

**THE IMPACT OF TECHNOLOGY ON THE VALIDITY OF ASSESSMENT IN LARGE SCALE PUBLIC
EXAMINATIONS**

THE WEST AFRICAN EXAMINATIONS COUNCIL'S EXPERIENCE

A PAPER PRESENTED

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ABSTRACT

With a track record in public examinations that spans over six decades, the West African Examinations Council presents some of the challenges and innovations in the conduct of high stake examinations in Nigeria. The major challenges identified were standardization of assessment tools, issues with item banking and item selection, uniformity and fairness in scoring assessment tests, effective supervision and invigilation of examinations, prevalence of fake results and certificates and the menace of examination malpractice. WAEC is involved in large scale assessment involving achievement tests covering seventy seven (77) subjects for an average of about two million (2,000,000) candidates annually. The paper describes various technologies adopted to continually improve on the validity of the Council's examinations in view of the stated challenges. These include computer solutions for Online Registration, incorporating an Offline Registration Module for rural schools, Online Validation of Candidates' examination details, Online Result Verification, Adaptation of the Item Response Theory (IRT) for item analysis and e-Item Banking, Remote e-Marking of essay scripts using Dongles and Internet Data Cards, Photo Embossment and QR Codes on certificates and the Candidates' Identity Verification, Attendance, Malpractice and Post Examination Management Systems (CIVAMPEMS). An analysis of the impact of these solutions shows a steady improvement in the reliability and validity of WAEC examinations. The deployment of these innovations especially CIVAMPEMS had engendered a steady reduction in examination malpractice cases recorded in the various diets of the examination.

1. INTRODUCTION

Assessment is the systemic basis for making inferences about the learning and development of students. It is the process of defining, selecting, designing, collecting, analysing, interpreting and using information to increase students' learning and development (Erwin, 1991). Large Scale Assessment is a data collection effort in which large numbers of students are assessed through administration of "instruments" or "measuring devices" referred to as educational tests. WAEC is one of the organizations in Nigeria conducting large scale assessment. The West African Examinations council (WAEC) was established in 1952 and mandated to determine the examinations required in public interest in the Anglophone West African Countries namely Ghana, Liberia, Nigeria, Sierra Leone and The Gambia; and to conduct such examinations and award certificates of comparable standard with those of similar examining authorities in the world. The Council has continued to pursue this mandate diligently over the years by adopting time tested and internationally acceptable procedures. The West African Examinations Council is responsible for the conduct of the final exit examinations for senior secondary schools in Nigeria. Examinations are conducted annually for about two million (2,000,000) candidates. See table 1 for entry figures of candidates in the last five years.

TABLE 1: ENTRY FIGURES FOR SCHOOL AND PRIVATE CANDIDATES' EXAMINATIONS (2010 – 2015) IN NIGERIA

S/NO	YEAR	ENTRY FIGURE (SCHOOL CANDIDATES)	ENTRY FIGURE (PRIVATE CANDIDATES)	TOTAL ENTRY
1.	2010	1,351,567	324,998	1,676,565
2.	2011	1,540,237	404,861	1,945,098
3.	2012	1,695,878	413,314	2,109,192
4.	2013	1,689,188	308,217	1,997,405
5.	2014	1,705,976	253,596	1,959,572

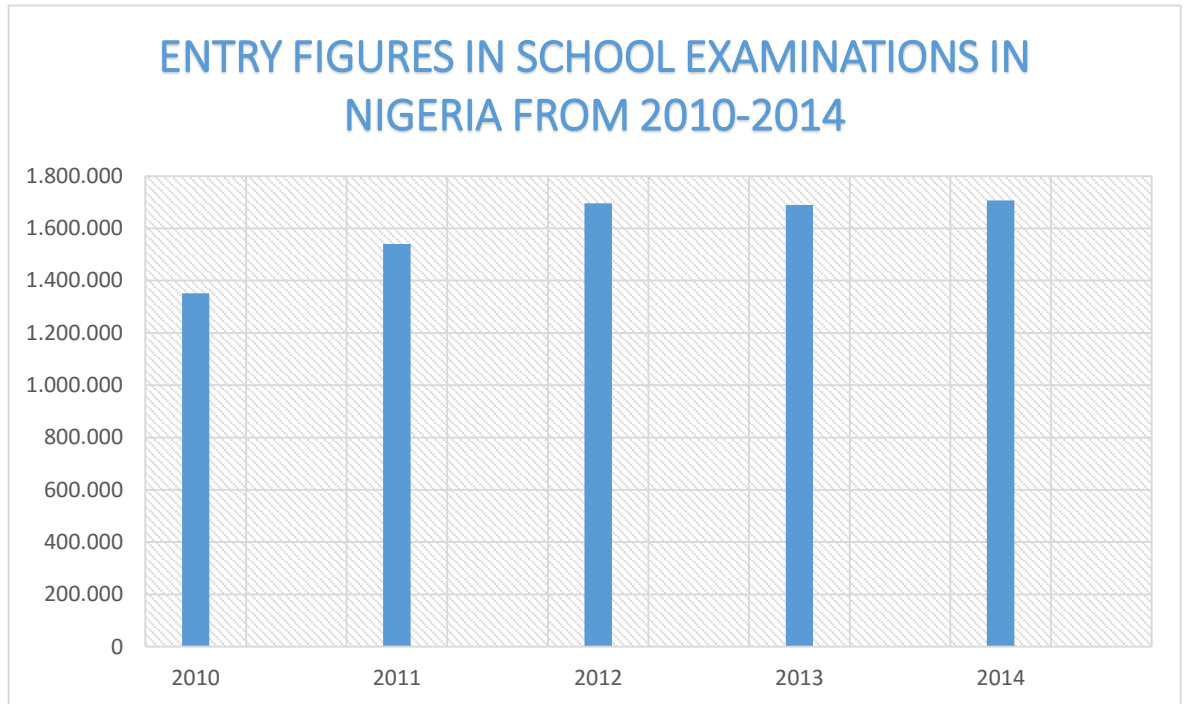


FIGURE 1: GRAPH OF ENTRIES (2010 – 2014)

Assessment instruments are developed in seventy – seven (77) subjects consisting of one hundred and ninety seven (197) paper components and administered in about fifteen thousand (15,000) schools spread across the country. The Council also conducts other examinations at the National level and equally administers examinations on behalf of other foreign bodies. The conduct of a high stake examination like WASSCE undoubtedly is fraught with a lot of challenges that could impugn on the integrity of the examination.

2. CHALLENGES OF ENSURING RELIABILITY AND VALIDITY IN LARGE SCALE ASSESSMENTS BY WAEC AND TECHNOLOGICAL INNOVATIONS DEPLOYED

Public examining bodies are constantly faced with the Challenge of maintaining standards from year to year. In the face of concerns raised over the validity, reliability and integrity of examinations, it is essential that the same standards are applied at every stage of an examination cycle. There is therefore the need to take measures that would eliminate/minimize sources of variance in test scores. Standard procedures should be adopted right from the development of the test papers to the conditions under which test papers are administered and scored, through to the award of grades, culminating in the issuance of results and certificates.

The challenges encountered in the administration of high stake examinations in Sub-Saharan West Africa are varied. They range from validity and reliability issues, socio-cultural, infrastructure, examination malpractice and other emerging technology related issues that are tangential to the overall test outcomes. How WAEC has been able to navigate through the complex maze of these hurdles in the discharge of its mandate is now discussed.

**(1) ONLINE REGISTRATION OF CANDIDATES, OFFLINE REGISTRATION MODULE
ONLINE VALIDATION OF ENTRIES AND BIOMETRICS**

At its inception, registration of candidates for WAEC examinations was very cumbersome and error prone. The manual system of registration involved a lot of paper work and the attendant problem of capturing and storing candidates' examination details accurately. The system was also bedevilled with many irregularities. In 2005, WAEC commenced the online electronic registration of candidates for its examinations. The system incorporates the offline registration module to capture candidate entries in schools located in remote rural places where access to Internet was not available. Data captured on the offline module are downloaded to the WAEC database at the nearest WAEC office to the school concerned. The system also incorporates an online facility which enables candidates to validate their entries and thereby reducing the challenge of errors in candidates' details during registration for examinations. The online registration system has been further improved with the provision for biometric capture of candidates' details.

(2) STANDARDIZATION OF TESTS, ITEM BANKING AND COMPUTER BASED

TESTING (CBT): The Council for many years carries out the following as part of its test standardization process:

- (a) Editing of items
- (b) Trial testing of multiple choice items
- (c) Item Analysis using the classical test theory (CTT)
- (d) Standardization of Marking schemes
- (e) Manual Item Banking

The Council trial test it's Multiple Choice Questions (MCQs) and carries out item analysis using the Classical Test Theory (CTT). CTT describes a set of psychometric procedures used to test items and scale reliability, difficulty, discrimination, etc. It has been used for many years by test constructors in WAEC to understand the statistical properties of test scores and to use the properties to optimize test construction and selection of items into examination papers. However, WAEC had struggled with the limitations of CTT for the standardization of its items and has now embraced the Item Response Theory (IRT).

The limitations of CTT are summarized by Nenty (2004), who argued that in psychological measurement, the amount of what is being measured inherent in an item should not depend on the ability of the group to which the item is administered, or on the set of items along which it forms a measurement instrument. Consequently, the most important problem of CTT is that its characterization of examinee is test-dependent and the characterization of the items or test is examinee-dependent. For example, with CTT, the difficulty of an item is not an inherent property of the item but is relative to the group on which the item is administered. This limitation has posed a problem for the Council in designing parallel sets of test papers with the same standard for its two diets of examinations every year coupled with the manual system of item banking which it has used for many years. To overcome this challenge the Council is collaborating with the National Institute for Educational Measurement (CITO), Netherlands, in terms of capacity building, item calibration, development of electronic item banks and delivery of computer based testing using IRT. The basic assumptions of IRT, using the appropriate model allows for proper calibration of item characteristics and electronic item banking. With this, WAEC is set to commence CBT for some of its examinations.

(3) EFFECTIVE SUPERVISION AND INVIGILATION OF EXAMINATIONS

From experience, ineffective supervision and invigilation of examinations have serious implications for the reliability and validity of examinations. The consequence of poor invigilation is the malaise called examination malpractice. Examination malpractice at any educational level poses the greatest threat to the validity and reliability of any examination and hence the authenticity of certificate issued under such situations.

WAEC defines examination malpractice as any irregular behaviour exhibited by candidates or anybody charged with the responsibility of conducting an examination in and outside the examination hall, before, during and after such examination. One million, seven hundred and five thousand nine hundred and seventy six (1,705,976) candidates sat the May/June 2014 examination out of which a total of one hundred and sixty three thousand, seven hundred and three (163,703) candidates were involved in examination malpractice. This figure represents 9.60% of the total candidates that sat the examination and showed an increase of 8.39% when compared with the proportion of 7.75% of candidates that were involved in malpractice in the May/June 2013 examination. All the cases of examination malpractice reported during the conduct of the examination in addition to those detected at marking venues were collated and classified as shown in table 2 in line with the Council's rules and regulations for dealing with such cases.

Table 2: Numbers and percentages of candidates involved in various types of malpractice in the May/June 2014 WASSCE in Nigeria

S/NO.	TYPE OF MALPRACTICE	NO. OF CAND. INVOLVED	% OF REPORTED CASES	% OF TOTAL THAT SAT
1.	Bringing foreign materials into the hall	3,485	2.13	0.21
2.	Irregular activity inside/outside the hall	22,302	13.62	1.32
3.	Collusion	126,186	77.08	7.46
4.	Impersonation	2,031	1.24	0.12
5.	Leakage	Nil	Nil	Nil
6.	Mass Cheating	7,155	4.37	0.42
7.	Insult/Assault on Supervisors, invigilators and other examination officials	728	0.44	0.04
8.	Miscellaneous/New cases	1,816	1.11	0.11
TOTAL		163,703	100	9.69

It can be deduced from Table 2 that:

- although there was no leakage of question papers in the May/June 2014 WASSCE in Nigeria, the other rules were breached to different extents;
- **collusion** was the most rampant offence at 77.08% prevalence, followed by **irregular activities** inside or outside the examination hall (13.62%) and **bringing in foreign materials** into the examination hall (2.13%); a trend similar to what was also observed for the May/June 2013 diet;
- the number reported to have been **impersonated** was 2,031 candidates, constituting 0.12% of total that sat, while 4.37% of reported cases had to do with **mass cheating**;
- the rate of **insult/assault** on supervisors, invigilators and other examination officials (0.44%) was relatively low compared to the other rules that were infringed upon but the incidence was higher than in the May/June 2013 diet when 0.35% was recorded;
- Two thousand, eight hundred and sixteen (1,816) candidates representing 1.11% of reported cases and 0.11% of the total that sat were involved in other **miscellaneous cases of irregularity/malpractice**.

Table 3: Summary of disciplinary actions on cases of examination malpractice in the May/June 2014 WASSCE.

S/N	DISCIPLINARY ACTIONS	NUMBER INVOLVED
1.	Cancel entire results	21,129
2.	Cancel subject results as appropriate	135,183
3.	Blacklist/report supervisors for condoning examination malpractice	621
4.	Report teachers/invigilators for aiding and abetting examination malpractice	59
5.	Bar candidates for 2 years	2,759
6.	Grant clemency	13
7.	Warn specified schools	725
8.	Derecognise specified schools	98
9.	Withdraw recognition from specified schools	07
10.	Withdraw and cancel results/certificates for previous examinations on grounds of restitution	37
11.	Release the entire results being withheld	2,269
12.	Continue to withhold entire results and investigate further	1,222

Table 4 indicates that there was a gradual decrease in the incidence of examination malpractice from 2012 to 2014.

Table 4: Three-year comparison of incidence of examination malpractice in the May/June (2012-2014) WASSCE in Nigeria

S/NO.	TYPE OF MALPRACTICE	% OF CANDIDATES INVOLVED		
		2012	2013	2014
1.	Bringing foreign materials into the examination hall	0.49	0.36	0.21
2.	Irregular activities inside/outside the hall	1.69	1.72	1.32
3.	Impersonation	0.17	0.14	0.12
4.	Insult/Assault on Supervisors, Invigilators and other examination officials	0.03	0.03	0.04
5.	Miscellaneous/New Cases	0.29	0.14	0.11
	TOTAL PERCENTAGE	2.67	2.39	1.80

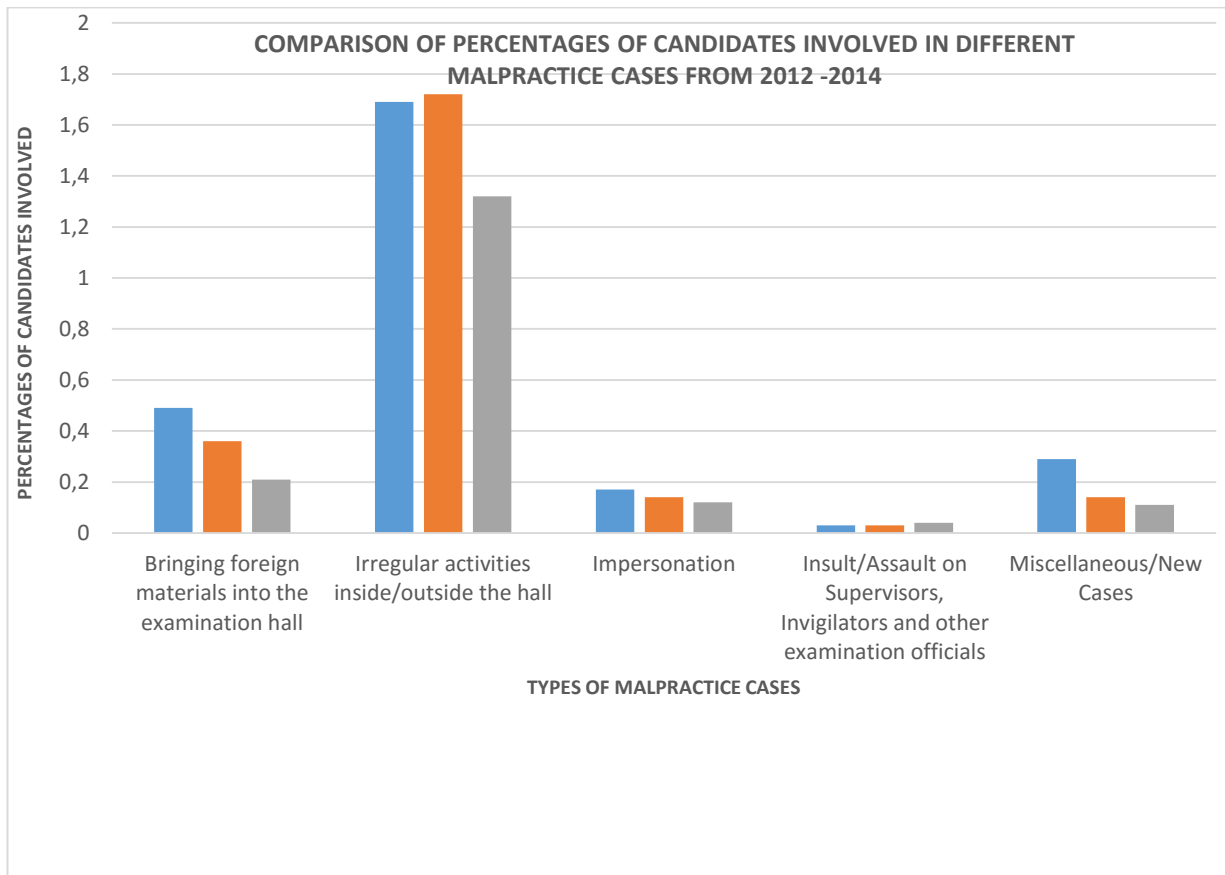


Figure 3: Comparison of percentages of candidates involved in different malpractice cases from 2012 -2014

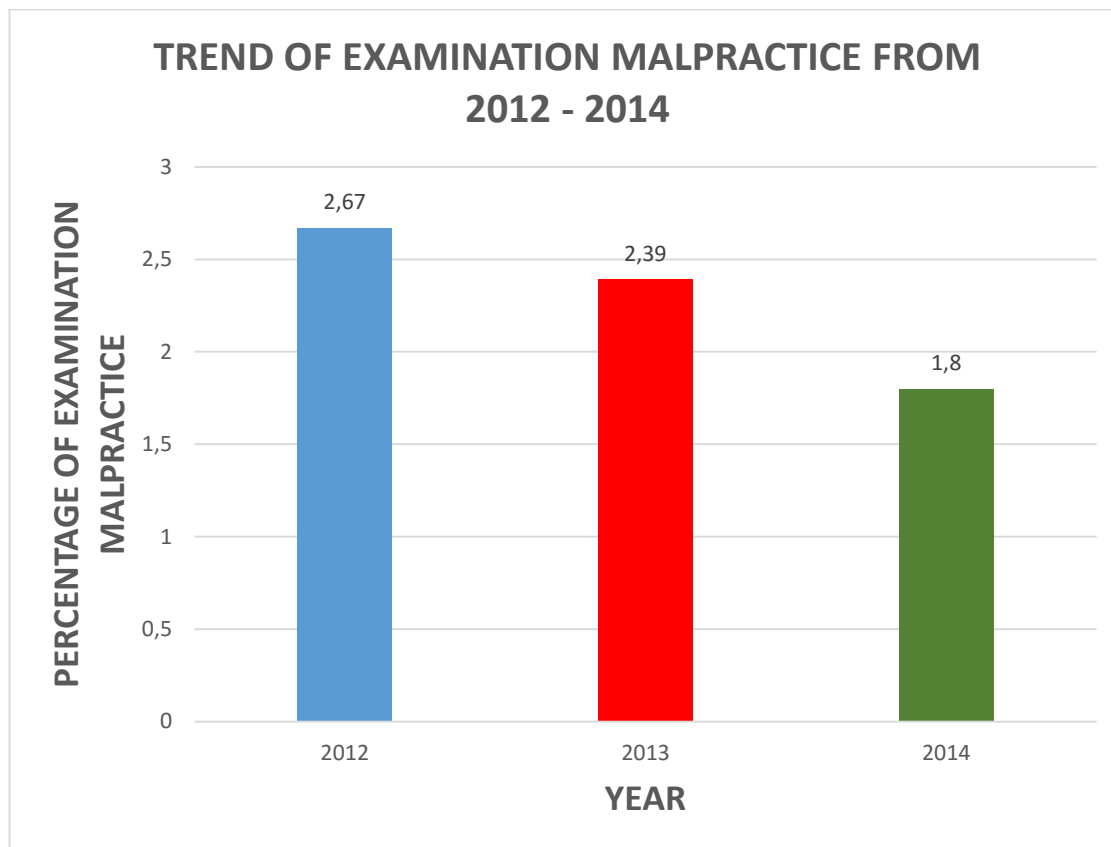


Figure 4: Trend of examination malpractice from 2012 - 2014

From the foregoing, it could be observed that there has been a steady decrease in cases of examination malpractice in recent years. This trend was due to the introduction of the “Candidates Identity Verification, Attendance, Malpractice and Post Examination Management Systems (CIVAMPEMS) in 2013.

CIVAPEMS was developed to address and record in real time, day-to-day examination processes, capturing and recording events/occurrences as they happen, with the ability to report them in a timely manner. This allows users of the system to access reliable data and post examination reports. Some of the functions of the system include:

- recording examination process in real-time;
- helping to curb examination malpractice;
- data management before, during and after examination;
- ensuring access to more reliable data after examination;
- solving the problem of impersonation during examination.

The system (CIVAMPEMS) works with the following components:

(a) Supervisors' Portal

The WAEC supervisor e-registration portal which serves as a major prerequisite for all intending supervisors as it enables them to generate their 8-digits **unique ID** which in turn grants them access to the CIVAMPEMS application. Supervisor registration on this portal is however handled by the state and branch offices of the council. After successful registration, a unique Supervisor's ID is automatically generated that conforms to the council's specification.

(b) Smart Card

The candidate's smart card is produced using PVC Plastic Materials and Secure MI fare tags with RFID contactless technology. The card personalization is achieved when the data of the candidate is accessed from WAEC's database after registering for the examination. The smart card personalization is done in two phases; printing and encoding.

(c) Handheld Device

It is specially designed in terms of appearance, portability, display screen, sensitive touch screen module, wireless communication, data transmission module, custom made data acquisition module and wireless communication data transmission module. It uses a powerful processor, stable windows Embedded CE 6.0 operating systems which makes it compatible with the smart card. The handheld device has the ability and to read the encoded smart card as it has RFID sensor which makes it compatible in reading the information that has been stored on the smartcard. Likewise the handheld device is GPRS enabled which allows connectivity to the internet for data transmission. The handheld device together with the secure application it runs, performs the following functions:

- (i) Read the data stored on the secure MI fare card and immediately display the following candidate's details; Photograph, Name, Date of birth, Gender, Exam Number, Examination location and Examination Centre.
- (ii) Display students subject information by pressing 'Subject on the screen. All enrolled subjects are displayed with candidate's photograph.
- (iii) Confirmation of candidate's identity against subjects enrolled for.
- (iv) Ability to record every scanned Examination Malpractice against specified Codes.

(d) Mobile Application which includes:

(i) The Exam Application

The Exam Centre application uses the ability of the mobile handheld terminal to read cards, irrespective of the centres and candidates' location, retrieve and display certain information stored securely on the card, record information

as input by the user and securely transmitting and storing the information on the cloud servers.

(ii) The Marking Application.

The CIVAMPEMS Marking Centre application captures and records examination malpractice discovered at the marking venues. It also has the ability to collate information by Marking Venue Source, availing the Council the opportunity to group malpractice as captured at the marking centre.

(iii) Post Examination Reporting

Post examination reporting is a major strength for the CIVAMPEMS System; it enables the Council access to important data and reports for post examinations assessments and Management. The CIVAMPEMS system deploys the Examination Monitoring component, and a powerful desktop application tool to produce Management reports for the Council.

The introduction of CIVAMPEMS has helped to reduce examination malpractice as shown in table 4. It has reduced compromise by Supervisors through its monitoring and timing capabilities. Also, cases of impersonation among candidates and examination supervisors have been on the decline. CIVAMPEMS has improved accountability in determining the actual number of candidates who sat for an examination and the number of scripts submitted by candidates. Consequently, smuggling of scripts by candidates is being prevented.

(4) UNIFORMITY AND FAIRNESS IN SCORING ESSAY TESTS

The need to develop marking scheme arises as a result of the subjectivity of marks assigned to the same essay answer by two or more markers. This lowers the reliability of measurement data obtained from such essay test scripts. Therefore, it will not be possible to maintain standards in large-scale examinations like ours without a means of achieving some level of uniformity or consistency in the scoring of essay tests. Once there is uniformity or consistency in scoring, then a valid basis for comparing students and also a valid measure of their achievements would have been established. One of the major problems in scoring students' responses in essay items includes the halo effect. It is a cognitive bias in which an observer's overall impression of a person influences the observer's feelings and thoughts about that entity's character or properties. (Wikipedia). Scoring may be affected by the quality of handwriting and language facility, the mood of the scorer, etc. Although a great deal of improvement can be made during moderation to reduce some of the difficulties in scoring, the essay test cannot be placed at the same scoring difficulty level as the objective test format. However, it should be noted that as at present, research evidence shows that a scorer can reduce subjectivity in scoring of essay items if the scoring is done using a standardized marking scheme (Obanya and Okpala, 1984). Our experience has shown that despite the provision of standardized marking schemes, the level of uniformity, and consistency of marking is still not satisfactory, largely because of dearth of qualified and experienced Markers. This is reflected in the high inter rater differences in candidates scores.

To overcome this challenge, WAEC has embraced electronic marking of scripts.

(a) **E-MARKING OF SCRIPTS**

Figure 2 shows a schematic representation of the e-marking process.

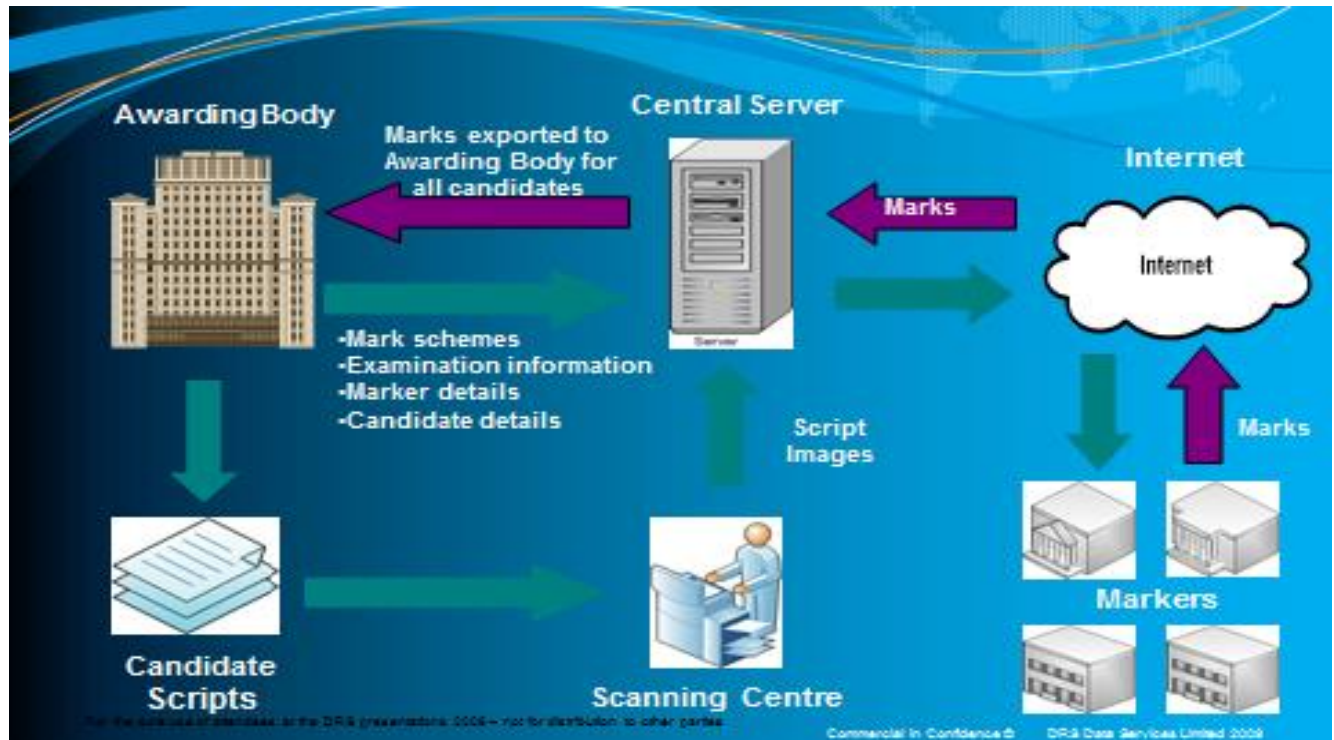


Figure 2: Schematic representation of the e-marking process.

(i) **PROCESS SUMMARY**

- Scripts are scanned
- Script portions are segmented either by a preconfigured set up or by intelligent scanner software
- For constrained candidate responses senior markers create a "seed bank" of quality checks
- For unconstrained candidate responses, quality checks are carried out using % double marking
- Markers – at home or marking centre – receive answers via the internet and mark on screen
- Marks returned via the internet

TRADITIONAL MARKING OF SCRIPTS	E-MARKING OF SCRIPTS
Planning and set up	Planning and set up
Standardisation	e- Standardisation
Distributing scripts to examiners	Scanning, segmentation and transmission
Marking scripts	Marking parts
Quality control by sampling	Built-in quality control throughout marking
Totalling of marks – manual	Totalling of marks – computerised
Return of scripts	No scripts for markers to return

COMPARISON OF THE OLD AND NEW WAYS

(ii) BENEFITS TO MARKERS

What has changed?

- No paper to handle.
- Ability to concentrate on one question at a time.
- Instant feedback about quality.
- On screen tools to aid marking.
- No adding up.

What has not changed?

- The basic marking process – mouse and screen replace pen and paper

(iii) BENEFITS FOR WAEC

What has changed?

- No script distribution to marking centres or markers.
- No script reallocation.
- No post marking mark adjustment.
- Real time monitoring of marking progress.
- Built in reporting tools in the administration software.

(iv) REAL TIME QUALITY CONTROL

The traditional approach:

- Standardisation.
- Marking.
- Vetting Samples of scripts.

With e-marking: “seeding”; % Double Marking; Marker Review:

- Senior markers set standards by pre-marking a bank of questions.
- Qualification.
- Regular automatic/built- in quality checks.

(b) THE INNOVATION OF REMOTE E-MARKING USING DONGLES

The innovation was introduced after the first live marking in 2012. Markers had to come to the computer based marking venue in order to mark. This posed a lot of difficulties to the markers who also had their primary assignments to attend to. Access to the computer based marking venue was restricted to certain hours of the day. Also, it was quite expensive running the computer based marking venue for almost twelve hours every day for more than thirty days due infrastructural problems such as electricity supply and Internet access. The e- Marking team came up with the idea of providing internet access for markers via dongles to enable them mark in places of their choice and at their convenience, twenty four hours a day. In the second series of live marking, the idea of remote marking was experimented and it achieved more than 80% success because markers were able to mark online, real time from different parts of the country using dongles and restricted data cards. Also, markers were able to communicate using prepaid close user group phone cards.

An in-house research, which compared the scoring of candidates’ scripts in Agricultural Science using the traditional and electronic marking showed that the e-marking process had substantially reduced subjectivity in the marking of essay scripts.

(5) VERIFICATION OF RESULTS AND AUTHENTICATION OF CERTIFICATES

There is a proliferation of fake results and certificates all over the world. Should this continue unchecked, it will erode the validity and integrity of assessment. In order to protect the integrity of its results and certificates, WAEC introduced the following innovations:

(a) Online result checker and verification:

The online result checker and verification solutions were developed to assist candidates, universities, other institutions of higher learning, organizations, embassies and employers of labour to have direct access to examination results and also verify such results from anywhere in the world at any time. Payment for the service is by purchase of scratch cards or e-payment within the application window using a master card.

(b) Production of electronic omnibus results for higher institutions

The Council further developed a solution for the production of customized electronic omnibus results for institutions of higher learning to facilitate the internal screening of results of their students either during admission process or at any other time.

(c) Improved security features on WAEC certificates

In order to deal with the challenge of counterfeiting of its certificates, WAEC embedded the following additional security features:

(i) PHOTO EMBOSSEMENT

In 2003, WAEC formally launched the embossment of candidates' photographs on certificates. Consequently, certificates awarded for examinations taken from 1999 were embossed with photographs. The effect of this, is a drastic reduction in incidences of impersonation during WAEC's examinations.

(ii) QUICK RESPONSE (QR) CODES

To combat the prevalence of counterfeit WAEC certificates, the council included quick response codes as added security feature on its certificates. This took effect with certificates produced from 2014 examinations.

The QR code is a two dimensional barcode which uses four standardized encoding modes, numeric, alphanumeric, byte and kanji to efficiently store data (Wikipedia). It consists of black modules (square dots) arranged in a square grid on a white background, which can be read by an imaging device or a smartphone. QR codes on WAEC certificates, when read, will display candidate's photograph, biodata, examination details and results. It is interesting to note that the QR code also enables the reading of a candidate's details even on a photocopy of the certificate.

3. CONCLUSION

This paper presented some of the challenges experienced by the West African Examinations Council in its quest to conduct high-stake examinations in fulfilment of its mandate. The paper discussed the effects of these challenges on the validity of the Council's examinations and described the technological innovations adopted to ameliorate the situation.

The innovations described have assisted greatly in improving the Council's internal procedures, the reliability and validity of its examinations and consequently the quality of its certificates.

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