MATHEMATICS ACHIEVEMENT AMONG SECONDARY SCHOOLS IN CROSS RIVER STATE, NIGERIA: THE ASSESSMENT DILEMMA

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Abstract
The paper set out to empirically verify the level of mathematics achievement among secondary schools in Cross River State, Nigeria, and the assessment dilemma appertaining thereto. One hundred secondary schools and 2,333 SS II students were selected by multi-stage random sampling technique across the state. The content validated 40 -item multiple choices Mathematics Achievement Test (MAT) was administered after a trial test on a comparable group of students outside the research area. Reliability index (KR20) was 0.78, with item difficulties within the range 0.28 ≤ I ≤ 0.79. Post administration analysis of data revealed a level of mathematics achievement significantly lower than expected. The assessment dilemma of making alternative, innovative choices like the alternative assessment, aptitude testing, open book examination, professionalism
in mathematics teaching and the e-assessment options were discussed.
Some recommendations were also made.

Every nation within the continent of Africa and in Diaspora strives for national development. In Nigeria, government sees education as an instrument par excellence for the realization of national growth (Federal Republic of Nigeria, 2004). This is partly responsible for the continuous curriculum reviews, educational innovations and adoption of principles in line with global educational best practices. The march from the traditional, through the 6-3-3-4 to the current variant of the 9-3-4 education in line with Universal Basic Education philosophy is indicative of this spirit of the quest for educational improvement. Associated with this thought is the change from research focus on education quantity and access to educational quality and effectiveness (Onwakpa, 1997). Consequently, according to World Bank (1978), it is now time to match quantity with quality in education.

To actualize national development through human capacity building, the citizens must be equipped with knowledge, skills and competences for critical thinking, problem solving and survival in the society. Mathematics education therefore becomes a vehicle for the delivery and attainment of these goals. The importance of mathematics cannot be overstressed. It is a harbinger and precursor for the much needed technological development (Denga, 1997). It helps the learners to understand and make sense of their world within and outside the school. It enhances the understanding of other school subjects that require numeracy, scientific thinking and logic. Furthermore, mathematics helps in rational decision making through statistical data collection and analysis. The daily natural phenomena in humanity, including cooking, buying and selling can hardly be accomplished without mathematical thinking. Finally, mathematics is a prerequisite in educational furtherance virtually for all courses of study in pure science, technology, social science and most disciplines in Humanities. This may be why the Federal Republic of Nigeria (2004) in the National policy on education made the subject compulsory at the Basic and secondary school levels.

Regrettably, in spite of its importance, mathematics education is bedeviled with several problems in Nigeria. Many students have serious difficulties performing basic mathematical operations, and some manifest overt dislike for the mathematics teachers (Uka, 2006). Some teachers and students exhibit very poor attitudes toward mathematics teaching and learning. Yet, there is also the challenge of older students indoctrinating new students that mathematics is difficult, thereby contributing to the phobia and withdrawal syndrome generally observed in schools. Denga (1997) averred that many students dread mathematics like the hydrogen bomb. The result of these
problems is poor students’ achievement in mathematics (Enukoha, 1995; Obodo, 1997; WAEC, 2002) as shown in table I below.

Table 1
Mathematics Results of the West African Examination Council’s (WAEC’s) May/June Senior Secondary Certificate Examination

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Candidates</th>
<th>No. of Passes Grade 1-6</th>
<th>No. of Passes P7 – P8</th>
<th>No. of Failures F9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>518,118</td>
<td>83,192 (16.10%)</td>
<td>215,108 (41.60%)</td>
<td>219,818 (42.40%)</td>
</tr>
<tr>
<td>1996</td>
<td>514,342</td>
<td>51,587 (10.00%)</td>
<td>190,899 (37.10%)</td>
<td>272,356 (50.80%)</td>
</tr>
<tr>
<td>1997</td>
<td>616,923</td>
<td>47,252 (7.60%)</td>
<td>161,526 (26.20%)</td>
<td>408,145 (66.20%)</td>
</tr>
<tr>
<td>1998</td>
<td>635,686</td>
<td>70,858 (11.15%)</td>
<td>159,000 (25.01%)</td>
<td>390,962 (61.50%)</td>
</tr>
<tr>
<td>1999</td>
<td>756,680</td>
<td>138,098 (18.25%)</td>
<td>212,514 (28.09%)</td>
<td>381,029 (50.36%)</td>
</tr>
<tr>
<td>2000</td>
<td>643,604</td>
<td>208,244 (32.81%)</td>
<td>196,080 (30.90%)</td>
<td>230,280 (36.00%)</td>
</tr>
<tr>
<td>2001</td>
<td>1,040,117</td>
<td>373,955 (36.55%)</td>
<td>334,907 (32.73%)</td>
<td>314,240 (30.71%)</td>
</tr>
<tr>
<td>2002</td>
<td>908,235</td>
<td>309,409 (34.06%)</td>
<td>308,369 (33.95%)</td>
<td>190,457 (31.98%)</td>
</tr>
<tr>
<td>2003</td>
<td>939,506</td>
<td>341,928 (36.91%)</td>
<td>331,348 (35.77%)</td>
<td>229,878 (24.81%)</td>
</tr>
<tr>
<td>2004</td>
<td>844,525</td>
<td>287,484 (34.52%)</td>
<td>245,071 (29.43%)</td>
<td>300,134 (36.04%)</td>
</tr>
<tr>
<td>2005</td>
<td>1,054,853</td>
<td>402,982 (38.20%)</td>
<td>228,816 (33.91%)</td>
<td>363,055 (34.42%)</td>
</tr>
<tr>
<td>2006</td>
<td>1,149,276</td>
<td>472,674 (41.13%)</td>
<td>389,776 (33.91%)</td>
<td>286,826 (24.95%)</td>
</tr>
<tr>
<td>2007</td>
<td>1,249,028</td>
<td>584,024 (46.76%)</td>
<td>362,230 (29.00%)</td>
<td>302,774 (24.24%)</td>
</tr>
<tr>
<td>2008</td>
<td>1,268,213</td>
<td>726,398 (57.27%)</td>
<td>323,197 (25.48%)</td>
<td>218,618 (17.24%)</td>
</tr>
</tbody>
</table>

Mean 866,436.14 292,720.35 (30.09%) 265,631 (31.64%) 293,469.42 (37.72%)

Source: WAEC Test Development Division (2009) Lagos

Table 1 shows that though there is a gradual improvement trend in recent student’s mathematics achievement, the average performance in the 14 years of focus (1995 – 2008) is deplorably low, with only about 30% of the candidates passing at the acceptable grades of 1-6. The aspiration for quantity and quality in education, the perennial poor students’ achievement in mathematics and the yearning for technological and national development are thought-provoking, raising question like “what is the level of mathematics achievement in Cross River State, Nigeria?”, and what is the assessment dilemma associated with this level of achievement?
There are basic theories that relate to the subject matter of academic achievement. First is the theory of accountability which evolved through its proponent Robert Lowe of Britain in 1862 and Ralph Nader of the United States of America. The corporate accountability theory holds the view that co-operations are responsible to and subject to the will of the people directly or through the government setup by the people. This implies that education workers, teachers, administrators and allied personnel have the responsibility to ensure acceptable level of educational attainment by the learners kept in their charge, a duty for which they earn their wages and emoluments.

Next is the classical text theory of educational measurement, propounded by Charles Spearman, who in his paper of 1904 introduced the decomposition of an observed score (X) into the true score (T) and an error (E), symbolically expressed as X = T + E. This theory simply means that every measurement contains some error. To obtain an individual’s true score therefore, the educator must employ standard measurement practice to minimize error as much as practicable. The use of the test blue print in item construction, test try-out, item analysis and revision, as well as other test validation procedures as professionally approved principles in educational measurement. Assessment on the other hand involves the interpretation of the results of measurement mostly based on internal standards, to ascertain desired changes observed. The systematic collection of data about learning in the cognitive, affective and psychomotor domains to improve teaching and learning. The traditional theory of assessment propounded by Wilhelm Wundt, Francis Galton and James Caltel in the late 1800’s to the twentieth century contends that human abilities differ and could be treated in the laboratory through writing of tests and examinations. This view holds that life offers all persons equal opportunity, and so life is fair to all. Consequently, the same instrument and items could be used to assess all persons equitably, with each achieving according to his ability. This is because knowledge is measurable (McKeller, 2002).

The practical (hermeneutic) theory of assessment rather believes that reality is not out there as the traditionalist believes, but rather reality is individually constructed. As students engage in their individual construction of their meanings, deep learning is bound to occur as in constructivism (Ramsden, 1992). While individuals are here encouraged to construct their own meaning, the schools provide support structures to help students in need to meet institutional standards in assessment practices. Establishment of writing centres and foundation courses especially in tertiary education are ready examples of such support. Here, since institutional standards and practices are not questioned, some traditional assessment practices are likely to be retained with the result that while some students manifest deep learning, others may exhibit shallow learning.
The critical or emancipatory theory of assessment developed by a group of German social theorists known as Frankfurt school in 1923 was later propounded by Jurgen Habermas. They contended that empiricism and positivism reveal only illusory statistical laws concerning events, and that not all human institutions and actions are reasonable. This theory addresses how to make life fair. It questions why some students fail, are unmotivated, are more difficult and why educational institutions are being organized the way they are (Gibson, 1986). Critical theory advocates the need to liberate people from what it regards as the false belief that society operates for the good of all. They postulated that false consciousness originated from Marxism which infested the minorities and the oppressed in the society, and perpetuating this false belief is the means by which those in power maintain their power and continue to impoverish others.

Each of the above theories is relevant to this work because each gives meaning to mathematics learning outcomes. For instance, the theories hold that it is the duty of the school operatives to justify their wages by ensuring high students’ learning attainment. Achievement score nay not however be accurate, and scores are determined by several factors including the individuality of the assessor.

Purpose of the Study
The purpose of the study is to verify whether the level of Mathematics achievement among secondary schools in Cross River State, Nigeria is as high as expected, and to discuss the assessment dilemma.

Research Question
What is the level of mathematics achievement among secondary schools in Cross River State, Nigeria?

Null Hypothesis
The level of schools’ mathematics achievement is not significantly higher than the expected 20 out of 40 (right responses).

Method
The study adopted a survey design, a data collection research plan in which the researcher goes to the field to obtain information as currently obtainable, for the purpose of describing observed phenomenon, without deliberate attempt to control the independent variables. The work was located in Cross River State, one of the thirty six (36) states of the Federal Republic of Nigeria, found in the south-south geo-political zone of the nation. Cross River State has eighteen (18) Local Government Areas, made up of seven in the south, six in the central and five in the north. Major towns in the state
are Calabar (the capital city), Ugep, Ikom, Ogoja and Obudu. Cross River State is bounded in the north by Benue state, in the south by Akwa Ibom State and the Bright of Bonny, in the East by the Republic of Cameroon, and in the West by Enugu, Ebonyi and Abia states. The state is a tourist haven, with major attractions like the Tinapa, Calabar Export Processing Zone (EPZ), the Obudu Cattle Ranch, the old residence museum, Marina resort and the Agbokim and Kwa waterfalls. Educational institutions of note include the University of Calabar, Cross River University of Technology, Calabar the State College of Education, Akamkpa and School of Nursing in designated centres across the state. Hope Waddel Training Institute, Calabar, St. Patrick’s College, Calabar and Mary Knoll Secondary School Ogoja are early post primary schools of note.

The population of the study was all the 571 post primary schools in the state in the 2008/2009 session and the 26,274 Senior Secondary II students in Cross River State. By multi-stage sampling technique, ten (10) Local Government Areas were selected from the eighteen (18), four from the southern senatorial zone where the state capital is located, three each from the central and northern zones. By the simple random sampling method, ten secondary schools were selected from each of the ten sampled Local Government Areas. The name of each school in a Local Government Area was written in a slip of paper, put in a chalk box and shuffled. Then one slip of paper was picked at a time with replacement until the ten secondary schools were selected. This was done in each of the sampled Local Government Areas. By this process one hundred secondary school (private and public) were obtained to form the sampled schools. The sampled Local Government Areas were Calabar Municipality, Calabar South, Akpabuyo and Akamkpa in the southern senatorial district. From the central were Abi, Yakkur and Ikom, while the north had Ogoja, Obudu and Yala. In all, 100 schools and 2,333 students were used as samples.

Instrumentation

The instrument used for this study was a researcher-designed four option multiple choice Mathematics Achievement Test (MAT) for Senior Secondary Two (SS II) students comprising of 40 items. The items were drawn from the approved SSII mathematics curriculum. Test construction principles involving the use of table of specification were employed in item setting. The items were generated from the SSI and SSII Mathematics curricula approved for secondary school students in the Federal Republic of Nigeria. All the topics were expected to have been taught as the MAT was administered when the students were ending the first term of SSIII. Students were expected to encircle the letter bearing the answer. The items covered Number and numeration (20%), Algebraic Processes (20%) Geometry and Measuration (30%), Trigeomerty (10%), and statistical/probability (20%). Typical items include
1. Express 0.000000015 in standard form
   A. $1.5 \times 10^{-9}$  B. $1.5 \times 10^{-8}$  C. $1.5 \times 10^{-7}$  D. $1.5 \times 10^{-7}$

2. Evaluate $8^{-\frac{2}{3}}$  A. $\frac{1}{4}$  B. 2  C. 4  D. $8^{2/3}$

3. Solve for $m$ the following pair of equations $m - 3n = 5$ and $2m + 3n = 1$
   A. 2  B. 1  C. -1  D. $-\frac{4}{3}$

4. Find the area of triangle ABC with $a=5$ cm, $b=4$ cm and $C=3$ cm
   A. $30cm^2$  B. $6cm^2$  C. $5cm^2$  D. $3.75cm^2$

The MAT was face and content-validated by two independent assessors, one a professor of Mathematics education and the other a professor of educational Measurement and Evaluation, both from the University of Calabar. A trial test of MAT in five schools outside the sample area revealed item difficulty indices $0.28 \leq I \leq 0.79$ and a reliability coefficient ($KR_{20}$) of 0.78. Based on this, MAT was then used for data collection by the researchers. Data obtained was then analyzed using the Statistical Package for Social Sciences Software (SPSS).

**Results**

**Null Hypothesis**

The level of schools’ mathematics achievement is not significantly higher than the expected 20 out of 40 (right responses).

The results of the analysis of the above hypothesis are presented in Table 2.

**Table 2**

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Sample (observed)</th>
<th>Sample (SD)</th>
<th>Reference (expected mean)</th>
<th>df</th>
<th>tcalc</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools mathematics achievement</td>
<td>2333</td>
<td>13.4575</td>
<td>4.0518</td>
<td>20.00</td>
<td>2332</td>
<td>-16.1470*</td>
<td>.00</td>
</tr>
</tbody>
</table>

*P<.05; df = 2332; t-critical 1.645 (for the one tailed test).
From table 2, the calculated t-value of 16.1470 is higher than the critical t-value of 1.645 for the one-tailed test at .05 level of significance and 2332 degrees of freedom. This means that the schools mathematics achievement is significantly lower than expected. The null hypothesis is therefore upheld. For the two tailed test, the calculated t-value of 16.1470 is also higher than the critical t-value of 1.960 at 2332 degrees of freedom and .05 level of significance. This means that there is a significant difference between the sample mean observed and the expected mean. The null hypothesis is rejected, which stated that there is no significant difference between observed and expected means.

**Discussion of Findings**

The finding of this study was that the mean level of students’ mathematics achievement was significantly lower than expected. Abysmally poor achievement in mathematics may be attributed to poor learners’ attitudes to studies, poor teaching, parental failure to foster learning continually at home and the decay factor in mathematics education, namely the pollution and dampening of learners’ enthusiasm by senior students who continue to amplify the difficulty of mathematics. The finding of poor mathematics achievement is consistent with several studies (Ukeje, 1997; Harbor – peters, 2001; Onwuakpa, 1997; Enukoha, 1995; WAEC chief examiner’s mathematics report, 2002). A poor achievement in mathematics is a pointer to a bleak future, and an indication that our future national development is in jeopardy. This is true because of the pride of place which mathematics as a discipline occupies in human advancement. It is the needed tool for scientific and technological breakthrough, a sinequanon for educational furtherance and a catalyst for critical and reflective thinking.

The items in MAT were expert-validated, an indication of item quality and suitability for the sample group. However, one is not certain whether the mathematics content supposedly taught was actually taught. This is because school-specific challenges like teacher supply inadequacies as well as teacher quality problem could to a great degree mar students’ achievement in mathematics. Teacher quantity and quality are two related factors that may unequivocally impinge on learners’ knowledge and skills. Teacher ill-health, truancy, dissatisfaction and ill-preparation for instance could spell down in the classroom. While these may be peculiar to one school, other institutions may possibly be faring far better and forging ahead. The aggregate achievement may therefore be affected by what happens to those specific institutions.

It is even more disheartening to note that apart from the discovery that mathematics achievement is lower in Cross River State than the minimum expected in Nigeria, Mathematics achievement in Nigeria is lower than the international average of 498 expected (Okebukola, 2002; p.24). This is indeed a cause for concern.
Collaborative effort of all education stakeholders may be needed to supplement current efforts at improving achievement. The writing of indigenous mathematics textbooks, payment of mathematics allowance, to mathematics educators, study leave, scholarship awards, for prospective mathematics teachers and the routine annual teacher capacity building efforts and others are commendable government intervention gestures to boost mathematics achievement. However classroom observation of instructional proceedings should be an added priority. This could be achieved through internal and external school supervision.

The Assessment Dilemma

Literally a dilemma is a situation in which a difficult choice has to be made. Naturally, the consistently poor mathematics achievement among schools calls for rethinking and fresh approaches in mathematics instruction.

1. Paper and pencil test or alternative assessment?

First, is whether to sustain the paper and pencil test practice or to employ alternative assessment modes. The advocacy for a change from paper-and-pencil tests to alternative assessment is predicated on the fact that the former, which has been in vogue in the entire continent of Africa right from the history and onset of formal education has not been able to project the desired level of educational functionalism, but is rather prone to indirect assessment, examination malpractice, over-emphasis and dependence on paper qualification, to the subterfuge of functionalism and practical ability. The question is whether to abandon paper and pencil test completely and replace it with an alternative assessment or use both integratedly? Anikweze (2010:301) contended that there is need to engage in continuing professional development (CPD), where they should be introduced to the innovation model of assessments being advocated, which entail the use of individual assessment, group assessment, self assessment, and peer assessment in addition to the conventional paper-and-pencil tests. The goal is to develop new assessment models geared towards fostering lifelong learning skills which serve to promote the development of the learner’s capacity to self-assess, reflection, and take active role in managing their own learning. Since each of these alternative assessment modes has its strengths and weaknesses, the choice of a particular form of assessment should depend on the purpose of testing. For instance, whereas individual assessments in the form of written assignments, presentation and performance tasks avail the opportunity for knowing individual learner ability, it is time uneconomical, which is a serious challenge in the face of the teeming population of learners in contemporary times. Portfolios, journals and projects are also forms of alternative assessments
2. **Achievement test or aptitude test?**

The second assessment dilemma for consideration is whether to emphasize achievement tests or aptitude tests. Achievement tests are those given to learners after exposure to instruction as a means of verifying learning gains. Aptitude tests on the other hand are those used to produce an individual’s future performance in a given subject area, or an individual’s likelihood of accomplishing a career in an area opted for.

Typically, the nature of items for achievement test differs from those of aptitude. Whereas items for achievement tests are content specific, those for aptitude are like those used for intelligence tests. Items for aptitude tests are content-free but seek to elicit responses that are confirmatory that given training, the respondent will likely excel in the prospective career of interest. In Nigeria today, most employers of labour and even reputable educational institutions seem to be doubting the credibility of achievement tests for employment, selection and even placement, and prefer to use aptitude test irrespective of the applicants’ claims or previous knowledge. What is the way forward for a brighter future in Mathematical education? Should we stick to achievement tests or change to aptitude testing or both? This is another difficult choice to make. However, it should be noted that abuses of continuous assessment, examination malpractice and the general societal corruption are compelling rationale for seeking innovation.

3. **Open Book Examination or other wise?**

Another assessment dilemma consequent upon the poor mathematics achievement in schools is whether to change from conventional examination/test practice to the open book option. In the society some social problems that challenge the individual do not stop him from book search. Therefore, there are also some challenges that require spontaneous and immediate response without reference to literature. However to avert and stem the tide of educational fraud like examination malpractice, some educators believe that a level-play ground be created for all competitors to write tests/examinations.

4. **Sustain the practice of quackery in mathematics teaching?**

In Nigeria today, the shortage of mathematics teachers has compelled permissive quackery in the teaching of the subject in schools. The phenomenon has far reaching consequences. Indiscriminate teacher postings and transfers have caused deficient schools in the supply of qualified/professional mathematics teachers to engage even those without the basic knowledge and interest in mathematics. The clause on the letter of postings that the teacher’s salary is effective from the date of assumption of duty, at a time of global economic recession compels the threatened to accept to teach any subject of school need, including mathematics. This practice is highly injurious to
the education system, as one cannot give what he does not have. Furthermore, it is better not to teach at all, than inculcate wrong concepts and principles in the learners. It is more difficult to unteach a wrong idea already internalized by the learner. Should we use only the professional mathematics teachers for instruction in schools? Their number is grossly inadequate to cope with students’ population. There may however be need to do preliminary screening prior to teacher deployment, to probe his aptitude, interest and probably proficiency in mathematics, especially for the non professional teachers.

5. **Adopt implicit curriculum instead of the explicit curriculum?**

Another dilemma is whether to continue the explicit curriculum emphasis or shift to the implicit curriculum. The explicit curriculum, the material learnt in school, is specified in course requirements and syllabi. It is subject to formal examinations and certified diplomas, conferring formal status on the beneficiary and giving some indication of what a person is. The implicit curriculum on the other hand is described as that which remains after we have forgotten what we learnt in school (Obanya, 2012). Here, the bulk of what constitutes the curriculum for a learning programme is in fact imperceptible, but its impact on the learner can be long-lasting. It is the curriculum that is “caught”, rather than “taught”. Obanya (2012) contended that the knowledge economy for the twenty first century requires integration of the explicit with the implicit curriculum. He described the more needed implicit curriculum as the non-codified, non-examinable, relatively unstructured, institutionally engineered, and relatively non-formal learning opportunities offered to students and the community. The implicit curriculum ensures better a post-training fit with job demands.

6. **Should we use e-assessment instead?**

Electronic assessment has the capacity to minimize cheating and measurement errors if properly used. But it raises questions about power supply in the face of unsteady electricity supply in Nigeria, Strategies for coping with a large population of learners, costs, skills and the peculiar problems of system failure are basic teaching challenges. This is yet another dilemma in educational assessment.

**Conclusion**

The study concludes that indeed schools mathematics achievement in cross river state is very poor, and the national performance is below the interaction mean. This is dangerous for the future of this nation. Urgent steps are needed to improve the situation.
Recommendations
The paper recommends:
1. The collaboration of all education stakeholders through a common forum for rethinking in tackling the menace of poor mathematics achievement.
2. The “modus operandi” of school supervision be re-strategized to give priority to what happens during classroom instruction since this arena is the main theatre of active learning experiences classroom interaction should be prioritized.
3. Teachers’ annual capacity building workshops should be used to retrain educators on classroom interaction and communication so as to improve classroom climate, to make mathematics learning more interesting and results-oriented.
4. The use of capable and qualified community personnel including alumni and student’s peers to supplement formal classroom instruction in mathematics may prove very helpful.
5. Students’ workshops and students focus on the need for attitude change and problem solving in mathematics.
6. Changes in curriculum emphasis should always be communicated to schools and students prior to implementation. The change from orthodox items setting to applicable items format currently going on in mathematics certificate examinations requires both adequate information and teacher re-orientation so that the impact of the change on students will be effective.

References


