

**(NWM) on Economic Development**

**By**

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**A Paper Presented at the First Biennial  
Conference of the Nigerian Women in Mathematics  
Holding at  
The Faculty of Science Lecture Theatre,  
University of Agriculture, Makurdi  
8<sup>th</sup> and 9<sup>th</sup> May, 2017**

## **Protocols and Acknowledgements**

I wish to sincerely appreciate the Executive Council of the Nigerian Women in Mathematics for the privilege to be part of this epoch making event in the society. The First Biennial Conference of the Nigerian Women in Mathematics taking place here at the Faculty of Science lecture Theatre, University of Agriculture, Makurdi. There is a very long list of more senior and qualified academic colleagues that could have done this job, this opportunity is not taken for granted. I congratulate the Nigerian Women in Mathematics (NWM) on this maiden conference. A gathering of women in mathematics is valid, is important and holds great potentials. I know that you all must have highly multitasked in order to make this day a reality. Many congratulations. Like the Bible reminds us, humble beginnings are not to be despised. Long live National Women in Mathematics!

## **Introduction**

The theme that has been selected for this beginning is a good one for the following reasons in my opinion. First, having been engaged in the teaching and learning of mathematics at all levels over time, reflecting on the impact so far will inspire women not to relent in doing what they have done well all this time. It will also provide the opportunity to examine the aspects of the practice that have not been as successful and if this examination is done dispassionately, it can engineer improvements in practice. It will bring to light the constraints, if any, on \*effective contribution. Thirdly, understanding this impact will provide evidence that further justifies investing in women in mathematics or not and make it clear what the priority areas for investments are for the future.

## **To begin, who is a Woman in Mathematics and what does she do?**

Any Nigerian female involved/engaged in the teaching of mathematics (somewhat more professionally) at all levels of education is a Nigerian woman in Mathematics. According to [www.study.com](http://www.study.com) the study of mathematics requires engagement in understanding mathematical concepts from addition and subtraction and all the way to complex calculus. These mathematical concepts are very useful in almost every aspect of life. From simple day to day tasks to complex engineering designs and innovations. Mathematics to Pierce (1978) and David (1982) is the science of quantity and space and their respective symbols. Similarly, it is the science of making necessary conclusions about quantity and space in a logical and objective way.

Studying and teaching mathematics requires consistent hard work in order to achieve success. It is not an area to be taken lightly. In my experience, more students are apprehensive than they are receptive of mathematics, considering it a difficult task, an undoable subject how be it erroneously. On a lighter note, this is a gathering of women in mathematics, you know certainly who you are and what you are up against academically. In addition to the academic requirements which are serious enough, you are wives, mothers, daughters, sisters, aunts and community leaders as well. Each of these roles you play are significant and stand high in their own rights.

### **What is Economic Development?**

Different scholars have contributed to the evolving definition of economic development. A perspective on the concept is always important and in this case there is need for a basis upon which to determine what country is developing and which is not. According to Todaro & Smith (2009), traditional measures of economic development lay in generating and sustaining increases in Gross National Income (GNI) and Gross Domestic Product (GDP) between 5 to 7% annually sustained over many years. It also meant a structural transformation in the production process and in labour employment in an economy requiring that the share of resources and labour employed in traditional agriculture shifted to the industrial sector. The experiences of many developing nations who reached their growth targets in the 1950s and 60s and still had living standards of the people for the most part unchanged and worsened in some cases, signaled that the definition of development was narrow.

Dudley Seers in Todaro and Smith (2009) posed the basic questions to ask about the meaning of development when he asserted that,

*“the questions to ask about a country’s development are therefore: what has been happening to poverty? What has been happening to unemployment? What has been happening to inequality? If all three of these have declined from high levels, then beyond doubt this has been a period of development. If one or two of these central problems have been growing worse, especially if all three have, it would be strange to call the result “development” even if per capita income (PCI) (GDP and GNI added) doubled”.*

This paper supports this argument completely because it implies that economic development happens when human beings get a better deal from the dynamics of resource allocation through the distribution of benefits. In essence, no matter what a nation says, it has

achieved, until it translates to a better life for its people, economic development cannot be said to have taken place.

When incomes and the purchasing power of the people improve, when options/opportunities in education and work increase, when health, nutrition and hygiene improve and are somewhat guaranteed and the capacity to sustain these improved levels is developed, then life for the majority can improve. In this opinion being presented, economic development will have a human face to be believable. It means that improvements in the quality of human resources (as human beings here) is an outcome of development. Interestingly, economic theory also posits that human capital is also an important determinant of growth and development- human capital development as an input as well as an outcome. We explore the dynamics as well.

### **The Case for Human Capital**

Classic economic models of growth which made a case for the accumulation of human capital in order to make labour and other investments yield the desired outcomes were the augmented neoclassical growth model, the Lucas (1988) model and the Romer (1990) model.

The perspectives that these theories bring and which the paper agrees with is that above financial and other non-financial resources, human capital is an important driver of economic development because it is the factor that makes labour and finance productive.

Taylor (2012) posits that policy makers have begun to acknowledge the critical role of a strong human resource base in complementing other investment and policies to boost productivity and economic progress.

Also, according to ...in Africa Development Bank (AfDB) Economics Working Series, the accumulation of human capital improves labour productivity, facilitates technological innovations, increases returns to capital and makes growth more sustainable which in turn supports poverty reduction and holds potentials for economic development.

Benhabib and Spiegel (1994) investigated for the United States the role of human capital in development and asserted that human capital had been considered as an important factor in its economic development process. Their findings revealed two mechanisms through which human capital affects growth. Firstly is that it directly influences the rate of domestically produced technological innovation and second, the stock of human capital affects the speed of adoption of technology from abroad. The significance of these findings is that the stock of human capital rather than the growth rate of human capital plays a vital role

in achieving economic development. When we examine these assertion with the understanding that reference is being made to human capital development, we begin to think about the role of mathematics and women in mathematics to building the stock of human capital in Nigeria.

According to Saif (2012), human capital can be described as the skills training and health status of labour acquired through on the job training and education. Michael Park in Saif (2012) also defines it as the skill and knowledge of human beings. It is the endowment of abilities to produce that exists in human beings, which can be increased through formal education, on the job training and improved health and psychological wellbeing. It follows logically that the more well educated, skilled, nourished and healthy people a country has, the greater the stock of human capital in it. We can begin ponder on the Nigerian story, as to the level of human capital that there is in Nigeria.

### **How does Mathematics contribute to Human Capital Development in the short run and Economic Development in the long run?**

Ukpata and Agha (2012) give insights in their work – which set out to examine whether the study of mathematics as a subject or course has a significant relationship with national development by ascertaining whether organisations whose workforce are sound mathematically are more productive than those with less mathematical competence. They studied 100 students, academic and non-academic staff in Kogi State University. Their findings revealed that being mathematically competent enabled fast thinking and fast problem solving. It also increased receptivity and adoption of new technology among the workers. They concluded that mathematical competence supports higher productivity levels in the long run in the university.

The US Department of State websites content as at December 2008 on science and mathematics for development posits very clearly that the basis of a knowledge based economy is an investment in science and mathematics education as they in turn pay for themselves in economic gain. It is clearly stated that training in mathematics and science must be fed steadily for progress. Furthermore, to them science and mathematics training represents a micro society built on the principles of critical inquiry, meritocracy, transparency, objectivity, individual speculation, access to information and innovation which are fundamental ingredients for good governance. It goes without saying that the more mathematicians control the economy, the more sound the economy will be given the skillset that the training itself provides. As the world's leading economy, this testament cannot be

overlooked. This submission implies that to the United States, teaching and learning of mathematics is a parallel to building skills, innovation, and economic growth as well as to good governance.

What is clear is that technological innovations simplify life and lead to economic development. Whether new for innovations or technology adoption, the role of mathematics is crucial. The science news, which is an online magazine of the Society for Science and the Public clearly shows that mathematics has been very important in successful air/space travel engineering, computer designs and programming and robotic engineering. Some current features of the magazine are that rockets can now be recycled and the use and potency of drones and atomic bits is increasing. These advancements would not be possible without mathematics. Though more sophisticated than we are more accustomed to, it is clear that the initial advancements which we require are also closely tied to mathematical skills.

Even though in Nigeria, desired levels of development have not been achieved, the levels we have attained will not have been possible without the skills of engineers, doctors, technicians, artisans, teachers and technocrats who have required training in mathematics at different levels. Building mathematical capacity is a prime example of transformational diplomacy in which individuals are empowered to step up to the plate of responsibility for their own development. In Nigeria, the transformation which we currently and very desperately pursue might be found if we take the path of investments for training in mathematics. Though the outcomes of mathematical training cannot be measured in the short term, the advantages in the long run are on human capital and economic development and they eventually become obvious. So while the government seeks short term fixes for the economy, a long term solution should be the goal – this justifies the investment in mathematical (scientific) teaching and learning.

### **Does it Matter Who Teaches Mathematics?**

According to Zeiglar (2017) not all students like mathematics but a good mathematics teacher can change that. She can help students who have traditionally struggled to build confidence and make her class a place where students want to be. A successful mathematics teacher according to her should have studied extensively and acquired a good knowledge of the subject at relevant levels required. Other characteristics of a good mathematics teacher are: she understands that students learn in different ways and so has different teaching strategies; she encourages multiple procedures to solve problems; she facilitates the learning

process by providing students with the tools and challenging them to work on their own; and not quit even if they fail; and encouraging them to figure out their mistakes and correct them.

Further, a good mathematics teacher has control of the classroom laying out instruction, and disciplining when students misbehave consistently and fairly. Finally, the good mathematics teacher from experience cares for her students. She recognizes when a student is having a bad day or when life gets in the way of studying and assignments and helps the student catch up.

Pretilla, (2013) in her study set out to define criteria for a good mathematics teacher at a Finish University. She connects the criteria for a good mathematics teacher to the view of oneself as a learner and teacher of mathematics as well as her view of the subject's teaching and learning. She studied 80 pre service teachers. Her conclusions are similar to Zeiglar but extend to include that a good mathematics teachers beliefs and conceptions should be as many – sided as possible and be based on a constructive view (knowledge has building blocks that can be assembled no matter what is being learnt) of teaching and learning mathematics.

Grande (2012) writes on qualities of a good mathematics teacher which he gathered from the opinions of his students, from freshman to seniors and his findings are interesting. The most recurring response from freshmen taking his mathematics of games and gambling class was that the math teacher should be patient. The next two most reoccurring responses were for the teacher to be fun and exciting. For the seniors taking his calculus classes fun was not a reoccurring characteristic. Here students used words like smart, insightful and organized respectively as the most highly desired characteristics. This points to the fact that the requirements for a good mathematics teacher might be age of student, topic being covered and/or level of study specific. Teachers must be sensitive to these possible peculiarities. From the following insights, this paper opines that while it is possible to have anyone teach mathematics, it is important who actually teaches it.

For the purpose of verifying some of these claims, I asked Nigerian graduates three questions via WhatsApp group chats and got responses from over thirty of them. All the respondents completed their first degrees at least five years ago. The questions are;

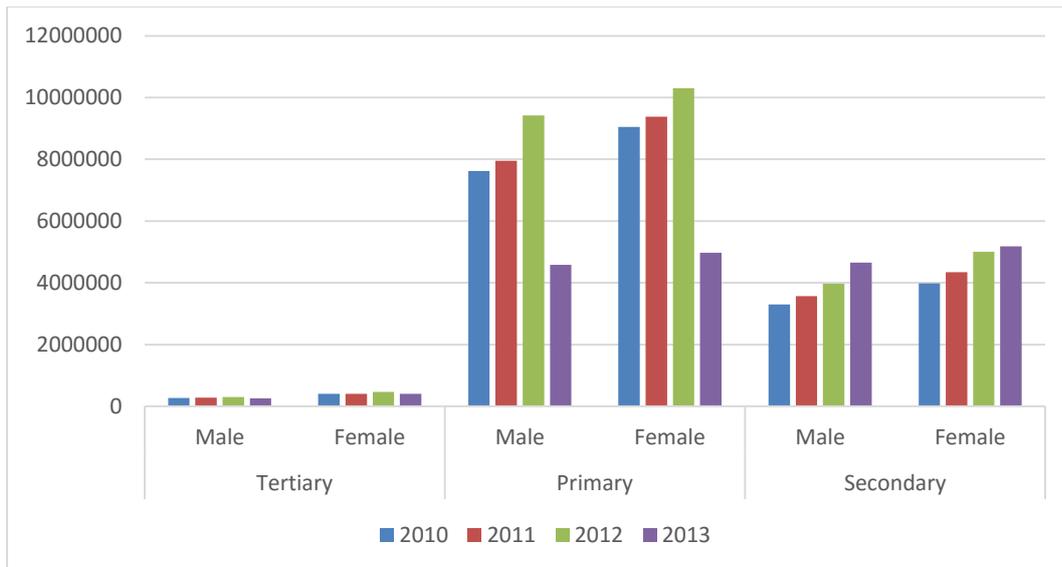
1. Was the mathematics teacher that made the strongest impression on you male or female?
2. In all your academic pursuits, did male or female characters make the strongest impression on you?

3. There might not be sufficient evidence to prove that good teaching (of mathematics) is gendered. True or False?

The results showed that for 50 percent of respondents, the mathematics teacher that made the strongest impression on them was male. 25 percent answered female and 25 percent answered none. In the overall academic experience (in this case not restricted to mathematics) strongest impressions were made by males for 60 percent of respondents and by females for 40 percent of respondents. To 90 percent of respondents there is not sufficient evidence to prove that good teaching is gendered. Taking a close look at these results from this sample, what makes a mathematics teacher leave a good impression might be more than what gender an individual is. Individual attributes contribute greatly and can be cultivated by any determined teacher.

Having a good knowledge of the subject comes with training and re-training on the job in addition to intelligence and hard work. Virtues of patience, strategizing, encouraging, disciplining being fun and the likes seem to describe the characteristics of a mother in nurturing her children or we might say come more easily to the women. As avenues for self-development are provided, the other virtues are more easily fitted in with the feminine nature. The opinion here is that men can learn to be good teachers, but for women it comes more as a tacit skill. There is a need for women to strive for excellence in knowledge. Women in Mathematics are therefore invaluable assets to human capital development and focusing on them is valid.

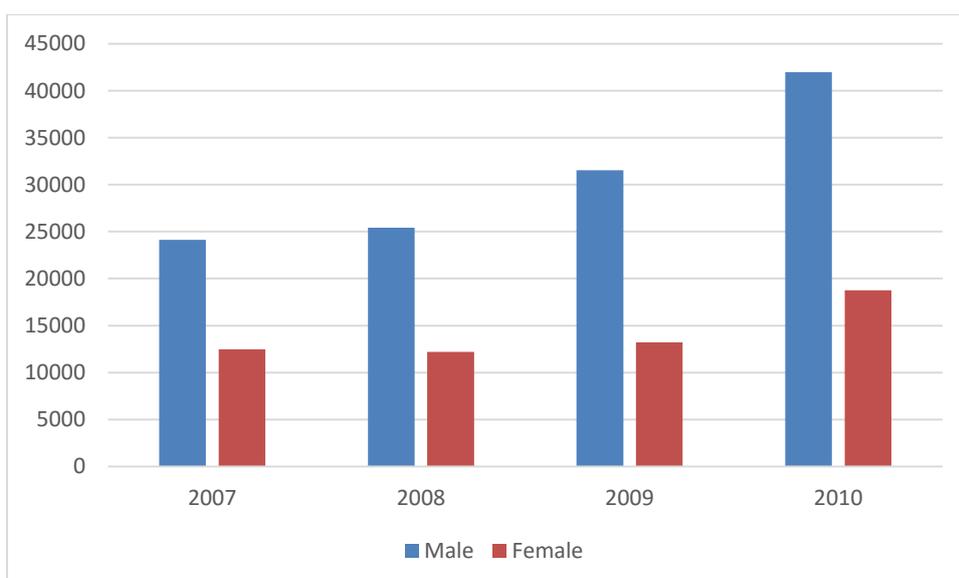
Before concluding on the dynamics of mathematics teaching in Nigerian educational institutions, some data accessed from the National bureau of Statistics is examined next.



**Figure 1: Total Enrolment in Primary, Secondary and Tertiary Institutions (2010-2013)**

This chart gives us an insight into the size and proportions of human capital developed in Nigeria within the period. Primary education has the highest participants and enrolment steadily falls in proportion at secondary and through tertiary levels. The capital stock that will be able to sustain the capacity to produce will likely be at higher than lower levels of education, yet participation drops.

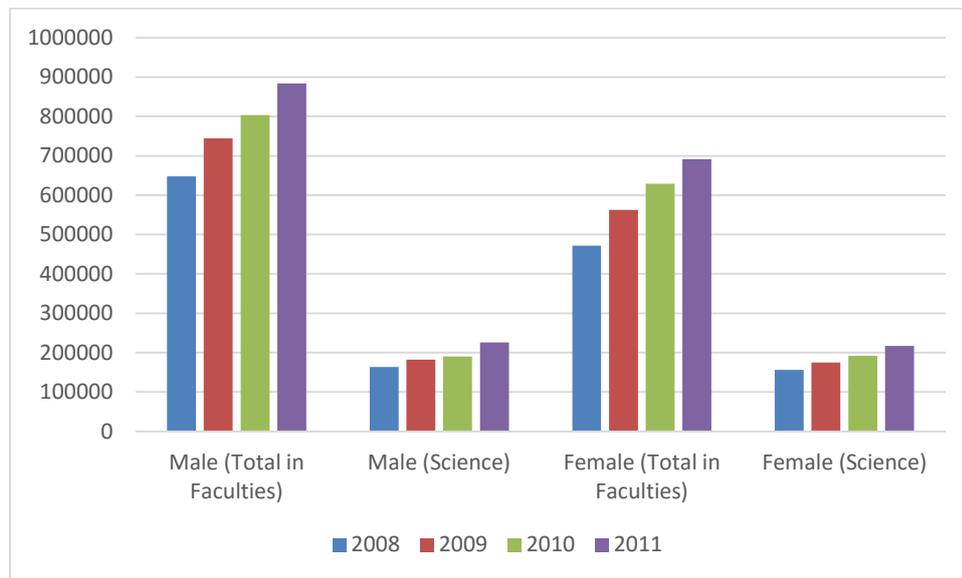
A look at the technical and vocational skills development sector, might explain the widening gaps in the regular school system. The enrolment in Mathematics in the National Business and Technical Board (NABTEB) is observed.



**Figure 2: Total Enrolment in Mathematics by Gender in National Business & Technical Board (2007-2010)**

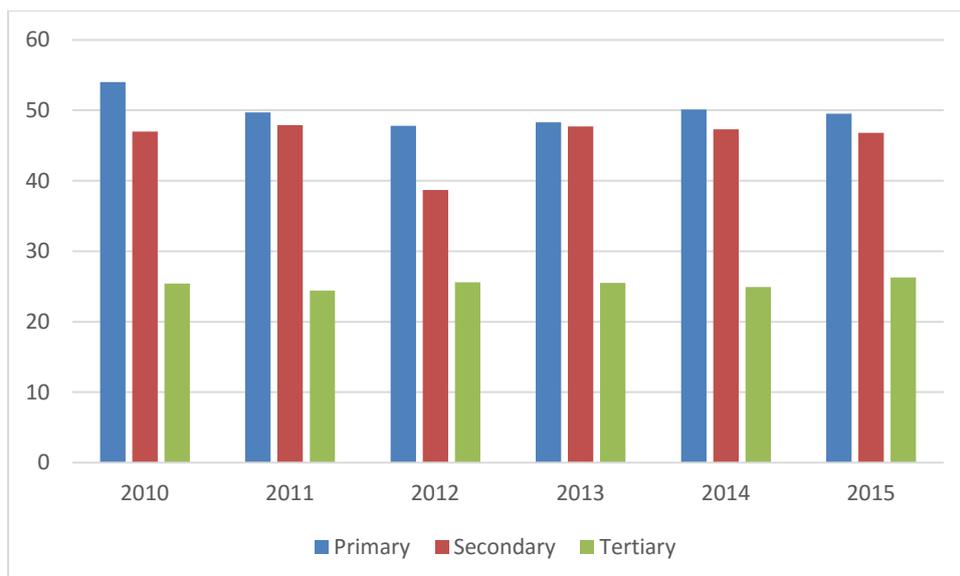
Candidates enroll for NABTEB an equivalent to the secondary level education. The participation in this area seems to be increasing, in the period under review. Many young people are opting for technical education which is not a bad idea if that is properly organized. Technical education is fundamental for industrial development which is a strong driver of economic development.

For the group that proceeds to the tertiary institutions, a look at the structure of the enrolments by faculty is interesting.



**Figure 3: Total Enrolment in Faculties and Science (Science, Medicine & Pharmacy) in Nigeria Tertiary Institutions (2008-2011)**

Enrollment into science faculties, mathematics inclusive is significantly less than that of the other faculties put together. Slightly more males enroll into the faculty than females from the figure. The mathematical skills required for specialized development planning are being developed by students whose numbers are in the minority. What this means is that Women in Mathematics, as valuable as they are might be an endangered specie if proactive and deliberate measures are not taken.



**Figure 4: Percentage of Women in Teaching Staff (2010-2015)**

The data available on female teaching staff is not disaggregated by subject but we can safely assume that this group is built from the secondary and tertiary training levels and since the proportions are generally low, it is not likely that of the smaller proportions of female teachers in the tertiary level (the green bars), they will form a significant part. This is in addition to the fact that more males are generally engaged in teaching than women. (NBS 2012). That might be a strong explanation for the fact that more respondents were impacted by males.

Recall that we had agreed that the qualities of a good mathematics teacher who can help students develop mathematical capabilities are with women in a tacit manner but we conclude that there might not be sufficient evidence to prove that good mathematical teaching is gendered. The results that need to be improved can be achieved if the constraints facing this very few and endangered women are understood and addressed in order to increase their productivity in addition to deliberately planning to increase the number of women in mathematics in Nigeria.

## **Challenges Facing Nigerian Women in Mathematics**

Bradshaw (2013) gives some insights into constraints that women face in contributing to the development process. First, workplaces and schools especially in this part of the world are gender neutral and/or blind. And the result is that women might not effectively compete and produce. The scheduling of lectures and other activities interfere with running the home and effective child care.

Second, political considerations over merit keep women out of management positions where they can influence decisions that affect them directly.

Also, limited mobility could reduce opportunities for on the job training in some cases as long absence from family can be problematic in some cases.

The fact that fertile ages and effective learning ages are the same, there is always a trade-off. Women might have to choose between increasing their skills and teaching and learning capabilities and having babies and raising families.

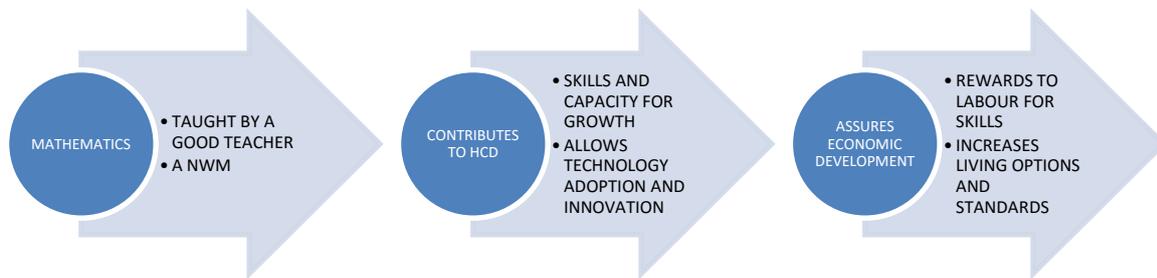
Financial constraints are very real, as the needs of the household are always considered first. Since resources are limited, when scales of preferences are drawn, their educational pursuits are usually down the list, meaning they are more likely to be postponed and or forfeited entirely

Time poverty resulting from a combinations of increasing unpaid house work which must be organized alongside. This is usually physically and mentally demanding on a daily basis and this reduces the amount of time and energy that can be invested in study teaching and learning especially in the absence of a good support system when children are young.

This list is not an exhaustive list and so it has left room for each and every constraint that is binding on NWM to be brought to light.

## Closing Remarks

The schema below summarises the impact of Women in Mathematics on Economic Development in Nigeria.



## Recommendations

1. There is evidence to support investing in Nigerian Women in Mathematics because of the significant contributions that they have made to human capital development which is fundamental for achieving economic development. It is therefore not just politically correct but good economics to plan to invest in national women in mathematics because in the long run, it will yield economic gains for Nigeria.
2. There are constraints to achieving their full potentials as national women in mathematics – students and teachers at all levels. Therefore it is imperative that institutions of learning consider developing gender/women policies so that learning and work places are not gender neutral and/or blind. Gender mainstreaming is an imperative. When conditions allow women to perform better, the outputs improve and the entire economy benefits in the long run.
3. While waiting for the government to awaken to its responsibility and get serious with investments in training women in mathematics, this biennial conference and other similar events are very useful avenues for more experienced, privileged and knowledgeable women in mathematics to share their knowledge and experiences with

other women in order to strengthen their collective contributions to the academic components of human capital development

4. Women will not just be good mathematics teachers simply because they are women, the stakes are high and each and every one must take up the challenge to be the best mathematics teacher that she can be.

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