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Research article

Factors affecting success and failure in higher education mathematics: Students' and teachers' perspectives

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ABSTRACT

Background: Students from Bangladesh pursuing STEM education often encounter obstacles when tackling diverse mathematical problems within various educational settings. Frequently, they find themselves lacking the essential prerequisite knowledge and strong foundational skills necessary to engage with the teaching and learning resources utilized at the undergraduate level, resulting in a significant number of students needing to seek readmission annually.
Objective: The objective of this study is to explore the determinants of academic achievement among university undergraduates majoring in mathematics in Bangladesh. Employing a mixed-method research approach, the study combines quantitative and qualitative data analysis to examine the viewpoints of both students and educators concerning these factors. The authors primarily emphasize classifying the factors that impact the efficacy of mathematics pedagogical methods.
Methodology: The study is structured into three phases: i. An initial exploratory qualitative survey. ii. A quantitative triangulation survey. iii. Followed by explanatory semi-structured interviews.
Findings: To begin, the initial qualitative survey identified significant factors that contribute to students' achievements and setbacks in mathematics. Subsequently, the quantitative analysis verified both similarities and distinctions in the perspectives of students and educators. Furthermore, the correlation coefficient analysis revealed that male students frequently exhibit inconsistency and a lack of enthusiasm for studying, resulting in subpar performance. Conversely, female students frequently cited challenges like the difficulty of connecting mathematical theories to real-world applications, heavy course loads, and limited resources as reasons for their academic difficulties. Lastly, insights from interviews with students highlighted their acknowledgment of inadequate study practices, excessive reliance on memorization, suboptimal teaching methods, low motivation, and external distractions as key factors leading to their struggles. They also recognized the importance of consistent practice, a solid comprehension of concepts, regular study routines, and effective learning strategies for successful mathematics education. In contrast, educators emphasized the significance of students having clear concepts, natural aptitude, motivation, and a sense of curiosity as pivotal elements for successful learning in mathematics.
Conclusion: This conclusion suggests a new beginning in the realm of local mathematics pedagogy, achieved by scrutinizing teacher-student feedback about the factors influencing success and failure, considering the diverse individual and contextual variables at play. To foster mutual trust and understanding between students and teachers, it may be beneficial to engage in open discussions and interactions.

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1. Introduction

The pre-tertiary education of students, encompassing secondary and higher secondary levels, plays a pivotal role in their successful transition to higher education [1,2]. Regrettably, these educational stages often fall short of equipping Bangladeshi students with the essential foundational knowledge required to establish a robust educational framework for higher education [3]. Even those pre-tertiary students who are well-prepared frequently exhibit dishearteningly low-performance levels in their first-year mathematics courses [4]. Alam's research [5] has highlighted a decline in the quality and priority of university STEM education in recent years, posing challenges to the country's pursuit of sustainable educational objectives. Widespread mathematics anxiety among students tends to foster negative attitudes towards mathematics, hindering their academic performance [6]. Additionally, numerous internal and external distractions may deter many students who have completed mathematics-related courses from realizing their full academic potential [7].

1.1. Factors affecting university mathematics education

A study delving into the factors behind the success and failure of first-year students in mathematics reveals that self-motivation emerges as the most influential element in achieving success, a perspective shared by both teachers and student participants [8]. Other factors contributing to success include students' enthusiasm and interest in mathematical concepts, the satisfaction of attaining desired outcomes, completion of assignments, and access to adequate support materials. Teachers attribute students' failures to ineffective study techniques, weak subject knowledge, and individual issues. In contrast, students point to unengaging lecture methods and inadequate course design as responsible for their struggles in first-year mathematics courses. Subsequently, Brazilian students also identify self-effort as the primary factor affecting success and failure [9]. In addition, they note that deficient teaching, impatience, task difficulty, nervousness, and misfortune are common causes of success and failure in mathematics tests. Older male students who consistently attend classes exhibit greater optimism regarding their prospects in mathematics education. Moreover, lower-ranked teachers tend to assign higher grades to these students, acknowledging their heightened readiness and determination to facilitate learning. Younger lower-ranked teachers, well attuned to the needs of their students, possess exceptional abilities to create a supportive classroom environment that contributes to improved grades [10]. A wide range of variables, including prior subject knowledge, excessive workload, assessment methods, teaching quality, and resource availability, significantly affect the performance of first-year mathematics students [4]. Among these, workload proves to be the most impactful, closely followed by students' prior academic knowledge. Furthermore, a four-element conceptual framework proposed by Bengmark et al. [11] introduces the role of students' self-efficacies, motivation types, study habits, and perceptions of mathematics in their transition to university life. In this framework, students' self-efficacy and motivation stand out as the primary drivers, overshadowing the influence of study habits and their perceptions of mathematics at the university level. However, this framework does not fully address the role of teacher perceptions and their capacity to provide motivational support to university mathematics students. Additionally, in Australia, poor performance among university students in mathematics classes is more closely linked to a lack of foundational knowledge than to the difficulty of grasping new concepts. This highlights the fact that students often possess a limited and inflexible conceptual understanding of mathematics acquired during their pre-tertiary education [12].

Sun et al. [13] found that there is a positive relationship between mathematics achievement and three intrinsic student factors: prior knowledge, self-efficacy, and learning strategies. Additionally, math anxiety can trigger self-consciousness in students, particularly impacting their performance in math-intensive subjects. Female students tend to experience higher levels of math anxiety compared to their male counterparts, often stemming from previous lower grades, which, in turn, fosters a negative attitude toward mathematics and related subjects [6]. Furthermore, research involving Portuguese engineering university students demonstrates a significant link between higher attendance rates and improved passing rates. This highlights the importance of educators adapting their pedagogical approaches to better align with students' needs and preferences, thus enhancing student engagement and involvement in the learning process [14]. In cases of students lacking awareness of their readiness and struggling to plan their studies consistently, this has been correlated with failures in mathematics learning. Consequently, there is a call for government and higher education institutions to take proactive measures to motivate students and ensure equal opportunities for them to complete their degrees within the expected timeframe [15]. Moreover, in the Saudi Arabian educational context, university students' mathematical achievement is heavily influenced by their perception of mathematics. Those with fragmented views of mathematics often exhibit limited self-directed learning skills, resulting in lower academic performance. Conversely, students with a holistic perspective of mathematics tend to excel academically, as this viewpoint fosters greater self-directed learning skills [16].

Australian students' perspectives on participating in various mathematics-related workshops as peer leaders prove to be advantageous in enhancing their comprehension of course materials and bolstering their confidence. Assuming the role of a peer leader also contributes to the development of students' communication skills and the establishment of stronger peer connections, resulting in a more interactive and engaging classroom environment [17]. In addition, educators who send personalized emails to students, offering quiz results, recommendations, constructive feedback, and reminders, have a positive influence on students' academic performance. These emails employ a conversational approach to engage students in the learning process, ultimately leading to improvements in their mathematical proficiency [18]. The implementation of Active Learning (AL) techniques, which encompass interactive presentations, collaborative work, discussions, group presentations, encouragement of curiosity, mathematical experiments, and projects, has a favorable impact on students' mathematics achievements [19].

The success of students in transitioning from pre-tertiary mathematics education to tertiary-level mathematics-intensive courses is closely linked to their prior learning experiences. The factors contributing to poor performance and lack of readiness in university mathematics courses are primarily rooted in deficiencies within the pre-tertiary or secondary-level educational processes. Notably, assessment systems focused on exams create substantial knowledge gaps and insufficient preparation among students due to passive, non-interactive, and rote learning approaches [1]. Furthermore, the level of proficiency in mathematics attained during secondary-level education significantly impacts students' performance in tertiary-level mathematics courses. To address this, the implementation of a brief preparatory mathematics course for first-year mathematics majors and minors can help less-prepared students better cope with their advanced mathematics studies [2]. Adopting an educational approach that empowers students to take ownership of their learning and actively engage with mathematical problem-solving can transform their perspectives. Involving students in the development of instructional resources and sharing responsibilities fosters their motivation to learn mathematics and helps them overcome their fear of failure [20].

While a substantial body of research worldwide has delved into the factors affecting students' academic performance, there is a notable gap in the literature concerning a comprehensive understanding of the relative significance of multiple factors that influence success and setbacks in mathematics education at the tertiary level. This knowledge deficit becomes particularly pronounced in the context of Bangladesh. Recognizing that students' academic achievements are not solely determined by their learning approaches but also by the quality of teaching and instructional methodologies [8], this study considers the viewpoints of both students and teachers. The proposed research, conducted as a cross-sectional mixed-method study, seeks to scrutinize the determinants impacting the academic accomplishments and failures of Bangladeshi students in mathematics-intensive courses at the tertiary level, as seen from the perspectives of both students and teachers. The methodologies employed in this study are primarily built upon prior empirical research in the field.

2. The research addresses the following questions

1. What are the perceived factors facilitating students' learning in university mathematics courses?
2. What factors cause these students' failure in these courses?

3. Ethical permission

The mixed-method study was conducted following the authentic research guidance and ethics protocol provided by the University of Dhaka, Bangladesh. The research surveys were approved by the Head of the Mathematics Department, and all participants were included in their agreement.

3.1. Procedure

The entire research was conducted in three phases. The first stage involved an exploratory survey using open-ended questionnaires. The second stage of the triangulation survey included a quantitative five-item Likert-scale questionnaire, and the final phase consisted of semi-structured interviews with randomly selected student and teacher participants. In each phase, participants were provided with an ethical protocol and assured that any personal information gathered would be kept entirely confidential and used solely for academic research purposes.

3.2. Phase 1

In phase one, two separate open-ended questionnaires were created for students and teachers. The student questionnaire requested socio-educational demographic information, including gender, study level, course nature, university and department name, university type, and monthly family income. The teacher questionnaire recorded comparable data on gender, teaching experience, designation, and university type. The surveys included corresponding questions regarding the participants' perspectives on the factors affecting students' success and failure in undergraduate mathematics courses.

3.3. Phase 2

At the end of the first phase, the authors identified more than 15 factors influencing mathematics students' success and failure, as reported by the respondents. After analyzing the responses, the factors were ranked to select the top 15 most frequently reported factors for success and failure separately. A total of 30 factors were predetermined for use in the second phase triangulation survey. Some of the factors overlapped, leading to changes in their ranking. Ultimately, the authors finalized 19 unique factors facilitating success and 21 exclusive factors contributing to failure. Based on these factors identified in phase one, the authors developed two separate quantitative survey questionnaires for students and teachers. The questionnaires utilized a 5-point Likert-type scale (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree) to assess the extent to which students and teachers agreed with the statements. The links to the questionnaires were shared again with the participants via various social media platforms, and data collection continued for approximately another month. Additionally, data from phase 2 were analyzed using statistical software named SPSS Statistic 21.0.

3.4. Phase 3

In the third phase, a total of 10 students and 5 teachers were selected as interview participants using purposeful sampling [21]. The authors randomly chose the respondents to avoid biases and requested their participation. Because of the ongoing pandemic situation, the interviews were conducted via Zoom Applications to avoid social gatherings. This approach was convenient, easy to use, cost-effective, manageable, secure, and reliable, with audio-video recording and auto-saving options. It was a potential tool for collecting in-depth qualitative data from remote or geographically dispersed participants. Furthermore, Zoom provided the authors with a secure means to record and archive sessions, eliminating the need for third-party software. This feature holds particular importance in research contexts where safeguarding sensitive data, such as facial expressions, body language, and interpersonal interactions, is paramount [22]. All the interviews were recorded so that the authors could transcribe and analyze the data later to produce accurate results. It took two weeks to conduct all the interviews, with each interview session lasting between 30 and 40 min. The meetings began informally by explaining the study's purposes and offering Q&A sessions to make the participants feel at ease and comfortable with the discussions. The respondents were asked a total of twelve structured questions, in addition to many relevant probing questions to elicit essential beliefs and opinions. All the authors were present during the interview sessions, which were conducted in Bengali. Later, the transcriptions were summarized in English, and translated quotations were presented to support the findings. The interview meetings are video recorded for verbatim transcription, and the coding is done thematically. At the end of all interview sessions, the authors transcribed each interview and sent the transcriptions to the corresponding participant via email, asking for any additions or edits they would like to make [23]. Then, the final drafts of the summarized interviews were developed. During the COVID-19 pandemic, our research faced challenges in arranging interviews with students from private universities. Consequently, participants from private universities were unable to be included in the qualitative section of the study.

Different phases of participant information are illustrated in Tables 1–4. The details of the questionnaires are included in a supplementary file.

4. Methodology

4.1. Participants

The research participants comprise 194 and 401 university students and 40 and 56 teachers for phases 1 and 2, respectively. The student participants consist of 151 and 41 for Phase 1 and 272 and 129 for Phase 2 as mathematics majors and minors enrolled in different public and private universities in Bangladesh. During their undergraduate studies, mathematics students commonly undertake a wide range of courses that cover both theoretical and practical aspects. These courses encompass subjects like number theory, linear algebra, calculus, real and complex analysis, topology, numerical analysis, ordinary and partial differential equations, discrete mathematics, financial mathematics, stochastic calculus, and mechanics, among others. Typically, each course is assigned 3 or 4 credits, although credit allocations may differ between universities (1 credit equates to 15 class hours, with each class lasting 50 min). To earn an undergraduate degree, students typically need to amass a total of 128–145 credits, which might include laboratory courses or projects. In Bangladesh, graduates with backgrounds in mathematics pursue diverse career paths, including teaching, roles in banking, government employment, and positions in the corporate sector. Furthermore, a significant number of mathematics graduates choose to continue their education abroad by enrolling in master's or Ph.D. programs.

The teacher participants consist of 28 and 11 for phase 1 and 47 and 9 for phase 2 and are mathematics faculty members at different

Table 1
Demographic Information of type of Students in Phase 1 (N = 194) and Phase 2 (N = 401).

		Phase 1		Phase 2	
Variables	Type	Total	Percentage (%)	Total	Percentage (%)
Gender	Male	127	66	290	72.3
	Female	65	34	111	27.7
Monthly Family Income	Low	84	43.75	224	55.9
	Medium	64	33.33	122	30.4
	High	44	22.92	55	13.7
Subject	Major	151	78.65	272	67.8
	Minor	41	21.35	129	32.2
Year of Study	First	81	41.8	69	17.2
	Second	47	24.2	144	35.9
	Third	22	11.3	95	23.7
	Fourth	44	22.7	93	23.2
Type of University	Public	171	89	262	65.3
	Private	21	11	139	34.7
Grades (CGPA)	Less than 3.0	–	–	88	21.9
	3.0 to 3.5	–	–	180	44.9
	Higher than 3.5	–	–	133	33.2
Data	Analyzed	192	99	401	100
	Rejected	2	1	0	0

Table 2
Demographic Information of type of Teachers in Phase 1 (N = 40) and Phase 2 (N = 56).

		Phase 1		Phase 2	
Variables	Type	Total	Percentage (%)	Total	Percentage (%)
Gender	Male	30	75	43	76.8
	Female	10	25	13	23.2
Type of University	Public	28	70	47	83.9
	Private	11	27.5	9	16.1
Designation	Lecturer	16	40	20	35.7
	Assistant Professor	18	45	23	41.1
	Associate Professor	3	7.5	7	12.5
	Professor	3	7.5	6	10.7
Teaching Experience	1–6 years	22	55	26	46.4
	7–12 years	10	25	19	33.9
	13–18 years	6	15	5	8.9
	19 years to higher	2	5	6	10.7
Data	Analyzed	40	100	56	100
	Rejected	0	0	0	0

Table 3
Demographic Information of type of Students in Phase 3 (N = 10).

Pseudonym	Gender	Year of Study	CGPA	University
Student 1	Female	Fourth	Below 3.00	Public
Student 2	Male	Fourth	Below 3.00	Public
Student 3	Female	Third	Above 3.00	Public
Student 4	Female	Third	Above 3.00	Public
Student 5	Male	Second	Above 3.00	Public
Student 6	Female	Second	Below 3.00	Public
Student 7	Male	Second	Above 3.00	Public
Student 8	Female	Second	Above 3.00	Public
Student 9	Female	Third	Below 3.00	Public
Student 10	Female	Third	Above 3.00	Public

Table 4
Demographic information of type of teachers in phase 3 (N = 5).

Pseudonym	Gender	Designation	Type of University
Teacher 1	Male	Lecturer	Private
Teacher 2	Male	Assistant Professor	Private
Teacher 3	Male	Professor	Public
Teacher 4	Female	Assistant Professor	Public
Teacher 5	Female	Assistant Professor	Private

public and private universities. A total of 10 students, including 7 females and 3 males, participated in semi-structured interviews via Zoom applications. All of the student respondents are studying mathematics at the undergraduate level. Five teachers, including 3 males and 2 females, attended interviews to provide further insights into the factors influencing students' success and failure. The teacher respondents hold higher degrees in mathematics as pre-service education, although none of them has received specialized training in teaching mathematics. In a typical academic year, a teacher generally instructs a single course, and classroom sizes can differ from one university to another. Public universities tend to have larger class sizes, frequently surpassing 50 students, while private universities typically maintain smaller class sizes.

Higher education students' academic performance is generally measured by their GPA or course completion [24] at Bangladeshi universities. The current research defines students' success as obtaining a CGPA (Cumulative Grade Point Average) of 3.00 or above on a 4.00 scale without retaking any courses while failure is securing a CGPA less than 3.00 on the same scale.

4.2. Data collection

The data collection process was conducted entirely online, utilizing Google Forms for data collection from participants and the Zoom platform for interview sessions. Survey links at two stages were shared with the participants via Facebook, Messenger, WhatsApp, LinkedIn, email, and various other social media sites. Participants were also allowed to share the survey links with their peers and friends studying at different universities. No additional incentives were offered to motivate participation; instead, the students and teachers responded to the research spontaneously. This indicates that the study is essential for reporting the unheard voices of the population. The snowball sampling method was used to ensure a representative number of participants, which incurred minimal costs and effectively drew responders from similar disciplines in a short period [25].

Online survey research provides researchers with easy access to a large number of participants who share common characteristics and may be hesitant to communicate problems in person [26]. Using web-based survey tools, such as Google Forms, has become increasingly popular among academic researchers due to its low cost, quick implementation, and convenient sharing [27]. Additionally, Google Forms is considered the most appropriate tool for conducting a survey to maintain social distancing and prevent the spread of COVID-19.

4.3. Coding

Coding represents a widely adopted technique for qualitative data analysis. This method involves assigning specific codes, typically meaningful and comprehensive words, to qualitative data, rendering the raw data more understandable for analytical purposes [28]. Qualitative data coding encompasses various techniques, with deductive coding and inductive coding being two prominent approaches. Deductive coding involves researchers beginning with a predetermined set of codes and then applying these codes to the collected dataset. In contrast, inductive coding follows a reverse path, commencing with the qualitative data collection and subsequently creating a set of codes that align with the data [1]. In the present study, we followed the deductive coding approach, initiating the process with a pre-established set of codes, namely, "Lecturer," "Courses," "Students," and "External," inspired by Anthony [8]. More details on coding are presented in Table A1 (Appendix A).

4.4. Data analysis

We used Anthony's [8] framework in the first two phases, while the third phase involved the Participatory Action Research (PAR) methodology, similar to Dube's [29]. The PAR method was used to collect data directly from the participants due to its pragmatic values, authenticity, comprehensiveness, and intractability. PAR offers solutions to complex and multi-dimensional problems by involving participants and researchers in a collegial procedure [29].

5. Results

5.1. Phase 1 analysis

In phase one, all the factors listed are responses from open-ended questionnaires. Students' most preferred factor responsible for success is 'doing a lot of practice' (37%), followed by 'clear understanding of a topic' (18%) and 'studying regularly' (9%). Similarly, 'irregular practice/study' (32%) and memorizing mathematics are the top two most cited factors responsible for failure. Additionally, 'unclear concepts' (13%), 'uninteresting lessons' (9%), and 'inadequate lectures' (9%) are the three most commonly cited failure factors by students. On the other hand, teachers emphasize students' 'motivation, passion, and confidence' (24%), clear perceptions about the course materials (15%), and 'increased practice' (12%) as key factors for obtaining high grades. 'Lack of interest, motivation, confidence, and seriousness among students' (28%), 'poor teaching quality (12%), and 'students' negligence' (8%) are the main factors contributing to students' failure in undergraduate mathematics courses.

In the next phase, all the factors contributing to students' success and failure, as addressed by both students and teachers, are categorized into four broad groups, namely lecturers, courses, students, and external factors, as suggested by Killen [24] and used by Anthony [8]. The student data reveals that most of their success and failure factors fall under the students' category, characterizing around 73% of their success factors and 47% of their failure issues. Moreover, 13% of students' success factors relate to lecturer quality, 7% to course concepts, and 7% to contextual factors. Additionally, the student participants attribute 7% of their failure factors to uninteresting lectures, 20% to unmanageable curricula and inadequate resources, and 27% to external political factors.

Likewise, the teacher data reveals a similar observation. Teachers attribute 60% of students' success factors and 47% of students' failure factors to the students' category. According to the participants, 13% of students' success factors are associated with lecturers or quality teaching, 7% with course concepts, and 20% with environmental factors. They also assign 7% of students' failure factors to poor quality teaching, 20% to unclear mathematical concepts, and 27% to external distractions.

Summary of the above findings in tabular form.

Type	Category	Success (%)	Failure (%)
		Factors: Students View in percentage	
C1	Lecturer	13.33	6.67
C2	Courses	6.67	20
C3	Students	73.33	46.67
C4	External	6.67	26.67
		Factors: Teachers View in percentage	
C1	Lecturer	13.33	6.67
C2	Courses	6.67	20

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(*continued*)

		Factors: Teachers View in percentage	
C3	Students	60	46.67
C4	External	20	26.67

5.2. Phase 2: Quantitative analysis

5.2.1. Comparison between students' and teachers' perception

In the success questionnaire, eight items are statistically correlated ($p < 0.05$) out of 19 items. Among these eight, three (S2, S11, S16) items show significant differences at a 0.1% level, three (S12, S15, S17) at a 1% level, and the other two (S4, S14) at a 5% level. The analysis shows that teachers emphasize the importance of students' clear understanding, motivation, passion, dedication, determination, self-confidence, patience, interest, and curiosity in mathematics to achieve success. Meanwhile, students emphasize the need to learn formulas, use strategies, follow proper guidelines, rely on prior knowledge, and possess good literacy skills.

In the case of failure, eight items are found to be statistically significant ($p < 0.05$), with one (F13) item at the 0.1% level, two (F2, F14) at the 1% level, and the other five (F4, F9, F11, F20, F21) at the 5% level, as shown in Table 5. For students' failure, teachers focus on their memorization tendency, inattention, irregularities, disinterest, avoidance of texts, consulting guidebooks, political involvement, high teacher-student ratio, low literacy skills, and part-time tutoring. Nonetheless, the only item mentioned by students beyond the teacher's list is the time constraint to complete the given syllabus.

5.2.2. Comparison between the male and female student perspectives

Gender has no significant influence on student perceptions, as male and female students differ only in two items (S7, S16) that show significance at a 1% level. Male students place more emphasis on imagination and literacy skills than females. Regarding failure, one item (F15) is significantly different at a 1% level, and two others (F12, F14) at a 5% level, as detailed in Table 6. Female students attribute their low performance more to inadequate resources than their male counterparts. Furthermore, they are more likely to struggle with connecting mathematical theories to real-life problem-solving and feel greater pressure due to the extensive curriculum compared to male students.

5.2.3. Comparison between the high and low-grade achievers

To analyze the perspectives of high and low-grade achievers regarding success and failure, two different groups of students were considered: higher-grade students with CGPA higher than 3.50 and lower-grade students with CGPA less than 3.00. When comparing these groups, one item in the success factors (S2) shows a significant difference at a 0.1% level, one (S5) at a 1% level, and three (S8, S14, S17) at a 5% level, as shown in Table 7. The analysis demonstrates that higher-grade achievers tend to place more importance on having a clear understanding of the subject and focusing on their studies than lower-grade achievers. Other highly attributed success

Table 5
Teacher and student perceptions.

Type	Item	Teachers Mean	Teachers SD	Students Mean	Students SD	p-value	t-value	95% CI
C2	S2	4.8393	0.3706	4.2618	0.8359	<0.0001***	−5.097	(-0.8002, −0.3548)
C3	S4	4.5357	0.5709	4.3392	0.7033	0.0461*	−2.000	(-0.3896, −0.0034)
C3	S11	3.9286	0.8281	4.3541	0.6552	<0.0001***	4.396	(0.2353, 0.6157)
C1	S12	4.3929	0.5618	4.6234	0.5660	0.0045**	2.857	(0.0720, 0.3890)
C3	S14	4.4464	0.6301	4.1870	0.7599	0.0151*	−2.439	(-0.4684, −0.0504)
C4	S15	3.8214	0.8551	4.1571	0.6912	0.0010**	3.300	(0.1358, 0.5356)
C3	S16	3.9464	0.7241	4.7107	1.0256	<0.0001***	5.390	(0.4856, 1.0430)
C3	S17	4.5179	0.5391	4.2319	0.7026	0.0036**	−2.927	(-0.4780, −0.0940)
C3	F2	4.1250	1.0798	3.6259	1.2113	0.0036**	−2.925	(-0.8344, −0.1638)
C3	F4	4.0179	1.0356	3.6060	1.1914	0.0143*	−2.460	(-0.7409, −0.0829)
C3	F9	3.8571	1.0167	3.4389	1.4226	0.0342*	−2.124	(-0.8050, −0.0314)
C3	F11	4.0179	1.0701	3.6608	1.1224	0.0254*	−2.243	(-0.6700, −0.0442)
C4	F13	3.7500	1.1322	3.0973	1.2684	0.0003***	−3.652	(-1.0039, −0.3015)
C2	F14	3.3214	1.0972	3.7357	1.0816	0.0076**	2.680	(0.1105, 0.7181)
C4	F20	3.9107	1.0140	3.5411	1.0950	0.0174*	−2.387	(-0.6739, −0.0653)
C3	F21	3.4286	0.8709	3.1072	1.1140	0.0389*	−2.072	(-0.6263, −0.0165)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, SD: Standard Deviation, CI: Confidence Interval.
Note: S2: Have a clear understanding of the subject, S4: Show interest, passion, dedication, determination, and self-confidence, S11: Need to memorize some formulas and follow strategy, S12: Need proper guidelines from teachers and departments, S14: Don't panic and enjoy mathematics, S15: Have prior knowledge to understand new information, S16: Have a good reading and writing ability, S17: Ask questions to teachers and yourselves, F2: Memorizing mathematics rather than understanding the subject, F4: Inattentive and irregularities in the classroom, F9: Not interested in mathematics, F11: Reading fewer books but reading solution materials and guide books, F13: Involvement in student's politics and doing lots of tuition, F14: Huge syllabus with limited time available, F20: The teacher-student ratio is too high, F21: Bad reading and writing ability.

Table 6
Male vs. Female Student Perceptions.

		Male (N = 290)		Female (N = 111)				
Type	Items	Mean	SD	Mean	SD	p-value	t-value	95% CI
C3	S7	4.2448	0.7478	3.9910	0.6674	0.0019**	−3.130	(-0.4132, −0.0944)
C3	S16	4.1000	0.7717	3.8739	0.7276	0.0080**	−2.666	(-0.3928, −0.0594)
C2	F12	3.7966	1.1838	4.0811	0.8542	0.0213*	2.311	(0.0425, 0.5265)
C2	F14	3.6621	1.1113	3.9279	0.9790	0.0275*	2.212	(0.0296, 0.5020)
C4	F15	3.5448	1.1252	3.8649	0.9389	0.0081**	2.663	(0.0838, 0.5564)

*p < 0.05, **p < 0.01, ***p < 0.001, SD: Standard Deviation, CI: Confidence Interval.
Note: S7: Be imaginative, S16: Have good reading and writing ability, F12: Failed to connect mathematical theory in real life, F14: Huge syllabus with limited time available, F15: Insufficient resources to study.

factors by the higher-grade students include regular class attendance, subject interests, and question-answers or reflections. In contrast, only three failure items are found to be statistically significant ($p < 0.05$), with one (F9) at a 0.1% level and the other two (F7, F11) at a 5% level, as shown in Table 7. The finding suggests that when it comes to lower academic performance, students in lower-grade levels show reduced focus on disinterest, fear of mathematics, avoidance of textbooks, and reliance on guidebooks as compared to other factors.

5.2.4. *Comparison between public and private university students' perspectives*

The analysis of the perspectives between public and private university students shows that four success items (S5, S8, S16, S17) are significantly different at a 0.1% level, one (S7) at a 1% level, and the other three (S13, S14, S15) at a 5% level, as shown in Table 8. Private university students place greater emphasis on regular class attendance, good literacy skills, interactions, and attentiveness compared to their counterparts. Additionally, other success factors mentioned by private university students include imaginative ability, resource availability, conducive classroom environment, patience, curiosity, and prior knowledge.

In contrast, two failure items (F12, F18) show a significant difference at a 0.1% level, one (F17) at a 1% level, and the other five (F3, F5, F8, F13, F15) at a 5% level, as shown in Table 8. The majority of public university students find applying mathematical theories and understanding abstract concepts difficult. They also attribute their failure to the poor academic system and emphasize teachers' failure to make lessons interesting and deliver deficient lectures more than private university students. Other factors contributing to students' failure include their inability to understand the course content, involvement in politics, excessive tuition, and inefficient resource utilization. Conversely, private university students mention a weak background as a hindrance to successful mathematics learning.

5.2.5. *Comparison between junior and senior students' perspectives*

The authors regrouped all the student participants according to their level of study, namely Junior (1st and 2 nd year students) and Senior (3rd and 4th year students). Most public and private universities offer four-year bachelor's degrees. However, there was no significant impact ($p < 0.05$) of study levels on the students' perceptions regarding the success and failure factors in mathematics courses.

5.2.6. *Comparison between high and low family-income students' perspectives*

To further enhance the understanding of diverse student perspectives, the authors compared the success and failure factors based on the student participants' monthly family income. Students with a monthly family income above 40,000 BDT (approximately 471 USD) comprised the high-income group, while those with a monthly family income less than 20,000 BDT (235 USD) constituted the low-income group. In total, seven success items were statistically significant ($p < 0.05$), with one item (S4) differing significantly at a 1% level, and the other six items (S1, S3, S9, S15, S17, S18) varying at the 5% level, as presented in Table 9. Regarding the success

Table 7
Perceptions of High vs. Low Grades Students.

		High (N = 133)		Low (N = 88)				
Type	Items	Mean	SD	Mean	SD	p-value	t-value	95% CI
C2	S2	4.4060	0.7691	4.0000	0.9469	0.0006***	−3.500	(-0.6346, −0.1774)
C3	S5	4.4737	0.6695	4.2045	0.8327	0.0086**	−2.652	(-0.4692, −0.0692)
C3	S8	4.4662	0.6803	4.2614	0.7950	0.0418*	−2.047	(-0.4020, −0.0076)
C3	S14	4.3158	0.6894	4.0682	0.8276	0.0167*	−2.411	(-0.4500, −0.0452)
C3	S17	4.3083	0.6417	4.0909	0.7825	0.0250*	−2.257	(-0.4073, −0.0275)
C3	F7	3.8722	1.0900	3.5341	1.1239	0.0268*	−2.230	(-0.6370, −0.0392)
C3	F9	3.4436	1.2335	2.8295	1.2705	0.0004***	−3.580	(-0.9522, −0.2760)
C3	F11	3.8647	1.0995	3.4773	1.1344	0.0120*	−2.532	(-0.6890, −0.0858)

*p < 0.05, **p < 0.01, ***p < 0.001, SD: Standard Deviation, CI: Confidence Interval.
Note: S2: Have a clear understanding of the subject, S5: Stay focused and be attentive in the classroom, S8: Attend classes regularly, S14: Don't panic and enjoy mathematics, S17: Ask questions to teachers and yourselves, F7: Fear about mathematics, F9: Not interested in mathematics, F11: Reading fewer books but reading solution materials and guide books.

Table 8
Perceptions of Public vs. Private University Students.

		Public (N = 262)		Private (N = 139)				
Type	Items	Mean	SD	Mean	SD	p-value	t-value	95% CI
C3	S5	4.2710	0.7675	4.5324	0.6405	0.0007***	3.431	(0.1116, 0.4112)
C3	S7	4.1031	0.7277	4.3094	0.7308	0.0073**	2.698	(0.0560, 0.3566)
C3	S8	4.2824	0.7609	4.6043	0.6093	<0.0001***	4.308	(0.1750, 0.4688)
C4	S13	4.3092	0.7427	4.4676	0.6290	0.0330*	2.140	(0.0129, 0.3039)
C3	S14	4.1183	0.7764	4.3165	0.7126	0.0128*	2.502	(0.0425, 0.3539)
C4	S15	4.1031	0.7009	4.2590	0.6631	0.0314*	2.159	(0.0140, 0.2978)
C3	S16	3.9237	0.7491	4.2518	0.7527	<0.0001***	4.167	(0.1733, 0.4829)
C3	S17	4.1336	0.7012	4.4173	0.6692	0.0001***	3.917	(0.1413, 0.4261)
C1	F3	3.7977	1.0473	3.5036	1.2648	0.0133*	−2.486	(-0.5266, −0.0616)
C2	F5	3.8015	1.0928	3.5540	1.2863	0.0433*	−2.027	(-0.4875, −0.0075)
C4	F8	3.0840	1.1550	3.3741	1.2527	0.0206*	2.324	(0.0447, 0.5355)
C2	F12	4.0153	1.0430	3.6115	1.1827	0.0005***	−3.520	(-0.6293, −0.1783)
C4	F13	3.5687	1.1683	3.2878	1.2754	0.0271*	−2.219	(-0.5298, −0.0320)
C4	F15	3.7214	1.0370	3.4676	1.1566	0.0257*	−2.240	(-0.4766, −0.0310)
C2	F17	3.8626	0.9161	3.5612	1.1864	0.005**	−2.822	(-0.5114, −0.0914)
C4	F18	3.9771	1.0647	3.5396	1.2756	0.0003***	−3.651	(-0.6731, −0.2019)

*p < 0.05, **p < 0.01, ***p < 0.001, SD: Standard Deviation, CI: Confidence Interval.
Note: S5: Stay focused and be attentive in the classroom, S7: Be imaginative, S8: Attend classes regularly, S13: Availability of resources and proper classroom environment, S14: Don't panic and enjoy mathematics, S15: Have prior knowledge to understand new information, S16: Have a good reading and writing ability, S17: Ask questions to teachers and yourselves, F3: Teachers failed to make the lesson interesting and insufficient lectures, F5: Failed to understand the subject, F8: Don't have a good mathematics background, F12: Failed to connect mathematical theory in real life, F13: Involvement in student's politics and doing lots of tuition, F15: Insufficient resources to study, F17: Failure to understand abstract ideas, F18: Poor education system.

factors, low-income students placed additional significance on showing interest, passion, dedication, determination, and self-confidence for success compared to high-income students. Other success factors highly recommended by the high-income group included applicational skills, regular study, group activities, teacher-peer interactions, and prior knowledge.

In contrast, one item (U9) is significantly different at a 1% level, whereas the other three (U7, U8, U21) are at a 5% level out of the four statistically significant ($p < 0.05$) failure items, as presented in Table 9. Students with high family income attribute disinterest as a reason for their failure in mathematics. Additionally, fear of mathematics, weak basics, and low literacy skills are responsible for their poor performances.

5.2.7. *Comparison between mathematics major and minor students' perspectives*

Considering the nature of the courses, the perspectives of mathematics major and minor students were analyzed, which showed no statistically significant difference ($p < 0.05$) between these two groups except for one success item (S16) at a 5% level, and two failure items with one (F8) at a 0.1% level, and the other (F21) at a 5% level, as presented in Table 10. Students majoring in mathematics consider good literacy skills essential for success, whereas mathematics minor students attribute low literacy skills and weak basics to failure.

Table 9
Perceptions of Low vs. High Monthly Family Income Students.

		Low family income (N = 224)		High family income (N = 55)				
Type	Items	Mean	SD	Mean	SD	p-value	t-value	95% CI
C3	S1	4.7054	0.5296	4.5091	0.7667	0.0262*	−2.236	(-0.3691, −0.0235)
C3	S3	4.3929	0.6941	4.1818	0.7224	0.0460*	−2.005	(-0.4184, −0.0038)
C3	S4	4.4196	0.6442	4.1091	0.8750	0.0033**	−2.968	(-0.5165, −0.1045)
C3	S9	4.3214	0.6725	4.0364	0.9421	0.0173*	−2.584	(-0.5021, −0.0679)
C4	S15	4.2098	0.6668	3.9818	0.8049	0.0303*	−2.177	(-0.4341, −0.0219)
C3	S17	4.2455	0.6680	4.0182	0.8922	0.0361*	−2.106	(-0.4398, −0.0148)
C1	S18	4.5446	0.5665	4.3273	0.7711	0.0190*	−2.360	(-0.3985, −0.0361)
C3	F7	3.5893	1.1756	4.0182	1.0970	0.0147*	2.456	(0.0851, 0.7727)
C4	F8	3.0446	1.2230	3.4364	1.1982	0.0335*	2.137	(0.0309, 0.7527)
C3	F9	3.0446	1.3519	3.6182	1.2246	0.0044**	2.870	(0.1802, 0.9670)
C3	F21	3.0134	1.1579	3.4000	1.0470	0.0246*	2.259*	(0.0497, 0.7235)

*p < 0.05, **p < 0.01, ***p < 0.001, SD: Standard Deviation, CI: Confidence Interval.
Note: S1: Need lots of practice, S3: Should study regularly, S4: Show interest, passion, dedication, determination, and have self-confidence, S9: Do group study and discuss with each other, S15: Have prior knowledge to understand new information, S17: Ask questions to teachers and yourselves, S18: Teachers need to show more real-life applications in the classroom, F7: Fear about mathematics, F8: Don't have a good mathematics background, F9: Not interested in mathematics, F21: Bad reading and writing ability.

5.3. Phase 3: Qualitative analysis

5.3.1. Students' interview

5.3.1.1. Factors influencing students' academic success. Students' interview responses demonstrate a wide range of factors contributing to their success and failure. Eight of the respondents' reported that previous lectures and class notes is very helpful to them. Student 1 states:

> I try to go through the lectures of the previous class very carefully before attending a new lecture since this helps me to understand and grasp the new information easily. Otherwise, I feel like a fish out of the water in a class discussing a new topic.

However, three students believe that a mere lecture is not enough for outstanding performance. Student 4 explains:

> Apart from lectures, internet resources are of great help. Sometimes it is difficult to understand everything in a lecture, which is often delivered too fast to focus on every single word. There are many good YouTube videos to reduce these perception gaps.

Seven students think that a strong foundation and prior knowledge of the subject are vital. Ninety percent of them agree that regular practice is very effective in achieving a good outcome in tests. Student 2 asserts:

> The first and foremost thing is having a clear concept about a topic. It's not only about remembering formulas and techniques; instead, it is about knowing how to derive these formulas. Simultaneously, one has to invest time to solve exercises and practice as much as possible.

Moreover, student 3 states:

> Prior knowledge is important; it helps to cope with the course material instantly. For instance, if a student does not understand Linear Algebra I in the first year, he/she will confront challenges in adopting the concepts of Linear Algebra II in the next year.

Four of the students highlight the significance of imagination in profoundly learning some complex topics. Student 4 says:

> I feel that imagination is quite significant in mathematics learning, especially in understanding abstract ideas. When I try to imagine the underlying concepts, I perceive the problems much better than using other methods. One of our Calculus tutors would try to make things visual to us, and I truly enjoyed studying that course.

Two of the respondents acknowledge the roles of studying regularly and completing all homework and assignments on time in successful learning. Student 5 states:

> Consistency is the key. If someone studies constantly throughout the year, obviously he/she will secure good grades at the end.

Also, student 6 asserts:

> One of my teachers used to assign us Partial Differential Equation tasks and problems to solve. I would complete all of them, and I was happy and confident with that course before the final exams.

Two more students also shared their personal experiences of successfully handling academic pressure and mathematics anxiety, which facilitated their success.

Student 7 states:

> When I feel pressured, I simply take a break and try refreshing myself before restarting. I make a routine that I try to follow strictly before the exams.

While student 8 states:

> I keep enough time in hand for preparation to avoid nervousness. I divide the complete syllabus into small parts and save some extra time for revision. Staying relaxed and preplanning helped me to overcome fear and anxiety before the exam.

Three students also mention the contribution of their family members to successful mathematics learning. Student 2 clarifies:

Table 10
Perceptions of Mathematics Major vs. Minor Students.

		Major (N = 272)		Minor (N = 129)				
Type	Item	Mean	SD	Mean	SD	p-value	t-value	95% CI
C3	S16	4.1838	0.6895	4.0078	0.8883	0.0307*	−2.169	(-0.3355, −0.0165)
C4	F8	3.0331	1.2068	3.5039	1.1119	0.0002***	3.741	(0.2234, 0.7182)
C3	F21	3.0294	1.1164	3.2713	1.0951	0.0421*	2.039	(0.0087, 0.4751)

*p < 0.05, **p < 0.01, ***p < 0.001, SD: Standard Deviation, CI: Confidence Interval.
Note: S16: Have a good reading and writing ability, F8: Don't have a good mathematics background, F21: Bad reading and writing ability.

> I receive much support and reinforcement from my family and relatives, including my father, when it comes to studying mathematics.

Student 9 states:

> A mathematics major student has many career options both at home and abroad. My family did not complain about my rejection of engineering subjects only because I secured outstanding results. They realized my passion and potential for this subject and helped me to overcome depression.

Eight students emphasize the significance of group study. They strongly support peer assistance as one of the best contributors to success. Students 1 and 10 states:

> Group study and online peer discussion have helped me achieve good grades. Most often, I do not understand teachers' lectures, which is easy if a friend explains. I am very much dependent on group study. I understand 50% of the class lectures, and I rely on group studies for the rest. Group study is very effective; if I explain a topic to my friends, it becomes clearer to me as well, and permanent learning happens. Whenever I am stuck with a problem, first I approach my friends, then seniors, and finally the teachers. Hence, I always get a solution to my problems somehow.

5.3.2. Factors influencing students' failure

Six students accuse the teaching quality and hold the teachers responsible for their failure. Students 1, 6, 8, 9 state:

> I often do not understand the lectures delivered by the teachers. I think the lectures should have been more intelligible. The majority of the teachers seem to teach as part of their job and do it anyway. Some lectures are quite hurried, just to complete the syllabus at the earliest possible time. Some teachers do not take class regularly, which demotivates the students and creates information gaps since they hardly remember the previous lesson. Also, many teachers do not teach efficiently; they just keep writing on the board without explaining. Teachers need to bring variations in lectures; making things more visible to us would help.

Four student respondents blame themselves for their failure. Students 2 and 3 state:

> Most of the local students believe university education does not involve study pressure and hence become a bit careless and do not study hard initially, which results in a grade fall. Some good students fail to reach their full potential at university because of easy distractions. They spend much more time hanging out with friends or enjoying things than studying. They only study a few days before the exam.

The majority of students (7) also talk about inconsistent study habits and inadequate practices. The interview data exposes that (40%) of students blame the habit of memorizing mathematical theorems instead of understanding, which was also evident in the phase one response. Student 5 states:

> Students tend to memorize theorems without properly understanding how they were derived because they always look for a shortcut to pass the exam, which weakens their basics.

Two students also talk about weak mathematical basics, unmanageable curricula, etc. Students 4 and 7 states:

> A good number of students skip getting admitted to mathematics; either they study it because of family pressure or for not qualifying in the other desired subjects at the same or different universities. My parents wanted me to be a doctor, although I had no other choice except to study mathematics after failing medical admission tests. Most mathematics students, either major or minor, study it only to complete graduation and receive certificates.

Being unaware of mathematics-related careers, many of them neither have any career plan nor aspire for government administrative jobs. It is also evident that residential students are not satisfied with the overall academic environment on the campus. Students 3, 8, and 10 complain:

> New students do not have proper accommodation during their first year of study; they have to share rooms with more students than conceivable. The environment is neither conducive nor friendly enough to concentrate on studies. Most of the residential halls have no suitable conditions for studying. From the first year, students engage themselves in politics, either willingly or forcefully, even before the exam night. Neither is the academic structure research-oriented; undergraduate students hardly get research opportunities.

5.4. Teachers' interview

5.4.1. Influencing factors for success

The teacher respondents discuss their roles regarding students' success. Teachers 1, 2, and 3 assert:

> Teachers have many responsibilities, such as presenting interesting lectures, discussing real-life applications, continuing research, communicating learning objectives, and the course's career prospects, etc. The 3D concepts should be taught using animation and graphs.

This will increase students' enthusiasm for learning the topics. Young lecturers also talk about the importance of organized class lectures. Teacher 1 states:

> Students have to follow lectures accurately; they have to understand any topic very well and try to apply what they learn in different fields.

Four teachers believe they need to share their own learning experiences during lectures and consider the students' learning needs in preparing lecture notes. Teacher 3 states:

> Since the majority of the students only focus on lecture notes, preparing the next lecture with good care is essential. While preparing my lectures, first I make sure that everyone understands the topic clearly; I focus on my understanding to ensure students' comprehension. I spend a good amount of time designing lecture notes and the way of presentation. Generally, I look into internet resources, read books, and watch YouTube videos to prepare for lectures. Well, this is not a fixed pattern, I should say.

Teachers 4 and 5 put importance on reading books rather than only going through class lectures.

> There are a few students who depend solely on class notes, which is never enough. To get good results in mathematics, students need to follow three things: understanding the concepts, practicing regularly, and learning some tricks and techniques.

Students should read books along with lectures to minimize knowledge gaps. They should also consult additional relevant resources from the internet. Students' high achievement in academia is shaped by the teachers' presentation of lectures to some extent. Teacher 1 claims:

> During a lecture, I generally start with a problem that is not too difficult, even for a weak student. Subsequently, I move forward to the harder ones. I always discuss the hardest one in detail so that the rest of the mathematics is easy for them.

Lectures should engage students directly with course content. Teachers can share relevant research papers with the students, encouraging them to understand the relevant findings. Properly explaining the theories and how these theories can be implemented will be effective. Teachers also justify the necessity of regular study and practice. Teacher 3 says:

> Mathematics is a practice-based subject. It is impossible to perform well without adequate practice. Knowing how to implement a theorem rather than only knowing the statement and proof of that theorem is crucial.

To ensure this, students have to work out as many problems as possible and solve the exercises given at the end of each chapter. Another concern regarding the relationship between lectures and students' academic performance is students' feedback and the evaluation process. Three teachers responded positively to the teachers' feedback while two other teachers mentioned its drawbacks. They admit that they do not have to attend to students' feedback. Teacher 5 clarifies:

> We don't have to follow this system, although it is certainly helpful for the teachers to improve the teaching quality. This system is not yet implemented on a large scale at our university except for a few courses. This system might not produce the expected results because of student and teacher politics prevailing at the universities. Instead, the method might be detrimental to start before banning politics in the university ambiances.

However, those who follow the system in a department expect the authority should send this student feedback to the teachers after publishing test results, so the students' negative feedback does not impact their results. Three teachers also address the issues related to the university's environmental or contextual factors and students' academic performances. Teacher 5 explains:

> The environment of the department and the teacher-student relationships are always good and friendly. Wi-Fi is available too; students can receive counseling from the teachers and discuss any topic with them. Teachers always make sure that students feel comfortable and do not hesitate to ask questions.

5.4.2. Influencing factors for failure

While responding to the major causes of students' failure, four teachers mention both teachers' and students' irresponsibility. Teacher 1 describes:

> I observe that students do not study mathematics meticulously. Lack of awareness is the key issue. Sometimes, topics are difficult for them to understand. Some teachers present the subject interestingly, while others use old notes prepared during their student life.

Hence, these teachers never improve their teaching styles or teaching materials over time. Thus, the issues regarding boring lectures leading to academic regression emerge from the interview data. Teacher 3 explains:

> Teachers should not dive directly into formulas and mathematical problems; they should first discuss the subject and why students need to study it. The course's applications and implications should also be explained.

To introduce variations in lectures, teachers should make them relevant to practical applications, assign collaborative tasks, and include question-and-answer sessions. Teachers 3 and 4 believe that long-term mathematics anxiety from childhood can be a root cause of student failure.

> From the primary level of education, we observe two groups of students: some who like mathematics and others who fear it. Unfortunately, the majority of students belong to the latter group. The early fear of mathematics continues to persist up to the university level.

To reduce such fear, teachers should instruct students on how to learn mathematics, instead of merely teaching it, so students can benefit from self-study. Teachers 2 and 5 indicate that students' lack of commitment to effective learning causes low academic performance.

> Students are not sincere; although they attend lectures, they do not study well at home. Students only practice before exams, instead of studying throughout the year. Furthermore, they do not practice regularly. Most often, students memorize theorems without understanding the basic concepts.

Moreover, students occupy themselves with tuition or hangouts, which decreases their study time and concentration… of the responding teachers highlight the problem of teaching a course declining with the teachers' research interests. Teacher 2 complains:

> Some teachers teach courses that are neither their research interests nor their field of expertise. Consequently, the lectures are not enriched enough, and the teachers are more concerned about their research than teaching.

These teachers do not make use of adequate preparation time. While discussing technology integration and online facilities in mathematics teaching, teachers 3 and 5 are reluctant to use technical or online options despite their availability. They did so only during the pandemic when they were required to teach virtually.

> Some teachers do not like to use technology, although they are currently using it due to the pandemic. However, technology has been essential to ensure effective learning. I am afraid that almost none of us use all the existing facilities.

Technophobia is a common trait that is hard to change. However, any kind of incentive or appreciation offered to the teachers can improve their practices. Students' overall academic performance is largely connected to the assessment systems. Most teacher respondents express some dissatisfaction regarding the existing exam-based evaluation. Teacher 4 reacts:

> The assessment system is not standardized here, especially at public universities. We should incorporate assignments or projects that require the implementation of course content. Written examinations alone are not sufficient.

The prevailing assessment systems encourage students to pursue good grades and a decent job, rather than motivating them to genuinely learn something new. In addition to this, teachers 1, 2, and 5 also attribute students' inadequate prior knowledge and indifference to learning mathematics to students' failure.

6. Discussion

The current study investigates the perspectives of teachers and students on the variables influencing the success and failure of Bangladeshi university students in mathematics. The research findings suggest that a wide range of multidimensional factors influence students' mathematical achievement and failure, irrespective of gender, family income, university type, study level, and grades.

Students' perceptions of their failure factors primarily include irregular practices, which are also the third most frequently mentioned teacher-stated factor in phase one. This finding coincides with that of Mazana et al. [30], who found that teachers reproved students for passively studying mathematics like history and practicing inadequately. Both teachers and students report one common cause of students' poor performance, which is more rote learning than conceptual development. Teachers share a similar viewpoint regarding exam-based assessment systems and an obsession with better grades, which encourages students to memorize the content rather than acquire an intuitive grasp of it. This is congruent with Basturk's [31] findings of student respondents' criticism about teaching and learning mathematics through memorization.

Students' low performance is also exacerbated by poor teaching quality and deficient lectures. This finding is consistent with Basturka and Yavuzb [32], who stated that ineffective teaching approaches and monotonous presentations lead to students' failure. Both students and teachers express concerns about the teaching merit of both public and private university lecturers. Teachers' involvement in academic activities, research projects, and career development can reduce their preparation time for ensuring quality lecture notes for students. This might result in students' dissatisfaction with the course, as teachers have stated. However, Casinillo [33] found no correlation between the factors affecting students' failure and their perceptions of mathematics teachers.

Another cause of failure is the mathematics phobia developed in childhood. Mazana et al. [30] report a similar conclusion in their study: teachers discover that most students nurture a pre-existing view that mathematics is a difficult subject, leading to low self-confidence and poor performance. Students' failure is also attributed to the stress of covering large curricula in a time constraint. Teachers' perceptions of student failure are impacted by their low motivation, curiosity, and confidence. In phase one, it is the most frequently identified failure factor by teachers. This justifies Tachie & Chireshe's [34] and Anthony's [8] findings about little enthusiasm for mathematics as one of the most significant impediments to Turkish students' success. Besides, teachers believe university students' difficulties with abstract mathematical concepts lead to low performance. Unfortunately, school students view math as a routine subject comprising mostly calculations based on logic and formulas, while university math is theoretical, consisting mainly of definitions and theorems [35].

Bangladeshi public university students are more apprehensive about the uncreative pedagogical structure discouraging experiments, as confirmed in Alam [5]. The research mentions the deteriorating features of the overall public university education system in

Bangladesh over time, with unwanted session jams causing delayed graduation. Students become frustrated due to family pressure and unemployment in such circumstances. On the other hand, private university and mathematics minor students are concerned about their weak mathematical background, which might hinder their prospects for further higher study options.

Students need to invest adequate practice time to achieve high academic success, which is one of the most frequently mentioned success factors by both students and teachers. However, these findings contrast with those of Anthony [8], who ranks regular practice as a low-priority success criterion. Students also identify understanding the course materials as a crucial success criterion, with high achievers placing greater emphasis on this aspect of success. It is the second most important component in students' success, as reported by teachers. Clear concepts of the subject are also significant in attaining desired learning objectives for students. Students believe that regular study increases their chances of succeeding in mathematics, which is in line with Shibanda et al.'s [36] findings that study regularity is the most frequently mentioned student success factor. High achievers acknowledge that focus, attention, and effective exam strategies and tactics contribute to achieving better test scores. This aligns with Casinillo's [33] findings about poor study habits being the main obstacle to succeeding in mathematics.

Good and quality teachers play a crucial role in shaping students' academic aspirations. Both students and teachers agree that access to quality teaching is key to a student's academic achievement. Garca y Garca [37] observe a similar condition where the variable 'excellent professors' predicts good marks for both male and female mathematics students. According to Alibraheim [38], students' attitudes toward mathematics are influenced by some internal and external factors, with the latter including instructor traits. However, students' perceptions of achievement are also shaped by the availability of resources, appropriate classroom settings, and their interests in mathematics. The first phase of the research explores the majority of teachers and students who believe that determination, enthusiasm, and confidence are essential for mathematics success. Anthony [8] and Bengmark et al. [11] corroborate this view held by teachers. Students' self-motivation and self-efficacy are the two most meaningful elements of success, followed by passion and interest in tertiary-level mathematics.

Teachers also recognized the importance of having prior knowledge of the subject to attain satisfactory results. Similar findings were observed in a study conducted in South Africa by Kizito et al. [4], who discovered that students' prior academic knowledge was the second most important factor, behind workload, in explaining their success in first-year mathematics courses. Furthermore, Rylands & Coady [2] found that students' secondary mathematics skills have a significant impact on their tertiary-level performance. On the other hand, teachers believe that regularly attending lectures, having a decent study atmosphere, and having a good examination system are less important criteria for achieving success, contrary to the findings of Gupta et al. [10], which state that a supportive learning system is mandatory for students' high accomplishments. We found no gender differences in success perceptions, except that male students believe visualization is very important in mathematics. Anthony [8] also found no statistically significant difference in male and female students' perceptions of achievement; however, Gupta et al. [10] reported that male students have a more favorable attitude toward mathematics.

7. Conclusion

Overall, it is evident from the data that both students and teachers hold students responsible for their success and failure in undergraduate math courses Findings conclude that students perceive factors for failure to include inconsistent study habits, ineffective pedagogies, and negative attitudes. Teachers consider students' little self-confidence, low motivation, and short foresight to be the major obstacles to students' success. Students report success factors comprising regular exercises, clear concepts, responsiveness, and strategy adaptation. On the other hand, teachers commend enthusiasm, prior knowledge, and strong basics in mathematics for achieving success in the subjects. The study demonstrates female students are equally competent as male students in their academic mathematics achievement.

Recommendations

- Embrace technology and develop digital learning platforms to support blended and remote learning.
- Ensure online resources and content are accessible to all students.
- Introduce competency-based education models focusing on learning outcomes rather than classroom attendance.
- Encourage faculty members to engage in research and adopt cutting-edge teaching strategies.
- Enhance faculty members' digital teaching abilities.
- Support students by emphasizing soft skills, adaptability, and resilience.
- Explore various approaches to ensure financial viability for both instructors and students.
- Foster a culture of shared accountability and transparency.
- Involve faculty members, students, and staff in central decision-making processes.
- Provide mental health and counseling services to address students' emotional and psychological needs.

Implications

The recommendations above have several implications for the higher education landscape.

- Increased reliance on technology implies a need for investment in digital infrastructure and staff training.
- Competency-based education suggests a shift away from traditional classroom-based models.

- The adoption of cutting-edge teaching strategies and digital skills will require ongoing professional development.
- Support for soft skills and resilience emphasizes the importance of holistic student development.
- Financial viability for instructors and students may necessitate changes in funding models.
- Shared accountability and transparency can foster trust and collaboration within institutions.
- Involving stakeholders in decision-making requires a more inclusive governance structure.
- Mental health and counseling services indicate a commitment to student well-being.

Limitations

The results presented in this paper might vary depending on time, territory, and perspective. Therefore, this dynamic research with expansion potential requires further attention in improving mathematics pedagogies and assessing the impact of these individual variables on students' success and failure. Furthermore, conducting research in various contexts would yield comparative results, ensuring generalizability on a global scale. Small sample sizes of both students and teachers are additional constraints of this research. Moreover, this study is limited by the three distinct phases of data collection, each involving different participant cohorts.

Future research

Future researchers might focus on how the research findings can be used to establish a profoundly supportive academic environment for effective mathematics instruction. More sophisticated techniques and statistical analyses can be employed to further expand upon the results and analysis. Additionally, future studies can extend beyond mathematics and into other relevant fields. It is essential to investigate the specific perspectives of Bangladeshi indigenous groups, as they encounter significant language barriers when studying science and mathematics, similar to English medium instruction (EMI) student groups.

Data availability statement

All data is freely available. Please see the following link.
Link: https://figshare.com/articles/dataset/Phase_2_Students_csv/24989073/2.
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CRediT authorship contribution statement

Mili Saha: Writing – review & editing, Writing – original draft. **Shobha Islam:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Asma Akter Akhi:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Goutam Saha:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Conceptualization.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e29173.

Appendix A

Table A1
Transcript themes and the corresponding codes

Transcript theme	Code
Success Factors	

(*continued on next page*)

Table A1 (*continued*)

Transcript theme	Code
Teachers have many responsibilities, such as presenting interesting lectures, discussing real-life applications, continuing research, communicating learning objectives, and the course's career prospects, etc.	Lecturer
Since the majority of the students only focus on lecture notes, preparing the next lecture with good care is essential.	
Students' high achievement in academia is shaped by the teachers' presentation of lectures to some extent.	
One has to invest time to solve exercises and practice as much as possible.	Students
If someone studies constantly throughout the year, obviously he/she will secure good grades at the end.	
Students have to follow lectures accurately; they have to understand any topic very well and try to apply what they learn in different fields.	
Group study and online peer discussion have helped me achieve good grades.	External
The environment of the department and the teacher-student relationships are always good and friendly.	
The first and foremost thing is having a clear concept about a topic.	Courses
Knowing how to implement a theorem rather than only knowing the statement and proof of that theorem is crucial.	
Failure Factors	
I think the lectures should have been more intelligible.	Lecturer
Some teachers do not take class regularly, which demotivates the students and creates information gaps since they hardly remember the previous lesson.	
Teachers need to bring variations in lectures; making things more visible to us would help.	
Some good students fail to reach their full potential at university because of easy distractions. They spend much more time hanging out with friends or enjoying things than studying.	Students
Students tend to memorize theorems without properly understanding how they were derived because they always look for a shortcut to pass the exam, which weakens their basics.	
Students are not sincere; although they attend lectures, they do not study well at home.	
New students do not have proper accommodation during their first year of study.	External
The environment is neither conducive nor friendly enough to concentrate on studies.	
From the first year, students engage themselves in politics, either willingly or forcefully, even before the exam night.	
Sometimes, topics are difficult for them to understand.	Courses
We should incorporate assignments or projects that require the implementation of course content.	

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