**A PROACTIVE BIG DATA FRAMEWORK FOR MONITORING LEARNING ACHIEVEMENT IN NIGERIAN JUNIOR SECONDARY SCHOOLS (JSS).**

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**Abstract**

*Assessment has been aptly described as the ubiquitous component of teaching and learning. In line with societal dynamics and advances in ICT, educationists have sought to redefine existing assessment techniques. The MLA as one of the innovations has been bogged by the problems of varied, complex and voluminous data. This paper presents a proactive bigdata framework for monitoring learning achievement in Nigerian junior secondary schools*.

**Introduction**

Nigeria operates a 6-3-3-4 system of education, designed to bring about functionality in the system by producing graduates who are appropriately equipped for individual and societal development. It entails six years of primary education, three years of junior secondary school(JSS), three years of senior secondary School(SSS) and four years of university education. The system is anchored on effective and efficient assessment regime. Assessment constitutes a central focus in the education ecosystem and encompasses the processes of fashioning and organising measurement data for making school-based decisions. Basically, it involves the consideration of processes for providing and communicating educational expectations and progress by collecting and interpreting data for the purpose of understanding, improving and adjusting teaching and learning (Asuru & Ogidi, 2012,) Over the years, educationists have fashioned mechanisms for not only reporting assessment but also periodically monitoring learners’ achievement with the aim of providing relevant and specific information on the outcomes of schooling. One of such mechanisms is the process of national assessment.

National assessment, also called system assessment or assessment of learning outcomes is a measure used to describe the level of achievement of an entire education system or a specific cohort of the education system of a country (Asuru, 2015). It aims at monitoring learning to determine the extent to which the learners have learnt, how effective schools are, and how schools compare in terms of performance across schools, zones, states, nationally and internationally. (Asuru, 2017), noted that given the ubiquitous nature of assessment generally and national assessment in particular, results therefrom provide answers to such questions as;

* Are there observable positive changes in the learners’ behaviours?
* Are the schools inculcating the right type of skills, competencies, values, knowledge and skills?
* Are the educational objectives achieved?
* Are there differences in achievements of sub groups?
* Are the results in line with school, local, state, national and international standards?

Different countries have over the years adopted different approaches to national assessment. UNESCO/UNICEF (2003:36) itemized differences in national assessment procedures viz:

* Most assessments are based on a sample of schools/students, while in some, all or most students at a targeted age or grade are assessed.
* Each student may take only a fraction of a large number of assessment tasks or all students may respond to the same tasks.
* Assessment may or may not be designed to provide information about individual schools.
* Complexity of assessment may be on the way students’ performance is described.

Differences may also be in the context of detailed description of performance in terms of sub-domains, relationships, factors, etc. It could also be based on the extent to which the data could be integrated into other aspects of the education system.

Specifically, impetus for MLA arose from concerns raised by the Jomtien, Thailand world Conference on Education for All, held in March, 1990 and re-emphasized by the 2000 Dakar World Forum on Education. MLA has over the years gained prominence as a valid and reliable mechanism for measuring and monitoring learning achievements and also inducing positive changes in school quality. As noted by Asuru, (2015, & 2010), in Nigeria, UNESCO, UNICEF, the federal government and agencies have either collaboratively or single-handedly carried out several MLA studies in the critical areas of literacy, numeracy, essential life skills and at subject levels since 1997, at the primary and secondary school levels.

Putting it succinctly, Obanya, (2002) emphasized the need for Nigeria to embrace the concept of MLA in its education system in order to address pertinent problems in the education system. The current method of generating and analysing data for MLA studies may span some years as a result of semi-manual processes and small data technology employed. A better approach to data management is therefore required.

This paper therefore aims to develop a Proactive Big Data Framework (PBDF) for Monitoring Learning Achievements in Nigerian junior secondary school system. The study is significant as it provides quicker big data analytics platform that provides real insight into the data that is being analysed. The paper identifies the reasons for which education stakeholders carry out education assessment, identifies sources of educational data for big data analytics, explores indicators used for monitoring learning achievements, and presents a proactive big data transformation model for Nigerian junior secondary school.

**Data Sources for MLA**

Assessment can be done through direct or indirect measures. Assessments done through direct measures use data from standardized tests to measure general education skills and specific knowledge. This method provides more evidence on students’ knowledge and abilities over a period of time compared to the use of indirect measures where assessment is based on data from survey of focused group, office records, retention rates and the likes (Breslow, Faye, Snover & Masi, 2007). This method assumes what students have gained during their stay in school.

**Integrating ICT into MLA**

Data generation is central to MLA. This deals with the procedures, techniques and sources of data for monitoring learning achievement. Like other components of assessment, data sources for MLA include:

* Students’ achievement test in the respective subject areas literacy, numeracy and life skills
* Pupils, teachers, headteachers and parents questionnaires
* Standard rubrics
* Government Interventions
* Critics activities
* Education Research
* Accreditation/Regulatory bodies
* Alumni organisations and
* Inventory of home and school facilities

These data are found in different forms (manual and digital) and are generated at different levels. Thus, they are not only voluminous, but also from a wide variety of data types/sources with attendant variability and complexity.

In line with societal dynamics, ICT has now become a handy tool for data generation, storage, retrieval and management in the school system. It is in this wise that educationists have constantly redefined existing assessment techniques to cope with available volume of data and ensure easy access to data.

**Big Data Analytics for Education**

Big Data Analytics is a computer-based technology that deals with the complexity associated with the management of voluminous bank of variety of data types and data analytics tools. On the big data infrastructure, different data capturing techniques are used to capture data which may appear in different digital file formats (text, number, audio, video, and image). Such data could be retrieved and transformed to discover the insight in the data, using big data analytics tools. Analytics is widely used by education stakeholders to support the monitoring of learning achievements.

As the education sector has grown in complexity and volume, so is the growth of big data and the increasing need for higher quality big data management framework. Pratiba and Shobha (2014) identified the following factors to be responsible for the generation of big data in the education sector:

1. The use of customised tools to support various administrative jobs such as student’s enrolment, fee collection, and reporting.
2. Adoption of technology to support effective teaching and learning improves students’ interest and confidence which in turn generates substantial amount of data that are difficult to manage with conventional data management technologies.
3. Increase in the number of students who use available online educational tools for virtual assignments, online interviews, and online focused groups, results in increased log files of their performances and capturing of large amount of data.
4. The use of virtual classes to update students’ skills in a convenient, cost effective and time saving manner, results in the generation of large amount of digital contents such as PowerPoint presentations, audio files, text files, images, and recorded class sessions which could not be stored and managed in conventional database servers and need to take the aid of befitting storage systems like Big Data.

Figure 1 is a representation of an existing educational big data. Education data analytics is the process of collecting information about the way education data is gathered and analysed for the purpose of providing correct and reliable information to educators, students, education administrators, and other related stakeholders. Analytics are applied to education data to describe, predict and improve performance.

Teaching Domain

* Students’ Scholastic Records
* Students’ Assignment
* Teaching Materials
* Curriculum

Administrative Domain

* Accounting and Financial
* Acquisitions
* Human Resources
* Legal
* Campus Administration
* Library Resources

Research Domain

* Project information
* Project management
* Results

Cloud

Educational Big Data

Figure. 1: Schematic of existing storage educational big data: Adopted from Pratiba and Shobha (2014).

Figure.1 shows that the big data is generated from different domains of an education system-teaching domain, administrative domain and research domain. Such big data is difficult to manage with conventional database tools and techniques. Big data offers a better deal when dealing with complex large data store. The complexity associated with big data architecture and big data analytics poses new challenges. The challenges (ranging from unavailability of befitting data mining and data ware-housing techniques to unproductive system analysis methodology) are undesirable as they serve as impediment to reliable knowledge discovery process, hence the need for a proactive big data framework that supports proper utilization of the big data for decision making.

In achieving an innovative form of data and information processing for enhanced insight, decision making and process control, a proactive big data framework for monitoring learning achievement in Nigerian JSS is proposed.

1. **Proposed Proactive Big Data Framework for Monitoring Learning Achievement in Nigerian JSS.**

Big data analytics technology is used to quickly discover valuable insight in the proposed big data framework, designed to support effective monitoring of learning achievement in Nigerian JSS . Even though learning achievement is also used to state what learners are expected to learn during their studies in school, in this work, our concern is limited to the concept of learning achievement that expresses what a learner with specific qualifications is able to know, understand and perform. “Qualifications” as used here cover knowledge, skills, and attitudes developed during schooling and the ability to apply developed capacity to solving social problems.

The Big data infrastructural design presented in this paper is silent on computer network infrastructure but covers storage and processing mechanisms that support real-time knowledge presentation, and visualisation. Big data mechanisms concerned with data security and trusted processing environments are also not the main concern of this paper.

A descriptive approach is used in analysing education data management and existing big data infrastructure architectures whereas a predictive neural network technology is used to achieve smooth data transformation processes. Visualisation of useful patterns and knowledge extracted from the big data generated is achieved with the use of variety of common visualization tools.

The proposed mechanism for data analysis is provided with processing skills to deal with combination of data types. This approach increases the chances of presenting an accurate picture of reality thereby giving users the opportunity to use the framework as an instrument of transparency in the monitoring of learning achievements.

**3.1. Key Requirements for Big Data Analytics for Nigerian JSS**

What students have learnt as considered in this paper covers applied knowledge, acquired skills-set, interactional strengths and personal attitudes of students in their years in school. Figure. 2 is a representation of key components of the proposed big data framework for JSS in Nigeria.

**Big Data Formation**

**JSS data sources:**

* **Survey documents**
* **Interview /questionnaire reports**
* **Standardised and non standardised test reports ( literacy, numeracy ,life skills and respective school subjects).**

**Big Data Analytics Target Use**

Data transformation

Figure 2: Schematic of key components of big data framework for JSS in Nigeria.

* **Any observable improvements in students’ skills, values, competence, attitude and knowledge?**
* **Are Learning objectives achieved?**
* **Are the students’ performances of acceptable standard?**
* **How does Nigeria compare with other countries in indices as enrolment ratio, literacy level, teacher/student ratio, , etc.?**

**Big Data Formation**: The big data creation component is provided with real time data capturing skills from anywhere and at any place. It is compatible with varieties of computing devices (both mobile and non-mobile computing devices) used in collecting hybrid of data formats including text, number, video, audio, and image data types.

**Transformation**

The data transformation component deals with mechanisms for data ingestion from big data stores, distributed processing, data analysis, reporting and visualization. All these mechanisms work towards providing actionable and commercially relevant information.

**Proposed Big Data Analytics Framework for JSS**

The proposed big data analytics framework represented in figure 3 consists of three main components- the big data storage system, data extraction mechanism and knowledge presentation and modelling platform, while figure 4 represents the proposed 3-tier Information processing system architecture for JSS in Nigeria.

Data Transformation Process

**Knowledge Presentation and modelling**

**Real-time Visualization**

**Big Data Storage**

Distributed Database System

**Data Extraction Mechanism**

**Distributed Transaction processing/ Analytics**

Figure 3: Schematic representation of the proposed big data analytics framework

**Big Data Storage System:** The big data storage system is one that supports ubiquitous access from multiple computing devices. To achieve data availability to big data consumers in the JSS system at all times, a distributed database technology is proposed. Organising the databases in this manner also supports ubiquitous information processing (Spencer & Nwachukwu, 2015). The third-tier of figure 4 represents the proposed heterogeneous big data storage system.

**Data Extraction Mechanism:** ANeural Network-based technology is used to achieve context-based, exponentially quicker data analytics mechanism. Descriptive and predictive analytics tools are used to derive real insight into the data that are being analysed. The second-tier of figure 4 represents the proposed data transformation framework.

**Knowledge Presentation and modelling:** Visualising the true picture of realities associated with the activities and achievements of JSS management in Nigeria is achieved through integrated real-time visualisation tools such as Google Chart, Tableau desktop, Data Driven Document (D3), Fusion chart, Highlights, canvas, Qlikview, Datawrapper, Microsoft Poer BI, and Microsoft Excel chat. With these tools, insights into big data are presented in the form of diagrams, images and animation.

Backend

Application server

Big Data Analytics mechanism

Heterogeneous Database Servers machine

Horizontally partitioned JSS Database

DBMS A

Transaction server

Vertically partitioned JSS Database

DBMS B

Database of JSS in a particular state

DBMS C

Computing device

Big data Consumer Machine

Presentation services

Presentation services

Educator

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Presentation services

Figure 4: Proposed Three-tier Information processing system architecture for JSS in Nigeria.

Education administrator

Parent

Figure 4 is an option of a 3-tier information processing architecture (Spencer & Nwachukwu 2015) for JSS in Nigeria. Tier-1 consists of the big data consumers in JSS system including, learners, parents, guardians, teachers, schools, education administrators, government, education researchers, national and transnational organisations. They can use their computing devices to get knowledge about the school system at any time and from anywhere. Knowledge extractions are visualized with the help of visualization tools that can be viewed from their computing devices. Tier 2 and tier-3 make up the backend where real-time processing mechanisms that interface with the big data consumers and the distributed big data storage systems are located. Pre-processing of consumers requests, actual processing of their requests, coordination of requests and processes leading to timely data analysis and reporting are handled by intelligently designed mechanisms located in tier-2 of the system architecture. Tier-3 holds the interconnected distributed databases of the school systems. A combination of feature selection mechanism consisting of Collaborative Agent programs and Multi-Level Perception Neural Network (Spencer & Nwachukwu 2016) is used to select relevant direct and indirect assessment values used for analysis.

**Conclusion**

Education is a valuable investment that equips the recipients to cope with the challenges of the present and the future. This can only be done through effective assessment mechanism. The MLA is therefore one of the handy tools. However, the variability, volume and complexity of MLA data have made its use an expensive (time and resources) venture. To reduce the cost of data generation, storage and analysis at the JSS level in Nigeria, a proactive big data analytic framework is presented.

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