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Automated Result Collation, Computing, and Reporting

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Abstract

Students' academic performance reports evaluate and report students' learning achievement in various courses for the duration of an academic programme. It applies statistical methods and data visualization tools to create statutory reports and inform learners of their academic progress. Typically, the associated tasks are laborious, time consuming, and repetitive. Hence, this manuscript investigated the metrics of such statutory reports for the three-year Nigeria Certificate in Education (NCE) programme, and developed an automated model of the processes. The Cross Industry Standard Process for Data Minning (CRISP-DM) methodology was applied. Major findings include: the RCCR model is 70% more effective and time-efficient compared to the legacy approach; the RCCR system minimizes resource and time waste by students and staff; finally, the RCCR system improves an academic department's decision making, and ultimately enhances education for sustainable development. The proposed data structure fast-tracks marks and attendance storage, collation, computation, and reporting.

Keywords: *Learning achievement reports; Result collation; Result computation; RCCR model; ESD*

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Background to the Study

There is the need for a contextually automated students' academic performance report in most Colleges of Education. This implies that the collation, computation and report generation processes need to be automated. Such a solution becomes a foundation for large-scale adoption, fact-based strategies to improve students learning achievement, and data-driven pedagogical strategies. Also, researcher survey of examination officer(s) request in Colleges of Education, reveal that they generally expressed need for a contextual students' performance reporting template. To achieve this, the capabilities of Microsoft Excel Spreadsheet which many staff of higher education institutions have received training on, needs to be harnessed and deployed.

Students' academic performance reports evaluates and report students' learning achievement in various courses for the duration of an academic programme. It applies statistical methods and data visualization tools to create statutory reports and inform learners of their academic progress. Typically, the associated tasks are laborious, time consuming, and repetitive. Hence, this manuscript investigated the metrics of such statutory reports for the three-year Nigeria Certificate in Education (NCE) programme, developed an automated model of the processes and termed it automated results collation, computation and reporting (RCCR). Having a reliable, efficient and effective student academic performance assessment and reporting system would boost the confidence of stakeholders and investors, so that the institution can channel other energy and resources towards other sustainable development targets. Specifically, student academic performance here refers to student learning achievement.

This manuscript expands on research previously presented at the African Regional Conference on Governance, Security & Sustainable Development. The conference paper titled, "Automated Results Collation, Computing and Reporting" presented an initial overview of the research approach and findings. The current submission expands on the initial presentation with detailed analysis, illustrations, applicable and reorganized literature, inclusion of method and additional findings. Generally, it aims to automate the collation, computing, and reporting of students' academic performance per department per matric set in an academic institution. To achieve this, the following specific objectives were pursued: Design Marks and Attendance (M&A) template; Design Matric Set Register template; Design Modules Register Template; Design and Automate Semester Report Template; Design and Automate Sessional Report Template; Design and Automate Summary Report Template; Design and Automate Graduation Report Template; Design and Automate Spill over Report Template; Identify the impact of an automated RCCR system to students learning achievement; Identify charts appropriate to visualize students' learning achievement.

Related Literature

Descriptive Statistics

Descriptive statistics refers to the use of statistical methods to describe data using statistical characteristics, charts, graphics or tables (DATAtab e.u., 2024). It can be sub-divided into four (4) categories namely: Location Parameter (Mean, Median, Mode, Sum), Dispersion

Parameter (Standard Deviation, Variance, and Range), Tables, and Charts (DATAtab e.u., 2024). Metrics in these four categories uniquely describe a student academic record dataset. Location Parameter, Dispersion Parameter, and Tables provide numerical analysis while Charts provide visual analysis. While descriptive statistics provide description and evaluation of the dataset, inferential statistics help to draw conclusions about other point in time or the population of the dataset (DATAtab e.u., 2024).

Student Academic Performance Computations

Student academic performance is often measured by the use of descriptive statistics that evaluate the student's historical academic achievement during an academic programme. Educational institutions achieve this by using several metrics associated with test measurements and evaluation. The most common are point earned (PE), and grade point average (GPA), total units (TU), and Total Failed (TF) (Osagie & Mallam, 2014). To evaluate the grade point average, the grade point and credit unit needs to be established. While TF keeps count of the difference between courses failed and remedied by the student, LCO keeps record of list of courses yet to be remedied by the student.

Grade and Grade Point

Table 1: Score grade and Grade Point

Score	0 - 39	40 - 44	45 - 49	50 – 59	60 - 69	70 - 100
Grade Point	0	1	2	3	4	5
Grade	F	E	D	C	B	A

A student earns Points (PE) for each course he/she attempts. Mathematically, PE is evaluated as:

$$PE = Credit\ Unit \times Grade\ Point$$

Where Grade Point corresponds to the score grade as illustrated in Table1 above.
Thus, a student who achieves 80 points in a 2-credit unit course would earn 10 points. And Grade Point Average (GPA) would be expressed as:

$$GPA = \sum_{1}^{k} \frac{(Grade\ Point \times Credit\ Unit)}{Credit\ Unit}$$

As a statutory report, Semester Reports must be authenticated by the authorised signatories after careful and rigorous quality checks. This entails verifying keyed in scores against authorized marks and attendance, and verifying computational accuracy, dates, signatories, and academic session amongst others.

Percentage Point Average (PPA): An alternative to GPA

Volwerk and Tindal (2012) recommends that the GPA system be replaced with a Percentage Point Average (PPA). This PPA would be calculated by converting the student score to percentage point awarded. Table2 illustrates the percentage point that would be awarded to a student based on different scales for each score achieved in a 1-credit unit course.

Table 2: Percentage Point Average for Different Grading Scales

Score	0	10	20	30	40	50	60	70	80	90	100
4-Point Scale	0.00	0.40	0.80	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00
5-Point Scale	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
3-Point Scale	0.00	0.30	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
7-Point Scale	0.00	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60	6.30	7.00

Mathematically:

$$PPA = \sum_{1}^{k} \frac{(\%age\ Point\ \times\ Credit\ Unit)}{Credit\ Unit}$$

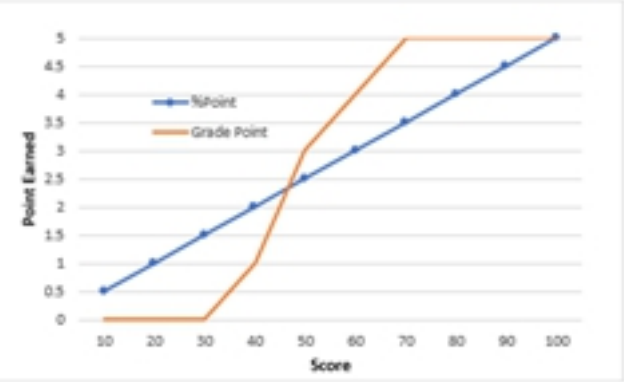


Figure 1: Grade Point Average vs Percentage Point Average - Point Earned

Figure 1 above exemplifies Volwerk and Tindal (2012) argument that the GPA approach deflates Points Earned at the bottom and inflates Points Earned at the top. That is, all scores between 70-100 are awarded a grade point of 5, letter grade A. Similarly, all scores between 0-39 are awarded a grade point of 0 and letter grade "F". Whereas, a score between 40-44 is awarded grade point of 1 and letter grade E, and scores 50-59 is awarded grade point 3 and letter grade C. The interval is not statistically consistent. Volwerk and Tindal (2012) refers to this as *disproportionate scale*.

However, the Percentage Point Average (PPA) proposed by Volwerk and Tindal (2012) has advantage over the GPA system in that, it provides a consistently proportional cumulative of student course/subject achievement. The PPA is a more "nuanced-free, fair, and direct measure of overall a student's achievement and also provides a more realistic estimate of the magnitudes of the achievement gaps between various student populations" (Volwerk & Tindal, 2012). Different grading systems can be observed in different regions, countries and even institutions, the institution under study uses the letter grade and grade point average (GPA) system, hence this study will showcase the design and implementation of such a system.

Spreadsheet

To an accountant, worksheets are invaluable however, the computing age has continued to raise the need for digitized alternatives (Ikpeama, F. U.; Nwaokokorom, O. W.; Nwokocha, F. Q.; Benstowe, 2025; Nwaokokorom & Ikpeama, 2018). For the educator who wants to assess or keep record of students learning achievement and performance, the spreadsheet is also invaluable. Since its release in September 1985, Microsoft Excel has continued to serve millions of users and thousands of industries as the preferred spreadsheet (Fallon, 2024). Other commonly used spreadsheets are Google Sheet, Zoho Sheet, Only Office, etc. The productive educator would find spreadsheets very useful in one or more of these areas as listed by Google Gemini: Data management, Analysis and assessment, Planning and organization, Collaboration and communication, and as a Teaching tool (2025).

Tables

Microsoft Excel's interface consists of alphabetical columns and numbered rows. These rows and columns intersect to form cells. You can create as many Tables as you want using this cell arrangement. Microsoft Excel Tables makes managing and analysing a group of related data easier (Microsoft, 2024). For example, data such as Product names, and quarterly sales can be stored in distinct columns then formatted as a Table to enable valuable functions like filtering, sorting, summarize with PivotTable, and Total Row (Microsoft, 2024).

	A	B	C	D
1	Product	Qtr 1	Qtr 2	Grand Tota
2	Chocolade	$744.60	$162.56	$907.16
3	Gummibarchen	$5,079.60	$1,249.20	$6,328.80
4	Scottish Longbreads	$1,267.50	$1,062.50	$2,330.00
5	Sir Rodney's Scones	$1,418.00	$756.00	$2,174.00
6	Tarte au sucre	$4,728.00	$4,547.92	$9,275.92
7	Chocolate Biscuits	$943.89	$349.60	$1,293.49
8	Total	$14,181.59	$8,127.78	$22,309.37

Figure.2 An Excel Table
Source: Microsoft (2024)

Sorting or filtering can be achieved by clicking on the drop-down arrow by the side of a column header. A column can be sorted in ascending or descending order. And it can be filtered to display specific record(s) that meet a given condition. Once a table has been created in Excel, it can be aggregated using PivotTable (Microsoft, 2024). A range of cells can also be filtered without being formatted as a Table (Microsoft, n.d.-a). MS Excel enables one to filter a field by text or numbers. Formulas can be written in the formula bar and begin with the equal sign "=". Unlike typical programming languages, MS Excel does not have provision for variable names but Tables can be named and renamed, data range can be created, and customized formulas can be created. Also, each cell has a unique address. It is these addresses or range that are used in formulas to perform calculations. To refer to a specific cell value all through a computation, the absolute cell reference is used, but to refer to a relative cell value all through a computation, the relative cell reference is used. Detailed examples can be found in

Microsoft (n.d.-b). However, a recent partnership between Microsoft and Anaconda now integrates Python line formulas in MS Excel formula bar ––(MICROSOFT, 2023, 2024). This feature requires the service to be run on the cloud - MS Azure. Python in Excel is indeed a revolutionary feature.

Software Model and Flowcharts

A software model is an abstract representation of a software system. It focuses on describing specific aspects of the system by communicating its characteristics using visual illustrations. Models simplify complex systems by omitting unnecessary details and highlighting relevant information for a particular purpose. The data Entity Relationship (ER) diagram will be used to model the RCCR system.

Flowcharts are used to visually illustrate the workflow, process, algorithm, or step-by-step approach to a task. It requires the use of standard symbols connected by arrows to show the sequence of operations and decisions. In a study by 'Bamidele and Oloyede (2013) the concept of the *mole* in Chemistry was made easy to understand by illustrating it using a hierarchical flowchart.

Impact of an automated RCCR system on students' learning achievement

Assessment is integral to the achievement of Education for Sustainable Development (ESD). An honest, objective and trusted academic assessment and interpretation enables all stakeholders understand and value the learning process and outcome. Specifically, a trustworthy assessment report builds students' self-efficacy, and investor's confidence. For the investor, it goes further to motivate them to continue their funding and support for academic infrastructures and services.

Education for Sustainable Development

Born out of Agenda 21, Education for Sustainable Development (ESD) is an approach beyond Basic Education and has been considered a means to achieving all other sustainable development goals (Leicht, Combes, Byun, & Agbedahin, 2018). The focus of ESD can be seen in the statement of SDG 4.7: "ensure that by 2030, all learners acquire the knowledge and skills needed to promote sustainable development in focus areas like human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and culture's contribution to sustainable development." This statement re-echoes the inestimable value of education in delivering societal goals as informed by (Ordu, 2020). Thus, ESD championed by UNESCO has four focus areas: Climate change, biodiversity, optimal resource utilization, and promotion of gender equality (James, 2024). Some educational institutions have integrated ESD into their curriculum by integrating sustainable development courses into an existing programme, integrating sustainable development topics into existing discipline-oriented courses, or creating sustainable development specialization course (Chakraborty, Singh, & Roy, 2018). Commendably, sustainable development issues can now be seen in some Basic Education publisher's texts.

Alexander Leicht et al., (2018) inform that there's a general desire by education stakeholders who are involved in SD to go beyond (a) access to education and (b) acquisition of basic skills, and move on to (c) relevant educational content that addresses contemporary challenges. Also, prior to the last two decades, the global educational focus has been Basic Education for all, and this was because education was considered a fundamental and enabling human right. However, with increasing complex and interconnected real-world common challenges, it became obvious that education needed to go beyond just knowledge and skills acquisition; that is, education began to be considered as an agent for sustainable development. Hence, the approach to teaching and learning needed to further be realigned to equip individuals to lead sustainable development as change agents. Owing to this, and the Dakar Framework for Action on Education for All, reorientation of existing educational programmes to address sustainability was listed among the four major thrust of ESD. It is commendable to note that sustainable development issues such as responsible use of resources and recycling of materials have been added to primary school text contents in Nigeria.

A reliable and efficient academic performance reporting system makes it easy for students to travel across cultural, language or geographical borders with little or no delay in contextually communicating their up-to-date academic and learning achievements. Thus, the institution becomes an effective producer of ambassadors. But to achieve this, academic staff and other key stakeholders must be enlightened and competent in the associated digital skills. Also, a reliable and efficient academic performance reporting system provides useful feedback to the students themselves and to the lecturers and administrators (Osagie & Mallam, 2014). This feedback can positively influence pedagogical approach, institutional ranking, increased application for admission by secondary school students, and retention of graduates as staff or into a higher learning degree.

Visuals for effectively communicating Student Learning Achievement

Experts often say that the monotonous use of numbers can overwhelm the audience. That is, the report of several numerical computations is best appreciated pictorially. The audience generally value pictures/illustrations than numbers. Hence, charts/illustrations are often incorporated to interpret and communicate computations. However, the legacy approach in most public higher education institutions over the years has limited the use of effective data visualization.

Microsoft Word, Excel, PowerPoint, and Power BI comes equipped with a number of such useful visualization charts. These include: column chart, bar chart, box plot, pie chart, line chart, scatter plot, and histogram amongst others. They are also the most common charts in statistics (DATAtab Team, 2025). Column and bar charts are best used to compare numerical/categorical data, box plot is best used to showcase outliers and the spread of the dataset, histogram is best used to view the data shape and distribution (spread), pie chart is best used to show the relative proportion of different categories within a whole, while line chart is best used to display trends and changes in data over time. These charts can be presented individually or arranged side by side to form report dashboards.

Dashboards are summative reports created to organize the diverse insights relevant to a report. These reports can be a tabular sum of score for each score administered in a semester, a tabular count of grades earned by students in a semester, a data segmentation of course codes, a pie chart count of students by grade, a card count of students, a card count of courses, amongst others.

Materials and Method

This section discusses the method, model, dataset, flowchart and algorithm applied in the study.

Methodology

The Cross-Industry Standard Process for Data Mining (CRISP-DM) model was adopted, since it is industry, tool, and application independent. Its phases (see Figure 3) were critical to the successful completion of this research. To overcome its limitations, the researchers scheduled periodic bottleneck identification and resolution, and extracted constructive feedback from key users. From observation and experience, each matriculation set had its peculiarities which most times differed from another, hence the decision to collate, compute, and report performance per matriculation set.

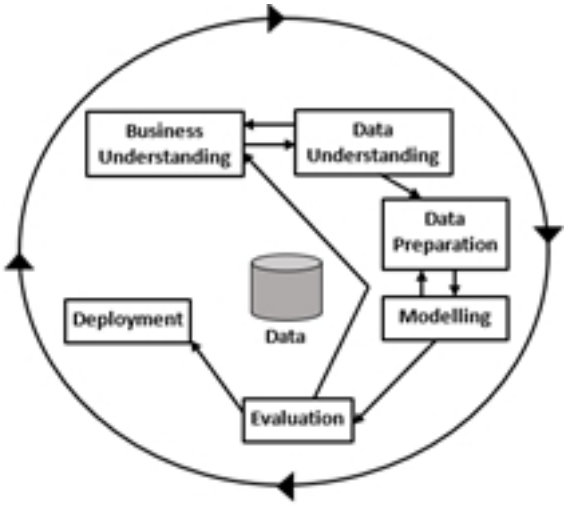


Figure 3: CRISP-DM model
Source: (Edoka et al., 2023)

RCCR Model

The proposed data structure and entity relationship of the RCCR model is presented in Figure 4.

Figure 4: RCCR Entity Relationship Diagram

Most of the entities in the model have a one-to-many relationship. There are core course modules and there are elective course modules. Each Course belongs to a specific semester and academic level.

RCCR Flowchart and Algorithm

The flowchart representing the RCCR system is presented in Figure 5 below

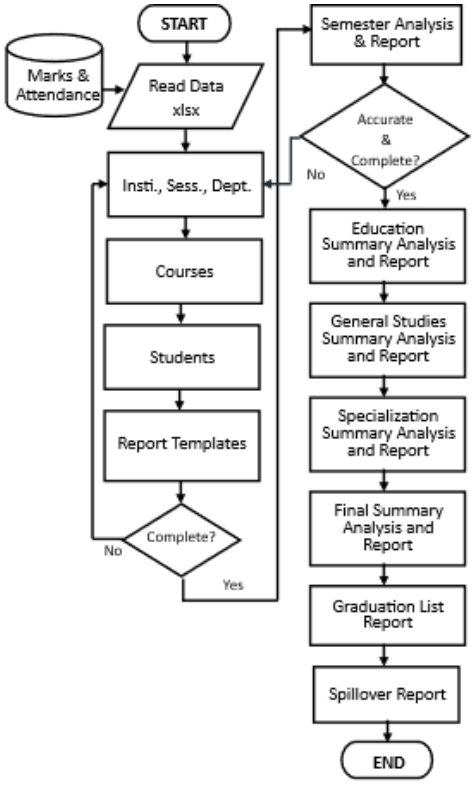


Figure 5: RCCR model flowchart

Table 3: RCCR system Algorithm

INPUT: Dataset **OUTPUT**: Student Learning Achievement Reports

1. Acquire the dataset
2. Validate dataset and Structure (Preprocessing)
3. Clean the dataset
   a. Outliers
      Are there outliers?
      If (Outliers == True)
        Fill cell (color = "*color*") and font (color = "*color*")
   b. Missing values
      Compulsory course Score?
      If (ISBLANK(field))
        Fill_cell (color = "*color*")
4. Data Transform ation
   a. Scores below 40
      If (score < 40)
        font (color = "*color*")
   b. Legible alternate Rows
      If (MOD(ROW(),2) == True)
        Fill row (color = "*color*")
5. Analysis
   a. Cumulative Point Earned (CPE)
      CPE = Previous CPE + Current Semester TPE
   b. Cumulative Total Unit (C TU)
      CTU = Previous CTU + Current Semester TU
   c. Cumulative Grade Point Average (CGPA)
      CGPA = CPE/CTU
   d. Cumulative Total Failed (CTF)
      CTF = Previous CTF + Current Semester TF – Count of Cleared Courses
   e. Remark
      if (CTF)
        "REF"
      else
        "CLS"
   f. Highest CGPA
      if (student.CGPA == top_1%(CGPA))
        Fill cell (color = "black") & Font (color = "White")
        Return student name, matric number, & CGPA
   g. %Pass
      for each course in the semester
        perPass = (count of scores > 39)/count o f assessed students)
   h. %Fail
      for each course in the semester
        perFail = (count of scores <40)/count of assessed students)
   i. Best Course
      if course. percPass == max(percPass)
        Return course.code, max(percPass)
   j. Poorest Course
      if course.percFail == max(percFail)
        Return course.code, max(percFail)
   k. No. of CS
      Return COUNTIF(ctf_column_range,0)
   l. No. of REF
      Return COUNTIF(ctf_column_range,">0")
6. Print Report: Semester or Summary
7. Print Report: Final Summary
8. Print Report: Graduating List
9. Print Report: Spillover List
10. Chart: Cumulative Performance

Research Data

The secondary data used to build and test this RCCR model consisted of 270-number marks and attendance for six (6) academic semesters and 9,247 entries. The test dataset comprised marks and attendance from two distinct faculties (schools) in Federal College of Education (Technical) Omoku. Six (6) semesters worth of marks and attendance corresponds to three (3) academic sessions – that is three (3) academic years. This is the minimum year to complete the Nigerian Certificate in Education (NCE) programme. After verifying the accuracy of the system (semester and summary reports accuracy, and metrics computational accuracy) with the test data, a synthetic dataset was used for publication. The publication dataset consists of 3,700 records (entries) and 124-number marks and attendance.

Results and Discussion

This section discusses the achievement of the over ten (10) research objectives of the study. The publication dataset consists of synthetic 3,179 records and 124-number marks and attendance. The over ten (10) objectives of the study as set out were achieved. It was found that tables, matrices, pie chart, data slicers, data bars, and column charts are commonly used to visualize students' academic performance.

RCCR Model

The RCCR model (see Figure 4) not only facilitates prompt and accurate statutory reporting for each semester and summary section but also, effectively provides a real time list of all unremedied courses for each semester and session.

Marks and Attendance Template

4	Matric #	Name	Gender	EDU 121	EDU 122	EDU 123	GSE 121
5	RE/1000	A Lastname	M	33	55	51	62
6	RE/1001	B Lastname	M	58	41	50	50
7	RE/1002	C Lastname	F	62	60	62	64
8	RE/1003	D Lastname	F	75	72	61	85
9	RE/1004	E Lastname	M	61	28	14	40

Figure 6: Marks and Attendance Template

Metrics of a Marks and attendance template include: Matric Number, Name, Gender, Course Code(s), Letter grade, Remark, Examiner(s), Course Title, Department, Semester and Academic Session, Performance analysis, and Moderator(s) Comment. Some of the fields are illustrated in Figure 6.

Modules Register Template

	A	B	C
1			
2	NCE 1 First Semester		
3	Code	Credit Unit	Title
4	EDU 111	1	History of Education in Nigeria
5	EDU 112	2	Developmental Psychology (Including Ado
6	EDU 113	2	Principles and Methods of Teaching at Juni
7	GSE 011	0	Media and Information Literacy 1

Figure 7: Modules register template
Metrics of the Modules Register include Code, Credit Unit, Title, and Kind.

Students' Register

	MATRIC N	NAME	Gende
10			
11	RE/1000	Student 1	M
12	RE/1001	Student 2	M
13	RE/1002	Student 3	F
14	RE/1003	Student 4	M
15	RE/1004	Student 5	M
16	RE/1005	Student 6	F
17	RE/1006	Student 7	F

Figure 8: Students' register template

Metrics of students' register include: Matric number, Name, and Gender. This keeps the information and related descriptive and inferential statistics focused solely on the student academic performance without deviating into cultural and other social details.

Semester Report Template

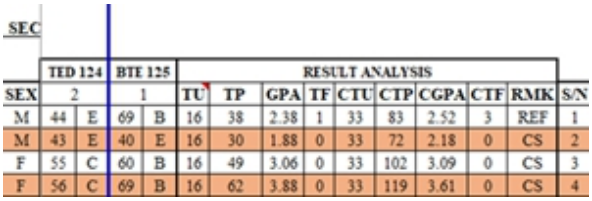
					EDU 111		EDU 112		EDU 113		GSE
8	S/N	MATRIC NO.	NAME	SEX	1		2		2		1
9	1	RE/1000	Student 1	M	50	C	53	C	41	E	75
10	2	RE/1001	Student 2	M	57	C	60	B	51	C	62
11	3	RE/1002	Student 3	F	56	C	75	A	75	A	63
12	4	RE/1003	Student 4	M	52	C	61	B	42	E	60
13	5	RE/1004	Student 5	M	50	C	40	E	43	E	55
14	6	RE/1005	Student 6	F	54	C	58	C	46	D	56

Figure 9: Semester report template

There are two semesters in every academic session. Hence, a three-year academic programme would have six semesters. Every session's analysis must therefore, account for at least two semesters. This report must contain all necessary details for authenticity. Scores that fall below the pass mark are formatted with font-colour red. The column of any course whose scores have not been keyed-in is filled with amber colour. Prompt feedback on students' academic performance would inform certain students from reattempting certain courses for

which they had received a pass mark. Thus, preventing waste of energy and resources by such students. Core and Elective Courses were catered for in the RCCR model collation, computation, and reporting.

Sessional Report Template

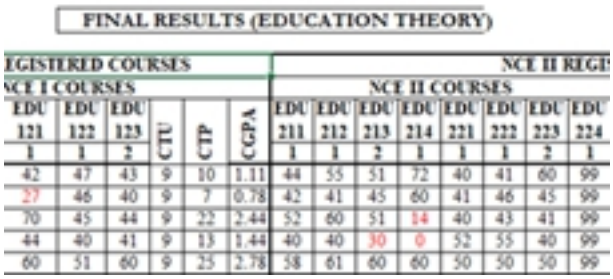


SEC														
	TED 124		BTE 125		RESULT ANALYSIS									
SEX	2		1		TU	TP	GPA	TF	CTU	CTP	CGPA	CTF	RMK	S/N
M	44	E	69	B	16	38	2.38	1	33	83	2.52	3	REF	1
M	43	E	40	E	16	30	1.88	0	33	72	2.18	0	CS	2
F	55	C	60	B	16	49	3.06	0	33	102	3.09	0	CS	3
F	56	C	69	B	16	62	3.88	0	33	119	3.61	0	CS	4

Figure 10: Sesional report template

Just like the semester report, this report has all details and metrics contained in a semester report including the key student's academic performance measured as CGPA. A remark is also provided: if the student has no carried over course, the remark is CLS, otherwise it is REF. Cell addresses are used to collate marks and course credit units from relevant tables. Each Sessional Report also keeps track of each student's attempt to remedy a failed course. Scores that fall below the pass mark are formatted with font-colour red. The column of any course whose scores have not been keyed-in is filled with amber colour.

Summary Report Template

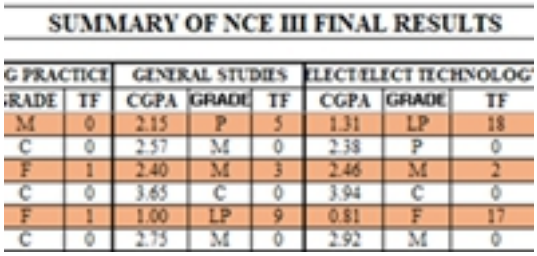


FINAL RESULTS (EDUCATION THEORY)

EGISTERED COURSES						NCE II REGI							
NCE I COURSES						NCE II COURSES							
EDU 121	EDU 122	EDU 123	CTU	CTP	CGPA	EDU 211	EDU 212	EDU 213	EDU 214	EDU 221	EDU 222	EDU 223	EDU 224
1	1	2				1	1	2	1	1	1	2	1
42	47	43	9	10	1.11	44	55	51	72	40	41	60	99
27	46	40	9	7	0.78	42	41	45	60	41	46	45	99
70	45	44	9	22	2.44	52	60	51	14	40	43	41	99
44	40	41	9	13	1.44	40	40	30	0	52	55	40	99
60	51	60	9	25	2.78	58	61	60	60	50	50	50	99

Figure 11: Summary report template

Since the NCE programme provides for three categories (Education, General Studies, and an area of Specialty) there are also an equivalent three summary reports plus one other (Teaching Practice). The first three follow the design in Figure 11 above and showcases the performance of each student in each core subject area. Scores that fall below the pass mark are formatted with font-colour red. The column of any mandatory course whose scores have not been keyed-in is filled with amber colour.



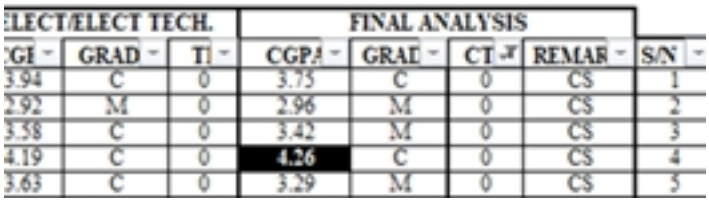
SUMMARY OF NCE III FINAL RESULTS

G PRACTICE		GENERAL STUDIES			ELECT/ELECT TECHNOLOG		
GRADE	TF	CGPA	GRADE	TF	CGPA	GRADE	TF
M	0	2.15	P	5	1.31	LP	18
C	0	2.57	M	0	2.38	P	0
F	1	2.40	M	3	2.46	M	2
C	0	3.65	C	0	3.94	C	0
F	1	1.00	LP	9	0.81	F	17
C	0	2.75	M	0	2.92	M	0

Figure 12: Final summary report template

The fourth report (see Figure 12) is designed to present the CGPA, Grade and TF achieved by each student in the four core areas.

Graduation Report Template

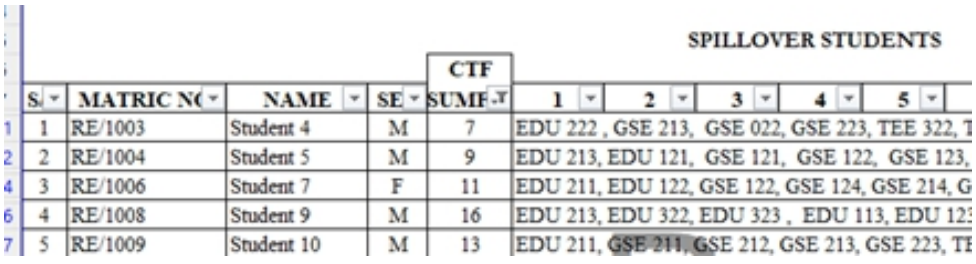


ELECT/ELECT TECH.			FINAL ANALYSIS				
GE	GRAD	TF	CGPA	GRAD	CT	REMAR	S/N
3.94	C	0	3.75	C	0	CS	1
2.92	M	0	2.96	M	0	CS	2
3.58	C	0	3.42	M	0	CS	3
4.19	C	0	4.26	C	0	CS	4
3.63	C	0	3.29	M	0	CS	5

Figure 13: Graduation report template

Major metrics of the Graduation Report template are the four summary areas, showcasing the CGPA grade and TF. This report contains the list of only students who are on clear standing at the end of the sixth semester. It is a filtered view of the Final Summary. Analysis revealed that a student would make the graduate list if he/she has one or more carryover courses. Accurate and prompt performance feedback with appropriate academic counselling can help improve the learning achievement of such students, as well as increase the number of graduates per department.

Spillover Students Report Template



						SPILLOVER STUDENTS					
	S	MATRIC NO	NAME	SE	CTF SUMF	1	2	3	4	5	
1	1	RE/1003	Student 4	M	7	EDU 222 , GSE 213,	GSE 022, GSE 223, TEE 322, T				
2	2	RE/1004	Student 5	M	9	EDU 213, EDU 121,	GSE 121,	GSE 122,	GSE 123,		
4	3	RE/1006	Student 7	F	11	EDU 211, EDU 122,	GSE 122,	GSE 124,	GSE 214, G		
6	4	RE/1008	Student 9	M	16	EDU 213, EDU 322,	EDU 323 ,	EDU 113,	EDU 12		
7	5	RE/1009	Student 10	M	13	EDU 211, GSE 211,	GSE 212,	GSE 213,	GSE 223, TE		

Figure 14: Spillover students report template

The spillover report returns the list of all students in the matric set, filtered to produce a report of all students who did not achieve *clear standing* at the end of the minimum six semesters. It is

often required that a list of the first 14 failed courses be displayed (see Figure14. The complete list of all failed courses can be queried from this template.

Impact of the automated RCCR system

With the automated RCCR system, students themselves, lecturers and tutors, the departments and indeed the institution can make data-driven decisions. Also, the effective and efficient use of this system would mitigate the waste of resources and time by students who have been observed to retake courses for which they were unaware that they had already been awarded a pass grade.

Compared to the legacy approach, this solution enables prompt evaluation and reports of students' academic performance; is 70% more effective and efficient compared to the legacy approach, provides data for further research, easy to manage and maintain by the practitioners, and easy to archive. The proposed data structure fast-tracks marks and attendance storage, collation, computation, and reporting.

Data-driven Strategies: semester analysis revealed that students performed consistently poorly in certain courses than others. Cumulative academic performance (see Figure 15) communicates visually the count of grade class – Distinction, Credits, Merits, Pass, Lower Pass and Fail – achieved by the matriculating set. These outcomes and challenges can be researched into objectively, with the aim to delineate the factors and strategies to ensure that subsequent students achieve higher performance. Some of such factors to be investigated can include time tabling, course load, pre-requisite knowledge, student self-efficacy, and motivation.

20YY MATRIC SET CUMMULATIVE PERFORMA *Class Size:* 25

GRADES	Education Theory	Teaching Practice	General Studies	Electrical and Electronic Technology	CUMMULATIVE
Distinction	0	1	0	0	0
Credit	2	14	5	2	3
Merit	10	2	10	12	13
Pass	11	1	9	10	8
Lower-pass	2	1	1	1	1
Fail	0	6	0	0	0
Total	25	25	25	25	25

	%
Distinction	0
Credit	12
Merit	52
Pass	32
Lower-Pass	4
Fail	0
	100

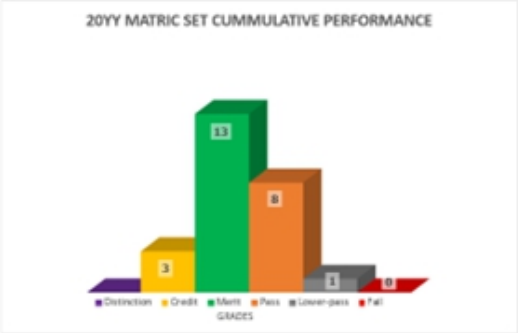


Figure15: Matric Set Cumulative Academic Performance

Pedagogical implication: the matriculation set sum of score per course and count of grades in a semester presented in Figure 16 helps administrators, lecturers and tutors to visually appreciate the most common *grade* earned by students taught per semester in their department. Hence, they can strategize on what alternative pedagogical approach to embrace that would stimulate higher student learning achievement, increased institutional ranking, increased institutional preference, and increased graduate retention.

COURSE CODE	Sum of SCORE
BTE 121	1130
BTE 122	1178
BTE 123	1162
BTE 125	979
EDU 121	1193
EDU 122	1095
EDU 123	1315
GSE 121	1215
GSE 122	867
GSE 123	963
GSE 124	880
TED 124	905
Total	12882

GRADE	Count of GRADE
A	27
B	51
C	63
D	31
E	57
F	23
Total	252

Figure 16: Sum of Score and Count of Grade per semester

Student Learning Achievement: A student's dedication and commitment to his/her academic performance and progress is as much as the quality of the performance and progress report (see Figure 17) he/she receives. The researchers recommend that while delivering these, an institution needs to proactively provide helpful guidance counselling and mental health tips to safeguard students all through an academic programme and prevent burn-outs, provide much needed encouragement when on the right track, and help realign student's focus when misinformed.

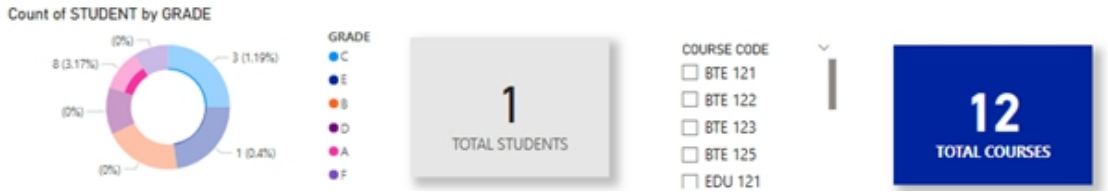


Figure 17: A simple student learning achievement dashboard

From the dashboard presented in Figure 17, the student can view his/her count of grades earned in each semester, as well as the total courses registered in each semester. While administrators (the department) and the lecturer can view count of grades earned in each semester, as well as the total courses registered in each semester by all students.

Conclusion and Recommendation

This research aimed to automate the collation, computing, and reporting of students' academic performance per department per matric set in an academic institution. This was achieved by Designing Marks and Attendance (M&A) template; Designing Matric Set Register template; Designing Modules Register Template; Designing and Automating Semester Report Template; Designing and Automating Sessional Report Template; Designing and Automating Summary Report Template; Designing and Automating Graduation Report Template; Designing and Automating Spill over Report Template; the

impact of the automated RCCR system on students learning achievement were identified; and appropriate charts were used visualize students' learning achievement.

A contextual results collation, computing, and reporting system can be designed and implemented using spreadsheet, the proposed RCCR model, and Cross-Industry Standard Process for Data Mining (CRISP-DM) methodology works together well to deliver such a project. The RCCR model makes it easy to customize reports per institution and department, archive student learning achievement, and is over 70% more efficient and effective compared to the legacy approach. A reliable and efficient academic performance reporting system inspires students, prompts lecturers to evaluate their pedagogical strategies, and provides administrators and investors with business intelligence. This feedback should be used to positively improve pedagogical approach, institutional ranking, institutional preference, graduate retention, and institutional productivity. This way, reliable students' assessment is promoted and educational development sustained.

Contribution to Knowledge

1) A Data Structure that can be adopted to store Marks and Attendance to fast-track collation, computation and reporting.
2) Charts with which student learning achievement per semester and cumulative learning achievement per matric set can be effectively visualized and presented to a non-technical audience.

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