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From enrollees to exit: Exploring factors associated with attrition in mathematics teacher education

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Abstract

This study aimed to identify the key factors associated with student attrition in the Bachelor of Secondary Education major in Mathematics (BSED Mathematics) program. Data were collected through an online Likert-scale questionnaire administered to 201 participants from BSED Mathematics programs across different higher education institutions (HEIs) in the Philippines. The participants included graduates, students who shifted to other programs, and students who discontinued their studies. Convenience sampling was used to recruit participants. Exploratory factor analysis (EFA) was conducted to identify the underlying dimensions associated with student attrition. The analysis revealed four factors: academic factors, curriculum and instruction, economic factors, and personal factors. Together, these factors explained 54.27% of the total variance, with factor loadings ranging from 0.413 to 0.783. The findings indicate that student attrition in BSED Mathematics is associated with multiple and interrelated factors involving academic experiences, curriculum and instruction, economic conditions, and personal circumstances. These findings provide a basis for understanding the factors that may contribute to students' decisions to remain in, shift from, or discontinue a mathematics teacher education program and may inform the development and evaluation of appropriate student-retention strategies in mathematics teacher education.

Keywords: Exploratory factor analysis (EFA); Higher education institutions (HEIs); Mathematics teacher education; Students' attrition

Introduction

Higher education has expanded substantially over the past decades, particularly in terms of student enrollment. Globally, more than 235 million students were enrolled in higher education in 2020, more than twice the approximately 100 million students enrolled in 2000 (Detmer, 2022). Despite this substantial growth, student attrition remains a major concern for higher education institutions worldwide. Student attrition refers to students discontinuing or leaving their academic programs before completion and may be associated with various factors, including students' adaptation to the academic environment, personal characteristics, socioeconomic conditions, teacher–student relationships, and the quality of educational provision (Lorenzo-Quiles, et al., 2023). High levels of attrition can affect students' academic and professional development and may also create challenges for higher education institutions in maintaining student retention and program completion.

The issue is also evident in the Philippine higher education context. The projected student attrition rate in the Philippines for the 2023–2024 school year was reported at 35.15%. In addition, a research initiative launched by the Commission on Higher Education (CHED) on February 12, 2024, to examine student admission and retention reported that at least four out of ten higher education students had temporarily or permanently left their institutions during the 2022–2023 academic year. These figures indicate that student attrition is not only an individual educational concern but also an important issue for Philippine higher education institutions. Understanding the factors associated with students' decisions to remain in or leave their programs is therefore important for developing appropriate retention strategies.

Previous studies in the Philippine context have identified several factors associated with student attrition. Bernardino et al. (2024), for example, examined student attrition behavior in a private higher education institution in the Philippines and found that academic, financial, and personal factors were among the common reasons for students' temporary discontinuation of their studies. Similarly, Bravo (2023), in a study conducted at a public state university in Northern Philippines, found that financial difficulties were the most common reason for student dropout despite the implementation of the Free Tuition Act. Other reasons included transferring to another institution and health-related concerns. These findings highlight the multifaceted nature of student attrition and indicate that students' decisions to discontinue their studies may result from the interaction of academic, economic, personal, and institutional circumstances. Understanding these factors is important for higher education institutions seeking to develop appropriate interventions to support student persistence and program completion.

Although student attrition has received considerable attention in higher education research, comparatively limited research has examined the issue among students enrolled in Bachelor of Secondary Education major in Mathematics (BSED Mathematics) programs, particularly in the Philippine context. BSED Mathematics students may encounter program-specific challenges associated with the academic demands of mathematics, curriculum and instruction, and personal and economic circumstances. The nature of mathematics teacher education also requires students to develop both mathematical knowledge and pedagogical competencies, which may create distinctive academic and curricular demands. Consequently,

findings from studies of student attrition in higher education in general may not fully explain the experiences of students in mathematics teacher education programs.

This gap highlights the need to examine the factors associated with attrition specifically among BSED Mathematics students. A better understanding of these factors may help higher education institutions identify areas that require attention and develop more appropriate strategies to support students' persistence and successful completion of their programs. Therefore, this study examined the experiences of graduates, students who shifted from BSED Mathematics to other programs, and students who discontinued their studies from BSED Mathematics programs in selected higher education institutions in the Philippines. Exploratory Factor Analysis (EFA) was employed to identify the underlying dimensions of factors associated with student attrition. Specifically, the study aimed to identify the key factors associated with student attrition in BSED Mathematics programs and provide a basis for developing appropriate student-retention interventions.

Methods

This study employed a quantitative descriptive research design to examine the factors associated with student attrition in the BSED Mathematics program. The study involved individuals who had graduated from the BSED Mathematics program, students who initially enrolled in the program but subsequently shifted to another program, and students who discontinued their studies during Academic Years 2019–2024. A quantitative approach was appropriate because the study collected participants' responses using a Likert-scale questionnaire and analyzed the data using statistical procedures.

A total of 201 respondents participated in the study. Participants were recruited using convenience sampling, a non-probability sampling technique in which individuals are selected based on their accessibility, availability, and willingness to participate. This approach was used to facilitate the recruitment of eligible participants who could be reached through online platforms.

Because convenience sampling was used, the study may have been subject to selection bias. Individuals who were more accessible, active on social media, or willing to participate may have differed systematically from those who were not reached or chose not to participate. Therefore, the 201 respondents may not fully represent the broader population of BSED Mathematics graduates, shifters, and dropouts during Academic Years 2019–2024. The findings should consequently be interpreted within the context of the respondents participating, and generalization to the wider population should be made with caution.

Research Instrument

The researchers developed a Likert-scale questionnaire to collect data on factors potentially associated with student attrition in the BSED Mathematics program. The questionnaire consisted of 28 items representing different aspects that may be related to students' decisions to remain in, shift from, or discontinue the program. The questionnaire was administered

electronically through Google Forms. The online format facilitated access to eligible participants from different locations and enabled efficient collection and organization of responses.

Before the questionnaire was administered to the main participants, a pilot test was conducted to assess the internal consistency of the instrument. Thirty individuals who met the general characteristics of the target participants, namely graduates, shifters, and dropouts from the BSED Mathematics program at Central Bicol State University of Agriculture (CBSUA) during Academic Years 2019–2024, participated in the pilot test.

The pilot-test data were analyzed using Cronbach's alpha. The initial Cronbach's alpha coefficient was 0.853, indicating good internal consistency. However, two items showed negative item-total correlations. After these two items were removed, the Cronbach's alpha coefficient increased to 0.877, indicating improved internal consistency. The final questionnaire therefore consisted of 26 items that were retained for the main data collection.

Data Collection

To recruit eligible participants, the researchers developed an electronic recruitment poster containing the eligibility criteria, a link to the questionnaire, and information about the incentive offered to participants. The poster was disseminated through the researchers' social media accounts. Interested individuals accessed the questionnaire through the provided link and completed the survey electronically. The collected responses were subsequently organized and prepared for statistical analysis.

Data Analysis

The collected data were analyzed using EFA to examine the underlying structure of the questionnaire items and identify the common dimensions associated with student attrition. Before conducting the EFA, the suitability of the data for factor analysis was assessed using the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity.

Because the questionnaire used Likert-scale items, the analysis employed a polychoric correlation matrix. Maximum likelihood was used as the factor-extraction method, and oblimin rotation was applied to allow the extracted factors to correlate. A factor loading of .40 was used as the minimum criterion for interpreting substantial relationships between items and factors. The factor structure was examined based on eigenvalues, percentage of variance explained, factor loadings, communalities, and uniqueness values.

Results and Discussion

This section presents and discusses the findings obtained from graduates, shifters, and students who discontinued the BSED Mathematics program at selected higher education institutions in the Philippines. The EFA was conducted to examine the underlying structure of the questionnaire items and identify the major dimensions associated with student attrition. The findings are presented in relation to the research objective and are further discussed in light of

relevant literature. The discussion focuses on the four factors identified through the EFA and their possible implications for student retention and the educational experiences of BSED Mathematics students.

Exploratory Factor Analysis

An EFA was conducted using responses from 201 participants to examine the underlying structure of the questionnaire items. Because the items were measured using an ordered Likert-scale response format, a polychoric correlation matrix was used. Maximum likelihood was employed as the factor-extraction method, while oblimin rotation was applied to allow the extracted factors to correlate. Factor loadings of .40 or higher were considered substantial for interpretation.

Before factor extraction, the suitability of the data for factor analysis was assessed using the KMO measure of sampling adequacy and Bartlett's test of sphericity. As shown in Table 1, the KMO value was .746, indicating adequate sampling adequacy for factor analysis. Bartlett's test of sphericity was statistically significant, $\chi^2(378) = 4112.359$, $p < .001$, indicating that the correlation matrix differed significantly from an identity matrix. These results indicate that the relationships among the questionnaire items were sufficient to proceed with factor analysis.

Table 1. Test of Sampling Adequacy and Factorability

Test	Value
Kaiser–Meyer–Olkin (KMO)	0.746
Bartlett's χ^2	4112.359
Degrees of freedom	378
p-value	< .001

The initial four-factor solution produced eigenvalues of 10.900, 1.915, 1.245, and 1.136, respectively. These factors accounted for 38.93%, 6.84%, 4.45%, and 4.06% of the total variance, respectively, resulting in a cumulative explained variance of 54.27% presented in Table 2. Thus, the four-factor solution explained more than half of the variance represented by the questionnaire items.

Table 2. Eigenvalues and Percentage of Variance Explained by the Four-Factor Solution

Factor	Eigenvalue	Percentage of Variance	Cumulative Percentage
Factor 1	10.900	38.93	38.93
Factor 2	1.915	6.84	45.77
Factor 3	1.245	4.45	50.22
Factor 4	1.136	4.06	54.27

The factor loadings provided an empirical basis for grouping the questionnaire items into four dimensions presented in Table 3. Factor 1 consisted primarily of items related to academic and instructional experiences, Factor 2 comprised items associated with curriculum and academic difficulty, Factor 3 included items reflecting economic and other contextual

circumstances, and Factor 4 consisted mainly of items related to personal engagement and social experiences.

Table 3. Factor Loadings, Uniqueness, and Communalities of the Questionnaire Items

Item	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness	Communality
23. Quality of instruction	.840	—	—	—	.281	.719
20. Instructor support	.785	—	—	—	.347	.653
7. Learning environment	.778	—	—	—	.439	.561
21. Course content	.775	—	—	—	.207	.793
9. Teaching style	.759	—	—	—	.470	.530
8. Teacher punctuality	.699	—	—	—	.494	.506
6. Class size	.667	—	—	—	.481	.519
22. Grades	.604	—	—	—	.389	.611
28. Academic coursework	.581	—	—	—	.415	.585
15. Limited teachers	.565	—	—	—	.540	.460
1. Low examination scores	—	.728	—	—	.408	.592
14. Difficult curriculum	—	.689	—	—	.237	.763
19. Difficult courses	—	.689	—	—	.276	.724
2. Understanding Mathematics	—	.654	—	—	.362	.638
5. Memorizing mathematical formulas	—	.401	—	—	.555	.445
18. Health-related issues	—	—	.669	—	.490	.510
24. Unexpected expenses	—	—	.610	—	.435	.565
16. Class scheduling conflicts	—	—	.585	—	.524	.476
11. Lack of money	—	—	.557	—	.553	.447
25. Family responsibilities	—	—	.542	—	.665	.335

Item	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness	Communality
17. Emotional and mental difficulties	—	—	.480	—	.547	.453
4. Lack of effort in papers/projects	—	—	—	.812	.286	.714
3. Inactivity during class discussion	—	—	—	.639	.458	.542
13. Parents' preference	—	—	—	.517	.440	.560
12. Communication with classmates	—	—	—	.488	.548	.452
10. Paperwork	—	—	—	—	.803	.197
26. Time management and adjustment	—	—	—	—	.468	.532
27. Classmates' attitudes and values	—	—	—	—	.713	.287

Most items demonstrated substantial loadings on one of the four factors. Factor 1 had loadings ranging from .565 to .840, Factor 2 from .401 to .728, Factor 3 from .480 to .669, and Factor 4 from .488 to .812. Three items, such as Item 10 (Paperwork), Item 26 (Time management and adjustment), and Item 27 (Classmates' attitudes and values), did not demonstrate factor loadings of at least .40 and therefore were not assigned to any of the four factors in the initial solution as shown in Figure 1.

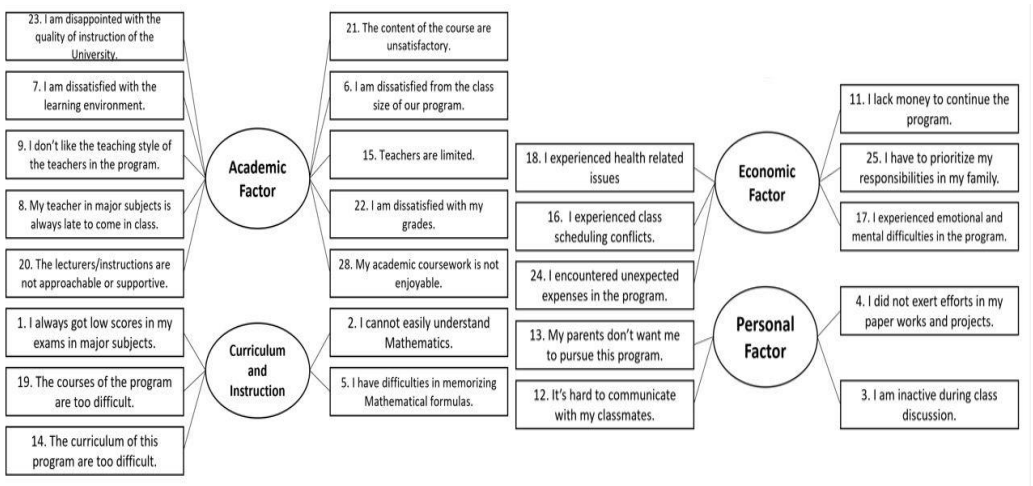


Figure 1. Conceptual Representation of the Four-Factor Structure Associated with Student Attrition

Figure 1 provides a conceptual representation of the four-factor structure identified through the EFA. The figure summarizes the factor structure, while Tables 1–3 provide the statistical evidence underlying the interpretation. Based on the common content of the items with substantial loadings, the four factors were labeled Academic Factor, Curriculum and Instruction, Economic and Contextual Factor, and Personal Factor.

Academic Factor

The Academic Factor emerged as the first factor and consisted primarily of items related to students' academic and instructional experiences. These included quality of instruction, instructor support, learning environment, course content, teaching style, teacher punctuality, class size, grades, academic coursework, and the availability of teachers. The highest loading was observed for Item 23, concerning quality of instruction (.840), followed by Item 20, concerning instructor support (.785), and Item 7, concerning the learning environment (.778).

The findings indicate that students' experiences of the academic environment and instructional quality represent an important dimension associated with attrition in the BSED Mathematics program. This finding is consistent with previous research emphasizing the role of academic experiences in student persistence. The University of Southern Mississippi (USM) reported that high-quality teaching was associated with greater student retention and persistence. Similarly, Magen-Nagar and Shachar (2017) emphasized the importance of teaching quality in reducing the risk of student dropout.

Supportive instructors and a conducive learning environment may help students remain engaged with their academic work. In contrast, students who perceive instruction as ineffective or insufficiently supportive may experience greater difficulty understanding course content, which may contribute to lower academic performance and reduced motivation. Tandet (2023) identified academic performance as an important factor in students' decisions to persist in their educational programs. Poor grades and difficulties in understanding course material may therefore increase the risk of discontinuing a program, particularly when students encounter demanding coursework or difficulties in managing academic requirements.

For BSED Mathematics students, these findings highlight the importance of instructional quality, teacher support, and the learning environment. Strengthening these aspects may provide students with greater academic support and help address difficulties that may otherwise contribute to decisions to shift programs or discontinue their studies.

Curriculum and Instruction

The Curriculum and Instruction factor consisted of five items related primarily to academic difficulty. These included low examination scores, difficult courses, a difficult curriculum, difficulty understanding mathematics, and difficulty memorizing mathematical formulas. Factor loadings ranged from .401 to .728, with Item 1, concerning low examination scores, showing the highest loading (.728).

The findings suggest that students' perceptions of curriculum difficulty and the demands of mathematical learning constitute a distinct dimension associated with attrition. A well-

structured and relevant curriculum can provide students with meaningful learning experiences and support their academic progression. McLeod (2019) reported that curriculum redesign that incorporated more structured and student-responsive learning materials was associated with improved student retention. Conversely, students may experience dissatisfaction when curricular content does not adequately respond to their needs or appears disconnected from meaningful applications. Edalatifard et al. (2012) similarly argued that students may leave academic programs when they perceive their curriculum as insufficiently engaging or disconnected from real-world applications.

Instruction is closely related to curriculum because it determines how curricular content is presented and experienced by students. Donch (2024) emphasized the importance of instructional methods in shaping students' classroom experiences. Engaging and interactive instructional approaches may promote participation and support learning, whereas inadequate instructional support and limited resources may negatively affect students' academic experiences.

The EFA findings therefore indicate that curriculum difficulty and instructional demands represent an important dimension of attrition among BSED Mathematics students. Institutions may need to regularly review the relevance, sequencing, and difficulty of mathematics courses while ensuring that instructional practices provide adequate support for students who experience difficulties with mathematical concepts.

Economic and Contextual Factor

The third factor consisted of six items concerning health-related issues, unexpected expenses, class scheduling conflicts, lack of money, family responsibilities, and emotional and mental difficulties. The factor loadings ranged from .480 to .669. Item 18, concerning health-related issues, had the highest loading (.669), followed by unexpected expenses (.610) and class scheduling conflicts (.585). Item 11, concerning lack of money to continue the program, also demonstrated a substantial loading (.557).

Although this factor includes financial concerns, the item composition indicates that it extends beyond economic conditions alone. The factor also captures health, family, scheduling, and emotional circumstances that may affect students' ability to continue their studies. Therefore, it is more appropriately interpreted as an Economic and Contextual Factor rather than as a purely economic dimension.

Financial difficulty remains an important concern in higher education. Students may experience challenges associated with tuition and living expenses, learning materials, employment obligations, and unexpected financial demands. Alcauter, et al. (2023) reported that students from economically disadvantaged backgrounds may be more likely to discontinue their studies because of financial stress, work obligations, or unstable home environments. Similarly, Watermark (2023) noted that financial burdens related to tuition, textbooks, and living expenses may make it more difficult for students to remain enrolled.

Olufemioladebinu, et al. (2018) also found that students from lower socioeconomic backgrounds may experience poorer academic outcomes and a greater likelihood of leaving

school than students from more advantaged backgrounds. In the present study, however, financial circumstances were found alongside health, family, scheduling, and emotional concerns. These findings suggest that students' decisions to continue or discontinue their studies may be shaped by a combination of financial and contextual circumstances rather than by financial difficulty alone.

This finding has important implications for retention efforts. Student-support policies should therefore extend beyond tuition assistance to include flexible academic arrangements, health services, counseling, and mechanisms for assisting students who face unexpected personal or family circumstances.

Personal Factor

The Personal Factor consisted of four items related to students' personal engagement and social experiences: lack of effort in papers and projects, inactivity during class discussions, parents' preferences, and communication with classmates. Item 4, concerning lack of effort in papers and projects, had the highest loading (.812), followed by Item 3, concerning inactivity during class discussions (.639).

The findings suggest that students' personal engagement and social experiences constitute another dimension associated with attrition. Ertem and Gokalp (2022) reported that personal factors can influence student attrition, particularly when students encounter circumstances that affect their ability to cope with academic demands. Limited engagement in academic activities may be associated with reduced motivation and participation, while difficulties in communicating with classmates may weaken students' sense of connection with their learning environment.

Social support may also influence students' educational experiences. Limited support from family or peers may increase feelings of isolation and make it more difficult for students to manage academic demands. Sa' (2023) emphasized that weak connections with peers and the academic community may negatively affect student retention. When students feel isolated or disengaged from their institution, they may become more likely to consider leaving their program. The present findings therefore indicate that personal engagement, family influence, and social interaction constitute an additional dimension associated with attrition among BSED Mathematics students. Retention efforts should consequently consider not only academic and financial support but also students' social integration, motivation, and personal decision-making.

Suggested Interventions to Address Student Attrition

The four factors identified through the EFA provide a basis for considering possible interventions to support student retention in BSED Mathematics programs. These interventions should be viewed as potential institutional responses to the factors identified in the study, rather than as interventions whose effectiveness was directly tested in the present research.

For the Academic Factor, institutions may strengthen the quality of teaching through continuous professional development, improved assessment practices, and additional academic

support. Mintz (2024) noted that professional development through training and seminars can provide teachers with strategies for lesson planning, effective communication, and classroom organization, all of which can contribute to more engaging learning environments. Similarly, Karlberg and Bezzina (2022) emphasized that continuous professional support can enhance teacher motivation and engagement, which may subsequently influence student performance.

Another possible intervention is the provision of remedial or supplementary instruction for students who experience academic difficulties. Remedial programs are designed to provide additional learning opportunities for students who have difficulty meeting expected academic standards. Rai and Penjor (2020), for example, found that students who participated in remedial classes demonstrated improvements in learning achievement. Their findings also indicated positive student perceptions of remedial teaching, suggesting potential benefits for motivation and engagement.

Furthremore, the Curriculum and Instruction factor indicates the need to examine the difficulty, structure, and relevance of courses within the BSED Mathematics program. Regular curriculum review and improvement of instructional practices may help address difficulties associated with mathematical content, formula memorization, and low examination performance. McLeod (2019) found that contextualized and program-specific learning modules in an online student-success course were associated with improved student retention. This finding suggests that learning experiences that are responsive to students' program-specific needs may support persistence. For BSED Mathematics programs, curriculum review may therefore consider the sequencing of mathematical courses, students' prerequisite knowledge, the integration of meaningful applications, and the availability of instructional support for difficult topics.

The Economic and Contextual Factor highlights the importance of addressing financial, health, family, scheduling, and emotional circumstances that may interfere with students' continuation in the program. Students experiencing financial difficulties may need to divide their time between academic responsibilities and employment, potentially increasing stress and reducing the time available for study.

Possible institutional responses include expanding financial assistance, providing flexible payment arrangements, offering financial literacy programs, and strengthening student-support services. Conzatti (2022), for example, reported that the New York Excelsior program, which provided tuition-free college for eligible middle-class New Yorkers, was associated with a 7% increase in student retention. Although the institutional and policy context differs from that of the Philippines, this finding illustrates the potential relationship between financial support and persistence. Because the factor also includes health and emotional concerns, financial assistance alone may not be sufficient. Institutions may also consider accessible health services, counseling, flexible scheduling, and referral mechanisms for students experiencing personal or family difficulties.

Finally, the Personal Factor highlights issues related to student engagement, family influence, and social interaction. Pressure from parents regarding program choice may create conflict when students' interests do not align with family expectations. Similarly, limited

motivation, weak peer relationships, or low participation in academic activities may contribute to disengagement from the program.

Higher education institutions may address these concerns by strengthening counseling, academic advising, career guidance, peer-support programs, mentoring, and opportunities for social integration. Such support may help students make more informed decisions about their academic and career pathways while strengthening their connection with the institution.

Selagea (2024) emphasized the importance of creating an environment in which students feel comfortable seeking assistance when facing academic or personal difficulties. Peer-support systems may also help students navigate challenging experiences by connecting them with peers who can provide encouragement and shared experiences. Mentoring or buddy programs, group activities, and team-building initiatives may further strengthen students' sense of belonging and reduce feelings of isolation.

Taken together, the four factors identified in this study suggest that student attrition in BSED Mathematics is a multidimensional issue. Academic experiences, curriculum and instructional demands, economic and contextual circumstances, and personal and social experiences may intersect in shaping students' decisions to remain in, shift from, or discontinue a program. Therefore, retention strategies should not rely on a single intervention. Instead, institutions may benefit from a coordinated support system that combines academic assistance, curriculum improvement, financial and contextual support, and personal and social services.

Conclusion

This study identified four dimensions associated with student attrition in the BSED Mathematics program: Academic Factor, Curriculum and Instruction, Economic and Contextual Factor, and Personal Factor. Together, these factors explained 54.27% of the total variance in the questionnaire responses. The findings indicate that student attrition in BSED Mathematics is a multidimensional issue associated with students' academic experiences, perceptions of curriculum and instructional demands, economic and contextual circumstances, and personal and social experiences.

The findings suggest that higher education institutions may strengthen student-retention efforts by improving instructional quality and academic support, reviewing curriculum and teaching practices, expanding financial and contextual support services, and strengthening counseling, mentoring, and peer-support programs. Such measures may help create a more supportive learning environment and address some of the circumstances associated with students' decisions to remain in, shift from, or discontinue the program. However, the present study did not evaluate the effectiveness of these interventions; therefore, these recommendations should be considered potential strategies rather than empirically established solutions.

Several limitations should also be considered. Three questionnaire items (Items 10, 26, and 27) did not meet the .40 factor-loading criterion in the four-factor solution and therefore require further examination. In addition, the factor structure identified through EFA is

exploratory and should not be regarded as a definitive measurement model. Future research should validate the identified structure using confirmatory factor analysis (CFA) with an independent sample. Further studies may also examine whether retention strategies developed from the identified factors are effective in improving student persistence and reducing attrition across different higher education institutions and contexts.

Ethical Considerations

The study was conducted in accordance with established ethical principles for research involving human participants. Prior to data collection, ethical approval was obtained from the appropriate institutional research ethics committee. Participants were informed of the purpose and procedures of the study, as well as its potential risks and benefits, and provided informed consent before participation. Participation was voluntary, and participants were informed that they could decline to answer any question or withdraw from the study at any time without penalty. Given the potentially sensitive nature of the questionnaire, which addressed academic experiences, financial circumstances, health, and psychological concerns, appropriate measures were taken to protect participants' privacy and confidentiality. No personally identifiable information was included in the dataset or reported in the manuscript. The collected data were securely stored and accessed only by the researchers for research purposes. The findings were reported in aggregate form to minimize the possibility of identifying individual participants.

Conflicts of Interest

The authors declare that they have no conflict of interest regarding the research, authorship, and publication of this manuscript. The authors have no financial, professional, or personal relationships that could have influenced the conduct, analysis, interpretation, or reporting of the study.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During revision of this manuscript, the authors used generative AI and AI-assisted technologies for language editing, grammar correction, clarity, organization, and refinement. The AI tools were not used to collect, generate, or manipulate research data, conduct statistical analyses, or determine the study's findings or conclusions. The authors reviewed and verified all AI-assisted content and remain fully responsible for the accuracy, originality, integrity, and final content of the manuscript.

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