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Gender Pattern in Participation and Performance at Mathematics Olympiads

[1]Meremikwu, Anne N., [2]Ekwueme, Cecilia O. and [3]Enukoha, Obinna I.
Department of Curriculum and Teaching University of Calabar,Calabar Nigeria
[1]annemeremikwu@yahoo.com, [2]olunwa1@yahoo.com, [3]obinnaenukoha@yahoo.co.uk

ABSTRACT

Rating of schools, regions and countries in mathematics performance is often based on olympiad results. International Mathematics Olympiad (IMO) was male-dominated with < 10% contestants being females from 1959 to 2012. Study analyzed math olympiad results for 6769 female (47.1%) and 7595 male (52.9%) Nigerian students. More males (3137/7595; 41.3%) than females (2677/6769; 39.5%) had scores above average total scores (Mantel-Haenszel =4.578, OR 0.92 (95% CI: 0.86 to 0.99; p < 0.001). Scores in objective question were better for males then females (Kruskal-Wallis =16.80; p<0.0001). Females had higher scores in theory question (KW- H test=14.96, p<0.001). Gender differences in participation and performance was marginal in the Nigerian contest. Implications of findings for gender inequity in mathematics olympiads is discussed.

Key words: Gender, Mathematics, Olympiad, Inequity, students

INTRODUCTION

The third Millenium Development Goal is an expression of the international commitment to promote gender equality and empower women. Education in science and technology is a key strategy to empower women. Since mathematics occupies a central place in all disciplines related to science and technology, improving the participation of girls in mathematics is crucial to strategies to empower women. It is widely acknowledged that women have been under-represented in mathematics, science and technology. Global and national efforts to improve gender equality and empower women has led to remarkable improvement in the situation of women in several fields sectors and disciplines including the sciences.

The rating of students, schools, regions and countries in mathematics has often been based on the results of competition and Olympiads. Track the performance the participation of girls in Olympiads provides an initiatives that promise to improve the motivation and participation of girls in mathematics education. Examining trends in the participation and performance of women in mathematics Olympiad may not be the best approach to determine the magnitude of improvements in the participation and performance of girls in mathematics but give an indication of the direction of change.

Studies into the processes and factors that hinder the interest, confidence and participation of girls in mathenatics have led to some understanding of these factors (Mulhem, 1999), but the longstanding contention that discrimination, intimidation and taunting of girls contributes to the under-representation of girls in mathematics especially situations where they have to compete with boys remains to be confirmed by consistent empirical evidence. Reward and recognition are key feature of competitions including mathematics Olympiads. Using achievement-based rewards for the purpose of improving students' motivation, participation and performance in mathematics is a key reason for national and international mathematics olympiads but achievement-based rewards have merits and demerits.(Cameron et al. 2005).

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Cognitive evaluation theory (CET) provides a framework for better understanding of the extent to which Olympiads and other competitive mathematics events motivate students to learn mathematics.

Cognitive evaluation theory (CET) explains how rewards tied to achievement affects intrinsic motivation. The theory proposes that the critical process that mediates the effects of performance-based rewards on intrinsic motivation are perceived autonomy and perceived competence. It posits that (Deci et al, 1999). When rewards are perceived to be controlling perception of autonomy decreases, leading to lower intrinsic motivation. The proponents of CET therefore hypothesized that because reward always has a controlling aspect, achievement-based reward will invariably decrease intrinsic motivation. A review of several studies that assessed the effect of rewards on autonomy and intrinsic motivation showed that rewards increase self-perception of autonomy and intrinsic motivation (Eisenberger, Pierce and Cameron, 1999). This dominant school of thought essentially validates the usefulness of mathematics competitions and Olympiads.

International Mathematics Olympiad (IMO) is the most prominent event brings boys and girls into contest for the purpose of encouraging improvement in participation and performance in mathematics. This paper seeks to illustrate gender patterns in participation and performance mathematics Olympiads.

METHODS

The research design is analysis of data available on participation of male and female high school students who have participated in the International Mathematics Olympiads from its inception in 1959 to 2012. Data available from the first stage of a recent (2012) nationwide mathematics competition involving male and female high school students in Nigeria were analysed to assess the current gender pattern in participation and performance in competitive mathematics tests in Nigeria. Mean scores were compared using the Kruskal-Wallis H Test. Proportions of male and female contestants whom performed above the composite average scores objective and theory tests were compared using Mantel-Haenszel chi-squared test and odds ratio with 95% confidence intervals.

RESULTS

Participation

Information on participation was available for the International Mathematics Olympiad (IMO) data set and the Nigerian nationwide mathematics competition data.

A total of 14,546 high school students had recorded to have participated in the IMO from 1959 to 2012 but data on gender classification were available for 12,531. There were a total of 11,587 (92%) male contestants and 944 (8%) female contestants. A sensitivity analysis assuming that 50% of the participant with missing gender data were females gave an assumed cumulative total of 1952 (13%) female contestant's in the IMO to date. Figures 1, 2 and 3 show that the number of female and female contestants in IMO has increased over time but with female students remaining grossly under-represented from inception of IMO to date.

Data on the first stage of the 2013 national junior high school mathematics competition in Nigeria shows that there were a total 14,364 contestants , 6769 (47.1%) were female and 7595 (52.9%) were male. This suggests that an early stage of mathematics competition at national level, the participation of girls is much higher than is suggested by the gross under-representation shown by IMO participation data.

Performance

Information on performance in theory and objective mathematics tests were available for the Nigerian junior high school competition data set and not for IMO data. Table 1 shows the comparison of the mean scores of female and male contestants. The performance of male students was significantly better in the objective and combined scores while the female performed significantly better in the theory test.

Table 2 shows the proportion of male contestants that scored above the mean objective test and combined test scores were significantly higher than the females. On the other hand, the proportion of female students with scores above the average theory test score was significantly higher than the males.

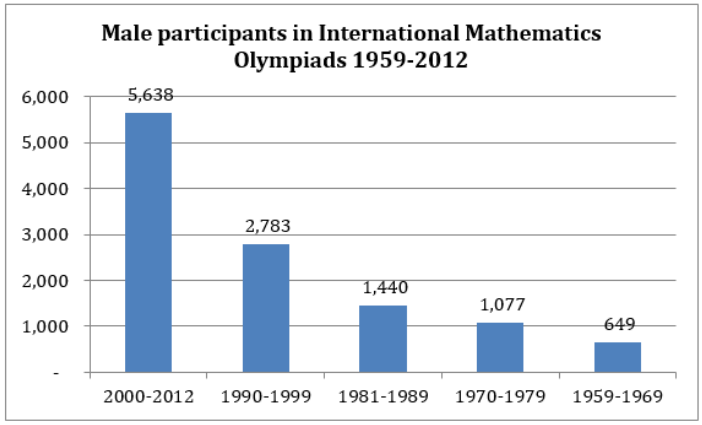

Figure 1: Numbers of Male Contestants in International Mathematics Olympiads (1959-2012)

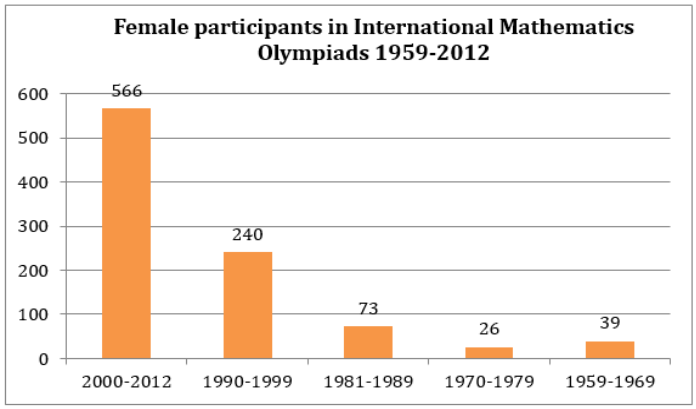

Figure 2: Numbers of Female Contestants in International Mathematics Olympiads (1959-2012)

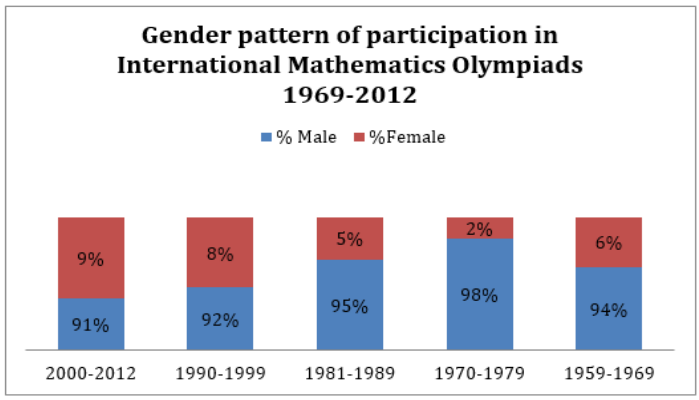

Figure 3: Percentage of Male and Female Contestants in Mathematics Olympiads (1959-2012)

Table 1: Comparison of mean scores of male and female contestants in high school mathematics national Olympiad in Nigeria

Question type	Mean score (SD)		Kruskal-Wallis H Test	P-value	Remarks
	Female N=6769	**Male N=7595**			
Objective	20.09 (9.99)	20.98 (11.0)	16.80	0.000	Male significantly higher
Theory	3.326 (2.949)	3.119 (2.832)	14.967	0.0001	Female significantly higher
Combined scores	23.409 (12.474)	24.082 (11.554)	5.618	0.0178	Male significantly higher

Table 2: Proportion of male and female contestants above mean score

	Number (%) above average score		Mantel-Haenszel X^2	P-value	MLE Odds Ratio (95% confidence interval)
Question type	Female	Male			
	N (%)	N (%)			
Combined score	2677 (39.5)	3137 (41.3)	4.578	0.000	0.92 (0.86 to 0.99)
Objective	2515 (37.1)	2989 (39.3)	7.329	0.0067	0.91 (0.85 to 0.97)
Theory	2598 (38.4)	2690 (35.4)	13.505	0.0002	1.13 (1.06 to 1.21)

DISCUSSION

The results show that although females performed better in one aspect of the competition (theory questions) compared to the males, the males achieved higher scores in the combined test scores (objective plus theory) and therefore more likely to be selected for the next stage of the competition. This shows that while female students show keen interest in competitive mathematics tests they were more likely to be eliminated at an early stage and therefore become under-represented in national level final competitions and the International Mathematics Olympiads.

The view that boys always out-perform girls in mathematics and science is widely held. The current study showed that female contestants in the Nigerian junior high school Olympiad performed significantly better that the males in theoretical mathematics tests. The influence of gender on mathematics achievement has been well studied. The dominant view in published literature is that gender significantly influences mathematics achievement but a study of Nigerian primary school pupils found out that in different settings, differences in mathematics achievement may vary significantly in favour of either males or females, showing a tendency for co-educational settings to favour male students more than the females (Meremikwu, 2002). Other studies have also shown that in some settings and topic areas girls do better than boys. For instance, Havinghurst (1974) should that there could be significant sex differences in favour of girls on numbers, word fluency, reasoning and memory sub-texts. Also McCensland and Stewart (1974) in their study of college students showed that females obtained higher grades than males because females study more effectively and accepted standards more willingly. Pelfier (1986) also noted that more girls graduated from high school than boys probably partly because of better achievement on the part of girls.

CONCLUSION AND RECOMMENDATION

Despite the fact that female students have the potential to perform as well or better that their male counterparts, the gross underrepresentation of girls in national and international competitions have gone on for decades apparently unnoticed nor given the required attention. We recommend multi-country studies to understand the mechanisms and factors that influence the low representation of girls in international and national mathematics competition. The results of these studies will provide useful information for planning and implementation of interventions to improve participation and performance of girls in mathematics competition. .

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