

N-TYPES ELECTRONIC EXAMINATION SYSTEM: AN EFFECTIVE APPROACH FOR COMBATING EXAMINATION MALPRACTICE

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ABSTRACT

Examination malpractice is a serious problem waging war against the nation's educational system. It appears all the efforts of the government to arrest this ugly problem, are yet to yield positive results. This paper aims to provide a solution to examination malpractice in our educational system. An N-Type Electronic Examination System (NEES) was designed to correct this problem. The system is made up of three components: the configuration phase, examination phase and the database. The system was able to generate different variants of question sets for a particular subject. Visual Basic was used to implement the design because of its interactiveness and high ability to support database. To the best knowledge of the authors, this method of conducting examination is the first electronic examination system in Nigeria supporting different variants of question sets. Testing the new NEES design with data, the result shows a system that can administer examination effectively.

Keywords: Convention Examination, e-Examination System, Examination malpractice, N-Type

INTRODUCTION

In an academic or professional context, examinations (or exams for short) are tests which aim to determine the ability of a student or a prospective practitioner. It is a tool or technique intended to measure students' expression of knowledge, skills and/or abilities. It is an official exercise designed to evaluate knowledge and skills, and covering the contents of a course or a program of studies (Wikipedia, 2007).

Examination can be conducted manually or electronically. Manual/conventional exams are performed with the use of sheets of pa-

per biros and/or pencil. The problems with conventional exams are absence of transparency and effective preparation of exams, lower grade of objectivity, no instant feedback on examination result, increased costs, increased teacher's workload, no elaborate feedback on teaching success, does not enhance audit quality management and bad security. The Electronic examinations are those examinations performed through a computer where questions and answers are computer files rather than sheets of paper. As useful as examinations are, conventional method of conducting examination opens way for examination malpractices. Having

the question-types pre-printed on the question papers as it is the case in some examinations such as Senior Secondary Certificate Examination (SSCE), Universities Matriculation Examination (UME) and Polytechnics and Colleges of Education Examination (PCE) has not solved the problem of cheating. Often time, candidates employ more hands from outside to assist in solving different question-types and with the aid of invigilators to distribute the answer in the exam halls.

LITERATURE REVIEW

Examination malpractices as a form of corruption and corrupt practices have crept into the fabrics of all levels of the educational enterprise in the country. According to Olujuwon (2004), the Nigerian education is in a state of confusion and disarray as a result of inconsistencies, non-implementation of educational policies, corruption and corrupt practices perpetrated by the stakeholders. Olujuwon (2006) believed that Examination malpractice is "any act of wrong doing or neglect that contravenes the rules of acceptable practices before, during and after an examination by anybody in any way is tantamount to malpractices". From the elementary school to tertiary level, exam fraud is perpetrated in one form or the other. The criminals are not only the students. Other stakeholders in education are guilty by design, default or both (Opeyemi, 2004).

Researchers on examination malpractice had argued and contributed to the basic factors responsible for examination malpractice in Nigeria, opinion and facts are gathered for this argument. Aina (1996) agreed in his submissions that the desire to pass at all cost is responsible for examination malpractice. To expatiate this manifestation,

Prof. Bello Salim, JAMB Registrar in 2002 said that thirty out of one hundred and sixty-six examination towns were involved in cheating and malpractice while forty-five thousand four hundred and forty-eight candidates seeking University admission had their results cancelled in the year 2002 because of examination malpractice (Olushola, 2007). Daily Champion (2007), reported that five Principals of schools in Delta State listed as centres for public examinations were downgraded. The five schools according to the report were among the 334 de-listed nationwide by the Federal Ministry of Education for their alleged involvement in examination malpractices. Oyekanmi, (2005), asserted that this is quite unhealthy for the educational sector. JAMB has been quoted as saying: "the electronic-examination is to help sanitize the shoddy conduct of examinations in the country in which most 'Mambites' lack the academic rigour to graduate" the body noted (The Tide, 2006). It is believed that the idea of e-examination is to reduce the stress and bottleneck as well as the attendant problems associated with the conduct of examinations by the body.

Electronic examination is of great interest from both educational and pedagogical points of view. It is aimed to resolve many questions and limitations in the conventional or traditional examination. It is flexible and handy to use with complete question types and excellent security strategy so as to make e-examination automatic and reduce the cost. It can be used for all kinds of different scaled e-examination in different subjects' primary, secondary and tertiary institutions and in class examinations or exercises.

Due to the fact that examination is used as a means of determining student's ability, it is therefore, paramount to continue to improve

on the previous method of conducting examination so as to have 100% secured examination. From literature, It is clear that students who were electronically examined performed better than those conventionally examined (Stergiopoulos *et. al.*, 2006). This leads to this research work which is to design an N-type electronic examination that will handle multiple choice examination questions and administer an examination process effectively.

DESIGN METHODOLOY

Architecture for N-Type E-Examination System (NEES)

The N-Type E-Examination System is developed using the Client/Server architecture. The client is the application designed to communicate with the database, which is the Server. The database is responsible for storing all information such as the Ques-

tions, all Questions type-set generated by some internal functions and all users unique identification number (UIN) with their subject type(s), answers and scores.

The main task of the N-Type E-Examination System is to generate multiple question types for a given subject and map these types to each candidate using the monotonic (1:1) mapping scheme such that candidates adjacent to each other do not have the same type even if they are taking the same subject examination.

Under the procedure design, the N-Type e-Examination System is made up of three components: the configuration phase, examination phase and the database. These components are shown in figure (1)

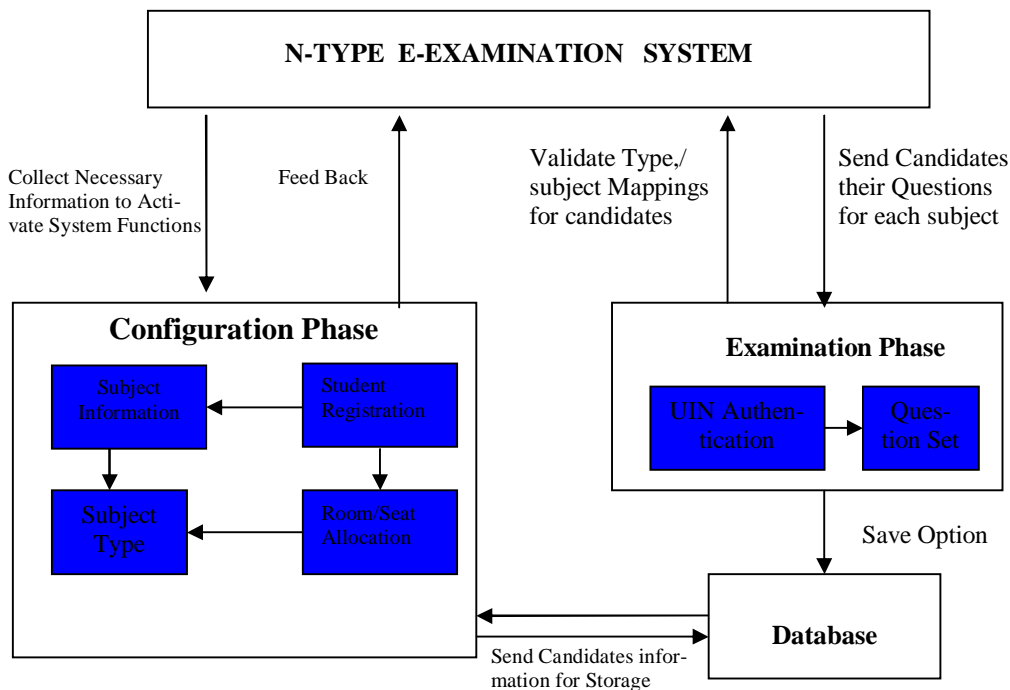


Figure 1: Simplified Architecture for the N-Type E-Examination System

Within this engine, we define the degree of closeness between 2 types to mean the ordinal similarity between corresponding questions using their positional reference. Also, we define the Type Variance of a particular type, which is the overall effect of the degree of closeness of that type against all other generated types within the Type Set for that subject. Mathematically, this can be expressed as

$$\text{Type Variance} = \sum \text{degrees of closeness}/(n-1)$$

Where n is the type cardinality. A Type variance Value μ for a particular type key is regarded as healthy if and only if $\mu < 0.01$. This means that if we have One Hundred

(100) Question types in a type set for a subject that 100 candidates are to take, the likelihood of two students having the same type will be less than one (1%) percent.

N-Candidates-Types Mapping Engine

The other significant component of the system is the N-Candidate-Types Mapping Engine. This component is capable of mapping generated subject types to each student such that adjacent candidates offering the same subject may not be allocated the same type. This engine repeats this function for as many subjects registered by each candidate.

The algorithm for this procedure is as follows:

Algorithm for the N-Types Generator

Get subject type count information

For i=1 to |subject type set| (cardinality of type set)

 Assign a type element identifier for each type in the type set

 Create an array field column for its questions number set

 Loop

 For i=1 to |subject type set| (cardinality of type set)

 Get the ith-1 array field column FA() (if i=0, then the original question number order will be called i.e. 1,2,3,.....,50)

 For j=1 to |question No. Set| (cardinality of selected question number set)

 If FA(j) mod 2 \neq 0 and FA(j) mod 3 \neq 0 then

 Prime(x)=FA(j)

 x=x+1

 elseif FA(j) mod 2 \neq 0 then

 even(y) =FA(j)

 y=y+1

 else

 odd(z)=FA(j)

 z=z+1

 end if

 loop

 loop

For i=1 to |Question Set| (cardinality of Question set)

 Get the ith-1 array field column FA() (if i=0, then the original question number order will be called i.e. 1,2,3,.....,50)

 If FA(j) mod 2 \neq 0 and FA(j) mod 3 \neq 0 then

Configuration Phase

The system will first have to be configured before it can be used for administering any examination. Firstly, the subject interface will appear where the examiner(s) will enter the number of subjects with subject identification for each subject that students will be examined on. Next is the Question/Type Interface where the number of Questions for each subject as well as the number of types they wish the system to generate will be entered into the system. For example, an examiner may have a subject A, with 30 questions and would like the question types to be 8.

When this is done, the next step will be an Interface that allows the examiner to specify either static/dynamic allocation of types to each candidate. If static is chosen, then the examiner will have to supply each candidate's Unique Identification Number (UIN) together with the subject(s) to be taken by each candidate. If Dynamic allocation is selected, then it is the user that will supply this information during the examination phase. When this is done, the system will now generate a type-set for all subjects to be examined and allocate subject type to each candidate and this information will be stored in a database.

The configuration phase on the client-side involves four major sub-phases namely;

- a. Students' Registration: this function will authenticate users whenever they login and verify if they have previously participated in the examination process.
- b. Room Information Entry/Seat allocation: This function will dynamically allocate seats to each registered candidate thereby filling up the room. The function will detect if a room has been filled up so that it can automatically move to the next room.
- c. Subjects' Information Entry: This function will allow candidates to select their pre-registered subjects and take part in the examination for that subject after a successful login. The routine just maps the type allocated to that students to the original question format in order to display the correct question. This engine also provides for a candidate who is seating for multiple subjects to switch between subjects while the time slot for the entire examination is still valid. The time remaining is displayed on top of the Title Bar for the Engine's interface so that the candidate is abreast of time used. The engine automatically shuts out the student when the time slot expires.
- d. Type Generation: This is the main component of the N-Type E-Examination system. This function is capable of creating an N-Type Question Set for each subject registered by an examiner. In designing this engine, the following constraints will be enforced:
 - i. Types will be created based on the maximum number specified by the examiner.
 - ii. Each Type generated will be allocated a Unique Type Identifier (UTI).
 - iii. Each subject type will be generated based on a pivot key supplied by the examiner. The Value of the pivot key will be in the neighborhood of the midpoint of the total number of questions available for that subject.
 - iv. Type keys will be filtered into even, odd and prime number arrays.
 - v. Type keys will now be re-arranged into the type key list
 - vi. Each type key will be saved along with the corresponding type list.

```

    newFA(i) = odd(z)
  elseif FA(j) mod 2 <>0 then
    newFA(i)=even(y)
  else
    newFA(i)=prime(x)
  end if
loop

```

Algorithm to Compute Type Variance For Each Type Set Element

```

Select an ith type element from the type set
Pivotal element = selected type element
For each type element in set excluding pivotal element
  Select a jth type element jtharray=selected type element
  For x=1 to |Question Set|
    If pivotal element(x)= jtharray(x) then
      RepeatedOccurrence=repeatedOccurrence+1
    End if
  Loop
  Likeratio=repeatedOccurrences/ |Question Set|
Loop
Pivotal type variance =  $\sum \text{Likeratio} / |\text{Type Set}| - 1$ 

```

Mapping of Subject Types to Students

```

Get subject information
Set NextType= type pointer
Get candidate's type and seat number as j
For each candidate in room
  If TypeOfcandidate(j-1) or TypeOfCandidate(j+1) = NextType then
    Nexttype =typepointer +1 'get next type in order
  End if
TypeOfCandidate(z) = TypeSet(NextType)
Typepointer=typepointer+1

```

Mark and Grade Candidates Performance

```

Get all candidates performance in selected subject
For i=1 to total number of candidates
  For each question
    If answer chosen = answer expected then
      RightAnswer = RightAnswer +2
    Else
      If answer chosen is not blank then
        Missed = missed +1
      End if
    End if
  End if

```

next
 Rightanswer = Rightanswer – (missed * negative marking multiplier entered)
 Score = rightanswer/ |Question Set| * 100
 Loop

Examination Phase

There will be a login interface where users (candidates) are able to access the examination module. The typical security for this area will be that each student is expected to login with a Unique Identification Number (UIN). If during the configuration phase the examiner selected dynamic allocation, then when the user gains access to the system, the subject interface will appear where the user will select the subject(s) to be taken. After this interface, the system now dynamically maps subject(s)-type(s) to the candidate and the examination clock begins to count down as the student answers each question. Since the Format for each Question is Multiple Choice Answer, the Candidate just enters an appropriate letter corresponding to an option in a white coloured answer box. This box automatically shades itself when an option is entered and reverses back to white when the option is

erased. The user may go back and forth to view each question for each subject and may submit all answers whenever it is desired. However, if the Examination Clock Located on the Title Bar of the Window expires, then the user will be automatically disabled from doing any more work while the Test-Engine collects all answers supplied by the user.

Database

Each entry made by the each candidate for all subjects both correct and incorrect options are collated and stored in the database. The database consists of various relational tables used for data storage and management. Some of these tables are Subject Table, Candidate Table, Subjectcode & _Type, Subjectcode & Q, WorkingInfo, Subject_Answered, Subcode & TypeInfo, student_SeatMap, SeatingPlan. The architecture of the database are highlighted using the schematic diagrams in table (1 – 9).

Table 1: Subjects Table

Field name	Description
SubCode	Code for each subject and Primary key for the table
SubTitle	Title of the subject
QuestionCount	Number of Questions In Set
TypeCount	Number of Types to be Created for this Subject
Types Prepared	If Types have been created or not
Next Assigned	Next Type to be assigned

Table 2: Candidates Table

Field Name	Description
Registration No	Candidate's Unique Identification Number
Surname	Candidate's Surname
First Name	Candidate's First Name
Gender	Gender
Telephone	Telephone Number of candidate/guardian
Address	Residential address
Picture	
Authenticated	Determines if candidate has been verified by administrator (YES/NO)
Exam Status	Determines candidates status during the examination (NOT YET TAKEN/COMPLETED)

Table 3: "SubjectCode" & _TYPES

Field Name	Description
ID	Primary key of table
Typed(i)	Dynamically created Field(s) for each element in type set for all subjects and $i \leq n$ where n is the type cardinality

Dynamically created table that contains information about the question order for each type created. Table Cardinality increases as the number of types increases Each subject has its own typeInfo

Table 4: "SubjectCode" & Q

Field Id	Description
Question No	Question number and primary key for table
File	Corresponding file containing details of question
Answer	Answer to that question

Dynamically created table for each subject. to hold information about each question for that subject.

Table 5: Working Info

Field Name	Description
Id	Primary key
Registration No	Candidate's Unique Number
Sub-Code	Subject code for subject taken by candidate
QN umber	Number corresponding to the question to be attempted
Ans Chosen	Answer Selected by Candidate
Ans Expected	Answer Expected by the System
Validation	Validates User Supplied Answer to see if Right/Wrong

This table contains Selected Options for questions attempted by candidates during the examination.

Table 6: Subjects Answered

Field Name	Description
Id	Primary key
Registration No	Candidate's Unique Number
Sub Code	Code for selected subject
Type Taken	Code for type assigned to candidate
Score Obtained	Stores Percentage Scored by candidate in this Subject

Table 7: "SubCode" & _TYPEINFO

Field Name	Description
Type Id	Code for each type generated and primary key
Variance	Stores Variance computed for each type created

Table 8: Students SeatMap

Field Name	Description
Registration No	Candidate's UIN and primary key
Room No	Room allocated
Row No	Row allocated to candidate
Seat No	Seat number in room allocated

Table 9: Seating Plan

Field Name	Description
Room No	Room Identification Number
Expected No	Number of candidates to use this room
Row Count	Number of candidates to seat per row
Available	Number of Seats unallocated

Implementation Procedure

The two (2) categories of software used are the system software and the application software. The system software consists of the operating system which was Windows XP professional Service Pack 2. The application software architecture is further subdivided into three categories; the programming language aspect in which Visual Basic 6.0 was used to build the client side architecture, the Microsoft Access database system used to develop the Server Side architecture and Structured Query Language (SQL) used as the Major Link Platform be-

tween the Client Side and Server side. The data used for the implementation was collected from the past questions of Universities Matriculation Examination (UME) conducted by Joint Admission Matriculation Board (JAMB), Nigeria. The output contains the following information: List of all registered Candidates, Analysis of Type Variance for Subject, Subject Type's Allocation Schedule, and Seats Allocation Schedule. Figure (2) shows the flowchart/design view of the N-Type Electronic Examination System.

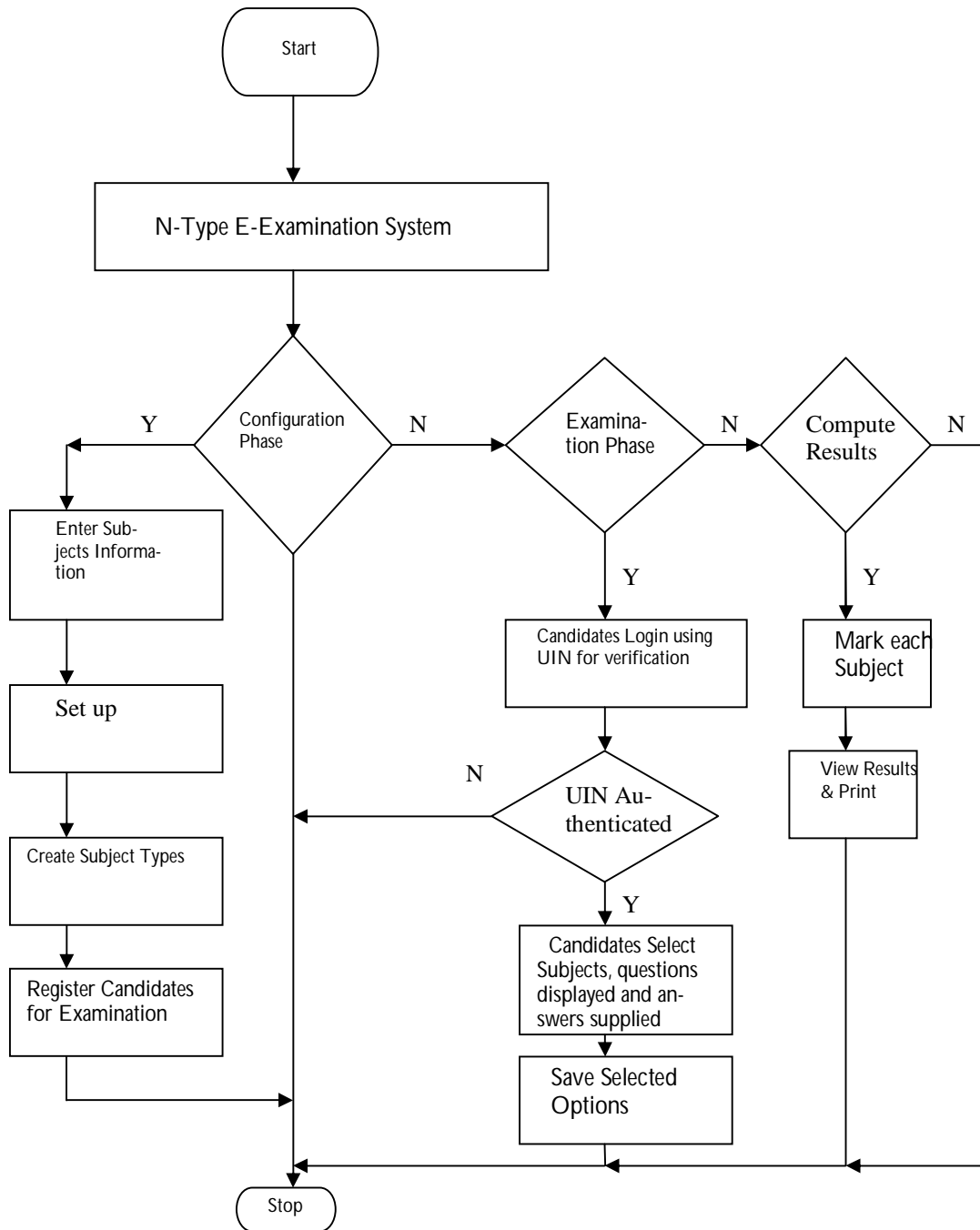


Figure 2: Design View of the N-Type E-Examination System

Interface Design

This is done with a deep sense of creativity and artistic effort to make the interfaces as interactive as possible and thereby ensuring that the user comprehension is unambigu-

ous. Figures (3 & 4) show the administrative and candidate console. On the Console, there are various tasks that have been labeled to guide the user. Each task is initiated by clicking on the arrow pointing to its label.

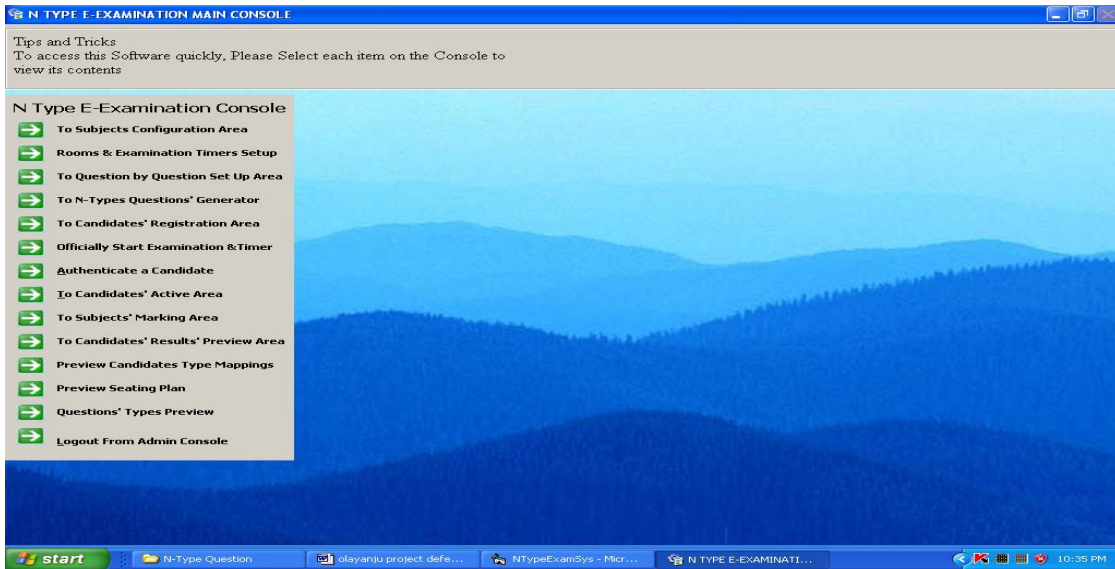


Figure 3: Administrator Console

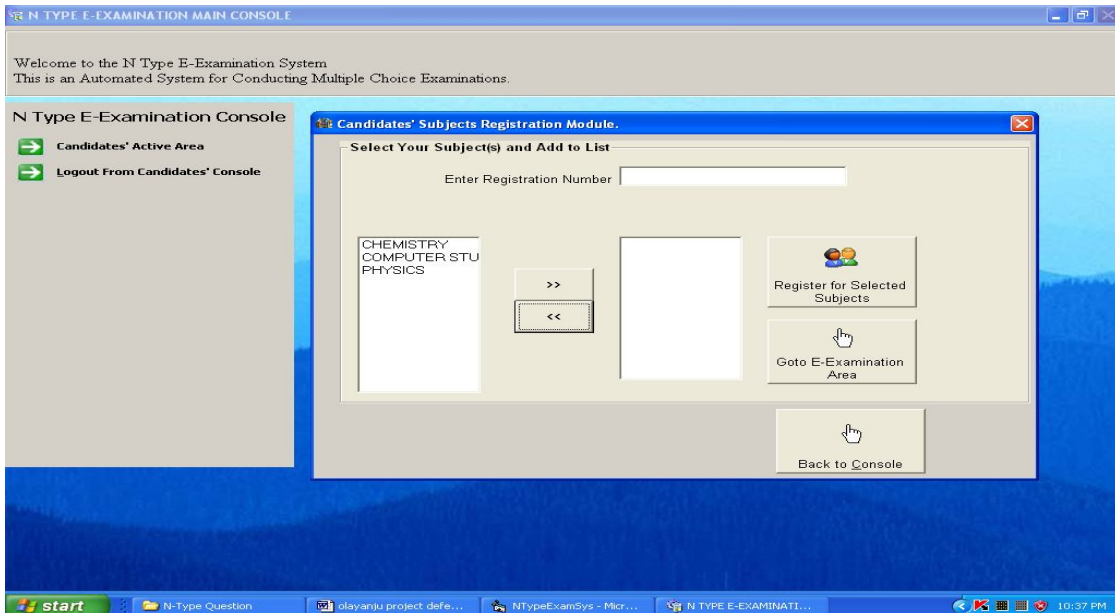


Figure 4: Candidate Console

Under the Administrator's Console in figure (3), we have the following tasks:

Subjects Configuration Area

This allows you to enter a new subject into the system database. To create a new subject profile, you will need the subject title, number of questions to be answered and number of types to be generated for the subject.

Rooms Configuration Area

This area allows the administrator to specify the number of rooms to be used for the examination. To complete the information you will be required to supply the number of rooms to be used for the examination, the number of students in each room, the number of students to seat per row, time duration (in hh:mm:ss) for the examination and the time of commencement for the examination (date and time).

Question by Question Set up Area

This area allows you to specify the questions set for each subject. To accomplish this, first select a subject from the subject list and then click on the "Get Subject Info" Button. Once this is done, a text screen appears where you can type your questions and also the correct option letter to each question. You can also add diagrams to each question as desired. The previous and Next Buttons allows you to move to the previous or next question as required. As you click on either of these buttons, your questions are automatically saved to the database. Mark is assigned to each question for a particular subject in the subject mark area and this is automatically updated in the database.

N Types Question Generator

This engine allows you to generate the N-

Type Set for each subject. First select the subject title from the subject list then click on "Get Subject Info". If the type set for this subject has been previously generated, the "View Type Variance Report" button will appear where you can view the analysis of type variance generated for the subject. You may wish to delete the previous generated values by clicking on "Reset Values". Before you can generate type set for a subject, you must first enter a pivot element, which the range has already been given. After this is done, then click on generate types. A message will appear prompting the user if the analysis of type variance is to be done. Just answer yes to do the analysis. After completion, you may view the report.

Candidates Registration Area

This area allows administrators to register candidates for the examination. The information to be collected here includes candidate's name, address, telephone number and passport photograph. The photograph is a precondition for registration as it will be used for authentication. Either a scanner or digital camera may be used to upload the photograph.

Authenticate a Candidate

Before a Candidate can access the examination area; he/she must have been authenticated by the administrator. Authentication requires the entering of the candidate's registration number in the pop up menu that will appear. To grant access, just click on the allow access option. To deny access, just click on the deny access option. Click close window to exit authentication Window.

Subjects Marking Area

This area allows administrators to automatically mark and grade examination perform-

ance for all students per subject. Just select the subject from the subject list and click on the "Mark and Grade Subject" Button. If you wish to apply negative marking, just check the negative marking box and enter the value to be deducted on each incorrect question. After you have done this, you may click on the "Preview Results" button to preview all students' performance in a selected subject.

Candidates Results Preview Area

This area allows a candidate to preview his/her performance in all subjects taken during an examination. Just enter the candidate's registration number and click on the "Preview results" button.

Preview Candidates Type Mappings

This section allows Administrators to preview how the various subject types have been mapped to each candidate. Preview may be done by room or by subject.

Preview seating plan

This section allows administrators to preview how the students have been allocated seats in a room. Just select a room number and click on the "Preview Seating Arrangement" button.

Questions Types Preview

This area allows administrators to preview question types and print them out in case there has been a situation where the e-examination implementation is no longer feasible. The procedure for doing this is as follows:

- a. Select the subject title
- b. Click on "Get Subject Info" button
- c. The Back and Forward buttons allow you to scroll through the type set.
- d. The "Preview Hard Copy" allows you to

- e. The "Print Hard Copy" allow you to print the type structure for the currently viewed type. The output will be sent immediately to the default printer.

Logout from Admin Console

Takes you out of your status console to the Select Status Gate.

For the Candidate's Console area in figure (4), the two tasks available to them are:

Candidates' Registration Area

In this area, candidates are expected to register for their subjects of choice. All that is required by the candidate is for him/her to select a subject from the list on the left by clicking it and use the > button to move it to the right. After this has been done, click on the "register Candidates for selected Subjects" button to complete subject registration. After this has been done, the candidate may now proceed to the e-Examination console which is the testing area. Once the candidate gets here, he/she is expected to click on the "Start Test Engine" button to commence the examination proper. However, the engine will be started if only the candidate has been authenticated by the administrator in charge.

Test Engine

The interface for the test engine allows a candidate to switch between subjects, save current selections and exit the testing area completely. Also, the time duration for the examination is appearing on the title bar of the test engine window to allow students keep track of their time spent. All the subjects the student has registered for appear at the top left-hand corner of the test engine

window. Just select a subject and click on start/resume paper button. The questions will appear automatically.

Logout from Candidate's Console

Takes a candidate out of your status console to the Status Gate.

RESULTS AND DISCUSSION

In this work, the running and testing of the design was carried out and the summary of the result are shown in tables 10 to 13.

Table 10: List of all registered candidate

Registration No	Name	Gender	Telephone No
GG481Z1038H	Olakunle Lola	Female	08065443212
GG488Z1038H	Otobo Lawrence	Male	08023658790
GG495Z1038H	Olowofoyeku	Male	08023765443
GG502Z1038H	Olagunju Samuel	Male	08023541287
GG509Z1038H	Olawale Samuel	Male	08023564532
GG516Z1038H	Enowa Caroline	Female	08023657912
GG523Z1038H	Olonisakin Adura	Female	08055343219
GG530Z1038H	Adegbenro David	Male	08023764553
GG537Z1038H	Popoola Aliu	Male	08023654376
GG544Z1038H	Banjo Alice	Female	08055435631
GG551Z1038H	Buhariheleen	Female	08023547612
GG558Z1038H	Adualere Grace	Female	08055478790

Total Number Registered 12

In Table10, the list of all registered candidates is generated by the system for the administrator verification.

Table 11: Analysis of Type Variance of Question Set : Physics

Type Number	Type Variance
1	0.0072
2	0.0102
3	0.0006
4	0.0120
5	0.0068
6	0.0072
7	0.0051
8	0.0085
9	0.0051
10	0.0051
11	0.0085
12	0.0111

In Table 11, the Type Variance for a particular type key is less than 0.01, meaning that if we have one hundred question types in a type set for a subject that 100 candidates are to take, the possibility of two candidates having the same type of question will be less than 1%.

**Table 12: Seat Allocation Schedule for Student in the Exam Room
Room Number: 1 Candidates Expected: 30**

Row	Seat No	Registration Number
3	14	GG558Z1038H
4	15	GG551Z1038H
4	16	GG544Z1038H
4	17	GG537Z1038H
4	18	GG530Z1038H
4	19	GG523Z1038H
4	20	GG516Z1038H
4	21	GG509Z1038H
5	22	GG502Z1038H
5	23	GG495Z1038H
5	24	GG488Z1038H
5	25	GG481Z1038H

In Table 12, the room and seat number are dynamically allocated to each registered candidate thereby filling up the room. The system will detect if a room has been filled up (the expected number of student per room is 30) so that it can automatically move to the next room. The room and seat no are allocated by the system for the candidate to sit for the e-exam.

**Table 13: Subject Types' Allocation Schedule
Subject : Physics**

Registration No	Room No	Seat No	Type Allocated
GG558Z1038H	1	14	D28A
GG551Z1038H	1	15	Q41A
GG544Z1038H	1	16	J94A
GG537Z1038H	1	17	E29A
GG530Z1038H	1	18	K10A
GG523Z1038H	1	19	R42A
GG516Z1038H	1	20	L11A
GG509Z1038H	1	21	S43A
GG495Z1038H	1	22	M12A
GG551Z1038H	1	23	F30A
GG488Z1038H	1	24	N13A
GG481Z1038H	1	25	T44A

In Table 13, the system generate different variant of type-question set for all subjects to be examined and allocate subject type to each candidate such that the type identification will be hidden to both the candidate as well as the examiner in order to ensure the integrity of the exam.

CONCLUSION

This work presents a solution to the problems of conventional examination. We have been able to design and implement an N-type examination system, a system that is able to:

- (a) Generate different variants of a question set for each subject such that each type's identification will be hidden to both the candidate as well as the examiner in order to ensure the integrity of the exam.
- (b) Promote transparency of an examination process by making available a real time analysis of student's performance.
- (c) Reduce the administrative costs/overhead associated with a manual process of examination.
- (d) Simplify the overall process of examination administration by lighting the burden on the examiners so that they can concentrate on other professional duties.
- (e) Develop a process that will evaluate each candidate's performance and save information.

Based on the implementation of our approach, we have derived performance results that indicate that using an N-type electronic examination can address the major problems of conventional examination. Our algorithm successfully administered an examination process effectively.

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