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Catching Up With the Global Trends inMathematics andScience Achievement: A Case ofWest Africa

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Abstract: *West African countries are lagging behind in the global trends in mathematics and science achievement. Globally, governments and educational stakeholders are interested in international comparisons' of student achievement, using assessment instruments such as Trends in International Mathematics and Science Study (TIMSS), PERIL, SACMEQ, WASSCE, and Programme for International Student Assessment (PISA). The reluctance of West African countries to join in these global efforts at finding means of improving the generally deteriorating performance in mathematics and science points to some problems. The purpose of this paper was to determine trends in mathematics and science achievement by African countries on TIMSS with an attempt to suggest what research and assessment in African education can do to catch up with the global trend. The data used in this study was extracted from TIMSS 1999 – 2011 Reports. Trends in achievements in TIMSS showed that Asian countries such as Singapore and China are far ahead while with the USA and other western countries are gradually striving to catch up with the trend in achievement. Unfortunately, the analysis showed that all the African countries that participated in TIMSS from 1999 to 2011 are at the bottom of the achievement ladder. Furthermore, the only West African country (Ghana) representative managed to score at or below the low international achievement benchmark and below its African counterparts. This implies that West African countries have not practically realized that quality knowledge and skills in math and science makes a nation economically competitive in modern world. This paper contends that if West African countries are to catch up with the trends in mathematics and science achievement as well as compete economically, quality research and assessment in African education is key. The quality of research and assessment information made available promptly to governments and educational stakeholders can motivate West African countries to develop relevant policies and invest in programmes that would enable them catch up with the global trend in these subjects. Researcher and assessment experts in these countries should go a step further in ensuring that the information gathered are valid and utilizable by authorities.*

Key Words*: Performance in mathematics and science, TIMSS, Assessment and Research.*

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I. Introduction

Comparative achievement level between African student's and students of other nations is often done by measuring test scores on International tests such as the Trends in Mathematics and Science Study (TIMSS), PERIL, and SACMEQ. The results emanating from these International examinations provide unsatisfying statistics for Africa. There are significant gap separating many developed and developing countries in the world. The performance of African students is pushed at the base of the global achievement ladder. Besides, most undergraduates in different countries around the globe pursue their degrees in the natural sciences. For example, South Korea, 38% of all undergraduate receive their degrees in natural science or engineering, as well as in France, 47%, China 50%, Singapore 67% and the USA 15% of their undergraduates earning degrees in the natural science or engineering (National Academies, 2006; Zhao & Yong, 2009). Unlike these countries, in Africa there is a gap in term of the number of students pursuing postsecondary qualification in math, science, engineering, and technology.

Generally, education is the vehicle that is supposed to equip future citizens with the requisite knowledge, skills, attitudes, behaviour and shape their perception to journey in a prosperous life. As such performance in school is essentially used to predict students' future success and serve as indicator of the quality of education students' obtain. One may want to ask, are these gaps significantly important? Or will these gaps actually influence the future of African children. These intriguing questions may be answered using international achievement standards and experiences of successful countries. Hence, making judgment whether achievement gaps between African students and other nationals can be implore as indicator of the quality of educationAfrican countries provide is an essential criteria in this regard. The issue of concern is that our beautiful world is drastically transforming as a result of economic globalization and advances in science and

technology. It is a fact that African schools are undoubtedly ill-equipped to prepare future citizens to compete in this new world.

What then can African do? Is the solution imbedded in more math and science? Or in more testing and push for school accountability? Perhaps, that is not what is at stake; Africa needs a paradigm shift in the way education is conceived. African countries have to independently decide about what to teach and how to deliver education. Even though adopting changes and closing the achievement gap takes a lot of hard work and resources, but as Michael Mark said "Revolutionary results require revolutionarily changes." These revolutionary changes are possible in countries whose education systems are highly centralized and want to intentionally improve schooling. For example, in Singapore, there is constant revising of the curriculum and the educational authority makes sure that teachers implement these changes into the classroom (Mervis, 2012).

II. Background of the Study

Century ago, prior to the arrival of Arabs and Europeans for the scramble of Africa, the fore fathers of Africa had developed their own systems of education. Even though those educational systems developed by the African people varied from one people to another, they shared similar goals and objectives. After the scramble of Africa, western education was used as the most appropriate means to eradicate poverty, illiteracy and diseases from the African continent by emphasizing mathematics, science, and language in the school system. This has opened the door for international achievement comparisonamong students globally in math and science. According to Anamuah-Mensah, Mereku and Asabre-Ameyaw (2004), participation in TIMSS by African countries specifically Ghana was strategic because it enabled countries to determine and compare the performance of their pupils to other countries.

Since the inception of TIMSS in 1995, seven African countries have so far participated in this prestigious International achievement test (TIMSS, 2007). The participating African countries include: Ghana (West African), Egypt, Morocco, Algeria, and Tunisia (North Africa), and Botswana and South Africa (Southern Africa). Morocco, Tunisia, and South Africa first participated in 1999 while Botswana, Ghana, and Egypt joined in 2003 (TIMSS, 2011). Even though, these countries are not representative of their respective regions, it is unfortunate that only Ghana represent West African Countries with no East and Central African countries participated in such an important International test.

Africa, as the continentnoted for more than a century as custodian and producer of raw materials, the poor achievement of its students in math and science should be a matter of urgency, concern, and priority. Most of the world's natural resources are earthed on the African Continent, but these natural blessings are refined elsewhere far from the African continent largely because we currently do not have the literate populace in math and science as well as technology to transform our raw materials into a more valuable product. Now and then, reports revealed that the African continent is endowed with a lot more natural resources than we have discovered. Unfortunately, the lack of expertise and the relevant technology hinder our efforts to improving our economics. According to the John Templeton Foundation (2009) report, low public support for educational research and assessment contribute many of the problems we encounter on the continent. This is one of the many reasons for which African countries should strive hard not to live with the continuous underachievement of students in math and science, hence the need for relevant research and assessment in African education.

Statement of the problem

Nowadays, mathematics and science are regarded by modern societies as the basic of scientific and technological advancement for social economic development of any nation. Consequently, almost all educational systems in Africa have made mathematics and science compulsory subjectsright from the primary to the secondary levels. These subjects serve as gateway for pursuing tertiary qualifications in courses such as pharmacy, medicine, architecture and engineering among others. Despite the essential and vital role that mathematics and science play in modern society, African students' performance in these subjects is persistently poor and continuous to deteriorate on national and international examinations. This trend in students' performance in the backbone subjects of modern civilization is worrisome and threatening to the social, technological, and economical development of the African continent.There is an urgent need to see the declining achievement in math and science as a conjunction of national, regional, and continental crisis, which require governments and educational stakeholders to intentionally embark on efforts to remedy the problem and ensure that needed manpower are produced for economic, political, and social development in the region and the continent at large.

Purpose of the study

The purpose of this paper wasto determine trends in mathematics and science achievement by African countries on TIMSS with an attempt to suggest what research and assessment in African education can do to catch up with the global trend.

Research question

1. What are African countriesaverage performances in TIMSS between 1999 – 2011?
2. To what extent African countries performance in TIMSS between 1999 – 2011meet the international bench marks?

III. Methodology

Data for this study were extracted from reports of TIMSS 2003 to TIMSS 2011. TIMSS Science and Mathematics assessment is organized around two dimensions. Acontent dimension which specify the subject matter or content domains to be assessed and a cognitive dimension specifying the thinking processes that students are likely to use as they engage with the content. In this study, the composite score for both content and cognitive domains were used.

TIMSS also uses the international scale average in reporting student achievement in Science and Mathematics as well as the international benchmarks to describe achievement at those benchmarks to describe achievement at those benchmarks in relation to student's performance on the assessment. TIMSS uses the Advanced International Benchmark 625, High International Benchmark 550, Intermediate International Benchmark 475 and Low International Benchmark 400 to represent the range of performance demonstrated by students internationally.

IV. Results and Interpretation

What are African countries average performances in TIMSS between 1999 – 2011?

Table 1:*Average math and science scores of participating African countries in TIMSS between 1999 – 2011*

Country	Year	Average scores			
		4th grade Math	4th grade Science	8th grade Math	8th grade Science
Tunisia	2011	359 (3.9)	346 (5.3)	425 (2.8)	439 (2.5)
	2007	327 (4.5)	317 (6.0)	420 (2.4)	445 (2.1)
	2003	339 (4.7)	314 (5.7)	410 (2.2)	404 (2.1)
	1999	o	o	448 (2.4)	430 (3.4)
Morocco	2011	335 (4.0)	204 (4.5)	371 (2.0)	o
	2007	341 (4.7)	297 (5.9)	341 94.7)	402 (2.9)
	2003	347 (5.1)	304 (6.7)	347 (5.1)	376 (2.2)
Algeria	2007	o	354 (6.0)	o	408 (1.7)
Egypt	2007	o	o	391 (3.6)	408 (3.6)
	2003	o	o	406 (3.5)	203 (3.9)
Botswana*	2011	419 (3.7)	367 (5.5)	397 (2.5)	404 (3.6)
	2007	o	o	364 (2.3)	355 (3.1)
	2003	o	o	366 (2.6)	365 (2.8)
*S. Africa	2011	o	o	352 (2.5)	332 (3.7)
	2003	o	o	264 (5.5)	244 (6.7)
	1999	o	o	275 (6.8)	243 (7.8)
Ghana	2011	o	o	309 (4.4)	306 (5.2)
	2007	o	o	276 (4.7)	303 (5.4)
	2003	o	o	331 (4.3)	255 (5.9)

Note: * Country that featured 6th and 9th graders for TIMSS assessment

o TIMSS assessment was not administered or country did not produce candidate

Table 1 shows the average mathematics and science achievement at fourth and eighth grades. The results show that the North African countries especially Tunisia and Morocco performed far better than the other participating African countries at both levels in math and science. It can be seemed from the results that all of the African countries fell below the international scale average in mathematics 500 in TIMSS 1999,495 and 467 in TIMSS 2003, 500 in TIMSS 2007 and 2011as well as science 500 in TIMSS 1999,489 and 474 in TIMSS 2003, 500 in TIMSS 2007 and 2011 for 4th and 8th grades.

To what extent does African countries performance in TIMSS between 1999 – 2011meet the international bench marks in math and science?

Table 2:*African Countries performance in TIMSS between 1999 -2011 against the International bench marks (Advanced 650, High 550, Intermediate 475, and Low 400)*

Country	**Year**	**4th grade Math**				**4th grade science**			
		Advanced BM (625)	High BM (550)	Intermediate BM (475)	Low BM (400)	Advanced BM (625)	High BM (550)	Intermediate BM (475)	Low BM (400)
Tunisia	2011	0(0.0)	2(0.3)	11(1.0)	35(1.8)	0(0.1)	3(0.4)	14(1.1)	35(1.9)
	2007	0(0.1)	1(0.2)	9(0.7)	28(1.6)	0(0.0)	3(0.4)	14(1.1)	32( )
	2003	0(0.1)	1(0.3)	9(1.0)	28(1.7)	0(0.0)	2(0.3)	10(1.0)	27(1.7)
Morocco	2011	0(0.2)	2(0.7)	10(1.2)	26(1.5)	0(0.1)	1(0.4)	6(0.7)	16(1.0)

	2007	0(0.2)	2(0.8)	9(1.1)	26(2.0)	•	•	•	•
	2003	0(0.0)	1(0.2)	8(0.8)	29(2.2)	0(0.0)	1(0.3)	9(0.8)	24(1.6)
Algeria	2007	0(0.1)	2(0.4)	14(1.4)	41(2.2)	•	•	•	•
Botswana	2011	0(0.1)	7(1.1)	29(1.7)	60(1.6)	1(0.3)	8(1.1)	23(1.7)	43(1.8)
	2003	0(0.0)	1(0.2)	8(0.8)	29(2.2)	•	•	•	•
		8th grade Math				**8th grade science**			
Tunisia	2011	0(0.2)	5(0.9)	25(1.4)	61(1.3)	0(0.1)	5(0.7)	30(1.4)	72(1.3)
	2007	0(0.1)	3(0.3)	21(1.2)	61(1.5)	0(0.0)	4( )	31( )	77( )
	2003	0(0.0)	1(0.3)	15(1.1)	55(1.6)	0(0.0)	1(0.2)	12(1.0)	52(1.0)
	1999	0(0.1)	5(0.5)	34(1.5)	78(1.2)	0(0.1)	3(0.5)	25(1.6)	68(2.1)
Morocco	2011	0(0.0)	2(0.2)	12(0.5)	36(1.0)	0(0.0)	2(0.2)	13(0.7)	39(1.0)
	2007	0(0.1)	1(0.5)	13(1.1)	41(2.0)	•	•	•	•
	2003	0(0.0)	1(0.2)	10(0.9)	42(1.6)	0(0.0)	1(0.3)	13(1.1)	48(1.9)
Algeria	2007	0(0.0)	0(0.1)	7(0.5)	41(1.4)	•	•	•	•
Egypt	2007	1(0.1)	5(0.4)	21(1.0)	47(1.5)	•	•	•	•
	2003	1(0.2)	6(0.5)	24(1.2)	52(1.7)	•	•	•	•
Botswana	2011	0(0.1)	2(0.5)	15(1.0)	50(1.4)	1(0.2)	6(0.6)	26(1.4)	55(1.4)
	2007	0(0.0)	1(0.1)	7(0.7)	32(1.3)	•	•	•	•
	2003	0(0.0)	1(0.2)	7(0.7)	32(1.5)	0(0.1)	1(0.5)	10(0.9)	35(1.3)
S. Africa	2011	1(0.1)	3(0.4)	9(0.7)	24(1.0)	1(0.2)	4(0.4)	11(0.8)	25(1.1)
	2003	0(0.1)	2(0.6)	6(1.3)	10(1.8)	1(0.2)	3(0.7)	6(1.4)	13(1.9)
	1999	0(0.1)	1(0.3)	6(1.1)	13(2.0)	•	•	•	•
Ghana	2011	0(0.0)	1(0.2)	5(0.8)	21(1.8)	0(0.1)	1(0.2)	6(0.8)	22(1.7)
	2007	0(0.0)	0(0.1)	4(0.7)	17(1.4)	0(0.0)	1(0.2)	6(0.8)	19( )
	2003	0(0.0)	0(0.0)	2(0.5)	9(1.3)	0(0.0)	0(0.0)	3( )	13( )

- Country did not present candidate for the component in correspondent year. Figure outside the parenthesis represent percent of students achieving specific international bench per country while numbers inside stand for the percent achievement globally.

Table 2 provides a summary of the achievement level of fourth grade and ninth grade students at the TIMSSInternational Benchmarks. This reveals what typicalAfrican 4th grade and 8th grade students know and can do in mathematics and science. The result shows that all the participating African Countries had candidates mostly scoring at or below the low international achievement benchmark. The result also shows that only Tunisia showed improvement across year and grade level given the international benchmark. This result means that African 4th grade and 8th grade students have some basic mathematical and scientific knowledge, but they cannot apply basic mathematical and scientific knowledge and understanding in straightforward situations, unable to solve problems as well as apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning.

V. Discussion and Implications

African Nations are lagging far behind rest of the world when it comes to mathematics and scientific literacy. Similar to the findings of Appiah (n.d), this study found that achievement of African 4th grade and 8th grade students on the international stage is dismally poor with Ghana's pupils recording the lowest among its African counterparts. Several African researchers (Fredua-Kwarteng; 2005; Anamuah-Mensah and Mereku, 2005) attributed Africa countries poor performance in TIMSS to differences in pedagogical orientation and lack of congruence between local curriculum content and global measures. The results simply imply that the young generation; 4th grade and 8th grade students, the African education systems attempting to develop them are far from the reality of the rest of the global village. The foundation of African education failed to equip students with basic mathematical and scientific knowledge as a result young students cannot apply basic mathematical and scientific knowledge and understanding in straightforward situations, unable to solve problems as well as apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning independently.

One may be tempted to ask, why other countries are doing well on these international assessments. The answers seem to be simple, but these countries are doing their best to stay on top of the international assessments because of several reasons. For example one of the major reasons why East Asian countries continue to dominate the rest of the world is attributed to their ability to institute and implement necessary reforms and improvement in their school systems (Mervis, 2012). Interestingly, these reforms are based on empirical research and intentional assessment in the educational systems. Take for instance, in Singapore, the government devotes huge resources in research and assessment and use the information gathered to constantly revise its curriculum. The government also helped teachers and made sure that teachers integrate those changes into their classroom. In contrast, most African countries especially the most of West Africa agonize because there is no or minimum emphasis in educational research and assessment at the school, national and regional levels. The ultimate goal of education is to maximize human development and improve the quality of human

life. In education, the effort of government, educational administrators, parents, teachers, students as well as the society at large is to help improve learning and achievements.

VI. Recommendation

To help West African countries catch up with the global trends in mathematics and science achievement, the following are recommended:

1. Improve research output across member states. Picking from the Johnson Foundation (2009) report, in West Africa, research output is only concentrated in Nigeria (between 71.4% [2007] and 92.5% [2000]) while the rest of the countries serve as spectators. Educational stakeholders especially governmentrely on policies to try to improve the quality of citizens lives and tackle national problems.But there is no or little empirical research information communication, dissemination, and utilization in the region. It is wise to note that policies are only valid if they are based on valid information. Hence, a research based consensus on the numerous problems confronting West African education serve as a valid input into decision-making and policy formulation and at such it must be the priority of researchers to take up the initiative.
2. Developassessment framework system to provide policy makers, national assessment authorities, and others with key indicators for diagnosis, discussion, and consensus-building around how to construct a sound student assessment system that is able to support and improve students' output and enhance quality learning.The propose assessment framework will provide valid information of significant quantity and quality, which will feed into stakeholders information and decision-making needs to improve educational quality and student learning. This is important because most governments, international organizations, and others are becoming aware of the role of assessment for monitoring and improving student learning (IEG, 2006; McKinsey & Company, 2007; UNESCO, 2007, cited in Clarke, 2011). This frame work will ensure that the right kinds of assessment activities and the right uses of information gathered from these activities contribute to improved learning and policy decisions in West African Nations. This could be achieved by ensuring an enabling environment, system alignment, and quality assessment.

References

[1]. Anamuah-Mensah, J. and Mereku, D.K. (2004). Ghanaian JSS Students'
[2]. Mathematics Achievement in TIMSS 2003. Implications for item construction for the BECE mathematics.
[3]. Appiah, J. K. (n.d). The significance of international comparison of student achievement. Retrieved from http://www.iaea.info/documents
[4]. Clarke, M. (2011). Framework for building an effective student assessment system. READ/SABER Working Paper. Retrieved from http://files.eric.ed.gov/fulltext/ED553178.pdf
[5]. Fredua-Kwarteng, T. (2005). Ghana Flunks at Mathematics and Science: Analysis (1) and (2).
[6]. John Templeton Foundation (2009). Mathematics in Africa: Challenges and opportunities.
[7]. Mervis, J. (2012). Why the best stay on top in latest math and science testis. Retrieved from http://www.sciencemag.org
[8]. National Academies (2006). Committee on prosperity in the Global Economy of the 21st Century
[9]. Zhao & Yong (2009). Catching up or leading the way: America Education in the age of globalization).