories. Notably, female participants significantly overshadowed their male counterparts in both participation and top-tier performance. While Bishkek, the capital, showcased considerable representation, the Osh region emerged as a nexus of high participation and academic excellence. Surprisingly, despite potential resource limitations, public schools dominated the top 30% score bracket, overshadowing their private institution counterparts. These finding resonate with, but also diverge from, the trends in mathematical education all over Kyrgyzstan, suggesting unique impact of civic initiatives on the Kyrgyz educational landscape. The insights offer multifaceted policy implications, underscoring the need for targeted strategies to bolster underrepresented regions, recalibrate private school STEM approaches, and maintain the momentum of female excellence in mathematics. The research paves the way for future studies to delve deeper into the underlying motivations, challenges, and socio-economic variables influencing these trends in Kyrgyzstan.

1.   Introduction

In the evolving global landscape, Science, Technology, Engineering, and Mathematics (STEM) disciplines have been recognized as pivotal cornerstones for advancement and innovation. While this global momentum gains traction, individual nations face challenges shaped by their unique socio-economic and historical paradigms. Kyrgyzstan, with its profound historical lineage in Central Asia, confronts one such challenge: addressing the evident inequality and restricted access to quality STEM education.

This research paper turns its focus towards an influential civic response to this challenge: the Republican Olympiad on Mathematics (ROM). Initiated as a grassroots effort to democratize STEM education for every Kyrgyzstani schoolchild, ROM evolved exponentially. By 2023, this initiative drew participation from over 17,000 schoolchildren, testifying to its widespread resonance. Beyond being a mere competition, the ROM has become a symbol of academic

ambition and equitable opportunity, as its winners are catapulted into advanced educational trajectories through scholarships.

Our case study, titled "Civic Engagement for Education Equity in Kyrgyzstan: The Republican Olympiad on Mathematics", intends to chronicle the transformative impact of ROM. More than a mere event, ROM represents a powerful statement of civic engagement, where community-driven efforts have tangibly advanced education equity, challenging and reshaping existing barriers.

To substantiate our exploration, we will undertake a rigorous statistical analysis of ROM's data. This will encompass evaluations based on diverse criteria, including participant demographics, score distributions by region, school type, and gender, coupled with illustrative data visualizations. Through this multifaceted approach, we aspire to capture the essence of ROM's contributions to Kyrgyzstan's educational paradigm.

The intrinsic value of events like the Republican Olympiad on Mathematics is undeniable. Nevertheless, it is imperative to scrutinize them from an educational equality perspective. The availability of resources, specialized tutoring, and opportunities often fluctuates based on factors such as geographic location, socio-economic background, gender, and ethnic affiliations. Delving deep into education equality and performance trends in these competitions can shine a light on existing biases, discernible disparities, or overlooked sectors. Such endeavors ensure that competitions remain inclusive, offering fair chances to aspirants irrespective of their origins or backgrounds. Moreover, these analyses can furnish critical insights for educators and decision-makers, spotlighting areas that demand attention. Consequently, it helps in sculpting policies that can mitigate discrepancies and champion a comprehensive STEM education landscape in Kyrgyzstan.

1.1 **Objectives of the Study**

Building on the established foundation of the significance of mathematical education and the emphasis on equality in such competitions, the research endeavors to dissect participant demographics and performance trends in the Republican Olympiad on Mathematics. The primary aims of the study encompass a distributional analysis to categorize participants based on their region, ensuring equitable geographical representation; school type, distinguishing between

public and private institutions for an understanding of institutional involvement; and gender, to gauge representation and inclusivity.

Further objectives delve into potential regional score discrepancies, highlighting any significant differences that might provide insights into regional educational quality and resources. A performance gap analysis between public and private schools aims to spotlight disparities, and the exploration of gender-based score differences will ascertain if there are notable disparities between male and female participants.

1.2 Scope and Limitations

The research encompasses the Republican Olympiad on Mathematics data for the last year which this event was held during the year 2022, ensuring latest sample to observe patterns. A comprehensive array of data points, from demographics to performance metrics, will be used, and while the focus is on the distribution and scores, the research also aims to provide insights into potential underlying factors.

However, some limitations should be noted. The research data, while comprehensive, may have inherent limitations like incomplete datasets for certain regions, self-reported data inaccuracies, and a lack of granularity in capturing specific nuances. Furthermore, the study's methodological approach, including the statistical tools used and qualitative aspects, may have certain constraints. Results, especially those about underlying causes of disparities, may be subject to interpretational biases. Lastly, while the study aims to provide an exhaustive understanding of the ROM's participant demographics and performance, it does not delve deeper into areas like curriculum content, teaching methodologies, or broader societal perceptions of mathematical education in Kyrgyzstan.

1.3 Thesis Statement

This study delves into the intricate dynamics of the Republican Olympiad on Mathematics, analyzing the representation and performance trajectories across region, school type, and gender over a one-year span. Through the lens of civic engagement, the research seeks to unearth potential educational disparities and inequalities. Ultimately, our findings aim to inform and influence educational policies and practices in Kyrgyzstan, ensuring that such civic

initiatives genuinely act as equitable springboards, nurturing the nation's forthcoming innovators and leaders.

2. 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 (2020) 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 (World Bank, 2018).

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 (OECD, 2019). Yet, participation in such elite competitions can often be influenced by access to specialized training and resources, potentially leading to representational disparities (OECD, 2019).

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 (UNESCO, 2017). Societal norms, biases, and a lack of female role models in STEM are often cited as contributing factors (Hyde & Mertz, 2009).

Kyrgyzstan, like many other nations, faces its 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 can offer valuable insights, guiding research, and policy in the region.

It is essential, now more than ever, to understand the intricacies of platforms like Mathematics Olympiads within varied cultural and national contexts, evaluating their role in enhancing or perpetuating educational inequalities.

There remains an undeniable obligation to explore and understand the role and impact of platforms like Mathematics Olympiads within the Kyrgyz context, and to determine their efficacy in addressing or perpetuating deep-rooted inequalities.

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. This research aims to bridge this gap, emphasizing its relevance and urgency.

3. Methodology

3.1 Data Collection Procedures

The crux of the data for this investigation emanates from the Organizing Committee of the Republican Olympiad on Mathematics, a pivotal entity that orchestrates the annual ROM and diligently catalogs myriad details ranging from participant profiles to performance metrics. Given the substantial participation over successive editions, this study judiciously narrows its focus on the 2022 rendition of the ROM, offering a contemporary and pertinent lens into Kyrgyzstan's mathematical education matrix. The dataset inherently encompasses crucial variables like scores, names, emails, regions, schools, and more. Augmenting analytical rigor, supplementary variables like gender, school typology, and an encompassing index are incorporated.

3.2 Data Preparation and Analysis

Initial data, anticipated to be predominantly in Russian, will undergo rigorous translation to English to foster accessibility and widespread interpretability. This translated dataset is subjected to a meticulous cleaning regimen. Pertinent actions include addressing void entries through robust imputation strategies—like median or mode substitution—or opting for selective omission. Concurrently, anomalies or non-standard entries will be identified and corrected.

In the analytical phase, a spectrum of techniques is embraced. Mean score computation furnishes an overarching view of aggregate performance, while participatory analytics discern disparities, if any, rooted in regional, institutional, or gender variables. Delving into the distributional intricacies of participants based on these categorical facets unveils nuanced ROM representation patterns.

Facilitating this intricate analytical journey is Python, a versatile computational language celebrated for its prowess in data wrangling and exploration. The abundant libraries and modules within Python's ecosystem enable profound data introspection and elucidative visualizations. Certain machine learning paradigms, especially clustering and classification, stand poised to unearth latent patterns and directional trends.

3.3 Ethical Considerations

Upholding ethical sanctity remains non-negotiable in this endeavor. The research remains committed to a path of unprejudiced analysis, vigilantly circumventing potential biases or predispositions. Such adherence ensures analytical fidelity and veracity. Moreover, the holistic ethos promises judicious data handling, eschewing arbitrary exclusions or oversights.

4.   Findings

### 4.1 Participant Demographics: Gender, Region, and School Type

The dataset provides a comprehensive breakdown of participation in the Republican Olympiad on Mathematics, highlighting distinct trends based on gender, region, and school type.

A dominant feature of this data is the pronounced female representation. Specifically, of the total 10,541 participants, 6,793 were females, accounting for nearly 65%, while 3,732 were males. This remarkable inclination toward female participants in the ROM underscores a positive trend toward gender inclusivity in STEM fields within Kyrgyzstan. It suggests the possibility of supportive educational policies, societal shifts, or institutional encouragement for females in STEM. However, the disparity also calls for an exploration into potential barriers or lack of incentives for male participants.

Gender Dististribution
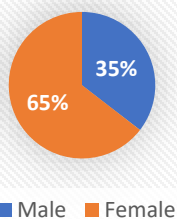
Regionally, the participation is diverse. Bishkek, being the capital, naturally recorded 1,109 participants. Yet, Osh surpassed this with 2,114 participants, making it the region with the highest participation. This elevated representation from areas like Talas, with only 387 participants, might require 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, 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
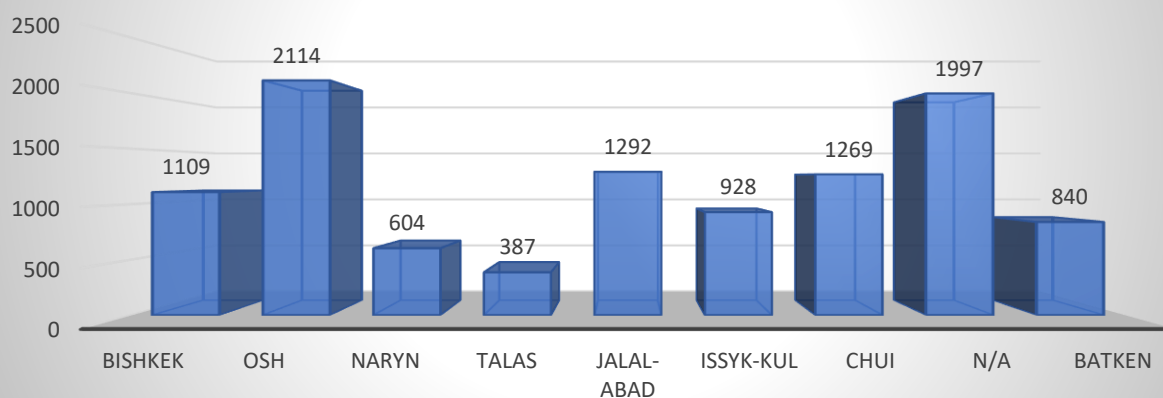
SCHOOL TYPE DISTRIBUTION

■ Public   ■ Private
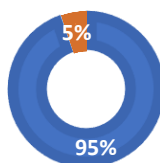
In terms of school types, a stark contrast is observed between public and private institutions. An overwhelming 9,984 participants hailed from public schools, compared to a mere 555 from private institutions. The significant representation of public schools might indicate their commitment to mathematical education, even in the face of potential resource constraints. In contrast, the muted participation from private institutions raises questions about their engagement with national mathematical competitions and their overall emphasis on STEM curricula.

4.2 Performance Analysis: Regional Standings

In the realm of academic excellence, the top 30% score distribution offers an illuminating perspective on regional competencies within the ROM.

Bishkek, the capital, accounted for 18.2% of the top scores. While significant, this positioning suggests that being the capital city does not necessarily guarantee supremacy in academic performance. There might be various factors at play, such as the volume of participants or diverse quality of education, which could be investigated further.

The standout performer is Osh, with a commanding 24.1% of top scores, overtaking even the capital. This dominance not only emphasizes Osh's strong emphasis on mathematical education but also implies a thriving culture of academic excellence. Such a trend might be indicative of the region's effective teaching methodologies, quality resources, or intrinsic student motivation.

Chui and Jalal-Abad, both securing 13.7% of top scores, present an interesting scenario. Their equal standing might suggest similar educational strategies, resource allocation, or student

engagement in these regions, or it could be a mere statistical coincidence that warrants further study.

Regions like Batken and Issyk-Kul, with 9.9% and 9.7% respectively, show commendable performances, reinforcing the notion that academic prowess is not solely confined to larger or more urban areas. Their near-identical performance also hints at potential commonalities in their educational approaches, which might be of interest to educators.

On the other hand, Naryn, with a 6.5% top score distribution, and particularly Talas, trailing at 4.2%, bring forth concerns. These figures indicate potential areas of improvement, whether in terms of teacher training, curriculum development, or resource allocation, to bolster mathematical performance in these regions.

Distribution of Regions in Top 30% Scores - All Classes Combined
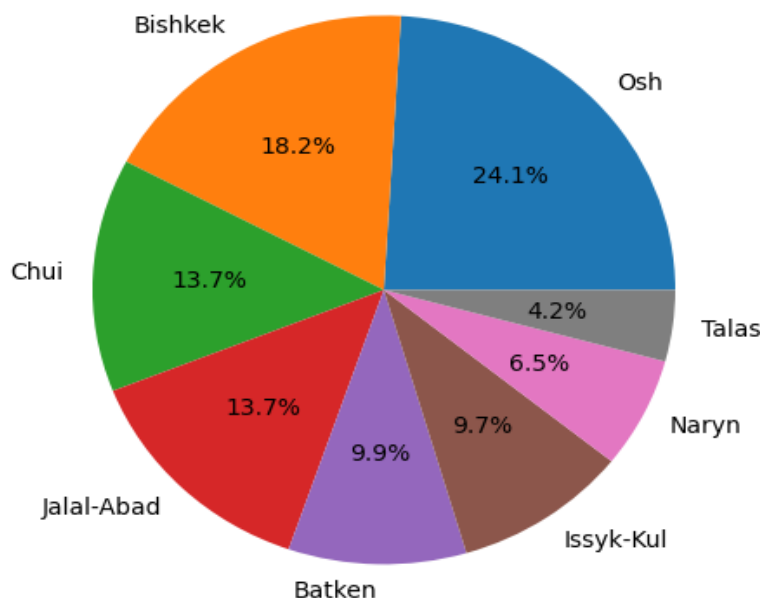
4.3 Performance Disparities: Public vs. Private Institutions

The descriptive statistics reveal a noteworthy distribution of scores when we examine public versus private school participation. For the top 30% of scorers across all regions, public schools account for a robust 2,500 students, while private schools present around 250 students.

Score Distribution in Top 30% for School Type (All Regions)
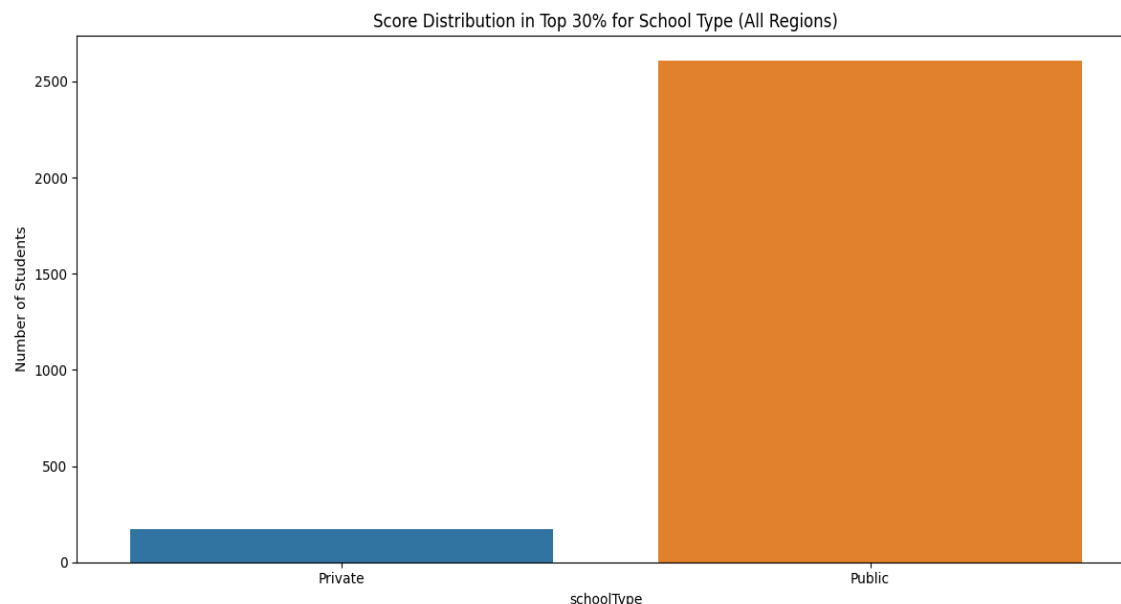
This disparity becomes even more apparent upon interpretation. The data indicates that public schools, despite the challenges they might face in terms of resources or funding when compared to private institutions, have a representation in the top 30% scorers, that is ten times more than their private counterparts. This suggests that public school students are not just actively participating, but also achieving significant success in the ROM.

The implications of this distribution are multi-layered. On one hand, it is heartening to see public schools, which traditionally serve a larger and often more diverse student body, excel in a national mathematical competition. This could be a testament to the dedication and efficacy of public-school educators and the resilience and hard work of the students. On the other hand, it raises questions about the performance of private schools despite potentially having better resources and facilities.

4.4 Gendered Performance Insights

When it comes to gender-based score distribution in the top 30%, females are ahead with 70% representation, while males trail at 50%.

Distribution of Genders Across All Classes and Regions
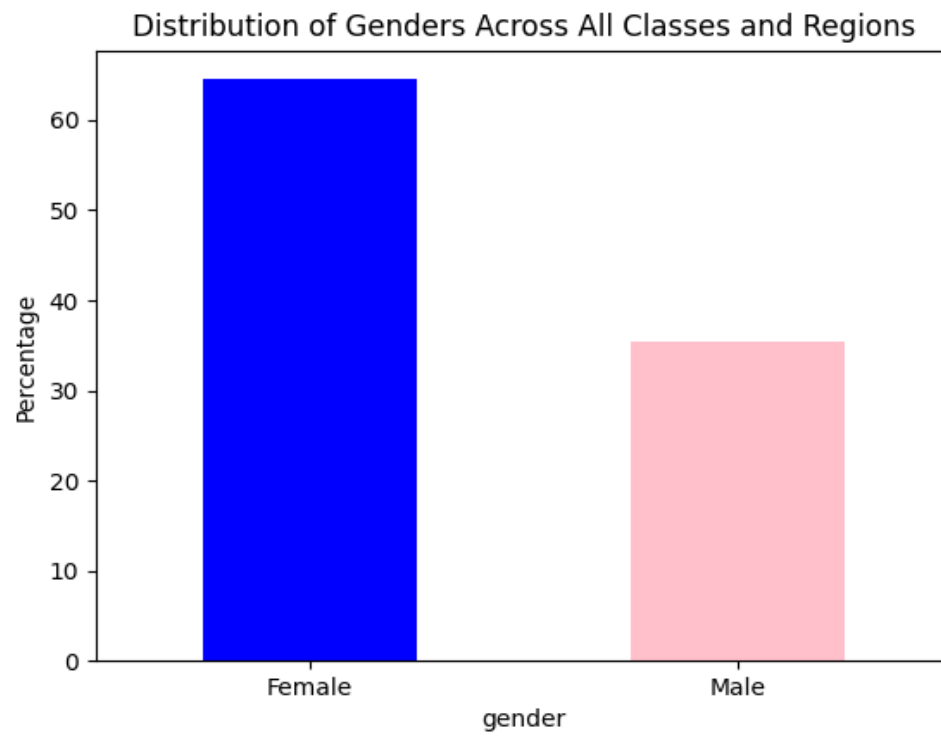
Digging deeper into regional specifics, for instance, in the Osh region, females lead with a score distribution.

Distribution of Genders in Top 30% Scores - Region Osh
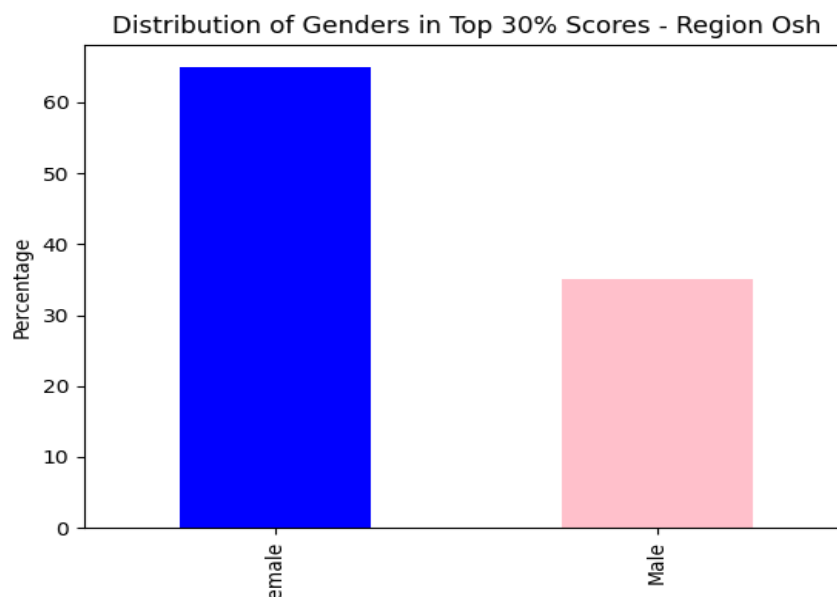
Interpreting this data offers a clear picture: across the board and more prominently in regions like Osh, females are not only more participative but also more successful in securing top scores, with their representation in the top 30% being twice as much as their male peers.

The implications of this gender-based distribution are significant. It is evident that in the sphere of mathematics, at least in the context of this competition, female students are taking the lead. This could be a result of the civic initiative approach and targeted educational initiatives, societal changes, or increased awareness about gender equality in academic pursuits. It challenges traditional gender norms and reiterates the importance of providing equal opportunities and encouragement to all students, irrespective of their gender. The data can also serve as an inspiring reference point for future female students, assuring them that they can achieve excellence in STEM fields.

5.   Discussion

This research elucidated critical revelations about the landscape of education equality and performance in the Republican Olympiad on Mathematics. Notably, female participants significantly outnumbered and outperformed males, particularly within the top-scoring echelons. Although Bishkek demonstrated robust representation consistent with its status as the capital, Osh emerged as a surprising nexus of participation and academic excellence. In contrast, certain regions, like Talas, showed underrepresentation. Furthermore, public schools, irrespective of potential operational constraints, remarkably eclipsed private institutions in top-tier scores.

Our findings regarding gender dynamics, particularly the pronounced female ascendancy in the ROM metrics, resonate with an escalating global momentum advocating enhanced female integration in STEM arenas. However, this overt female predominance in our data surpasses the metrics in numerous international STEM competitions. Contrary to anticipatory norms, the capital region did not unequivocally dominate performance metrics. Additionally, the ROM results provide an intriguing dichotomy to conventional discourses, wherein resource-endowed private institutions typically surpass public schools.

5.1 Policy Implications:

1. Strategies for Underperforming Regions: Considering the diminished participation and achievements from regions like Talas, interventions like enhanced teacher training, STEM-

focused extracurricular initiatives, and symbiotic collaborations with high-performing regions could be potent strategies.

2. Public vs. Private School Dynamics: The findings propose introspection for private institutions. An overhaul of their mathematical curriculum, pedagogical methods, and national competition participation might be warranted. Simultaneously, public schools, buoyed by their ROM performance, could advocate for augmented STEM-specific resources and investments.

3. Mitigating Gender Disparities: In the realm of mathematics and broader education, sustaining the promising female performance trajectory necessitates focused civic engagement. Initiatives such as community collaborations with local organizations to establish mathematics-centric workshops, and expanded mentorship programs involving professionals from mathematical and STEM backgrounds, can pave the way. The introduction of targeted scholarships for underrepresented genders in mathematical disciplines, combined with curriculum adjustments emphasizing inclusivity in mathematical studies, can further amplify representation. Continuously championing female accomplishments in mathematics and STEM is vital. Conversely, to address male underrepresentation, delving into its underlying factors and crafting engagement strategies, potentially through experiential mathematical challenges, becomes essential for a holistic and balanced educational approach.

5.2 Prospects for Future Research

The research's unexpected revelations underscore the importance of further inquiry into qualitative facets. Through the lens of civic engagement, understanding the drive behind education equity becomes paramount, especially in the context of Kyrgyzstan. A deeper comprehension of the motivational paradigms, hindrances, and ecosystems influencing students, especially in top-performing demographics like Osh or amongst females, emerges as a crucial component of this narrative. A meticulous examination of pedagogical contrasts across public-private and regional spectrums, bolstered by civic initiatives and stakeholder participation, could yield actionable insights for pedagogical enhancements. Furthermore, an enriched discourse exploring the nexus between socio-economic variables, civic involvement, and the ROM metrics stands to offer a more holistic perspective of Kyrgyzstan's educational tapestry.

6.   Summary and recommendations

Our exploration into education equality and performance trends in the Republican Olympiad on Mathematics, backed by concerted civic engagement, has been profoundly enlightening. We uncovered a notable dominance of female participants, both in numbers and in top scores, a revelation that challenges conventional STEM stereotypes. Regionally, while certain areas like the Osh region exhibited notable achievements, regions like Talas underscore the need for enhanced civic initiatives and educational opportunities.

At the heart of a flourishing society is the principle of equitable access to education. Through civic engagement, we underscore the irreplaceable role it plays in addressing disparities. This endeavor is more than just creating a level playing field; it's about creating an enriched nation ready to face the challenges of the future. Our study emphasizes the role of civic engagement in dismantling traditional educational barriers and biases. When provided with equal opportunities and resources, all students, irrespective of gender, region, or school type, have the innate potential to shine. This is particularly salient in STEM fields, which will dictate the trajectory of our shared future.

This data encapsulates dreams, aspirations, and untapped potential. Civic engagement is the clarion call for every stakeholder—be it policymakers, educators, parents, or community leaders—to unite in harnessing this potential. For regions like Talas, it's imperative to strategize and ramp up investment in education, to create more opportunities for every child. For schools, irrespective of being public or private, the need is to adopt best practices, champion innovation, and loudly celebrate every success. For our students, especially our young women making strides in mathematics, civic platforms must serve as pillars of unwavering support and recognition. Our nation's strength is encapsulated not just in its milestones but in its potential and the opportunities we create. Together, through civic engagement, we can ensure every student realizes their fullest potential.

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