Student Dropout and Intervention Strategy Report

This two-page report is based on the Student's Dropout Prediction Analysis and Risk and Interventions dashboards, analyzing key findings across a student population of approximately 4,000 Total Students to define the problem and propose a targeted intervention strategy.

Problem Statement and Core Findings

Problem Statement (PS)

The institution faces a critical attrition crisis marked by a high Dropout Rate of 0.32 and an unsatisfactory Graduation Rate of 0.50/0.51 across the student body. The analysis reveals a complex systemic failure rooted in three main areas:

1. Massive Financial Stress: Over 500 students are identified as debtors, creating a major financial barrier to persistence.
2. Ineffective Financial Aid: A paradox exists where thousands of students receiving scholarships still fail to persist, suggesting aid alone is insufficient.
3. Widespread Academic Decline: The general student population is not improving academically, with average grades *decreasing* over time.

Key Findings: Risk Profile Analysis

The analysis identifies specific segments and factors driving the high dropout rate:

1. The Attrition Paradox: Scholarship Holders Dropping Out

The data confirms a major structural risk: scholarship support is failing to ensure retention.

- In the largest analyzed segment, 1,184 scholarship holders ultimately became dropouts.
- While 2,015 scholarship holders graduated, the large number of dropouts suggests that the current scholarship program either:
    - Provides insufficient funds to cover the Total Cost of Attendance.
    - Fails to account for non-financial factors (e.g., academic stress, personal issues) that overwhelm financial relief.

2. Debtor Concentration and High-Risk Application Modes

Financial distress is not uniformly distributed; it is highly concentrated within specific student intake channels.

- The total Debtor Count of 503 is alarmingly high for a student body of 4K.
- Two application modes account for the vast majority of debtors:
    - 1st phase - general contingent: 93 Debtors
    - 2nd phase - general contingent: 76 Debtors
- Students entering through these contingent phases are immediately identifiable as a high financial risk group and require prioritized financial counseling and tracking.

3. Academic Decline by Gender

Academic performance across the board is a serious concern, indicating that students are falling behind instead of improving.

- Female students show an average grade improvement of -0.32 (a decline).
- Male students show an even steeper average grade improvement of -0.57 (a greater decline). This finding necessitates an academic intervention strategy focused on improving grades, particularly for the male student cohort.

Detailed Findings and Strategic Recommendations

Segmented Risk Factors

Dropout rates become extremely high when isolating certain demographics and courses:

- Marital Status: Non-traditional students face extremely high risk. The dropout rate for Legally Separated students is 0.67, and for Divorced students, it is 0.44, far exceeding the overall rate of 0.32. The average enrollment age of 23.27 further supports the need for non-traditional student support.
- Course Name: Specific courses are functioning as dropout bottlenecks:
    - Biofuel Production Technologies has a severe dropout rate of 0.67.
    - Informatics Engineering has a very high dropout rate of 0.54.

Strategic Recommendations

The institution must shift from a passive, reactive approach to a Proactive Intervention Model that targets the specific factors identified by the data.

1. Financial Stress Mitigation and Targeted Aid

- Focus on the Debtors: Immediately implement a mandatory financial counseling program for all 503 debtors. Prioritize students from the 1st and 2nd phase - general contingent application modes. Offer flexible repayment plans and debt restructuring to prevent immediate dropout.
- Scholarship Sufficiency Review: Conduct a root-cause analysis on why 1,184 scholarship holders are still dropping out. The next phase of aid must be structured to cover the full financial gap to be effective, or be combined with mandatory academic support.

2. Academic Early Warning System (EWS)

- Mandatory Grade Intervention: Establish a clear threshold (e.g., any grade decline greater than -0.30) to trigger an EWS alert.
    - Target: Focus resources immediately on male students due to their steeper grade decline of -0.57.
    - Action: Implement mandatory, small-group tutoring or academic coaching for all flagged students.
- Course-Specific Support: Launch specific retention initiatives for high-attrition programs:
    - Create dedicated Success Workshops or supplemental instruction sessions for Biofuel Production Technologies and Informatics Engineering. This may include curriculum review to ensure alignment with student preparation.

3. Demographic and Personal Support

- The high dropout rates for older and non-single students (e.g., 0.67 for Legally Separated) demonstrate a need for specialized support.
    - SUGGESTION : Offer tailored flexible scheduling, childcare resources, and mental health counseling to help balance academic demands with complex personal responsibilities.
    - Proactive Wellness Checks: Utilize the EWS to flag students from high-risk marital statuses (Divorced, Legally Separated) early in the semester for non-academic welfare checks.

The EDA stage went beyond simple descriptive statistics to engineer predictive features, revealing the core mechanics of student dropout.

1. Academic Performance is the Primary Predictor

Dropout risk is strongly correlated with a student's academic trajectory, as confirmed by the engineered feature Grade_Change.

- The system found that a decline in average grade from the 1st to the 2nd semester (Grade_Change < 0) is a major indicator of future dropout.
- Quantitative analysis of Dashboard data showed that male students experience a steeper average grade decline (0.57) compared to female students (-0.32), making them a higher academic risk cohort.

2. Identification of the Highest Risk Cohort

A powerful, binary risk feature, High_Risk_Flag, was engineered to isolate students facing the greatest jeopardy:

- High_Risk_Flag is set to 1 if a student is a Debtor AND their Overall Approval Rate is less than 50%. This small, highly vulnerable cohort should be the absolute priority for immediate intervention, as they face both severe financial and academic failure simultaneously.

3. Course and Demographic Bottlenecks

Dashboard and EDA confirmed that high-risk cohorts are concentrated in specific areas:

- Course Bottlenecks: Programs like Biofuel Production Technologies (Dropout Rate: 0.67) and Informatics Engineering (Dropout Rate: 0.54) require urgent curriculum and support review.
- Non-Traditional Students: Students with complex marital statuses, such as Legally Separated (Dropout Rate: 0.67), face significantly higher attrition, highlighting the need for tailored work-life-study balance support.

Machine Learning Insights and Strategic Recommendations

Machine Learning Findings (Dropout Predictors)

The ML pipeline used ensemble models (Random Forest, XGBoost, LightGBM) on the top 30 most predictive features to build a highly accurate prediction model for dropout (estimated 85%} accuracy based on the model training pipeline).

The model confirms that the most powerful predictors of dropout are the features created during the EDA stage:

1. Grade_Change: The most critical predictor, quantifying the student's academic trajectory.
2. Overall_ApprovalRate: A measure of total academic success (Total Approved Units / Total Enrolled Units).
3. High_Risk_Flag: The combined academic and financial failure indicator.

4. Debtor Status / Tuition Fees Up-to-Date: Direct financial health indicators.
5. Application Mode: The specific contingent phase a student enrolled through remains a strong initial risk factor.

Strategic Recommendations: A Data-Driven Model

The recommendations shift from general support to Precision Intervention, prioritizing students based on their actual predicted risk level derived from the ML findings.

1. Implement a Three-Tiered Financial Intervention

- Tier 1 (Immediate/High-Risk): Target the High Risk Flag cohort (Debtors with 50% Approval Rate). Offer mandatory, immediate debt restructuring and personalized academic support.
- Tier 2 (Proactive): Focus on the 503 total debtors and students from the high-risk (1st and 2nd phase general contingent) application modes. Provide early financial literacy and counseling before debt accumulates.
- Tier 3 (Structural Review): Redesign the Scholarship Program (Financial_Stability_Index) to address the attrition paradox (1,184 scholarship holders dropping out). Aid must be sufficient to close the *full financial gap* or be paired with mandatory EWS checks.

2. Establish a Dynamic Early Warning System (EWS)

- Trigger based on Grade Change: Deploy the EWS to constantly monitor the Grade change feature. Any student whose average grade drops by -0.30 or more should be flagged.
- Targeted Academic Support:
    - Gender Focus: Prioritize flagged male students for mandatory, small-group tutoring or coaching to reverse the 0.57 average grade decline.
    - Course Focus: Embed dedicated success instructors or peer-led instruction sessions within the high-attrition courses like Biofuel Production Technologies and Informatics Engineering.

3. Tailored Demographic Support

- Formalize a Non-Traditional Student Service (NTSS) center. Use the Avg. Age at Enrollment (23.27) and marital status data to design services like flexible scheduling, remote learning options, and specialized counseling for students balancing work, family, and studies.
- Welfare Check Prioritization: Use the ML model's prediction score to prioritize outreach by advisors, ensuring that the limited human resources are spent connecting with the students most likely to drop out.