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The Causal Factors Affecting the Management of Predictive Student Relationship using Business Intelligence Concept for the Retention of Undergraduate Students

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Abstract

This study aims to analyze causal factors affecting predictive student relationship management for undergraduate student retention using business intelligence. Phase 1 involved identifying key factors influencing retention through document analysis, categorizing them into social, learning, teaching, and student-related factors. Social factors include student community, friendships, communication channels, and organizational culture, which promote engagement, motivation, and perseverance. Learning and teaching factors, such as supportive learning environments, scholarships, instructional design, and structured assignments, impact academic success and retention. Student-related factors, including learning abilities, academic preparedness, goals, and parental support, are essential for persistence. Data was gathered from 1,574 students at Valaya Alongkorn Rajabhat University, with 1,160 usable entries after cleansing. Exploratory Factor Analysis (EFA) grouped these variables into five components: Student Communication Channels, Academic Proficiency, Parental Guidance, Scholarships, and Organizational Culture. Confirmatory Factor Analysis (CFA) validated the model, highlighting well-clustered factors. In Phase 2, a predictive model was developed using stepwise multiple regression, identifying impactful variables, such as note-taking abilities, scholarship counseling, peer communication, and access to advisors. The final model, with an R value of 0.881 and an adjusted R^2 of 0.777, demonstrated 77.7% predictive accuracy, emphasizing the combined influence of academic support, communication, financial aid, and social integration on student retention. The findings suggest that institutions should prioritize these areas to foster a conducive environment for student success.

Keywords: predictive student relationship, business intelligence, retention

1. Introduction

Undergraduate student retention is crucial for both universities and students, affecting academic success, financial stability, and institutional performance. Retention, the ability of an institution to keep students enrolled through graduation, serves as a key performance indicator. High retention rates reflect student satisfaction with academic experiences, support services, and the institutional environment, enhancing a university's reputation (Berger, Ramirez, & Lyons, 2019). Conversely, low retention rates have financial consequences, as recruiting new students is costly. Additionally, many higher education systems link government funding and institutional rankings to student outcomes, including retention and graduation rates (Nichols & Belfield, 2019). Therefore, institutions with high dropout rates risk losing financial support and reputational standing.

For students, retention is equally important for long-term success. Those who leave university without earning a degree often face financial challenges, such as accumulating student debt without the earning potential that a degree provides (Selingo, 2019). Beyond financial burdens, dropping out can negatively affect students' personal development, self-esteem, and future educational aspirations (Barefoot, 2020).

Improving retention benefits both students and universities. Students gain the opportunity to complete their degrees, enhancing career prospects and avoiding financial instability. Universities, in turn, benefit from increased revenue, enhanced reputations, and improved performance metrics.

Business intelligence (BI) tools are increasingly used to manage retention by aligning with key factors that affect student outcomes, including academic performance, financial stability, social integration, and institutional support (Zhao et al., 2020). BI enables institutions to predict which students are at risk of dropping out by analyzing data such as attendance, grades, and financial aid (Ravichandran & Lacity, 2021; Park et al., 2020). BI also helps universities monitor student engagement in extracurricular activities, identifying those at risk of disengagement (Romero & Ventura, 2020). This proactive approach allows universities to tailor their support services, improving retention by addressing the unique needs of students (Chen et al., 2019).

2. Objectives

To analyze the causal factors affecting the management of predictive student relationships using business intelligence concepts for the retention of undergraduate students.

To develop a predictive student relationship management model using business intelligence concepts for the retention of undergraduate students.

3. Method

In Phase 1, the study focused on identifying and analyzing the causal factors affecting undergraduate student retention using business intelligence (BI) concepts. Through literature review, data analysis, and synthesis, key factors affecting student relationship management were identified. These factors were used to develop assessment questions, which were evaluated through Exploratory Factor Analysis (EFA) and validated using Confirmatory Factor Analysis (CFA). This laid the foundation for understanding how BI can be applied to enhance student retention by effectively managing student relationships. The population targeted for this phase included all students of Valaya Alongkorn Rajabhat University under the Royal Patronage. The sample consisted of students in their second to fourth years of study from various faculties, who had completed both general and field-specific courses. The sample was selected using simple random sampling, with academic advisors assisting in distributing the questionnaires online to the students.

Phase 2 aimed to develop a predictive student relationship management model. Using the causal factors identified in Phase 1, Stepwise Multiple Regression Analysis was applied to refine the model, ensuring that only the most significant factors influencing retention were included. The result was a robust predictive model that accurately reflects the key drivers of undergraduate student retention, enabling institutions to identify and support at-risk students more effectively. This research highlights the importance of integrating academic, social, and institutional factors through BI to improve student retention strategies.

4. Results

Phase 1: Analysis of causal factors affecting the management of predictive student relationships using business intelligence concepts for the retention of undergraduate students.

The objective of this phase is to analyze the causal factors affecting predictive student relationship management using business intelligence concepts for the retention of undergraduate students. The process was carried out as follows:

4.1 Document Analysis to Identify Causal Factors Affecting Undergraduate Student Retention

Student retention refers to the capacity of an educational institution to maintain students' enrollment from their initial registration through to the completion of their academic program. It is a multifaceted concept that encompasses factors such as academic success, engagement, and institutional support. Academic performance, particularly grades, serves as a critical predictor of retention, as students with higher grades are more likely to persist in their studies (Johnson et al., 2021). Recent studies highlight that grades, especially those earned in foundational courses, strongly influence retention rates. For instance, first-year grade point averages (GPAs) are consistently identified as significant determinants of whether students continue their education (Smith & Taylor, 2020). Furthermore, incorporating grade performance into retention frameworks allows for a more nuanced understanding of how academic achievement intersects with other factors, such as socio-demographics and institutional characteristics (Brown & Martinez, 2022).

In this stage, the researcher reviewed relevant documents and research studies on student retention to analyze the causal factors. The identified causal factors were then grouped into categories based on the analysis of the factors influencing undergraduate student retention. The study identified three groups of causal factors: social factors, learning and teaching factors, and student-related factors. The details are as follows:

4.1.1 Social Factors

Social factors significantly affect students' academic success and retention by shaping their daily academic lives

and helping them overcome learning challenges. These factors are crucial for promoting collaborative learning and ensuring students complete their studies on time, leading to higher retention rates. Key social factors include:

1) Student Community: Collaborative learning environments foster trust and information exchange, enhancing student engagement, motivation, and retention. Research shows that strong group relationships improve academic success and sense of belonging, especially in STEM fields (Baanqud et al., 2020; Newpher et al., 2020).

2) Friendship: Friendships provide essential peer support, promoting solidarity and mutual respect. Positive relationships among students enhance communication and encourage perseverance in overcoming academic challenges, contributing to better retention rates (Bowers & Lee, 2020; Wentzel, 2019).

3) Student Communication Channels: Efficient communication systems between students and academic staff facilitate timely access to information and support, helping students resolve academic issues and stay on track with their studies. This improves student persistence and retention (Robinson & Hullinger, 2019; Karp & Bork, 2020).

4) Organizational Culture: A positive, inclusive organizational culture that promotes knowledge sharing and collaboration creates a supportive environment for students. This culture encourages persistence and helps students overcome academic challenges, contributing to higher retention (Hatch & Schultz, 2019; Kahu & Nelson, 2018; Thomas & Jones, 2017).

These social factors are critical drivers of student retention, providing essential support for academic success.

4.1.2 Learning and Teaching Factors

Learning and teaching factors are crucial in shaping students' academic success and retention by influencing their comprehension and engagement. Key factors include:

1) Learning Environment: The physical and mental conditions of a learning environment, including classroom setup and teacher-student interactions, significantly impact students' learning experiences and retention. A positive environment promotes better academic outcomes (Cleveland-Innes & Campbell, 2019; Konradt & Bohle, 2020).

2) Scholarships: Financial support, such as scholarships, alleviates economic burdens, enabling students to focus on their studies. This financial aid greatly enhances retention, especially among financially disadvantaged students (Alon, 2019; Castleman & Long, 2020).

3) Instructional Design: Engaging and well-structured lessons increase student interest and participation, improving academic performance and retention. Active learning and inclusive classroom interactions are particularly effective (Darby & Lang, 2019; Johnson et al., 2020).

4) Assignments: Clearly defined and aligned assignments help students manage their workload, leading to timely submissions. This contributes to academic success and supports retention by maintaining student engagement (Kandiko & Mawer, 2019; Moore & Morton, 2020).

4.1.3 Student Factors

Several factors affect student retention in undergraduate programs, determining whether students persist until graduation:

1) Learning Ability: Selecting courses that align with students' interests and strengths increases enjoyment and academic success, enhancing retention. When students perceive courses as relevant to their skills, they show higher motivation and persistence (Bowers & Lee, 2020; Tinto, 2019).

2) Academic Ability: Preparedness, including high school performance, entrance exam scores, and prior academic background, plays a critical role in retention. Students with stronger academic foundations are more likely to succeed and persist in higher education (Tinto, 2019; Bowman et al., 2020).

3) University-Student Relationship: A strong bond between students and the university promotes persistence and long-term engagement. Positive relationships foster commitment, satisfaction, and institutional loyalty, improving retention rates (Wilkins & Huisman, 2019; Webber et al., 2020).

4) Student Goals: Clear academic and career goals drive motivation and engagement, enhancing academic performance and retention. Goal-oriented students exhibit greater persistence and success in overcoming academic challenges (Schunk & DiBenedetto, 2020; Locke & Latham, 2019).

5) Parental Support: Parents' attitudes, education level, and financial stability significantly influence student retention. Strong parental support provides emotional and material resources that help students stay focused and succeed academically (Hossler & Vesper, 2019; Wilder, 2020).

4.2 Analysis of Factors and Formulation of Questions

In this stage, causal factors affecting undergraduate student retention are analyzed to define and measure these factors. After reviewing definitions of 13 identified factors, relevant questions from existing research were refined. Similar questions were consolidated, and irrelevant ones were removed, resulting in 35 comprehensive questions to assess retention factors.

4.2.1 Formulating Evaluation Questions and Data Collection

Data for this evaluation was collected from students across all faculties of Valaya Alongkorn Rajabhat University under the Royal Patronage, specifically those in their 2nd to 4th years of study during the second semester of the 2021 academic year. These students have completed both general education courses and courses specific to their fields of study. To gain a clear view of the study trends, an online questionnaire was developed and distributed using simple random sampling, with the cooperation of academic advisors who shared the questionnaire link with their students. A total of 1,574 students responded to the evaluation. The consideration of student retention in this study is based on a cumulative Grade Point Average (GPA) of no less than 2.00, which represents the minimum threshold set by the university for maintaining student status. Students whose GPA falls below this threshold may be deemed ineligible to continue their studies under the university's academic regulations.

Subsequently, the data underwent a data cleansing process, which involves inspecting, correcting, or reformatting the data to ensure it was in the most usable state. This process also included filtering out incorrect or unnecessary data from the dataset to ensure that the data used for analysis was complete and of high quality. After cleansing, 1,160 usable data entries remained.

4.2.2 Data Analysis and Predictive Model Development:

The dataset was split into two equal parts: 580 entries for training and 580 for testing. This division was necessary for developing and validating a predictive model to ensure its accuracy before implementation.

4.3 Analyzing Causal Factors Affecting Predictive Student Relationship Management using Business Intelligence Concepts for the Retention of Undergraduate Students Using Statistical Tools: Exploratory Factor Analysis (EFA)

EFA was employed to identify which common factors can explain the interrelationships among various variables and to reduce the number of original variables into fewer grouped factors. Data from 35 questionnaire variables were used for the exploratory factor analysis.

Table 1. Factor, Eigen Value, and Percentage of Variance

Factor	Eigen Value	Percentage of Variance	Cumulative percentage of Variance
1	7.670	25.568	25.568
2	7.398	24.660	50.228
3	3.632	12.105	62.333
4	2.072	6.907	69.240
5	1.069	3.563	72.803

From Table 1, considering the components with eigenvalues greater than 1, there are a total of 5 components with a cumulative variance of 72.803%. The results of the orthogonal rotation, specifically using the Varimax method, after extracting 5 components were aimed at clarifying the relationships between variables and components. Variables with factor loadings of .60 or higher, regardless of positive or negative values, were selected. The results were shown in Table 2.

Table 2. Variables, Indicators, and Factor Weights in Component 1

Variables	Indicators	Factor Weights
C1	There are easily accessible channels for communicating with academic advisors, such as Facebook and Line.	.841
C2	There are various accessible channels for contacting classmates, such as Facebook and Line.	.850
C3	There is convenience in communicating with academic advisors.	.788
C4	Receiving attention and care from academic advisors.	.797
C5	When encountering adjustment issues, students can seek advice from academic advisors.	.817

From Table 2, Component 1 consisted of 5 indicators with factor loadings ranging from .788 to .850. This component was named "Student Communication Channels.

Table 3. Variables, Indicators, and Factor Weights in Component 2

Variables	Indicators	Factor Weights
A1	Able to study and research independently.	.857
A2	Easily understands the material studied.	.877
A3	Able to take clear notes during lectures.	.860
A4	Consistently consults professors when encountering problems with studies or assigned tasks.	.780
A5	Capable of explaining studied material to peers for their understanding.	.835
A6	Always reads in preparation for exams in advance.	.858
A7	Able to apply principles, rules, and methods learned to solve problems in new situations.	.864
A8	Exhibits enthusiasm for learning activities.	.884
A9	Willing to cooperate with peers on group tasks.	.772

From Table 3, Component 2 consisted of 9 indicators with factor loadings ranging from .772 to .884. This component was named "Academic Proficiency."

Table 4. Variables, Indicators, and Factor Weights in Component 3

Variables	Indicators	Factor Weights
F1	When issues arise, parents are always available to assist and provide advice.	.904
F2	Parents offer guidance on further education.	.901
F3	Parents monitor and advise on academic matters.	.909
K1	Regularly participates in extracurricular activities.	.756

From Table 4, Component 3 consisted of 4 indicators with factor loadings ranging from .756 to .909. This component was named "Parental Guidance."

Table 5. Variables, Indicators, and Factor Weights in Component 4

Variables	Indicators	Factor Weights
D1	Consistently receives information on scholarship opportunities.	.715
D2	Receives information about the Student Loan Fund (SLF).	.808
D3	Receives counseling and services from staff regarding scholarship applications.	.695
D6	Receiving scholarships reduces the need to seek additional part-time employment.	.645

From Table 5, Component 4 consisted of 4 indicators with factor loadings ranging from .645 to .808. This component was named "Scholarship."

4.4 Confirmatory Factor Analysis (CFA)

After obtaining factors from the exploratory factor analysis, in developing the predictive student relationship management model using business intelligence concepts for undergraduate student retention, the four

components; Student Communication Channels, Academic Proficiency, Parental Guidance, and Scholarship will be subjected to CFA to validate the accuracy of these factors. This step was conducted using the AMOS software to assess the suitability of the measurement model for all variables, as illustrated in Figure 1.

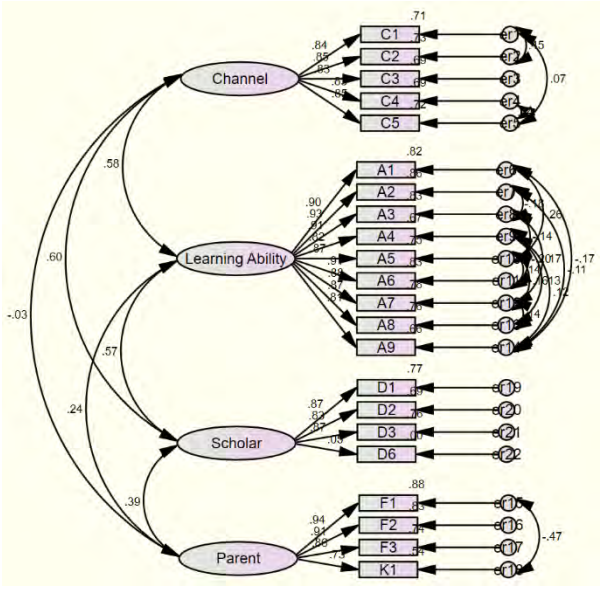

Figure 1. Second Stage Confirmatory Factor Analysis

Chi-square = 1397.025, Chi-square/df =7.471, df= 187, p= .000

GFI = .918, CFI = .951, RMR = .050, RMSEA = .075

From Figure 1 and the statistical evaluation of the model fit with empirical data, it was found that only the GFI, CFI, and RMR values met the criteria. However, when considering the Correlation Coefficient, which indicates the relationship between two variables, it was observed that within the same component, there is a high degree of clustering and clear differentiation between groups, except for the variable D6, as shown in Figure 6.

	K1	F3	F2	F1	D6	D3	D2	D1	A9	A8	A7	A6	A5	A4	A3	A2	A1	C5	C4	C3	C2	C1
K1	1.000																					
F3	.633	1.000																				
F2	.668	.783	1.000																			
F1	.577	.807	.852	1.000																		
D6	.014	.016	.017	.017	1.000																	
D3	.250	.293	.309	.319	.041	1.000																
D2	.239	.280	.296	.305	.039	.725	1.000															
D1	.251	.295	.311	.321	.041	.762	.728	1.000														
A9	.143	.168	.177	.183	.022	.401	.383	.403	1.000													
A8	.154	.181	.191	.197	.023	.433	.414	.435	.708	1.000												
A7	.156	.183	.193	.199	.024	.438	.419	.440	.716	.805	1.000											
A6	.161	.188	.199	.205	.024	.450	.431	.453	.737	.795	.804	1.000										
A5	.153	.179	.189	.195	.023	.429	.410	.431	.701	.757	.802	.816	1.000									
A4	.144	.169	.179	.184	.022	.405	.387	.407	.703	.750	.723	.697	.708	1.000								
A3	.161	.188	.199	.205	.024	.450	.430	.452	.736	.794	.836	.827	.757	.743	1.000							
A2	.164	.192	.203	.209	.025	.459	.439	.461	.727	.810	.820	.843	.803	.758	.814	1.000						
A1	.160	.187	.198	.204	.024	.447	.428	.450	.690	.790	.799	.822	.839	.739	.821	.838	1.000					
C5	-.021	-.025	-.026	-.027	.024	.443	.423	.445	.398	.430	.435	.447	.425	.402	.447	.456	.444	1.000				
C4	-.021	-.025	-.026	-.027	.024	.434	.415	.437	.390	.421	.426	.438	.417	.394	.438	.447	.436	.720	1.000			
C3	-.021	-.024	-.026	-.027	.023	.431	.412	.434	.388	.418	.423	.435	.414	.391	.435	.444	.433	.704	.690	1.000		
C2	-.021	-.025	-.027	-.027	.024	.444	.424	.446	.399	.431	.436	.448	.426	.403	.448	.457	.445	.724	.710	.705	1.000	
C1	-.021	-.025	-.026	-.027	.024	.438	.419	.440	.394	.425	.430	.442	.421	.397	.442	.451	.439	.736	.700	.696	.844	1.000

Figure 2. Correlation Coefficient

Pharse 2: *Develop a predictive student relationship management model using business intelligence concepts for the retention of undergraduate students*

After conducting stepwise multiple regression analysis on individual components, it was confirmed that all factors analyzed had an impact on undergraduate student retention. In regression analysis, the exclusion of certain factors was a critical step aimed at enhancing the predictive accuracy and interpretability of the model. Factors were typically excluded based on a combination of statistical significance, theoretical relevance, and data

quality. Variables that failed to achieve a predefined level of statistical significance (e.g., $p > 0.05$) were removed to ensure that only those with meaningful contributions to the outcome variable were retained. Additionally, multicollinearity was addressed by excluding variables with high correlation to other predictors, as such, redundancy could distort estimates and reduce model stability.However, to enhance the predictive model's clarity, and less influential factors were excluded. The final analysis, focusing on significant variables, showed how these factors interact and contribute to retention outcomes. The results, as presented in Table 6, highlight the most impactful factors and provide a refined predictive framework, emphasizing the key drivers of student success and retention. This streamlined approach ensured that only the most relevant variables were considered in efforts to improve retention strategies.

Table 6. Results of Stepwise Multiple Regression Analysis for Predicting Undergraduate Student Retention

Undergraduate Student Retention Factors		Coefficients	t	sig
A3	Able to take clear notes during lectures.	.065	4.760	.000
D3	Receives counseling and services from staff regarding scholarship applications.	.188	4.827	.000
C2	There are various accessible channels for contacting classmates, such as Facebook and Line.	.101	4.794	.000
C3	There is convenience in communicating with academic advisors.	.083	3.942	.000
A4	Consistently consults professors when encountering problems with studies or assigned tasks.	.036	3.243	.001
C1	There are easily accessible channels for communicating with academic advisors, such as Facebook and Line.	.112	5.296	.000
A1	Able to study and research independently.	.049	3.709	.000
C4	Receiving attention and care from academic advisors.	.085	3.660	.000
D2	Receives information about the Student Loan Fund (SLF).	.124	3.543	.000
A9	Willing to cooperate with peers on group tasks.	.031	3.219	.001
	R = 881, R Square = .777, Adjusted R Square = .774			
	Std. Error Square = .260			

**p < .05

The analysis from Table 6 identifies key affecting undergraduate student retention, including academic engagement, social integration, and institutional support. Critical elements such as taking clear notes during lectures, regular consultation with professors, access to counseling regarding scholarships, and communication with classmates and academic advisors significantly affect retention. Independent study skills and peer collaboration also contribute to persistence. The findings highlight that student retention was driven by a combination of academic readiness, financial stability, social support, and institutional care, all of which were essential for student success.These factors collectively underscore the importance of a supportive learning environment, effective academic advising, and financial aid in promoting undergraduate retention. Institutions aiming to improve retention rates should prioritize these areas to foster a more conducive environment for student success. Based on the data analysis, a predictive equation for undergraduate student retention had been developed as follows:

$$\hat{Y} = .353 + .065(A_3) + .188(D_3) + .101(C_2) + .083(C_3) + .036(A_4) + .112(C_1) + .049(A_1) + .085(C_4) + .124(D_2) + .031(A_9)$$

The model yielded a multiple correlation coefficient (R) of 0.881, and an adjusted R Square of 0.777, indicating that the model can predict 77.7% of the variance in student retention outcomes. This high degree of predictive accuracy demonstrated the strong relationship between these factors and student retention, emphasizing the importance of academic support, communication, financial guidance, and peer collaboration in affecting students' decisions to persist in their studies.

5. Discussion

The findings from Table 6, which highlight key factors influencing undergraduate student retention, align with and expand upon existing research on student retention in higher education. These factors—ranging from academic support, financial aid, and peer collaboration to effective communication with faculty and advisors—are consistently underscored in scholarly literature as critical to student persistence.

Academic Support and Engagement: The ability to take clear notes during lectures (A3) and the importance of

regularly consulting professors when facing academic challenges (A4) directly correlate with Tinto's (2019) model of student retention, which emphasizes academic integration as a core determinant of student persistence. Tinto argues that students who engage meaningfully with their academic work, maintain strong academic performance, and seek out help when necessary are more likely to persist to graduation. Similarly, Bowman et al. (2020) highlight that students' preparedness and their ability to engage with course material, through skills like note-taking, enhance their academic success and retention.

Financial Aid and Institutional Support: The role of financial support, as evidenced by the importance of receiving counseling and services regarding scholarship applications (D3) and information about the Student Loan Fund (D2), reflects Hossler and Vesper's (2019) findings, which note that financial aid is one of the most significant predictors of student retention. Their research demonstrates that students with adequate financial support are more likely to persist, as financial burdens are a common reason for dropout. Additionally, Castleman and Long (2020) emphasize that well-structured financial aid programs, especially those offering scholarships, can significantly improve retention, particularly for students from low-income backgrounds.

Social Integration and Peer Collaboration: The analysis also underscores the importance of social integration, with factors such as accessible communication with classmates (C2) and willingness to cooperate on group tasks (A9) emerging as significant predictors of retention. This is consistent with Tinto's (1993) theory of student departure, which posits that social integration within the academic environment—through peer interactions and collaboration—positively impacts student retention. Wilkins and Huisman (2019) also found that strong relationships with peers foster a sense of belonging, which is essential for students to remain engaged and committed to their academic goals.

Institutional Communication and Advising: The findings further highlight the importance of easy communication with academic advisors (C1, C3) and receiving personal attention from them (C4). According to Robinson and Hullinger (2019), effective advising and frequent communication with faculty and staff contribute to a student's sense of connection to the institution, which enhances retention. When students feel supported by their advisors, they are more likely to seek assistance, navigate academic difficulties, and ultimately succeed.

Self-Directed Learning: Independent learning ability (A1) as a retention factor reflects findings from Schunk and DiBenedetto (2020), who argue that self-regulation and independent study skills are vital for academic success in higher education. Students who can effectively manage their own learning are more resilient in overcoming academic challenges and are more likely to complete their studies.

6. Conclusion

In summary, the key factors influencing student retention identified in this analysis are well-supported by existing literature. Academic engagement, social integration, financial support, and strong advising relationships all play critical roles in determining whether students persist in their studies. Institutions aiming to improve retention should focus on enhancing these areas, providing comprehensive academic support, robust financial aid programs, and effective communication systems to foster a supportive environment that encourages student success.

Future research should examine longitudinal data to identify retention trends, explore how university policies influence outcomes, and investigate non-academic factors like mental health and extracurricular involvement. Tailored predictive models for subpopulations, such as first-generation or part-time students, can guide targeted interventions. These efforts will address research gaps, enhance policy effectiveness, and develop comprehensive strategies to better support diverse student needs and improve retention outcomes.

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Data sharing statement

No additional data are available.

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