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TRAJECTORY ANALYSIS OF STUDENT ACADEMIC PERFORMANCE ACROSS NATIONAL DIPLOMA (ND) LEVEL: A THREE-SEMESTER STUDY

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Abstract

This study presents a trajectory analysis of student performance across three semesters in National Diploma (ND) programs, examining how academic outcomes evolve from the first to the third semester. We analyze data from 1,308 ND student records to understand the influence of each semester's performance on final academic outcomes. Results reveal that first-semester performance is a strong predictor of success, while second and third semesters offer critical insights into students' academic stability and improvement. These findings provide valuable information for educational institutions to design targeted interventions that support students across different stages of the ND program.

Keywords

Trajectory analysis, Student performance, National Diploma (ND), First-semester impact, Academic progression

1. Introduction

Student performance prediction has become a major focus in educational data mining (EDM) as institutions seek to improve

academic success rates by identifying at-risk students early on [1]. Trajectory analysis, which examines changes in performance over time, provides a longitudinal perspective that static models lack, offering deeper insights into students' academic journeys [2]. This study investigates the progression of student performance across the first three semesters in National Diploma (ND) programs, aiming to identify patterns and factors influencing academic trajectories.

National Diploma programs, which are often vocational or technical in nature, cover foundational courses that prepare students for either advanced studies or direct entry into the workforce. Tracking the academic progression of ND students across multiple semesters allows for a more comprehensive understanding of how early performance impacts later outcomes and identifies potential intervention points [3]. This research focuses on three critical stages in the ND program—first, second, and third semesters—to capture a detailed view of students' academic trajectories.

1.1 Problem Statement

Most educational research focuses on single-point predictions of student performance, neglecting the evolving nature of academic progress [4]. Although first-semester performance is often emphasized, understanding the changes in academic outcomes over subsequent semesters is crucial, as students may experience fluctuations due to various academic, social, and personal factors [5]. This study aims to address this gap by examining how performance evolves across the first three semesters in ND programs.

1.2 Research Questions

The study addresses the following research questions:

i. How does student performance progress across the first, second, and third semesters in ND programs?

ii. What are the significant factors influencing academic trajectories across these semesters?

iii. How do changes in semester-specific performance predict final academic outcomes?

1.3 Research Objectives

The primary objective of this research is to analyze and interpret the academic trajectories of ND students across three semesters. Specific objectives include:

i. To analyzed the student performance at each semester in the ND program.

ii. To identify the influence of first, second, and third semester grades on final academic success.

iii. To highlight patterns of improvement, consistency, or decline across semesters.

2. Literature Review

2.1 Educational Data Mining and Performance Prediction

Educational data mining (EDM) has gained prominence in higher education, offering predictive insights into student performance based on historical academic data. Machine learning algorithms such as Decision Trees, Random Forests, and SVM are commonly used for performance prediction, leveraging features like demographics, attendance, and previous grades [6]. Decision Trees are intuitive and interpretable, though they may suffer from overfitting, while ensemble models like Random Forests improve accuracy by aggregating multiple decision trees [7].

However, EDM research often focuses on one-time predictions rather than capturing the dynamic changes in student performance across semesters. Trajectory analysis can address this limitation by providing a longitudinal view of academic progression, thus offering a more comprehensive approach to student success prediction [8].

2.2 Trajectory Analysis in Academic Performance

Trajectory analysis tracks student performance over time, enabling educators to identify trends and intervention points. Previous research has shown that students' academic trajectories vary significantly, often influenced by their adaptation to early academic challenges and the support they receive [9]. Herzog's [10] longitudinal study highlighted the importance of examining performance over multiple semesters to better understand student progression. Similarly, Zhang and Lee [11] found that early performance in educational programs significantly impacts long-term academic success, though changes in later semesters can also alter outcomes.

2.3 Importance of Semester-by-Semester Analysis

Analyzing each semester's performance offers a nuanced understanding of students' academic journeys. First-semester grades often provide initial indicators of a student's adaptation to academic demands, while the second and third semesters reflect students' academic resilience and potential improvement [12]. This study seeks to build on these insights by examining ND students' semester-by-semester performance, thereby identifying when interventions might be most beneficial.

3. Methodology

3.1 Data Collection

The dataset for this study was obtained from the Federal College of Animal Health and Production Technology, NVRI Vom, Nigeria, and consists of 1,308 ND student records. Each record includes demographic information (age, gender) and academic data (course grades, GPA, CGPA) across the first, second, and third semesters.

3.2 Data Preprocessing

To ensure data quality, the following preprocessing steps were applied:

- Data Cleaning: Missing values were addressed through mean and mode imputation, depending on variable type.
- Normalization: Continuous variables like GPA and CGPA were normalized to facilitate comparability across records.
- Feature Selection: Features including GPA, CGPA, and semester-specific grades were selected for their relevance to academic progression [13].

3.3 Trajectory Analysis Across Semesters

Trajectory analysis involved tracking student performance from the first semester through the third semester. By visualizing academic trajectories, patterns of improvement, stability, or decline were observed, helping to identify key transition points where students either improved or faced academic challenges.

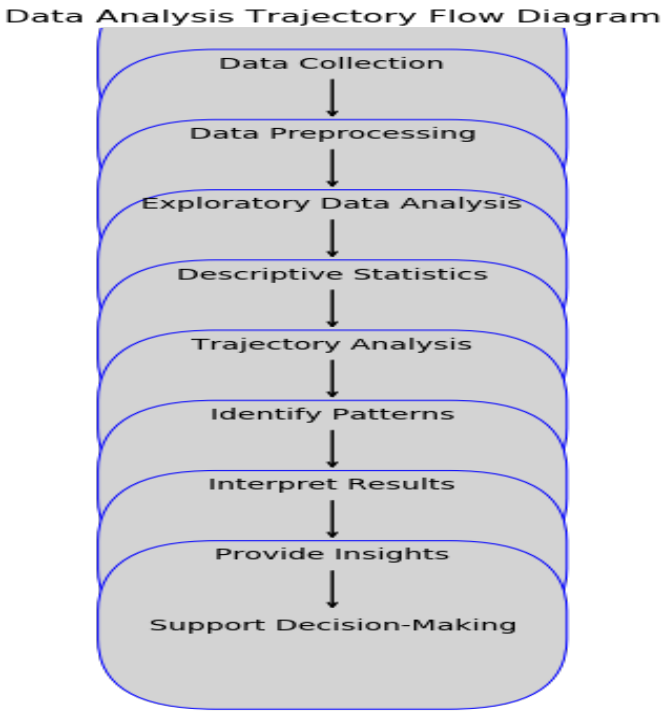

Figure 1: Sample Academic Trajectories of ND Students Across Three Semesters

4. Results

TABLE 4.1 the trajectories summary of graduate results grade in first semester ND 1 and that of their final grade

The table below shows the grade students started with in their first semester ND 1 and comparing it with the grade the graduated with.

Total Sample Size = 1308

Rating	Frequency	Percentage (%)
Summary Representation Of Record Of Students That Were In Pass In ND 1 First Semester Compared With The Grade The Finally Make In Their Final Semester		
Pass To Pass	362	60.64
Pass To Lower Credit	234	39.2
Pass To Upper Credit	1	0.17
Pass To Distinction	0	0
Grand Total	597	100
Summary Representation Of Record Of Students That Were In Lower Credit In ND 1 First Semester Compared With The Grade The Finally Make In Their Final Semester		
Lower Credit To Pass	20	4.04
Lower Credit To Lower Credit	413	83.43
Lower Credit To Upper Credit	61	12.32
Lower Credit To Distinction	1	0.2
Grand Total	495	100
Summary Representation Of Record Of Students That Were In Upper Credit In ND 1 First Semester Compared With The Grade The Finally Make In Their Final Semester		
Upper To Pass	0	0
Upper Credit To Lower Credit	36	20
Upper Credit To Upper Credit	138	76.67
Upper Credit To Distinction	6	3.33
Grand Total	180	100
Summary Representation Of Record Of Students That Were In Distinction In ND 1 First Semester Compared With The Grade The Finally Make In Their Final Semester		
Distinction To Pass	0	0
Distinction To Lower Credit	0	0
Distinction To Upper Credit	21	58.33
Distinction To Distinction	15	41.67
Grand Total	36	100

TABLE 4.2 the trajectories summary of graduate results grade in second semester ND 1 and that of their final grade

The table below shows the grade students started with in their second semester ND 1 and comparing it with the grade the graduated with.

Total Sample Size = 1308

Rating	Frequency	Percentage (%)
Summary Representation Of Record Of Students That Were In Pass In ND 1 Second Semester Compared With The Grade The Finally Make In Their Final Semester		
Pass To Pass	373	66.13
Pass To Lower Credit	191	33.87
Pass To Upper Credit	0	0
Pass To Distinction	0	0
Grand Total	564	100

Summary Representation Of Record Of Students That Were In Lower Credit In ND 1 Second Semester Compared With The Grade The Finally Made In Their Final Semester		
Lower To Pass	9	1.63
Lower Credit To Lower Credit	479	86.93
Lower Credit To Upper Credit	63	11.43
Lower Credit To Distinction	0	0
Grand Total	551	100
Summary Representation Of Record Of Students That Were In Upper Credit In ND 1 Second Semester Compared With The Grade The Finally Made In Their Final Semester		
Upper Credit To Pass	0	0
Upper Credit To Lower Credit	13	7.51
Upper Credit To Upper Credit	153	88.44
Upper Credit To Distinction	7	4.05
Grand Total	173	100
Summary Representation Of Record Of Students That Were In Distinction In ND 1 Second Semester Compared With The Grade The Finally Made In Their Final Semester		
Distinction To Pass	0	0
Distinction To Lower Credit	0	0
Distinction To Upper Credit	5	25
Distinction To Distinction	15	75
Grand Total	20	100

TABLE 4.3 the trajectories summary of graduate results grade in second semester ND 2 and that of their final grade

The table below shows the grade students started with in their second semester ND 2 and comparing it with the grade the graduated with.

Total Sample Size = 1308

Rating	**Frequency**	**Percentage (%)**
Summary Representation Of Record Of Students That Were In Pass In ND 2 First Semester Compared With The Grade The Finally Made In Their Final Semester		
Pass To Pass	380	72.11
Pass To Lower Credit	147	27.89
Pass To Upper Credit	0	0
Pass To Distinction	0	0
Grand Total	**527**	**100**
Summary Representation Of Record Of Students That Were In Lower Credit In ND 2 First Semester Compared With The Grade The Finally Made In Their Final Semester		
Lower Credit To Pass	2	0.34
Lower Credit To Lower Credit	534	90.66
Lower Credit To Upper Credit	53	9
Lower Credit To Distinction	0	0
Grand Total	**589**	**100**

Summary Representation Of Record Of Students That Were In Upper Credit In ND 2 First Semester Compared With The Grade The Finally Made In Their Final Semester		
Upper Credit To Pass	0	0
Upper Credit To Lower Credit	2	1.14
Upper Credit To Upper Credit	166	94.86
Upper Credit To Distinction	7	4
Grand Total	**175**	**100**
Summary Representation Of Record Of Students That Were In Distinction In ND 2 First Semester Compared With The Grade The Finally Made In Their Final Semester		
Distinction To Pass	0	0
Distinction To Lower Credit	0	0
Distinction To Upper Credit	2	11.76
Distinction To Distinction	15	88.24
Grand Total	**17**	**100**

4.1 Trajectory Analysis of ND Students

The analysis across three semesters provided several insights into student performance patterns:

- First Semester Impact: Students who performed well in the first semester were more likely to maintain or improve their performance across subsequent semesters. The first semester was the most predictive of overall academic success, with many high-performing students consistently achieving Upper Credit or Distinction.
- Second Semester Patterns: The second semester showed the most variability in student performance, with some students who initially struggled beginning to improve, while others experienced a decline. This semester served as a critical point where students either adapted to academic demands or continued to face challenges.
- Third Semester Stability: By the third semester, students' academic performance largely stabilized. Students who achieved consistent results in the first two semesters were likely to maintain their grades, while those with poor performance in the first two semesters found it difficult to make significant improvements.

5. Discussion

The results underscore the importance of a multi-semester approach to analyzing student performance, as it provides a more accurate picture of academic progression. First-semester performance remains a strong predictor of final outcomes, consistent with prior research [11]. However, the second semester emerged as a pivotal stage, where students' trajectories either improve or decline, suggesting that this semester is an optimal time for interventions [12].

The third semester, characterized by stability, suggests that by this stage, most students have either adapted to academic demands or reached their performance plateau. Educational institutions should consider providing targeted support during the second

semester to help students who struggled initially but show potential for improvement.

6. Conclusion

This study provides a detailed trajectory analysis of ND students across three semesters, highlighting the significance of each semester's performance in shaping long-term academic success. While first-semester performance offers predictive insights, the second semester serves as a crucial adjustment period where targeted interventions could have the greatest impact. By understanding how academic trajectories evolve over time, educational institutions can implement data-driven strategies to support students effectively throughout the ND program.

Future research should expand on these findings by exploring additional factors, such as attendance and study habits, to enhance the predictive models. Such research could further refine intervention strategies, helping institutions maximize student success and retention.

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Final Remark

This paper has provided a detailed trajectory analysis of student performance across three critical semesters in National Diploma (ND) programs, demonstrating how each semester's performance impacts long-term outcomes. These findings offer valuable insights for educational institutions seeking to develop data-driven interventions that support students at different stages of their academic journey. By understanding the significance of each semester's performance, particularly the pivotal role of the second semester, institutions can better support students, enhancing their chances of academic success and program completion.