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Perceptions of failed mathematics education students toward preparatory mathematics course

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Abstract

Investigating the experiences of mathematics education students who have faced academic challenges is vital for shaping the professional development of future mathematics educators. This study examines the experiences of Indonesian mathematics education students who have encountered difficulties in a Preparatory Mathematics Course (PMC). Employing a qualitative case study narrative approach, we explore these students' perceptions, emphasizing the crucial role of foundational mathematics skills and the potential of PMC in aiding underprepared learners. Data were collected through questionnaires and interviews. The findings reveal varied perspectives on the course's value. Some students recognized its significance and contribution to their university studies, particularly in mathematics content courses, while others viewed it as less impactful. Factors contributing to student failures included a lack of focus and dedication, carelessness in test assessments, and discrepancies between expected and actual learning experiences. Additionally, participants provided constructive suggestions for improving the course, such as integrating collaborative learning, enhancing assignments and assessments, incorporating instructional videos, offering in-person learning opportunities, adjusting schedules, and facilitating anonymous online discussion forums. These insights offer valuable directions for refining PMC and improving outcomes for mathematics students and educators.

Keywords: case study narrative, mathematics education, matriculation, preparatory course, unprepared students

Introduction

Proficiency in basic mathematics skills, such as operations involving integers, fractions, and algebraic expressions, is essential for student success. These foundational skills are particularly important due to the hierarchical structure of mathematics (Ernest, 2013; Hoffmann & Egri-Nagy, 2021) and the necessity of numeracy skills (Westwood, 2021). They serve as the cornerstone for various disciplines, including accounting, science, technology, engineering, and mathematics (Büchele et al., 2022; Zakaria et al., 2010). Despite entrance exams for selecting prospective students in Indonesia, some universities continue to offer preparatory courses at the beginning of the academic year (Armianti et al., 2016; Kawuwung & Palit, 2016; Noviantari, 2022; Susiaty, 2016). These preparatory courses are designed to equip students with essential foundational competencies, enabling them to succeed in their subsequent academic pursuits (Noviantari, 2022; Zakaria et al., 2010).

In this article, the term 'preparatory course' is used interchangeably with various terms, such as 'matriculation' in Indonesian universities and 'remediation' or 'remedial' in countries like Germany, the US, and the UK (Büchele, 2020; Di Pietro, 2014), as well as 'pre-matriculation' in the US (Griffith & Griffith, 2016). For the purposes of this study, a preparatory course is defined as a program or intervention designed to help students acquire the necessary academic skills or knowledge to effectively engage in and complete their coursework, thereby achieving their educational objectives. Consequently, this article uses the terms matriculation, pre-matriculation, and remediation interchangeably. As previously mentioned, the implementation of preparatory courses is driven by higher education instructors' recognition that students often lack adequate preparation in terms of competency (Büchele et al., 2022; Crisp et al., 2017; Hagedorn & Kuznetsova, 2016). These courses aim to improve students' competencies, enhance course satisfaction and academic self-efficacy, facilitate adaptation to the new educational environment, and support the completion of academic tasks (Crisp et al., 2021; Zhao et al., 2022). Consequently, preparatory courses also anticipate and mitigate student dropout rates resulting from academic challenges (Venegas-Muggli et al., 2019).

The implementation of preparatory courses is generally driven by the underperformance of admitted students in terms of their competence (Büchele et al., 2022; Crisp et al., 2017; Er, 2017; Hagedorn & Kuznetsova, 2016). These courses are intended to encourage students to effectively engage in their coursework. Ideally, students would be well-prepared for their courses upon university enrollment. However, surveys conducted in various countries, including Germany (Büchele et al., 2022; Büchele, 2020), Turkey (Er, 2017), the United States (Crisp et al., 2017), Malaysia (Tambychik & Meerah, 2010), and Indonesia (Noviantari, 2022), have reported a lack of preparedness among students, particularly in mathematics. Additionally, Büchele et al. (2022) suggest that preparatory courses should be mandatory for unprepared first-year students. Büchele (2020) also finds that a preparatory mathematics course (PMC) can improve students' mathematics abilities and increase their probability of passing mathematics tests. However, the effectiveness of PMCs depends on

their design and implementation, as well as the level of support and resources provided to students during and after the program (Griffith & Griffith, 2016).

To strengthen the foundations of the Preparatory Mathematics Course (PMC) and foster a learning environment conducive to student growth, understanding students' experiences and perceptions is crucial. In line with this objective, the mathematics education department at a public university in North Kalimantan, Indonesia, has implemented the PMC three times since 2020. The program focuses on the remediation of school-level mathematics. Preliminary research, including interviews with faculty from the mathematics education department and document analysis, revealed that in the 2022 PMC, two sixth-semester students failed three times, and seventeen fourth-semester students failed twice. Therefore, an investigation is necessary to better understand the factors contributing to students' repeated failures in passing the PMC despite multiple attempts.

Exploring the experiences of these students who have failed is essential, as the findings can inform the professional development of future mathematics teachers (Lutovac & Flores, 2021; Lutovac & Kaasila, 2021). This study focuses on students' encounters with the PMC to extract valuable insights for program improvement. As emphasized by Snead et al. (2022), identifying and supporting students at risk of failure through demographic data is crucial. This proactive approach can lead to targeted interventions, enhancing students' chances of success and ensuring the positive impact of the PMC on their academic journeys.

Unresolved challenges in mathematics education can have far-reaching consequences for students, including feelings of overwhelm, low self-confidence, and poor academic performance. The reasons behind high failure rates in mathematics courses remain unclear, necessitating thorough investigation. This study aims to describe the perceptions of mathematics education students who have failed the PMC. The central research question guiding this inquiry is: "How do students who have failed mathematics courses perceive their experiences during the preparatory course?" By exploring this question, we aim to illuminate the complex landscape of mathematics education and provide insights that will significantly impact mathematics education faculty, policymakers, and program organizers. Ultimately, this research seeks to develop innovative strategies to improve students' mathematical comprehension and foster academic achievement.

Methods

This research employed a qualitative case study narrative approach, focusing on a specific group of students who participated in the PMC. The primary data comprised participant narratives obtained through extensive interviews. The study adopted a constructivist paradigm, recognizing the socially constructed nature of reality and its interaction with individual interpretations and knowledge construction through participant interactions and experiences (Creswell & Creswell, 2017; Merriam & Tisdell, 2015).

The PMC in this research was a fully online program conducted three times from 2020 to 2022. Each iteration of the PMC began with a pre-test and concluded with a post-test, both lasting 90 minutes. The passing score was set at 70.00 out of a maximum of 100.00 points.

Throughout this period, the course content was meticulously refined. In 2020, the PMC covered integer and fraction operations, linear equations and inequalities, equations of lines, basic trigonometry, and basic integrals. These five topics were divided into two sessions, each lasting one hour, totaling 10 hours of instruction. The pass rate for this year was 73.68%, with 42 out of 57 students passing the post-test.

Following an evaluation of the 2020 course, it was determined that the content needed to be deepened for the 2021 iteration. Consequently, each session was significantly extended from one hour to three hours. The topics for PMC 2021 remained largely the same as those in 2020 but included additional depth: integer and fraction operations (including mixed numbers and decimals), elementary algebra (covering basic concepts of algebra and operations such as addition, subtraction, expansion, and factoring), linear equations, linear inequalities, quadratic equations, equations of lines, trigonometry, and basic integrals. The total duration of the course increased to 18 hours. The pass rate for this iteration improved to 86.52%, with 77 out of 89 students scoring 70.00 or above.

Significant changes were implemented in 2022. The PMC committee decided to eliminate trigonometry and replace basic integrals with statistics. Additionally, some topics were consolidated: linear equations, linear inequalities, quadratic equations, and equations of lines were combined into a single algebra topic. The committee prioritized statistics over basic integrals, reasoning that students could learn basic integrals in the Calculus course. In contrast, basic statistics was essential across various courses, even in the first year of university. Consequently, the topics for 2022 included

1. Numbers and Their Operations (covering the real number system, whole numbers, fractions, and decimals),
2. Algebra (introduction to algebraic forms, algebraic operations, linear equations, linear inequalities, and quadratic equations),
3. Geometry (cartesian system, linear functions, quadratic functions, equations of circles), and
4. Statistics (data, data presentation, measures of central tendency and dispersion).

Despite maintaining the session duration at 150 minutes, the total instructional time was reduced to 12 hours due to eliminating some topics.

In 2022, all participants in the PMC experienced failure. Among them, 73 students had not passed, including 2 students in Semester 5, 17 in Semester 3, and the remaining 54 in Semester 1. This situation prompted the current study, which collected data from February 2023 to July 2023. Initially, 10 out of the 73 students who had failed were recruited for interviews 1 and 2. To ensure comprehensive exploration of the topic and achieve data saturation (Charmaz, 2014), three additional students who had also failed the PMC were selected, resulting in a total of 13 participants.

Ethical considerations were carefully addressed in the study. Each participant was fully informed about the study's purpose and their rights, including the right to withdraw at any time. Informed consent was obtained from all participants before data collection, ensuring

confidentiality by using pseudonyms for each participant. Finally, Figure 1 shows the Learning Management System (LMS), which was Utilized in the PMC 2022.

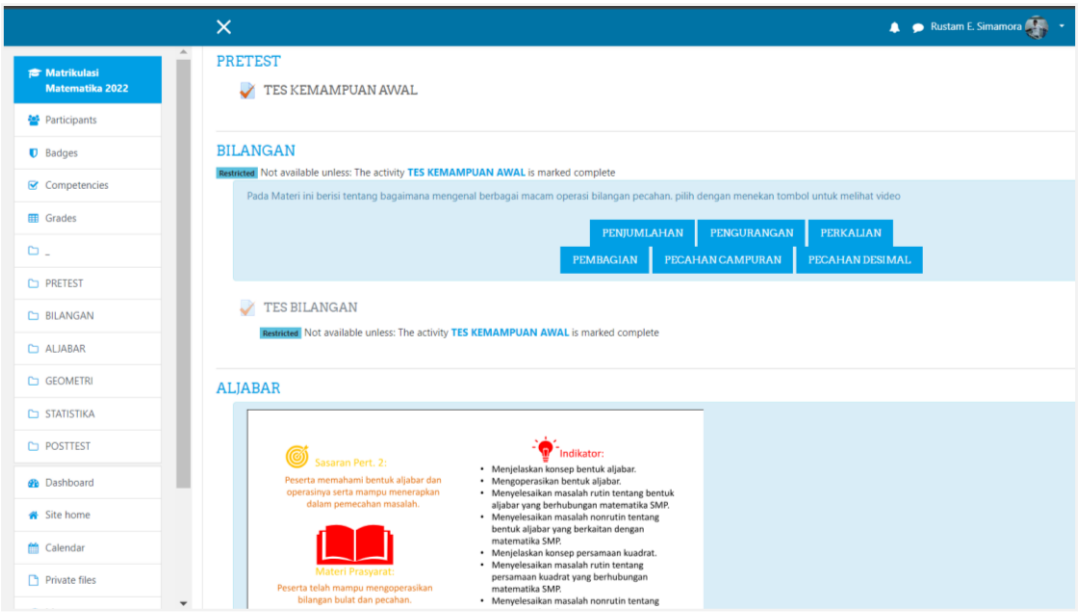

Figure 1. Learning Management System, which was Utilized in the PMC 2022

An open-ended questionnaire comprising six questions was distributed to all participants who had not passed the PMC. Developed using Google Forms, the questionnaire included open-ended prompts aimed at eliciting detailed narratives and reflective responses from students. The questions focused on various aspects: their preparation in mathematics content courses (such as Introduction to Basic Mathematics, Calculus I, Trigonometry, Number Theory, and Geometry), their experiences during the PMC, suggestions for enhancing the PMC, observed good practices during the program, factors contributing to their failure in the PMC test, and their consent to participate in the research study.

The research team distributed the online questionnaire and allocated one week for initial participant recruitment among students who had not passed the PMC. The questionnaire was accessible from March 2 to March 8, 2023, and garnered responses from 30 individuals, with 13 agreeing to participate in the research presented in Table 1. Initially aiming for a maximum of 10 participants per interview, the first ten students who consented were selected as initial participants. However, due to limited participation, only three new participants agreed to join the third interview after member checking (second interview). Despite redistributing the questionnaire and extending the recruitment period, additional participants meeting the maximum quota could not be secured.

The interviews were transcribed verbatim and analyzed alongside the questionnaire data. The analysis process included validating findings through member checking, specifically after Interview 2 and Interview 4. Initial conclusions drawn from Interview 2 were further tested in Interview 3, which involved three new participants (Group 2). The data collected from Interview 3 and the corresponding questionnaire responses were analyzed, and member

checking was conducted again during Interview 4 to ensure the reliability and validity of the conclusions drawn from the study.

Table 1. Demographic Profile of Participants

Group	Participant	Sem.*	Background	Year	Sex	f**
Group 1	P#01	5	Senior High School	2020	female	3
	P#02	5	Vocational School	2020	female	2
	P#03	3	Vocational School	2021	female	2
	P#04	3	Senior High School	2021	female	2
	P#05	3	Senior High School	2021	female	2
	P#06	3	Senior High School	2021	female	2
	P#07	1	Senior High School	2022	female	1
	P#08	1	Senior High School	2022	male	1
	P#09	1	Senior High School	2022	female	1
	P#10	1	Senior High School	2022	female	1
Group 2	P#11	3	Islamic Senior High School	2021	male	1
	P#12	1	Vocational School	2022	female	1
	P#13	1	Senior High School	2022	female	1

Note: *) Sem. = The last semester when students followed the preparatory mathematics course; **) f = The frequency of participants following the program (until 2022)

The data analysis followed Miles et al.'s approach (2014), incorporating data condensation, display, and the drawing and verifying of conclusions. In the data condensation phase, the researcher summarized the interview data and applied codes—labels in words, phrases, or sentences—to capture key ideas and concepts. These codes were then organized into categories or themes that represented common patterns or topics across the dataset. Throughout this phase, the researcher also wrote memos to record reflections and insights (Charmaz, 2014).

In the data display phase, themes, narrative texts, and tables were developed based on the condensed data. This step involved organizing and presenting the coded data in a structured format to facilitate understanding and interpretation. To verify the conclusions drawn from the analysis, participant feedback and member checking were employed. This process ensured that the identified themes and interpretations accurately addressed the research questions and reflected participants' perspectives.

The analysis of data from new participants followed a similar approach to achieve saturation by replicating and confirming earlier findings (Charmaz, 2014; Miles et al., 2014). NVivo® 12 software was utilized during the data analysis process to assist in coding, organizing themes, and managing the qualitative data effectively.

Results and Discussion

We have identified three primary themes that encapsulate the perceptions of underperforming students regarding their Preparatory Mathematics Course (PMC) experiences. We extensively explore these findings, presenting the core themes along with their respective subthemes. This

detailed depiction offers a comprehensive insight into the experiences, viewpoints, and emotional reactions of our participants.

Finding

The data analysis revealed three primary themes concerning how unsuccessful students perceive their experiences in the Preparatory Mathematics Course (PMC): perception of the preparatory course, factors contributing to student failure in the preparatory course, and expectations regarding the enhancement of the preparatory course. Table 2 presents the themes, their corresponding subthemes (focused codes), and the number of participants assigned to each code. These descriptions and elucidations offer a comprehensive overview of the themes and subthemes discussed in the qualitative research report, providing insights into the participants' experiences, perspectives, and emotional responses within each thematic domain.

Table 2. Theme, Sub-theme, and the Number of Participants Proposed Each Subtheme

Theme	Sub-theme/Focused Code	N
Perceptions toward the preparatory mathematics course	Emphasizing the importance of the course	12
	Recognizing assistance from the course in mathematics content courses	10
	Not significantly impactful for mathematics content courses	3
	Considering the course to be less necessary	1
Factors contributing to students' failures in the preparatory mathematics course	Lack of focus during the course participation	10
	Lack of dedication to the course	10
	Careless mistakes on test assessments	8
	Lack of engagement in the course	7
	Test assessments beyond students' cognitive level	7
	Incongruity between expected and actual learning	6
Suggestions for the development of the preparatory mathematics course	Implementing collaborative learning	12
	Improving assignments, tasks, and test assessments	12
	Providing learning videos	12
	Carrying out in-person learning	11
	Fitting course schedules	9
	Integrating anonymous discussion forums on the LMS	5
	Improving educators' communication skills	3

Note: N = number of participants propose the subtheme/code; LMS = learning management system.

Perception of The Preparatory Mathematics Course

This theme examines participants' perceptions of the PMC's influence and importance, detailing how they perceive the program's role in preparing them for mathematics content courses. Participants recognized the PMC's value in addressing disparities in educational backgrounds and supporting their university-level academic journey. The program aims to provide foundational educational experiences through relevant content and support. However,

perceptions of its impact vary among participants: while some find it moderately beneficial, one participant viewed it as less crucial due to their particular academic focus.

Emphasizing the importance of the course vs. Considering the course to be less necessary

Almost all participants recognized the value and significance of the PMC in facilitating their transition to university-level education. For instance, in Interview 3 (Int._3), Participant P#11 remarked, "*Students entering mathematics education come from various backgrounds. Some are well-prepared, while others lack the necessary skills and knowledge to follow lectures. In my opinion, this program should be maintained*." This perspective underscores the PMC's role as a valuable tool for addressing varying levels of student preparedness.

However, Participant P#01 held a contrasting view, perceiving the preparatory course as less influential in her academic journey, potentially impacting her engagement and commitment. She stated, "*The preparatory course is not important. It's a requirement for my thesis proposal*." (P#01, Int._1) This viewpoint reflects a shift in priorities towards more advanced academic pursuits, viewing the PMC primarily as a procedural obligation rather than a significant contributor to her studies.

Recognizing assistance from the course in mathematics content courses vs. Not significantly impactful for mathematics content courses

Participants overwhelmingly credited the PMC for supporting their initial experiences at the university level, citing its positive impact. Participant P#03 noted, "*The Algebra material in the preparatory course helped in Linear Algebra and Trigonometry courses. The geometry material was advantageous in Plane Analytic Geometry. It was beneficial, Sir*." (P#03, Int._1) This perspective highlights the program's role in reinforcing foundational concepts and facilitating a smoother transition to advanced university courses.

However, some participants, like P#13 in Interview 4 (Int._4), expressed reservations about the PMC's broader effectiveness in university studies, despite its role in addressing the needs of underprepared students. She commented, "*This program helps during lectures, but its impact isn't felt significantly*." This sentiment reflects a recognition of the PMC's assistance in specific areas while questioning its overall efficacy in university-level studies. These perspectives illustrate the varied views among participants regarding the PMC's role and effectiveness in supporting their academic progression and preparedness at the university level.

Factors Contributing to Students' Failures in the Preparatory Mathematics Course

This theme examines the underlying reasons for participants' lack of success in the PMC, detailing the specific factors that impeded their progress and completion of the program. Analysis of participants' experiences identified several contributing factors to their failures in the PMC, including diminished focus, inadequate dedication, unreliable internet connectivity,

errors in test-taking due to carelessness, insufficient motivation, and discrepancies between anticipated and actual learning outcomes.

Lack of Focus During Course Participation

Numerous participants encountered difficulties maintaining concentration throughout the program, potentially leading to misunderstandings of PMC content and learning opportunities. For instance, one participant acknowledged, "*The primary cause of my failure was lack of focus. I did not engage deeply with the material and neglected to review the explanations and content.*" (P#03, Int._2) Several factors, including coursework demands, network disruptions, and student organization commitments, distracted participants during the course. Notably, nine out of thirteen participants reported experiencing network disruptions during online activities, adversely affecting their ability to concentrate during virtual meetings. For instance, one participant attributed her failure in the 2021 PMC to poor network connectivity during the initial test: "*Yes, Sir, during the first test, I was in a rural area with unreliable network coverage.*" (P#03, Int._2)

Lack of Dedication to Course

This sub-theme underscores the lack of commitment among several participants (ten individuals), resulting in incomplete assignments and suboptimal learning experiences. For example, one participant admitted, "*I was not adequately prepared. At the time, I overlooked fundamental mathematical topics, resulting in confusion when tackling various subjects*." (P#07, Qtn.) The reasons for insufficient commitment varied among participants; some felt that the program revisited previously learned material, requiring minimal effort. Others, particularly first-year students, viewed the PMC as a prerequisite for their thesis proposal defense but considered it less critical due to the ample time available before initiating their thesis work. Additionally, the non-credit-bearing nature of the PMC led some participants to prioritize other coursework over participation in the program. Participant P#07 remarked,

> *"I needed to prepare for my studies, Sir. My preparation before the test was minimal. I lacked motivation even to review past preparatory test questions. [...] Although a preparatory course certificate is required for proposing my thesis, failing this course does not significantly impact my academic progress as I can re-enroll next year." (P#07, Int._1)*

Careless Mistakes in Test Assessment

Participants' lack of attentiveness during test-taking adversely affected their performance and overall outcomes in the program. As one participant noted, "*I was not cautious, Sir, whereas mathematics demands meticulousness. A minor error at the outset could invalidate the entire solution*." (P#12, Int._4) Three participants expressed surprise at their results post-exam, realizing their answers were incorrect. Reflecting on the multiple-choice format, one participant lamented,

> *I found the questions quite challenging. My answers were based on calculations, but they proved erroneous [...] I wish the answer choices had been less misleading to avoid such mistakes. (P#01, Qtn.)*

Lack of Engagement in Course

Lack of motivation impeded participants' active participation, hindering their progress and achievement. Factors such as peer interaction dynamics, alignment of course content with expectations, and challenges adapting to the program environment contributed to reduced motivation. For example,

> *At the outset of the preparatory course, I did not find it engaging. Initially, I struggled to adapt to my peers, compounded by the pressure of course activities. Consequently, I felt disillusioned when the results were announced. (P#10, Int._2)*

Participant P#01, who undertook the PMC for the third time, felt isolated due to separate study arrangements from peers. Conversely, Participant P#09 lacked motivation, finding the material inadequately challenging. Another participant cited the transitional phase required for acclimatizing to new peers as a demotivating factor.

Test Assessment Beyond Cognitive Levels

A majority of participants felt the test questions exceeded their preparedness levels, leading to poor performance and feelings of inadequacy. Participant P#01 described the test as exceptionally challenging, with deceptive multiple-choice options. In subsequent interviews, she highlighted the test's short duration, stating, "*The allotted time is insufficient; it should ideally be extended to two hours or two hours and fifteen minutes*." (P#01, Int._2) Another participant noted that some post-test topics were unfamiliar from their junior and senior high school studies. However, contrasting views existed among participants, with some appreciating the test's structure in terms of content coverage, difficulty level, allocated time, and question format (20 multiple-choice and five essay questions). For instance, one participant remarked,

> *Overall, the test questions were well-designed, Sir. However, my difficulty stemmed from comprehending how to approach them." (P#03, Int._2)*

Incongruity Between Expected and Actual Learning

Participants' expectations of the program did not align with the content and delivery, contributing to disengagement and subsequent failure. "*Some instructors merely read aloud from PowerPoint slides, hindering our understanding of the material*." (P#09, Int._1) Another participant echoed concerns about insufficient interaction and detail in instruction methods, stating, "*Certain instructors lacked engagement; their delivery primarily involved reading slides without fostering interactive discussion*." (P#11, Int._4) Conversely, participants

acknowledged that effective comprehension required active participation and attentiveness during program activities. "*Although the instructors explained the material well, lack of student attention hindered comprehension*." (P#05, Int._2)

Expectations for the Development of the Preparatory Mathematics Course

This theme revolves around participants' aspirations for enhancements and improvements in the PMC, exploring their recommendations to enhance the program's effectiveness and benefits. It underscores participants' proactive involvement in program enhancement, encompassing a variety of strategies. These include collaborative learning, high-quality assessments, multimedia resources, hybrid learning approaches, optimized scheduling, anonymous discussion forums, and improved instructor communication. These suggestions reflect participants' commitment to fostering a more effective and learner-centered PMC that caters to diverse learning preferences and needs.

Implementing Collaborative Learning:

A significant majority of participants advocated for integrating collaborative learning activities to foster peer interaction and enhance learning outcomes. This sub-theme highlights their preference for group learning settings, where active discussions and peer teaching enhance understanding. Participant P#02 stated, "*Participants may not fully grasp the material when studying individually. However, through peer discussions, understanding improves*." (P#02, Int._2) Similarly, Participant P#04 noted, "*Those with a strong grasp of the material can assist others who are struggling*." (P#04, Int._2) Participants emphasized that group sessions maximize learning potential by facilitating open expression of ideas and enhancing mastery of the material. (P#08, Int._2)

Improving Assignments, Tasks, and Assessments

Nearly all participants stressed the need to enhance the quality and relevance of assignments and test questions to enrich the learning experience. They recommended providing answer keys for practice exercises and tests to promote self-directed learning. Participant P#05 emphasized, "*Answer keys are crucial for verifying correctness and self-improvement*." (P#05, Int._2) Additionally, Participant P#07 highlighted, "*Post-test answer keys are essential for self-assessment and future improvement.*" (P#07, Int._2).

During Interview 1, a participant suggested increasing the number of questions to encompass a broader range of mathematics topics. He noted, "*In junior high national exams, there were numerous questions, up to 40 multiple-choice questions in two hours. For the previous preparatory course, perhaps around 30 multiple-choice questions and five essay questions would be appropriate.*" (P#08, Int._2). However, most participants generally disagreed with the suggestion to increase the number of questions. One participant remarked, "*Even with 25 questions, I ran out of time, so increasing the number would be even more challenging*." (P#03, Int._2). Participants emphasized the need for well-designed, manageable, and relevant assessments to enhance the learning experience.

Providing Educational Videos

The majority of participants strongly advocated for incorporating educational videos to supplement their learning experiences, citing their effectiveness in simplifying complex concepts and facilitating comprehension. Participant P#09 expressed,

> *The usefulness of videos, stating that they facilitate a clearer understanding of the material. He noted that videos provide an easy way to review content when needed, unlike text-based resources such as modules, handouts, or books, which are more challenging to comprehend deeply. Therefore, the use of videos makes learning more accessible and practical. (P#09, Int._2)*

Conversely, another participant suggested that instructional videos might be less essential if the learning material is already well-visualized. He mentioned that while videos can be helpful, their absence would not be detrimental: "*Maybe it helps, but if it is not available, it is okay, Sir, because videos are more about helping students visualize how a topic can be easily understood.*" (P#08, Int._2). The instructional videos referenced here include recordings of asynchronous sessions.

Implementing In-Person Learning

Numerous participants expressed a preference for in-person interactions to enhance their understanding and engagement with the learning material. For example, one participant stated, "*Honestly, I think learning mathematics online is not effective. Interaction through Zoom meetings is suboptimal. Therefore, I find direct in-person learning significantly better than online learning*." (P#11, Int._3). This sentiment underscores the belief among participants that face-to-face interactions are more effective in addressing their challenges with online learning. Conversely, another participant considered in-person learning for this program optional, noting, "*Since the materials in the previous preparatory course are topics we have already studied, it is acceptable if it is not conducted face-to-face. This participant suggested that face-to-face sessions for tests alone would suffice to ensure integrity*." (P#08, Int._2). Similarly, Participant P#12 expressed a preference for the program to be fully online, citing its greater efficiency compared to in-person learning. (P#12, Int._2).

Optimizing Course Schedules

Participants recommended adjusting the program's timing to align with their optimal learning hours and minimize the likelihood of drowsiness. This sub-theme highlights participants' concerns regarding scheduling, taking into account their circadian rhythms and ideal learning conditions. Four participants noted that the program was scheduled during periods when they typically felt drowsy and suggested rescheduling it. An interview excerpt illustrates this perspective:

Researcher: "*How about the arrangement of this previous preparatory course schedule? Do you think the timing of the program's implementation in the past was appropriate?*"
Participant: "*It seems like the timing is not right for me, Sir.*"
Researcher: "*Why is the timing not right?*"
Participant: "*Because during the daytime, I usually feel tired, Sir. I feel drowsy."* (P#01, Int._1)

Other participants suggested scheduling the program during vacation periods or before the commencement of regular coursework to ensure their concentration remains undisturbed during their participation.

Integrating Anonymous Discussion Forums on the LMS

The inclusion of online discussion forums facilitates peer-to-peer interaction and knowledge sharing. This sub-theme underscores participants' suggestions for enhancing peer engagement and communication through an online platform that ensures anonymity, thereby promoting open discussions and practical learning. Five participants highlighted the necessity of anonymous discussion forums. One participant suggested:

> *You could establish a forum where the identity of the individual posing the question remains anonymous. This way, when the instructor reviews the questions, they can address them without the student feeling uncomfortable about asking for clarification. Similar to the question box feature on Instagram, the instructor could respond through video or written explanations. This approach allows other students to see that a particular question has already been asked and is awaiting a response, ensuring that they do not need to repeat the query." (P#07, Int._2)*

Other participants expressed neutrality regarding this suggestion for program development.

Enhancing Educators' Communication Skills

Several participants emphasized the necessity of developing effective communication skills as an essential component of the program to support their academic journey. This sub-theme reflects participants' acknowledgment of the critical role instructors play in facilitating effective knowledge transfer and their aspiration for clear and engaging communication. Specifically, three participants expressed the expectation that instructors could improve their communication skills. They desire lecturers to better address their learning needs and encourage greater engagement during the program. One participant shared:

> *My suggestion pertains to the lecturers, Sir. The manner in which instructors deliver content should be enhanced to be clearer, more detailed, and more explicit, enabling us, as participants, to comprehend it better. It is akin to the*

concept of stimulus and response, Sir. If the stimulus provided by the instructor is effective, our response will also be positive. (P#09, Int._2)

These findings underscore the significance of considering diverse participant perspectives within the PMC. While some participants acknowledge the program's value, others find it less beneficial. Moreover, the factors contributing to participant failures, such as difficulties in maintaining focus and motivation, highlight areas in need of improvement. Consequently, these findings emphasize the necessity for a comprehensive approach to program design and enhancement to better prepare students for university success.

Discussion

Research studies on Preparatory Mathematics Courses (PMCs) (Kälberer et al., 2014; Greefrath et al., 2017; Ottinger et al., 2020) underscore their significant role in refreshing students' knowledge, clarifying program requirements, and introducing self-organized and blended learning methods. These findings align with our emphasis on personalized interventions and program enhancements to effectively support students during their transitional phase. This discussion section provides a detailed analysis of our research findings, focusing on contrasting and confirming identified themes: perceptions of the PMC, factors contributing to student challenges, and expectations for program improvement. By exploring these themes, we aim to construct a comprehensive understanding of participants' experiences and derive insights for enhancing programs and interventions.

Our investigation into participants' perceptions of the PMC reveals a nuanced landscape. For some students, the program catalyzes academic success, leading to tangible improvements in subsequent courses (Büchele, 2020). They attribute their progress to foundational knowledge and support acquired through the program. However, a subset of participants, such as Participant P#13, did not perceive a substantial impact on their overall academic performance. This variability underscores the context-dependent effectiveness of the program and emphasizes the necessity of tailored interventions.

Delving into factors contributing to participant challenges exposes a spectrum of issues. Narratives highlight rigorous assessment standards within the program and a misalignment between instructional content and evaluation criteria (Büchele et al., 2021). This misalignment can leave students feeling unprepared. Additionally, challenges in time management due to competing academic demands and personal responsibilities emerge as significant obstacles, as indicated by Participant P#11. This multifaceted landscape underscores the complexity of addressing student challenges and reinforces the need for personalized approaches that consider both external pressures and internal factors.

Participants' expectations for program development provide valuable insights into enhancing the learning experience. Recommendations include incorporating collaborative learning activities and integrating instructional videos (Büchele, 2020). These suggestions resonate with existing literature, advocating for innovative teaching methods and resources (Büchele et al., 2021). Furthermore, the recurring preference for face-to-face interactions

highlights the importance of personal engagement and suggests potential benefits of direct instructor-student communication.

Our findings both confirm and extend established research. Challenges faced by students transitioning to higher education echo those identified in contexts such as Büchele et al. (2021) in Germany and Mullen et al. (2023) globally, indicating a universal demand for adaptable, student-centered learning experiences. Moreover, alignment with Nushi et al.'s (2022) emphasis on learner-centered approaches in university settings resonates with our focus on engaging, motivating, and empowering students through preparatory courses.

Recent developments in instructional design, as proposed by Kirsten and Greefrath (2023), underscore the importance of tailoring program delivery to meet students' specific needs and preferences, particularly in evolving educational landscapes. Kälberer et al.'s (2014) findings emphasize the significance of personalized support for non-traditional students preparing for the challenges of higher education, echoing our emphasis on tailored interventions and program enhancements.

Miller & Bernacki's (2019) exploration of self-regulated learning skills in mathematics mastery aligns with our discussion on personalized interventions and program development, advocating for enhanced learning skills to improve academic outcomes. Simamora et al.'s (2022) research underscores the role of inspirational educators, reinforcing the importance of personalized interventions in creating effective learning environments. Schoenfeld's (2022) call for deeper engagement in mathematics education aligns with our goal of fostering profound understanding and equitable learning environments.

Our study identifies a shared concern across universities regarding students' foundational mathematics skills and their impact on academic outcomes, consistent with findings from Greefrath et al. (2017) on the proactive role of PMCs in addressing these issues. The diverse designs and focuses of these courses echo our discussion on tailoring interventions to meet specific student needs and expectations.

In addressing challenges faced by first-year students in Computer Science programs during the transition from secondary to higher education, Ottinger et al. (2020) introduced an innovative PMC that addressed fundamental mathematics concepts alongside essential technological and non-technological skills. This comprehensive approach highlights the value of tailored interventions and program development in enhancing students' transition experiences.

While this qualitative exploration provides nuanced insights, inherent limitations exist due to the subjective nature of participant perspectives. Further validation through quantitative research with a broader, more diverse sample is necessary. Member checking and triangulation strengthened our research's robustness, yet recommendations derived from this study should be augmented by assessing the impact of proposed interventions on student outcomes. Moreover, exploring the balance between face-to-face and online learning, as suggested by Büchele et al. (2021) and Lin (2022), could provide deeper insights into effective instructional strategies and student preferences.

Our comprehensive discussion offers a multidimensional understanding of participants' experiences within PMCs. Identifying challenges and confirming established trends forms a basis for informed decision-making in program enhancement. By embracing a student-centered approach and acknowledging nuanced attitudes toward failure, educators and administrators can proactively tailor interventions to foster engagement, resilience, and academic success. As educational institutions navigate the evolving higher education landscape, our findings provide a roadmap for refining PMCs to maximize student potential and create supportive, effective learning environments (Schneid et al., 2022). Furthermore, insights from this qualitative research contribute to a holistic understanding of academic challenges and failures, guiding the development of effective, student-centered learning experiences.

The quality of our research was ensured through member checking and data triangulation (Creswell & Creswell, 2017; Miles et al., 2014), with findings validated through replication and saturation testing (Charmaz, 2014; Miles et al., 2014). However, the primary data's subjective nature, based on participant narratives, suggests that not all perspectives were fully corroborated. Future studies should consider quantitative approaches and a larger sample size to enhance validity and generalizability.

Conclusion

This study offers a comprehensive insight into participants' perspectives on PMC, revealing varied perceptions regarding the program's impact. While many students recognize its role in bridging educational gaps and preparing them for university studies, others perceive its influence as less significant. This nuanced understanding highlights the importance of tailored interventions and learner-centered approaches to address the multifaceted challenges students face during their transition to higher education. Recommendations from the study include integrating collaborative learning activities, enhancing assessment quality, providing instructional videos, and considering opportunities for in-person learning, all of which present promising avenues for program development.

Future research efforts should prioritize quantitative studies to validate these qualitative findings and quantify the impact of suggested interventions on student outcomes. Additionally, investigating the optimal balance between face-to-face and online learning within PMC will be crucial to inform effective instructional strategies. By actively refining these programs and fostering supportive learning environments, educational institutions can better equip students for success in their higher education journeys.

Conflicts of Interest

The authors assert that there are no conflicts of interest related to the publication of this manuscript. Additionally, ethical considerations, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies, have been thoroughly addressed by the authors.

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