THE KENYA NATIONAL EXAMINATIONS COUNCIL

THEME : Assessment and Big Data

SUB -THEME: Access To Big Data – Opportunities To Ask New Questions About (Teaching, Learning and) Assessment.

Title : Evaluating Utilization of Big Data for Learning and Assessment of Mathematics in Nairobi County Secondary Schools, Kenya.

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Abstract

The efficient use of Big Data in assessment for learning is a game changer in the teaching-learning (TL) process. Teachers, students, educationists and other stakeholders on the day-to-day basis , interact, generating enormous (big) data used in the TL as well as in assessment cycles. These stakeholders should with ease and precision, make informed evaluation of instructional and assessment programmes. However, statistics show that achievements level in secondary education, especially in mathematics is below expectations yet a lot of big data have continued to be generated. This paper endeavours to highlight the relationship between the performance of Students in secondary schools in mathematics and the access as well as the use of big data in mathematics during the TL process. The evaluation questions are: to what extent do teachers, and Students access big mathematical data for assessment? Do the teachers and Students have requisite skills to validly and reliably construct, analyse and interpret instructional and assessment content. Prescriptive Instructional Design (ADDIE model), based on the Cognitive Learning Theory guided the study. The Naturalistic Research Design and the Case Study methodology were used. The research data was collected using semi-structured interviews on focused groups; and analysed using the coding, document analysis as well as the descriptive statistics. The study findings revealed that learners' performance was proportionate to extend of their access and use of big mathematical data. The study also observed that the validity and reliability of instructional and assessment data given to the Students was affected by teachers' inadequate skills in test construction, assessment, storing and retrieval of the relevant big data. It is recommended that teachers and Students be capacity built to make use of big instructional and assessment data for effective learning and assessment.

Key words:

Teaching- learning, Reliability, Validity, Prescriptive Instructional Design, Cognitive Learning Theory

Introduction

Big data is the product of digital technology. It entails the generation, process, analysis, storage, and retrieval of massive data with the extensive application of information communication technology infrastructure (ICT) (CAI, L. & Zhu, Y., 2015), to allow for an enhanced insightful decision making in the relevant discipline.

Big data could be in form of text files/ pictures/ tabular data/ images/ audio or video. This form of data usually is in high velocity, volume and variety (3Vs), and may take the structured, semi-structured or unstructured format.

In educational context, Laney (2001) describes big data as referring to the "numbers of student observations, the frequency of observations, and the number of types of observations of learning process data (tests scores) and administrative data such as demographics. The amount of data generated is so vast that it is even difficult to capture, manage and process it through conventional means, convenient to use digital technology.

One of current research hot spots in the field of education is on how to effectively use big data technology to carry out educational reforms in the teaching and assessment model.

This study attempts to determine the relationship between performance of learners in mathematics and the access and use of big assessment data in mathematics during the TL/assessment and the achievements level of students in secondary schools in mathematics. It also looks at the effect of teachers and students capabilities to make use of big data on the learner's achievement levels.

Background to the Study

Big data in education can play a significant role in the achievement of learning outcomes. Its a key facilitator in the achievements of authentic assessments in classrooms, where standardized testing and assessments is a premium.

Kenya's basic education system programme is guided by the Kenya Institute of Curriculum Development (KICD). Teaching content, including syllabi, is received from the KICD. The department of basic education alongside other education stakeholders (publishers, consulting firms etc.) and with adherence to the KICD syllabi guide, have developed robust instructional and assessment materials in electronic and manual formats, while Kenya national examinations council (KNEC) develops national examinations done at the end of course.

Schools generate their own school-based assessments (SBA), course work assessments, continuous assessments tests (CATs), end of term, and mock examinations. Some schools for varying reasons, source assessment materials (data) from renowned educational consulting firms (websites) and online libraries. Such materials contains teaching notes, charts, models, graphs, text books, set books. It also consists of an assortment of locally selected school SBAs, CATs, mock tests and past examination papers from different examining bodies. To gain access to such content, learners /schools would require appropriate ICT infrastructure (PCs, Internet, servers, printers). They will be downloading and (sometimes) upload enormous assessment data and reports.

Most of the website containing assessment content are freely assessed, though others others are charged. Some of the big assessment data hubs' (websites) that are publicly assessed are:

- KNEC https://www.knec.ac.ke/ ***(on requests only)***
- KICD https://kicdinteractivecontent.ac.ke/
- Digital Learning Programme (Ministry Of Education) http://www.education.go.ke/
- DigiSchool (ICT Ministry) http://icta.go.ke/digischool/
- FREE KCSE PAST PAPERS https://www.freekcsepastpapers.com/
- *Schools Net Kenya* http://schoolsnetkenya.com/
- KenyaPlex.com https://www.kenyaplex.com/
- Online Tutors https://kcpe-kcse.com/
- Scribd https://www.scribd.com/

Students, therefore, from any global location are able to sit for assessment tasks and get prompt feedback reports and with ease.

Statement of the Problem

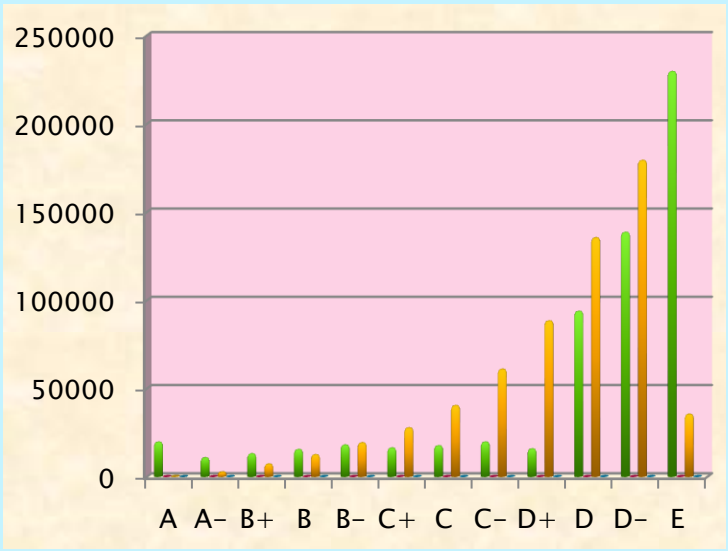
Utilization of big assessment data plays a significant role in the achievement of learning outcomes. It also enhances the realization of authentic assessments of learning outcomes.

Using such data, stakeholders should with ease and precision, make informed evaluation of instructional and assessment programmes. The Performance indicators of students (learning outcomes) are expected to be on upward trends given this complementary resource of big teaching and assessment data. However, statistics (KNEC 2017 KCSE / Mathematics Performance) (***refer to Table I***), shows poor achievement levels in secondary school, particularly in mathematics, and the data indicates that most candidates scored below C plain grade.

This study attempts to determine the relationship between performance of learners in mathematics and their access and use of big assessment data in mathematics.

Table I: 2017 KCSE Mathematics and Overall Grade Distribution.

Candidates Grades	**A**	**A-**	**B+**	**B**	**B-**	**C+**	**C**	**C-**	**D+**	**D**	**D-**	**E**
Math. Only Grades	19784	10915	13147	15550	18106	16425	17711	19782	15901	93869	138619	229714
Percentage of Math. Only Grades	3.22	1.78	2.14	2.53	2.95	2.68	2.89	3.22	2.59	15.29	22.58	37.42
Overall Mean grades	**142**	**2714**	**7344**	**12628**	**19385**	**27860**	**40474**	**61040**	**88447**	**135550**	**179381**	**35536**
% of Over all Mean Grades	**0.02**	**0.44**	**1.19**	**2.05**	**3.15**	**4.53**	**6.57**	**9.92**	**14.37**	**22.02**	**29.14**	**5.77**



2017 KCSE Grade distribution

Objectives of the Study

The study highlights the relationship between the performance of learners in secondary schools in mathematics against the access and use of big mathematical data during the TL and assessment process.

The research objectives are to determine the:

- extent to which the teachers and learners do access big mathematical TL / assessment data;
- effect of the teachers' capability to access and use mathematical data for teaching and assessment on the learners' achievement levels;
- Requisite skills teachers need to validly & reliably construct/ analyse/ interpret the teaching & assessment content.

Definition of Key Terms

The following used terminologies have specific meaning and connotation as used in this study.

- **Assessment:** This is the quantitative method that involves the systematic collection and orderly arrangement of education information that aids in evaluating student performance and attainment
- **Cognitive Learning Theory:** This is a learning theory in psychology that explains the thinking and differing mental processes that produce learning in individual students.
- **Prescriptive Instructional Design:** is an instructional design model that informs how learners are assisted (by teaching) to organize appropriate teaching leaning concepts to achieve instructional goals.
- **Reliability**: This is the degree to which an assessment tool (tests) produces consistent stable and results.
- **Teaching learning**: This is an aspects of the curriculum instruction phenomenon for which students are taught towards the goal producing learning as an outcome.
- **Validity**: The validity of a test refers to the degree to which such a test measures what it is purported to measure.

Acronyms

ICT	: Information Communication Technology
TL	: Teaching- Learning
ADDIE	: Analysis, Design, Development, Implementation, Evaluation
PID	: Prescriptive Instructional Design
KICD	: Kenya Institute of Curriculum Development
SBA	: School-based assessments
CWA	: Course Work Assessments
CAT	: Continuous Assessments Tests
KNEC	: Kenya National Examinations Council
KCSE	: Kenya Certificate of Secondary Education

Review of Related Literature

The use of big data to support teaching learning as well as assessment has gained significant interests and use.

Gabrielle Matters (2006) acknowledges that the use of data for supporting learning is premised on an educational system designed on evidenced-based practice and that decisions at all levels should be grounded in a well supporting documented data analysis and rigorous discussion, otherwise the reliability and validity of the interpretations is not assured.

In another study, the U.S. Department of Education, (October 2012) using adaptive learning acknowledged that big data systems enhanced the possibilities of harnessing the power of feedback loops for individual teachers and students leading to improved students achievements levels.

Huebner, Richard A. (2013) acknowledged that as we pursue the concept of big data in assessment and learning, the validity of such data can only be effectively be determined by the quality of the data mining and learning analytics. Therefore, it is important to pay more efforts on how such data is acquired, processed, stored and retrieved.

Whereas the above review of literature focused on similar area of interest, no such study focused on the relationship between the access and utilization of big assessment data and achievement levels, hence the research gap.

Design and Methodology

The Prescriptive Instructional Design (ADDIE model) based on the Cognitive Learning Theory guided the study. The Naturalistic Research Design was used because the study is done in their 'real-world' settings, without situations of manipulating and controlling the respondents and the study findings are not predetermined but open to whatever emerges.

Data was collected using semi-structured interviews on focused groups of form four (grade12) students, mathematics subject teachers and school principals).

Theoretical Framework (Tyler's)

The framework outlines the role played by the big assessment data in supporting learner achievement at classroom setting as well as the large-scale assessments level. The model advocates for the learning & assessment by objectives model. This model is relevantly used because the model emphasizes consistency among objectives (about the students output), learning experiences, and outcomes. Therefore, the instructional and assessment strategy involving the use of big data is to be evaluated, to determine the extent to which the objectives are achieved within the new the instructional and assessment strategy.

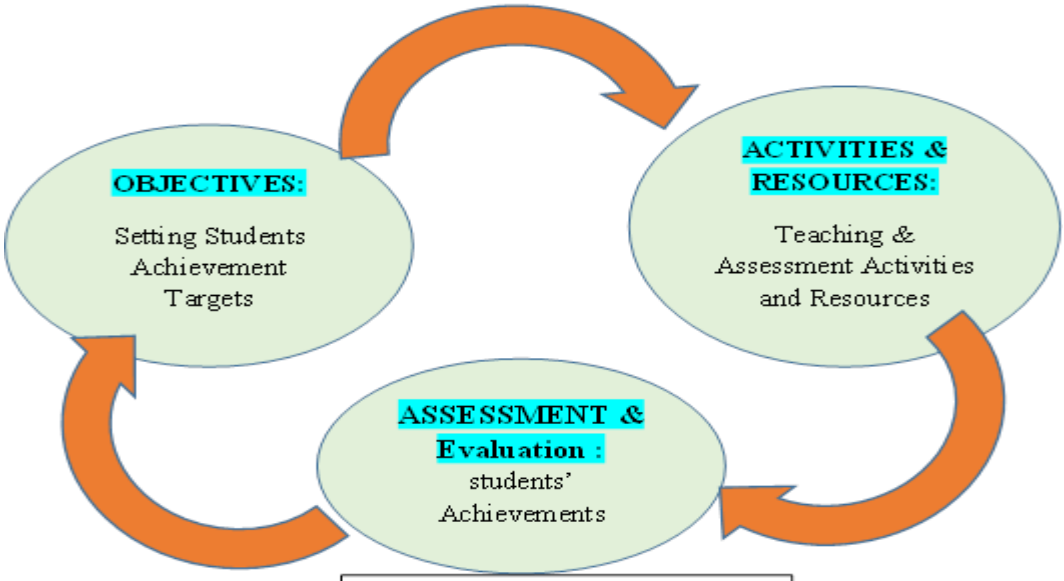


Fig. 1: Tyler's' Theoretical Model

Conceptual Framework

The conceptual framework postulates that the learner's infractructional environment and frequency of teaching/assessment activities (data) determines achievements level of the outputs. It also identifies all the variables and determinants geared towards the (learning) outputs.

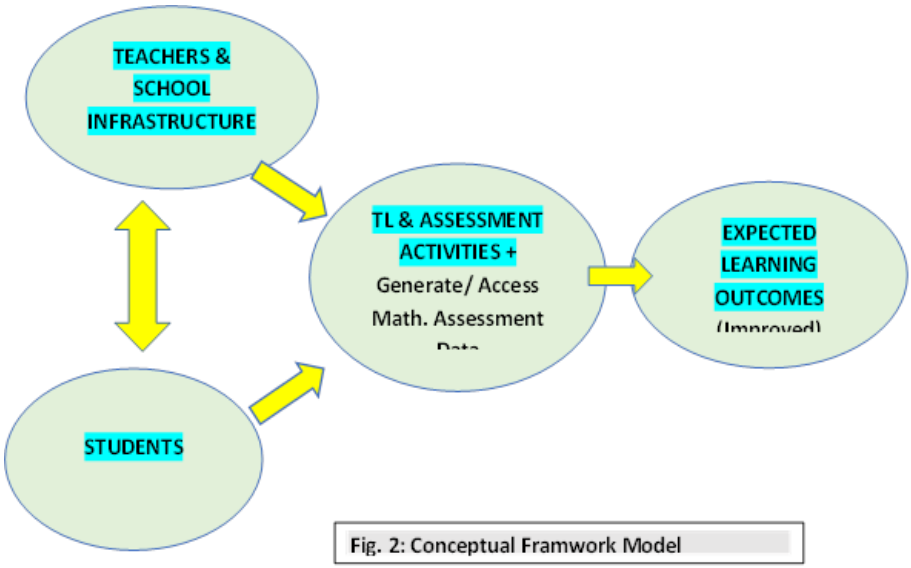


Fig. 2: Conceptual Framwork Model

In the traditional teaching mode, the teaching method is relatively fixed, with the teacher instructing according to the syllabus and the prescribed class hours. The traditional teaching mode is easy to master and apply the theoretical knowledge points but has certain limitation, one cannot benefit from diaspora instruction and assessment materials. One has to be a specific location with the teachers on teaching -assessment contents to benefit.

However, big data era had simplified this into an arm's length of an ICT enabled infrastructure.

The teachers and students can interact on and offline as they learn and perform assessment tasks, and checking of their assessment reports in good time from anywhere , as long as one has an website access.

Research Questions

This paper endeavours to highlight the relationship between the performance of learners in secondary schools in mathematics and the access as well as the use of big data in mathematics during the TL process.

The research questions are:

- ✓ To what extent do teachers and learners access big mathematical TL / assessment data?
- ✓ Do the teachers and learners have the requisite skills to validly & reliably construct/analyse/ interpret the teaching & assessment content?
- ✓ Are the learners' performance affected by capability of the teachers to access and use teaching and assessment mathematical data?

These question informed the choose of research tools used for the data collection from identified respondents.

Research Methodology

The Case Study methodology was used to carry out the study. The method was chosen as it has the ability to narrow down the field study from very broad field of an education setting and allows for the testing of whether a specific theory and model actually applies to phenomena in the real world.

Kenya is administratively divided into counties. The counties are sub divided in to smaller units called sub-counties. The study area was West lands and Starehe sub counties in Nairobi County

They were purposively sampled for they are cosmopolitan urban counties, most schools and homes have ICT infrastructure and high population densities.

The collected data was analyzed by coding, document analysis as well as the descriptive statistics.

A total of 660 form four (grade 12) students out of 4454 participated in the study, representing 95% confidence level and 5.0% margin of error. Similarly 53 out of 53 form four mathematics teachers and 53 out of 53 school principals were selected as respondents, representing 99% Confidence level and 1.0% Margin of Error.

Table II: The Sampling Design

	Population				Sample Selected				Total
Sub-counties	**Starehe**		**West lands**		**Starehe**		**West lands**		
Category of Participants	Public	Private	Public	Private	Public	Private	Public	Private	
Secondary School	16	7	23	7	15	8	20	10	**53/ 53**
Principals	15	8	23	7	15	8	20	10	**53/ 53**
Mathematics Teachers	15	8	23	7	15	8	20	10	**53/ 53**
Form 4 Students	1398	601	1910	546	235	87	203	135	**660/ 4454**

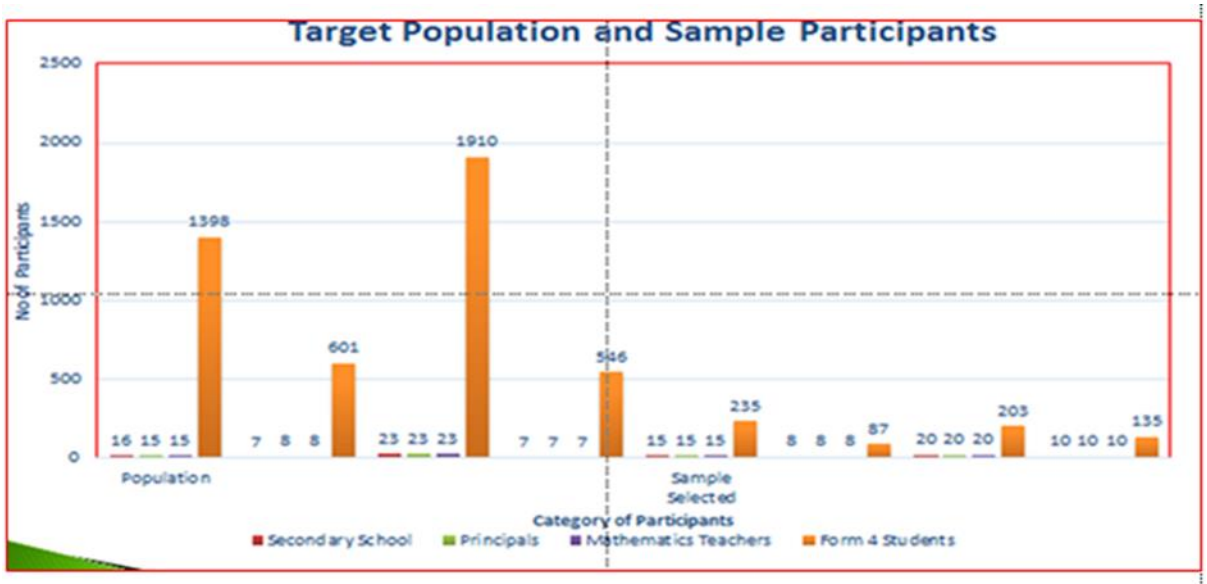


Fig 3 Target Population and Sampled Participants

Research Findings and Discussions

❖ Teachers and learners extent to access big assessment data in mathematics

The study observed that most teachers, students and principals were not able to use big data technology for instructional/assessment purposes. A small proportion of students (9%), teachers (15%) and school principals (11%) reported being able to access big assessment data.

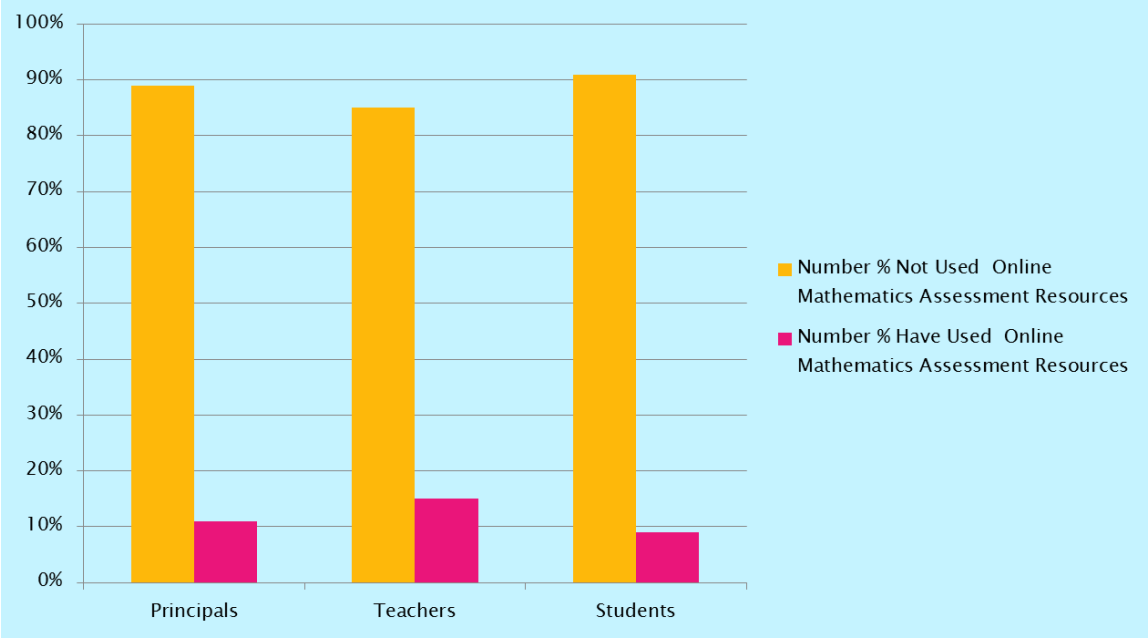


Fig 4. : Not Able/Able to Access big assessment data (mathematical)

❖ Purpose for accessing/using online mathematical data

When asked on reasons the teachers and learners do access the online mathematical data, most of them teachers (73%) and learners (85%) acknowledge using it for revisions/preparation for examination.

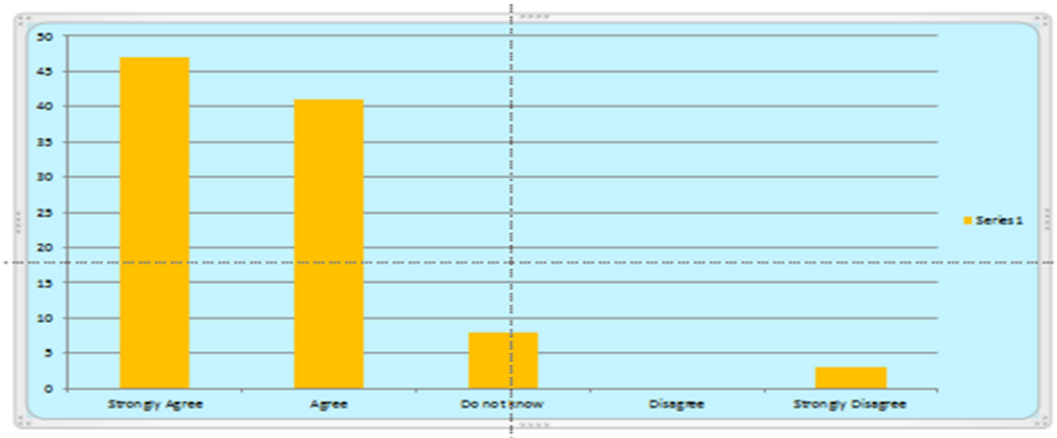


Fig.5: **Online mathematical data is Used for Exams Preparation**

- **requisite skills teachers need to validly & reliably construct/ analyse/ interpret the teaching & assessment content.**

As to why few teachers and Students accessed the online content, most (78%) attributed it to lack of abilities (skills and knowledge) to harness the huge potential of online assessment content for TL and assessment processes.

- **Effect of the teachers and Learners capability to access and use online assessment mathematical (big data) on the Achievement levels.**

When asked if there was any effect on the achievement levels on their capabilities to access and use online assessment content, most of the teachers (78%) and Students (89%) believe that their competencies to access / use the online teaching/assessment will affect their (students) achievement levels.

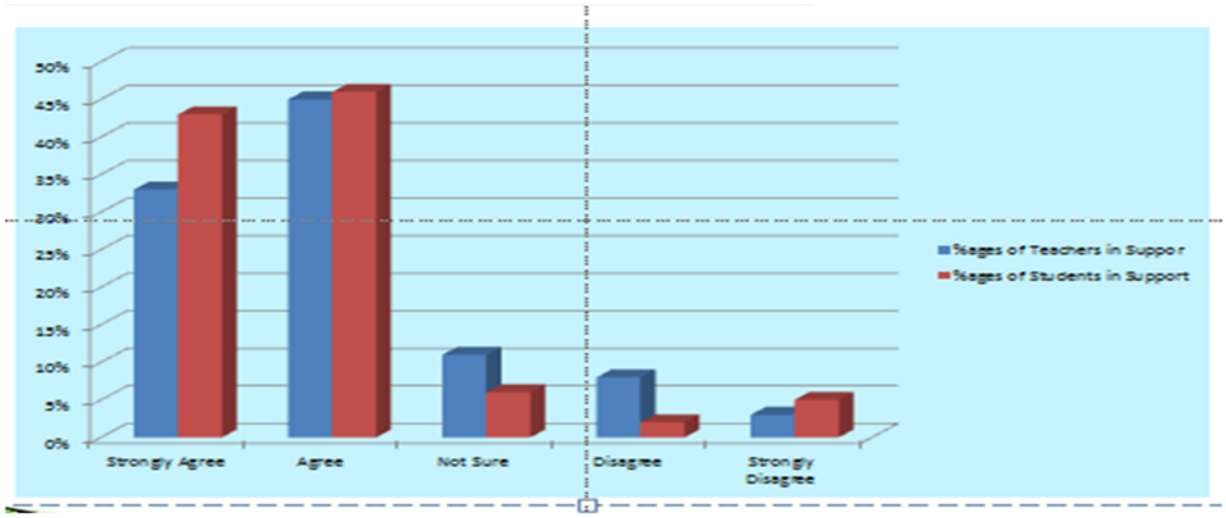


Fig. 6 : Effect of Teachers /Students capability to access and use on line Assessment data on the Learners Achievement Levels

Conclusion

The efficient use of Big Data in assessment for learning is a game changer in the teaching-learning (TL) and assessment process.

From the study, it is observed that many teachers, learners and principals have not benefited sufficiently from the big data revolution, in teaching/ learning and assessment because of lack of requisite knowledge and skills.

It was also observed that there was a positive relationship between the achievement levels and the capabilities of both teachers and students to access and use the large mathematical assessment data (big data). Teachers and students who were ICT technology compliant had better opportunities to access sufficient learning and assessment content, and hence were able to perform better learning outcomes.

Recommendations

- **ICT and Big Data Policy**

  Schools and parents should be encouraged to develop a robust ICT and Big data policy. Such policies would provide on strategies to leverage on ICT and Big data policy in education for learning and assessment purposes.

- **ICT infrastructure**

  Schools stakeholders should develop appropriate and commensurate ICT infrastructure to be able to benefit from the big data revolution in the teaching and assessment arena, as this is a borderless resource sharing.

- **Training and capacity building**

  School stakeholders should be appropriately trained and capacity built on access and manipulation big data for assessment. In cases where resources are scarce, collaboration as a mode of sharing of physical and human resources among schools should be encouraged.

- **Training of teachers on standardized assessment modules and big data**.

  Teachers should also be the trained on teachers on standardized test construction, assessment, storing and retrieval of the relevant big assessment data. This will make possible for them to make significant contribution to the assessment discipline.

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