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A Proactive Big Data Framework for Monitoring Learning Achievements in Nigerian Secondary Schools

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Abstract

The process of Monitoring Learning Achievement has over the years become one of the major concerns of education administrators, educators, parents, learners and the society at large. In the light of this, education systems all over the world have continually fashioned assessment mechanisms for determining, measuring, and monitoring learning outcomes. However, the effectiveness of these mechanisms which is greatly depended on the availability of relevant educational data and easy access to these data is the major concern of this paper. Considering the fact that the process of monitoring learning achievement deals with wide-ranging of voluminous data generated from different sources, the paper presents a Proactive Big Data Framework for Monitoring Learning Achievements with a focus on Nigerian Secondary Schools. The aim of the study is to make educational data available at all times and accessible from anywhere and at any time. To achieve this aim, the study reviewed the process of education assessment and presents a big data transformation model for Nigerian Secondary Schools. Computer-based data analytics tools are employed to support various administrative jobs including student's enrolment, fee payment, and reporting. Apart from showing good reliability, providing real insight into educational data that is being analysed, the framework serves as a model for other studies in Education Monitoring, Assessment and Evaluation.

Keywords: Proactive, Big Data, Monitoring, Learning, Achievement, Nigeria & Secondary Schools
Aims Research Journal Reference Format:
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1. INTRODUCTION

Nigeria as a country currently operates a 6-3-3-4 system of education. This system of education was designed to bring about functionality in the system by producing graduates that are developed all-round (Adeyemi et al., 2012). It specified that, a child spends 6 years in primary school, 3 years in junior secondary school, after junior secondary school, if the child is academically okay, he or she moves to senior secondary where he/she is expected to spend another 3 years before proceeding to the university to spend 4 years. At the end of junior secondary education, those who are not academically okay are given the option of going to learn a trade or attain technical education from any technical school. The achievement of the goal of this national initiative coming from the Nigeria Education Sector may not have been realised due to lack of systematic Monitoring of Learning Outcomes (MLO) at the different levels of her education system. It is evident that the existing educational system has highly revolutionised in its practices (Pratiba & Shobha, 2014). Therefore, the need for proactive measures in monitoring learning outcomes cannot be overemphasised.

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 products or outcomes of schooling. One of such mechanisms is the process of National Assessment. This paper presents a Proactive Big Data Framework for Monitoring Learning Achievements with a focus on Nigerian Secondary Schools. The aim of the study is to make educational data available at all times and accessible from anywhere and at any time. To achieve this aim, the study reviewed the process of education assessment and presents a big data transformation model for Nigerian Secondary Schools. The transformation model of the framework employed Computer-based analytics tools to support various administrative jobs including student's enrolment, fee payment, and reporting. Apart from showing good reliability, providing real insight into educational data that is being analysed.

2. A REVIEW OF ASSESSMENT OF LEARNING OUTCOMES CONCEPT

National Assessment, also called System Assessment or Assessment of Learning Outcomes is defined as a measure put in place to describe the level of achievement of an entire education system on a specific cohort of the education system of a country (Asuru, 2017). 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, 2015).

According to Asuru (2010) highlights of information national assessment seeks to provide include:

i. To what extent are the students learning?
ii. What are the strength and weaknesses in the knowledge and skills so acquired?
iii. Are there differences in the achievement of subgroups in the population?
iv. What is the degree of association between achievement and the characteristics of learning environment?
v. To what extent do the achievements of the students change overtime?

National assessment is distinct from the assessment of individual learner. As noted by UNESCO/UNICEF (2003), the requirements for national assessment include:

i. Appointment of implementation agency by relevant authority
ii. Determination of the policy needs that are to be addressed in the assessment
iii. Identification of the population or cohorts to be assessed
iv. Determination of the achievement domain to be assessed (such as, Literacy, numeracy, English language, life skills).
v. Preparation of achievement tests, questionnaires and test manuals.
vi. Pilot/Trial testing of the instruments and subsequent review
vii. Sample selection
viii. Training of test administrators
ix. Administration of instruments
x. Collection of instrument and preparation for analysis
xi. Data analysis and writing of report.

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

i. 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.
ii. Each student may take only a fraction of a large number of assessment tasks or all students may respond to the same tasks.
iii. Assessment may or may not be designed to provide information about individual schools.
iv. Complexity of assessment may be on the way students' performance is described. For example, use of mean scores, percentages, scaling of scores using item response modelling.

Difference 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. Within the African context, four categories of National Assessment approaches have emerged- the Monitoring of Learning Achievement (MLA) project, the Southern African Consortium for Monitoring of Educational Quality (SACMEQ) project, while the fourth category is made up of national assessments that are not related to any of the above, but are undertaken in individual countries (UNESCO/UNISEF, 2003). Specifically, impetus for MLA arose from concerns raised by the Jomtien, Thailand world Conference on Education for all (WCEA), held in March, 1990 and re-emphasized by the 2000 Dekar 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. Thus, as noted by Asuru, (2015, & 2010), UNESCO, UNICEF and national government as well as agencies have either collaboratively or individually carried out MLA programmes in critical areas of literacy, numeracy, essential life skills and at subject levels in Nigeria since 1997, several MLA studies have been carried out as itemized in table 1.

Table 1: Some MLA Studies in Nigeria

S/N	Sponsor	Focus and Cohort	Year	Area (s) Covered
1	Federal Government of Nigeria/UNICEF/UNESCO	Primary four pupils in numeracy, literacy and life skills.	1997	Nationwide
2	Federal Government of Nigeria/Universal Basic Education Council	Primary four English Language and mathematics	2001	Nationwide
3	Federal Government of Nigeria/Universal Basic Education Council	Primary Six and Junior Secondary School one to three English, Mathematics, Primary and Integrated Science, Social Studies, and Introductory Technology	2006	Nationwide
4	National Examination Council (NECO)	Senior Secondary three English Language and Mathematics	2009 (Year of report)	Nationwide
5	Education Sector Support Programme in Nigeria (ESSPIN)	Pre-test of MLA instrument on Mathematics and English Language in primary classes three and five.	2010 (Year of report)	Kano and Lagos States

It is on this premise that Obanya (2002) underscored the need for Nigeria to embrace the concept of MLA in its education system in order to address pertinent problems in the education system. Generating and analysing data for each of the MLA studies shown in table 1 may have span up to two or more years as a result of semi-manual processes and small data technology employed. A better approach to data management is therefore required.

2.1. Data Sources for MLA

Assessment can be done through direct measures or indirect measures (Breslow et al., 2007). Assessments done through direct measures use data from standardized tests to measure general education skills and specific disciplinary 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 et al., 2007). This method assumes what students have gained during their stay in school.

2.2. Integrating Technology into MLA

One cardinal issue in MLA is that of data generation. Data generation deals with the procedures, techniques and sources of data for monitoring learning achievement. Like other components of assessment, data sources for MLA include:

i. Students' achievement test in the respective subject areas and life skills
ii. Pupils/Student questionnaires
iii. Teachers' questionnaires
iv. Head Teachers/Principals' questionnaires
v. Standard rubrics
vi. Teachers' engagement
vii. School Administrators' engagements
viii. Government Interventions
ix. Critics activities
x. Education Research
xi. Parents' questionnaires
xii. Accreditation/Regulatory bodies
xiii. Alumni organisations and
xiv. Inventory of home school facilities

These data are found in different forms (manual and digital forms) and are generated at the school, Local Government Area, State and National levels of education administration. This implies that the required data are not only voluminous, but also from a wide variety of data types with attendant variability and complexity. In line with societal dynamics, information and communication technology (ICT) has in recent times become a handy tool for data generation, storage, retrieval and management. The Education sector has no doubt become one of the beneficiaries of technological innovations. 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.

2.3 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). You can retrieve and transform data to discover the insight in your data using big data analytics tools. Analytics is widely used by education stakeholders to support the monitoring of learning achievements.

As the educational sector revolutionise, 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:

i. The use of customised tools to support various administrative jobs such as student's enrolment, fee collection, and reporting.
ii. Adoption of the use technology to support effective teaching and learning improves students' interest and confidence which in turn generates quite a substantial amount of data that are difficult to manage with conventional data management technologies.
iii. 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.

iv. 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.

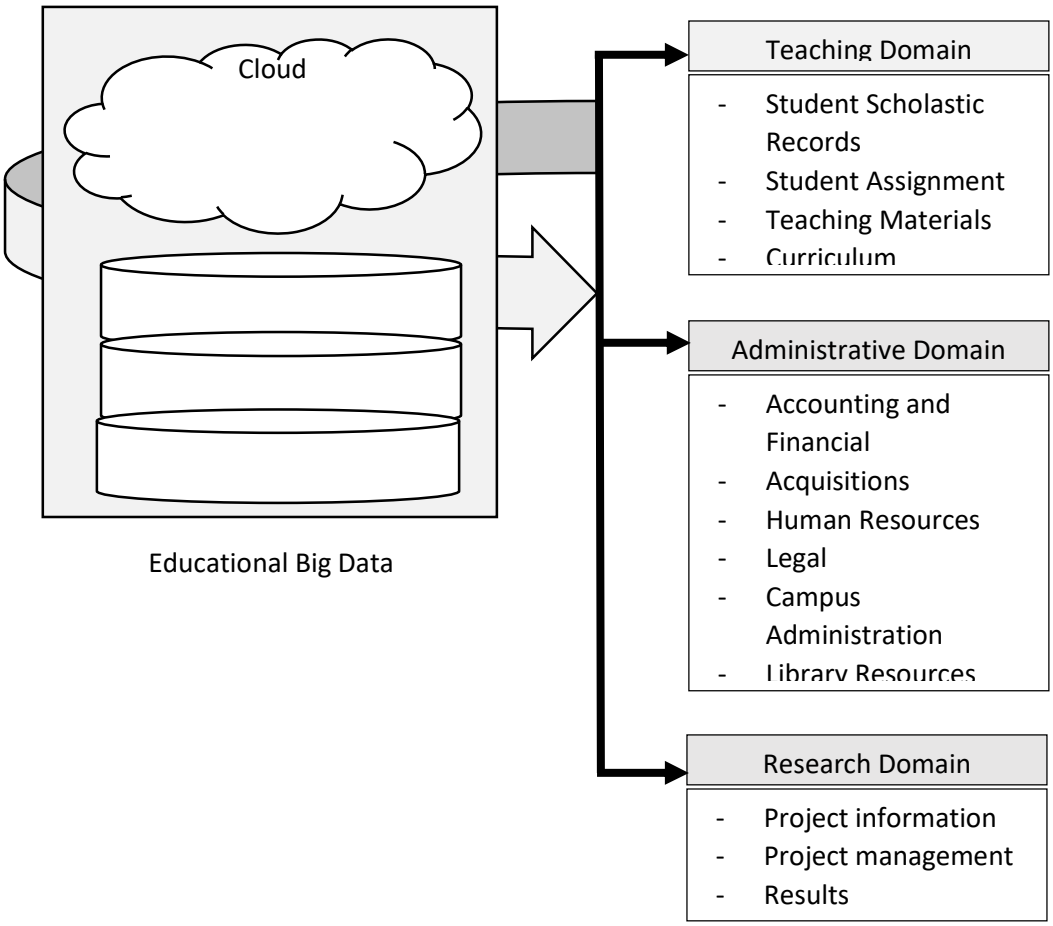


Figure. 1: Schematic of existing storage educational big data: Adopted from Educational Big Data Mining Approach in Cloud: Reviewing the Trend by Pratiba and Shobha (2014).

Analytics are applied to education data to be able to describe, predict, and improve academic performance. 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. There is therefore urgent need for a proactive big data framework that supports proper utilization of the big data that can be used for decision making.

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 be able to describe, predict, and improve academic performance. 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 Secondary Schools is proposed.

3. PROPOSED PROACTIVE BIG DATA FRAMEWORK FOR MONITORING LEARNING ACHIEVEMENT IN NIGERIA JUNIOR SECONDARY SCHOOLS

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 Secondary Schools. Even though learning achievement is also used to state what learners are expected to learn during their studies in school, in this paper, 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 covers knowledge, skills, and attitudes developed during education 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 equipped 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 instrument of transparency in the monitoring of learning achievements.

3.1. Key Requirements for the proposed Big Data Analytics for Nigeria Secondary School

What students have learnt 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 Secondary Education System in Nigeria.

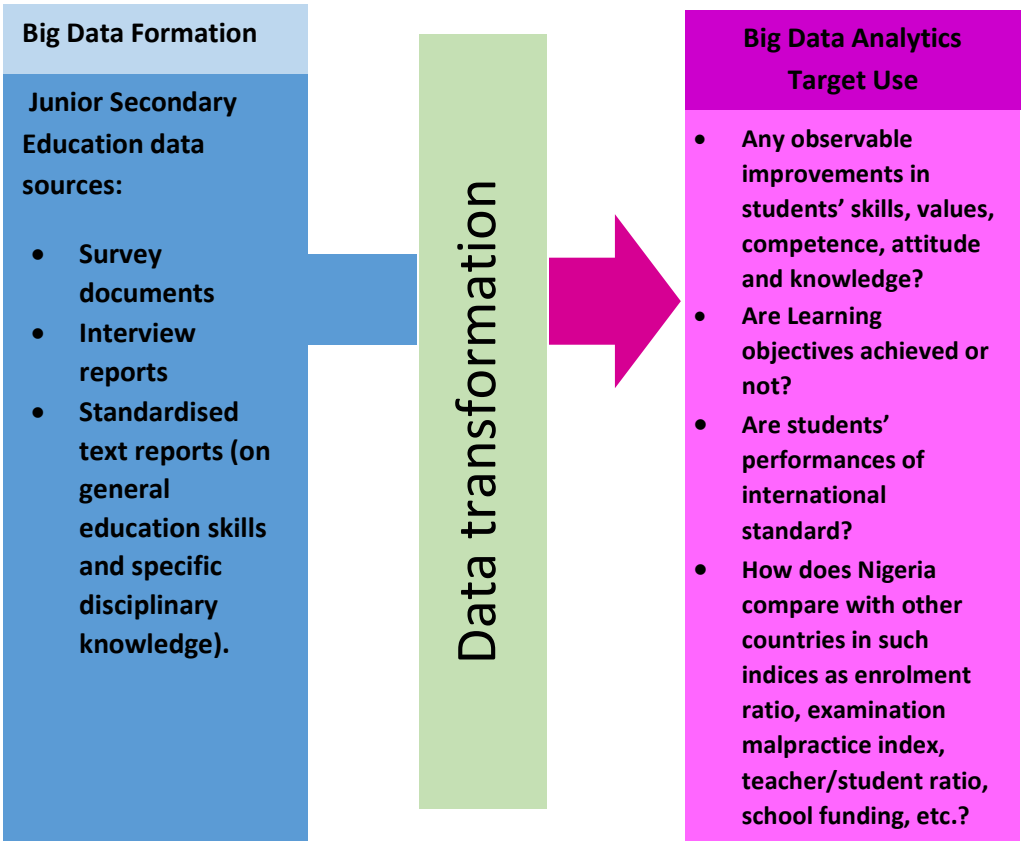


Figure 2: Schematic of key components of big data framework for Junior Secondary Schools in Nigeria.

Big Data Formation
The proposed big data creation component is equipped with real time data generation skills. It is compatible with varieties of computing devices (both mobile and fix-location computing devices) used in collecting hybrid of data formats including text, number, video, audio, and image data types.

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

Big Data Analytics mechanism
The proposed big data analytics mechanism in figure 3 consists of three main components- the big data storage system, data extraction mechanism and knowledge presentation and modelling platform. Figure 4 represents the proposed 3-tier Information processing system architecture.

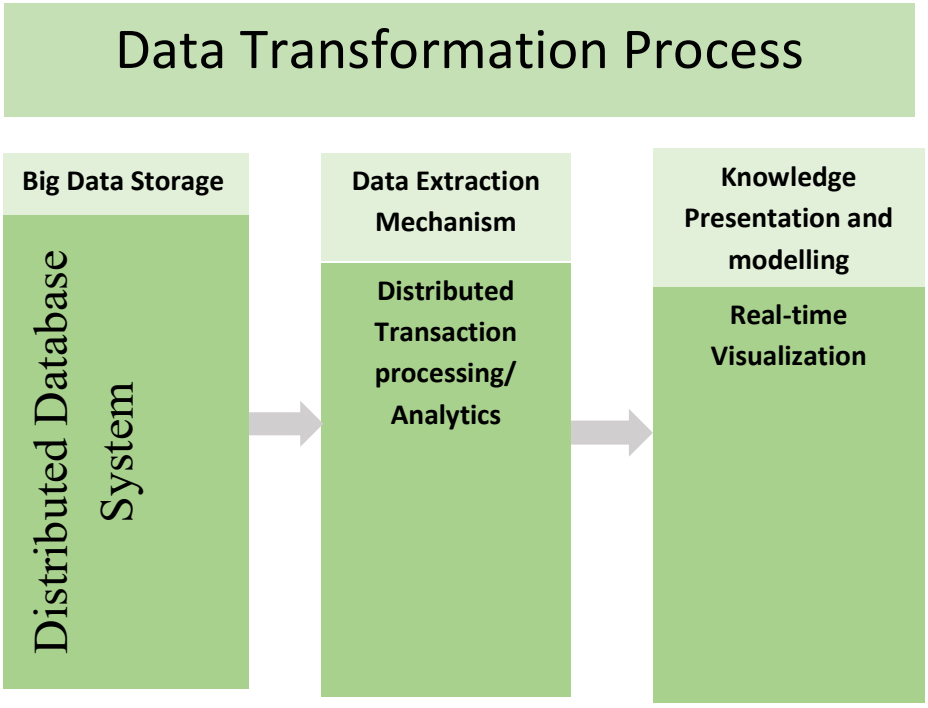


Figure 3: Schematic representation of the proposed big data analytics

Big Data Storage System
The proposed big data storage system is one that supports ubiquitous access from multiple computing devices. To achieve data availability to big data consumers 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
A Neural 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 data transformation mechanism is found on the second-tier of figure 4.

Knowledge Presentation and modelling
Visualising the true picture of realities associated with the activities and achievements of the School is achieved through integrated real-time data analytics tools. with these tools, insights into big data are presented in the form of diagram, images, and animation.

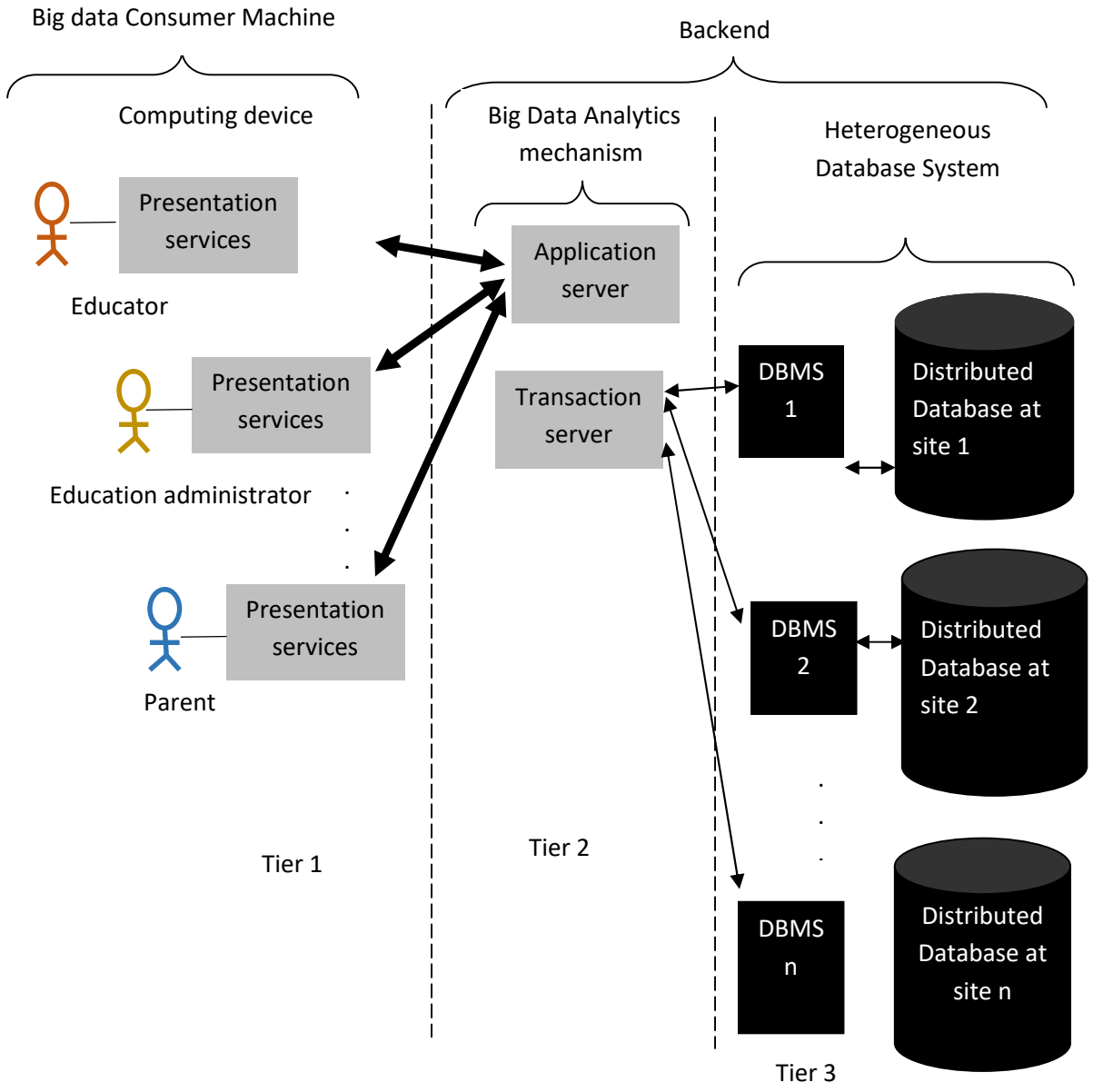
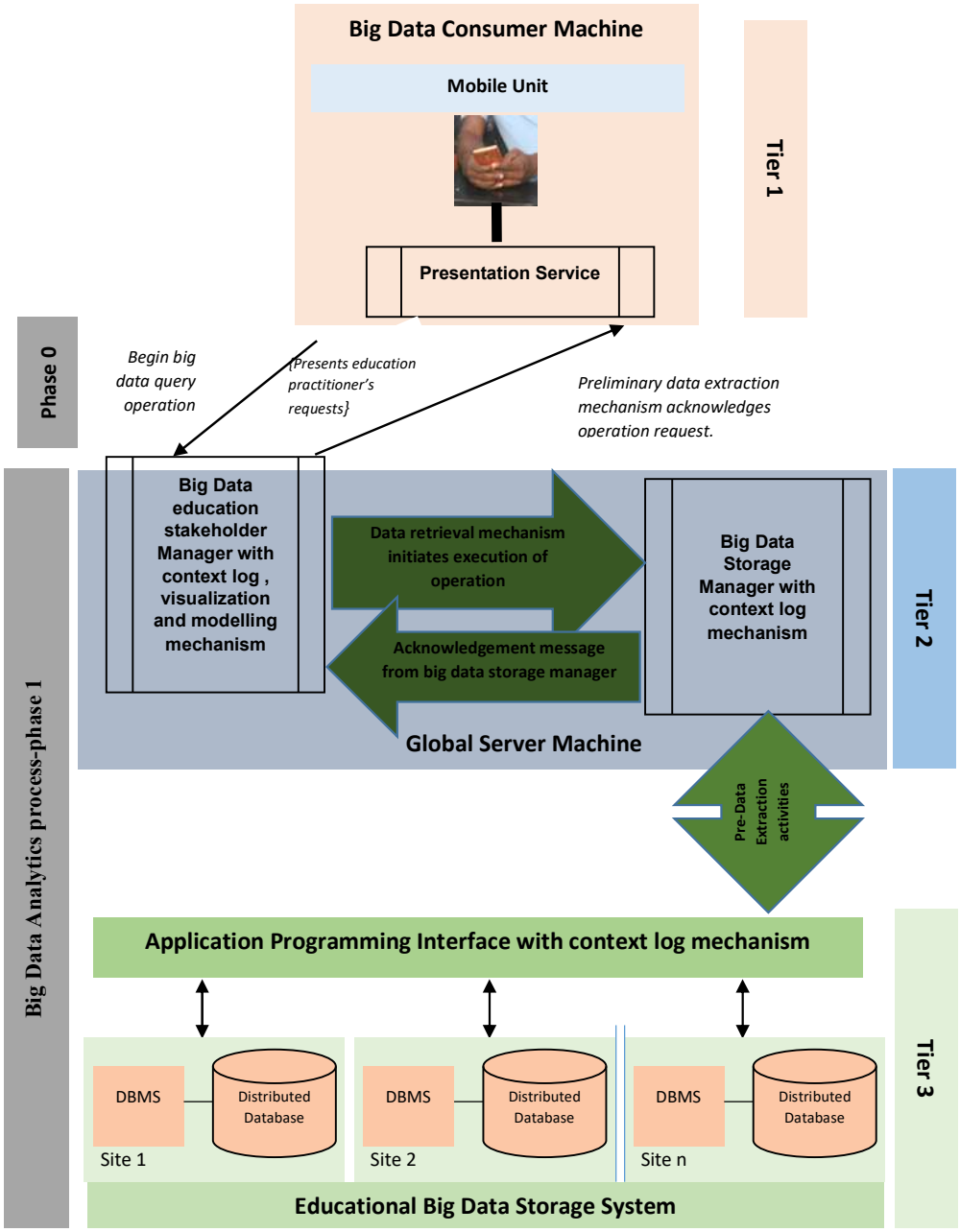


Figure 4: Proposed Three-tier Information processing system

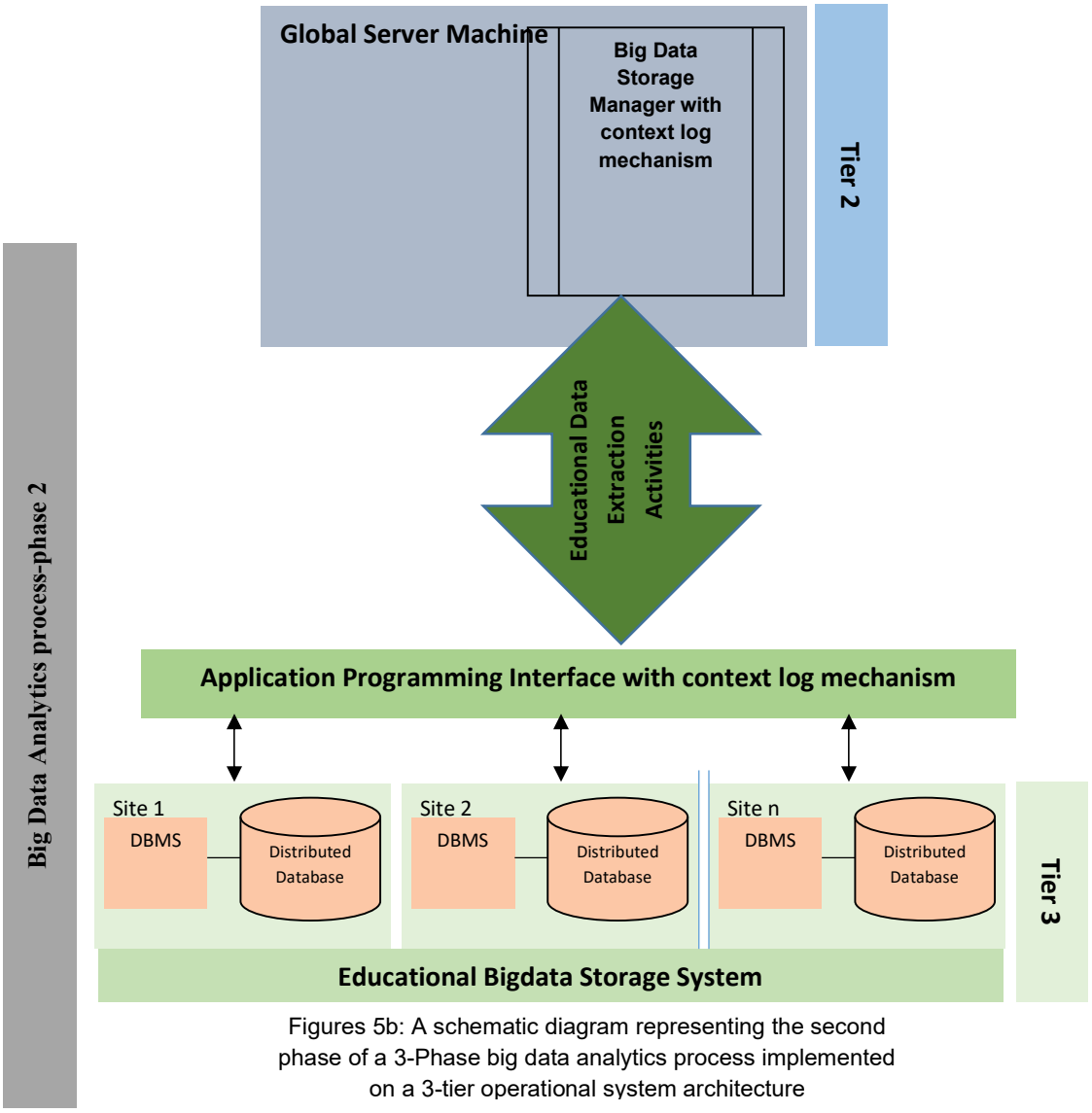
Figure 4 is actually an option of a 3-tier information processing architecture (Spencer and Nwachukwu, 2015) where Tier-1 consists of the big data consumers including, learners, parents, guardians, teachers, schools, education administrators, government, education researchers, national and transnational organisation. They can use their mobile devices to get educational data concerning the school system at any time and from anywhere. Information are presented with the help of integrated analytics tools. 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 neural network-based feature selection (Spencer & Nwachukwu, 2016) mechanism consisting of Collaborative Agent (CA) programs and Multi-Level Perceptron Neural Network (MLPNN) is adopted and used to select relevant direct and indirect assessment (Breslow et al., 2007) values used for analysis. The 3-phase data communication process design of the framework presented in figure 4 is illustrated in figure 5a, 5b, and 5c.



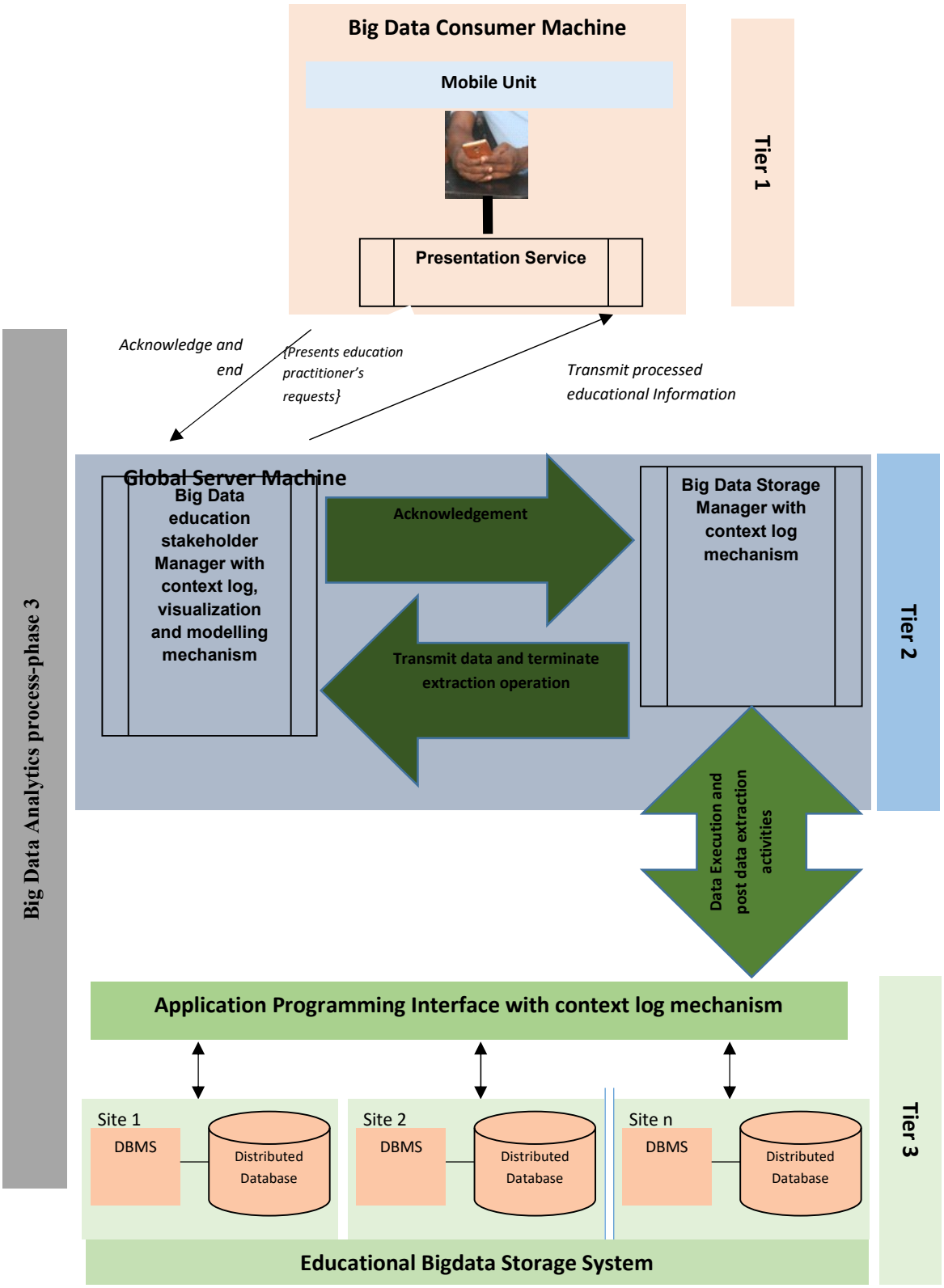
Figures 5a: A schematic diagram representing the first phase of a 3-Phase big data analytics process implemented on a 3-tier operational system architecture

Education practitioners can access the proposed analytics big data using variety of computing devices from anywhere and at any time. The practitioner's computing device indicated as Mobile Unit in figure 5a, and 5c plays host to user support programs called "Client" Hence the name "Client Machine" or Big data Consumer Machine as shown in figure 5a and 5b. The client programs are saddled with the responsibility of organizing the user's request for execution and reporting. The activities of these programs are managed by the Client Operations Manager (COM) indicated as b*ig data education stakeholder manager* in figure 5a, and 5c. The COM is designed to have context log, visualization and modelling skills. It also interfaces with the *big data storage manager* to extract data from the Educational Big Data Storage System. The operation request initiation stage that triggers the big data analytics process is referred to as *phase 0.* Phase 1 is the pre-data extraction stage designed to ascertain the readiness of processing units hosting the educational big data stores. Pre-data extraction activities between the big data storage system manager and the educational big data storage system also occur at this stage. Figure 5b is a representation of the second stage of the big data analytics process.



Figures 5b: A schematic diagram representing the second phase of a 3-Phase big data analytics process implemented on a 3-tier operational system architecture

The data extraction process continues depending on the readiness of the processing units hosting the big data storage system. This forms the 2nd phase of the big data analytics process.



Figures 5c: A schematic diagram representing the third phase of a 3-Phase big data analytics process implemented on a 3-tier operational system architecture

In phase 3 of the execution process, the extraction of data is finalized and transmitted to the Client Operations Manager for visualization and modelling using appropriate visualization or modelling tool before a report is generated for the consumer. Figure 5c shows that the Client Operations Manager and the Big Data Storage System Manager form the second tier of the system architecture.

4. CONCLUSION

Education is a valuable investment that cannot be undermined as young people through this means are prepared for challenges ahead of them while contributing meaningfully to nation building. In this paper, the Nigerian 6-3-3-4 system of education designed to produce all-around graduates is reviewed with focus on the Secondary School System. The periodic assessment of learners' achievement is identified as an important procedure in any education system, since it provides relevant and specific information on the outcomes of schooling. It is also pointed out that assessment data are not only voluminous, but are also generated from a wide variety of data sources and are of varied types. For cost effective and reliable process of monitoring learners' achievement, the use of big data technology is proposed and a proactive big data analytics framework for Nigerian Secondary Schools is presented. With the proposed big data framework, MLA process provides answers to pertinent questions about the education system in a transparent and reliable manner. The framework also serves as a model for other studies in Education Monitoring, Assessment and Evaluation

5. Future Work

Future work will attempt to develop and implement a Distributed Database Framework for Nigerian Secondary Schools system.

REFERENCES

1. Adeyemi, B. A., Oribabor, O. A., & Adeyemi, B. B. (2012). An overview of Educational Issues in Nigeria:Thoughts and Reflections. 2012-12-12]. http://nau. edu/uploaded Files/Academic/COE/About/Projects/An% 20Overview% 20of% 20Educational% 20Issues% 20in% 20Nigeria. pdf.
2. Asuru, V. A.(2017) . Assessment for, as and of learning: A psycho-legal convergence for national development. Inaugural lecture. Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt, Nigeria.
3. Asuru, V. A. (2015). Measurement and evaluation in education and psychology. Port Harcourt. Pearl publishers international ltd.
4. Asuru, V. A.(2010) Monitoring of Leaning Achievement: A Strategic entrenching quality assessment. Journal of Education Assessment 227-239
5. Asuru, V. A. & Ogidi R. C.(2012). Evaluation of awareness and implementation of best practices in assessment in secondary schools in Port Harcourt metropolis, Rivers State, Nigeria; A wake-up call. Journal of Educational Assessment in Africa. 6
6. Breslow, L., Faye, A., Snover, L., & Masi, B. (2007). Methods of measuring learning outcomes
7. And value added. Teaching and Learning Laboratory, Massachusetts Institute of Technology. Retrieved from http://tll. mit. edu/sites/default/files/guidelines/ae-tools-methods-of-measuring-learning-outcomes-grid-2. pdf.
8. Obanya, P.A.I (2002). Revitalizing education in Africa. Ibadan. Stirling- Horden Publishers
9. Pratiba, D., & Shobha, G. (2014). Educational BigData Mining Approach in Cloud: Reviewing the Trend. International Journal of Computer Applications, 92(13).
10. Spencer, P. & Nwachukwu, O. E. (2015). Light-Weight Client/Server Transaction Processing Architecture for Ubiquitous Computing Environment. African Journal of Computing & ICTs, 8 (4), 20.
11. Spencer, P. & Nwachukwu, O. E. (2016). Identification and Classification of Processing Unit Eligibility for Ubiquitous Computing Using Feature Selection Mechanism and Artificial Neural Network. International Journal of Wireless Communications and Mobile Computing, 4 (2), 26.
12. UNESCO/UNICEF (2003). Monitoring learning achievement (MLA) project data base. Paris. UNESCO