A Case Study on Transition From Teacher-Centered Learning to Online, Asynchronous Learning

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Abstract: The transition from teacher-centered to online, asynchronous learning represents a significant shift in educational paradigms. Traditional teacher-centered approaches, characterized by direct instruction and passive student roles are being increasingly replaced by asynchronous online models that prioritize learner flexibility and engagement. This shift allows students to access content at their own pace and encourages self-directed learning. While the flexibility of asynchronous formats can empower students and accommodate diverse learning styles, the lack of real-time interaction may lead to challenges in motivation, time management, and reduced opportunities for immediate feedback. Adapting to online, asynchronous learning can be challenging and can have varying levels of ease and difficulty. There is a lack of information in this regard when it comes to the learners' perspective. This study attempts to provide insights on the shift from traditional learning to modern online, asynchronous learning by analysing the results of a group of students which followed an elementary mathematics module as per the requirements of a degree programme in information technology offered by the University of Moratuwa, Sri Lanka. The cohort of students came from varying backgrounds and streams of study. However, all students in the group had obtained at least a credit pass for mathematics at the GCE Ordinary Level examination (secondary school) and passed the GCE Advanced Level (high school) examination. The preliminary results indicated a significant positive correlation ($r=0.287$, $p<0.001$) between the marks obtained for mathematics at secondary school and marks obtained at the university. The findings of this study provide insights on the learners' experience on transition from teacher-centered learning to online asynchronous learning. Furthermore, the study proposes best practices to be adopted to ensure a smooth transition.

Keywords: Distance Education, Online Asynchronous Learning, Self-directed Learning, Teacher-centered Learning, Educational Paradigm Shift

1. Introduction and Background

The transition from teacher-centered instruction to online, asynchronous learning marks a significant shift in pedagogical practice, with implications for learner engagement, autonomy, and instructional design. Traditional models emphasize instructor-led delivery and passive student roles, whereas asynchronous formats promote self-directed learning and flexible access to content. Despite these advantages, challenges such as reduced real-time interaction, motivation, and time management persist. This paper presents a case study from the University of Moratuwa, Sri Lanka, examining how a cohort of undergraduate students adapted to asynchronous learning in an elementary mathematics module.

The transition to asynchronous learning is underpinned by key instructional theories that advocate for learner autonomy and digital engagement. Constructivism promotes active, self-directed learning, where learners build up knowledge through experiences and reflection (Alam, 2023). Such an approach corresponds effectively with asynchronous learning frameworks, which emphasize self-directed learning. This emphasis is especially important in mathematics education, where conceptual understanding develops progressively. Complementing this, connectivism highlights the role of digital technologies and social networks in facilitating learning beyond the physical classroom (Alam, 2023). These theories collectively justify asynchronous learning as a deliberate, contextually appropriate design rather than a makeshift alternative to real-time instruction. Observational evidence further reinforces this shift. Comparative studies of teacher-centered and student-centered instructional models indicate that student-centered approaches are grounded in constructivism and connectivism as learning theories. These approaches are linked with increased engagement, enhanced conceptual understanding, and superior academic performance (Alam, 2023). These findings support the relevance and effectiveness of learner-centered asynchronous learning environments in higher education.

The effectiveness of asynchronous learning has been widely compared across disciplines, especially in mathematics, where conceptual continuity is critical. (Libasin, et al., 2021) conducted a study comparing academic performance between synchronous and asynchronous online learning modes during the COVID-19 pandemic. Their findings revealed a statistically significant difference, with students in synchronous settings outperforming their asynchronous peers (mean scores of 79.31 and 74.86 respectively; $p = 0.004$), highlighting the potential performance gap attributed to mode of delivery. Asynchronous learning allows students to study at their own pace and engage deeply with content. At the same time, it demands strong self-regulation and can increase feelings of isolation (Libasin, et al., 2021). These insights are particularly relevant in the context of mathematics education, where (Libasin, et al., 2021) suggest that the suitability of a learning mode may vary by subject. Their study underscores the need to evaluate how asynchronous environments affect learner outcomes, especially in theoretically intensive subjects.

(Awacorach, et al., 2021) highlight that transitioning from teacher-centered to student-centered models such as Problem-Based Learning (PBL) can significantly enhance students' research capabilities and employability. Through engagement with real-world community problems, students developed critical thinking and practical skills, suggesting that learner-centered approaches have value beyond academic performance. This aligns with asynchronous learning environments, where students often work independently on problem-solving tasks. The study further highlights that reallocating responsibility from instructors to students fosters learner autonomy; however, elements of traditional hierarchical structures continue to persist in some learning environments (Awacorach, et al., 2021). These findings resonate with the challenges faced in asynchronous models, where students may struggle if accustomed to directive instruction. Finally, the success of student-centered transitions like PBL depend heavily on institutional and instructor readiness. Researchers identified barriers such as low digital literacy among faculty and infrastructural constraints. These findings imply that asynchronous learning environments need parallel investment in educator support and technological infrastructure (Awacorach, et al., 2021).

Research on student preferences across academic disciplines indicates a clear inclination toward teaching methods that combine both teacher-centered and student-centered elements. Students consistently favored approaches such as lectures with opportunities for interaction, demonstrations followed by hands-on practice, and free-flowing classroom discussions (Murphy, et al., 2021). These findings support the notion that even in asynchronous learning environments, student engagement can be sustained by embedding interactive components like collaborative tasks or application-based exercises. In contrast, students viewed teacher-centered approaches such as impromptu quizzes, unsupported lectures, and passive media as least effective. These methods limited interactivity and reduced learner participation (Murphy, et al., 2021). This highlights the importance of rethinking traditional delivery when adapting to asynchronous modes to avoid replicating passive learning structures online. While teaching preferences may vary slightly by academic major, there is strong evidence that students across fields value methods that promote active participation, real-world relevance, and autonomy in learning (Murphy, et al., 2021). The evidence points to a critical need for structured yet adaptable instructional approaches in asynchronous mathematics modules to ensure both flexibility and sustained student engagement.

Studies comparing online and face-to-face learning environments indicate that instructional format significantly affects student performance, particularly among traditional undergraduates. One study found that traditional students were less likely to pass online courses than face-to-face courses. In contrast, non-traditional students achieved better outcomes in the online format (Spencer & Temple, 2021). This suggests that asynchronous learning may pose challenges for younger students who are still developing self-regulation skills. Despite reporting that online tools facilitated prompt feedback, enhanced problem-solving, and met their learning needs, students expressed a clear preference for face-to-face instruction (Spencer & Temple, 2021). This preference was largely attributed to discomfort in online peer and instructor interactions, highlighting a limitation of asynchronous environments. Furthermore, course structure and the effective use of instructional technology by instructors were found to be crucial factors in student success. Organized course design, regular communication, and meaningful engagement strategies significantly contributed to positive student outcomes in online settings (Spencer & Temple, 2021). The results emphasize the necessity of well-designed asynchronous instructional frameworks, especially in content areas like mathematics that demand sequential and cumulative understanding of concepts.

Recent innovations in online mathematics education highlight the importance of maintaining instructor presence and real-time interactivity to support student engagement. One study introduced a method where the instructor and content are displayed simultaneously on screen, enabling the use of eye contact, body language, and digital handwriting during live-streamed lectures (Jin, 2023). Students reported significantly higher satisfaction and engagement with this approach compared to conventional screen-sharing, suggesting that social cues and instructor visibility play a crucial role in maintaining focus during mathematical instruction (Jin, 2023). The use of real-time handwritten content improved comprehension by aligning spoken explanations with written visuals. This benefit is supported by the temporal contiguity principle in multimedia learning (Jin, 2023). These findings highlight the value of adding visual embodiment and simulated instructor presence to asynchronous learning designs. This is particularly important in mathematics courses, where high cognitive load and abstract reasoning require strong guidance.

2. Problem Statement

There is lack of knowledge on the students' transition from traditional teacher-centered learning to modern teaching and learning methods which focus on student-centered, synchronous/asynchronous online activities. It is unclear what factors may be helpful for the students to adapt seamlessly.

3. Methodology

This study employed a quantitative, observational research design to investigate the relationship between students' prior mathematics performance and their achievement in first-year university-level mathematics. The research also explored how educational background specifically A/L subject stream and geographic origin relate to academic performance in an asynchronous learning environment.

3.1 Data Collection

The dataset used in this study consisted of academic records from first-year Bachelor of Information Technology (BIT) students enrolled in the first semester mathematics module at the University of Moratuwa. Data were collected through the institutional student registration database, which included G.C.E. Ordinary Level (O/L) Mathematics results, A/L subject stream, and regional data.

Key variables included:

- O/L Mathematics grades
- A/L stream
- ITE1813 Mathematics scores
- District (inferred from A/L region)

Only students with complete and valid records were included. Those with missing or invalid A/L stream information, or those absent from the exam, were excluded.

3.2 Data Preparation and Transformation

To enable analysis, several transformations were applied to the dataset:

- O/L Mathematics grades were encoded numerically on a 1–3 scale, where A = 1, B = 2, and C = 3. Since university entry requires a minimum of a 'C' in O/L Mathematics, any lower grades were excluded from the analysis.
- A/L stream was encoded using values from 0 to 12, with higher values assigned to streams involving greater mathematical intensity (e.g., Physical Science and Combined Maths), and lower values to less mathematically intensive streams (e.g., Arts).
- Mathematics performance in the first semester module was calculated from students' grades, which were numerically estimated using the average value within each grade range.
- District information was inferred from the A/L examination region, as explicitly recorded in the registration database.
- Students with missing or ambiguous A/L stream data were excluded to preserve the integrity of group-wise comparisons.

These transformations allowed for effective application of statistical and visual analysis techniques, while ensuring that comparisons were grounded in consistent and meaningful representations of students' academic backgrounds.

3.3 Statistical Analysis

3.3.1 Normality Testing

The Shapiro-Wilk test was applied to both the O/L Mathematics grades and first semester scores to assess whether they followed a normal distribution. As both variables significantly violated normality assumptions ($p < 0.05$), non-parametric methods were prioritised in subsequent analysis.

3.3.2 Correlation Analysis

Both Pearson's correlation coefficient and Spearman's rank correlation coefficient were used to measure the association between prior performance in mathematics (O/L grades) and ITE1813 scores. These methods provided complementary insights into the linear and monotonic aspects of the relationship.

3.3.3 Group-wise Analysis by A/L Stream

The average Semester 1 mathematics score was computed for each A/L stream to explore how subject specialisation influenced mathematical performance in an asynchronous setting. Additionally, the number of students achieving an 'A' in O/L Mathematics was analysed per stream to assess foundational readiness.

3.3.4 Geospatial Visualisation

A map-based visualisation was developed using Tableau, representing average mathematics scores and O/L Mathematics grades by district. The map used marker size to indicate average ITE1813 scores, and colour gradient to reflect O/L grade averages, allowing clear geographic comparisons of academic performance.

3.4 Tools and Software

The following tools were used:

- Python (pandas, scipy, matplotlib, seaborn) – for data manipulation and statistical analysis
- Tableau – for map-based visualisation
- Microsoft Excel and Word – for data handling and documentation

3.5 Ethical Considerations

All student data were anonymised, and no personally identifiable information was used. Data access and processing complied with institutional ethical standards and relevant data protection regulations.

4. Analysis and Discussion

This section presents a comprehensive analysis of the relationship between students' prior mathematics performance at the G.C.E. Ordinary Level (O/L) and their outcomes in the first-year university mathematics module (ITE1813). The analysis also explores the impact of the asynchronous learning model adopted for this module, investigating correlations, distribution patterns, and performance trends across various demographic and academic segments.

4.1 Correlation Analysis

The statistical analysis was performed using Python. Figure 1 illustrates the code used to compute both the Pearson and Spearman correlation coefficients between students' G.C.E. Ordinary Level (O/L) Mathematics grades and their performance in the first-year mathematics module.

```
In [1]: import pandas as pd
        import matplotlib.pyplot as plt
        import seaborn as sns
        from scipy.stats import pearsonr, spearmanr, shapiro

In [2]: link_grades = '/kaggle/input/olvs1813/OLvsITE1813.csv'
        grades = pd.read_csv(link_grades, index_col='reg')

In [ ]: print(grades.head())

In [3]: # Pearson
        pearson_r, pearson_p = pearsonr(grades['ol'], grades['ite1813'])
        print(f" Pearson Correlation (r): {pearson_r:.3f}")
        print(f" Pearson p-value: {pearson_p:.3e}")

        # Spearman
        spearman_r, spearman_p = spearmanr(grades['ol'], grades['ite1813'])
        print(f"\n Spearman Correlation (r): {spearman_r:.3f}")
        print(f" Spearman p-value: {spearman_p:.3e}")

        Pearson Correlation (r): 0.287
        Pearson p-value: 2.460e-11

        Spearman Correlation (r): 0.279
        Spearman p-value: 9.167e-11
```

Figure 1: Correlation Analysis

The Pearson correlation coefficient between students' grades in G.C.E. Ordinary Level (O/L) Mathematics and their performance in the first-year mathematics module was found to be r = 0.287, with a p-value of 0.000 Similarly, the Spearman rank correlation coefficient was ρ = 0.279, with a p-value of 0.000. These results indicate a weak but statistically significant positive correlation between students' prior performance in mathematics and their achievement in the Semester 1 Mathematics module.

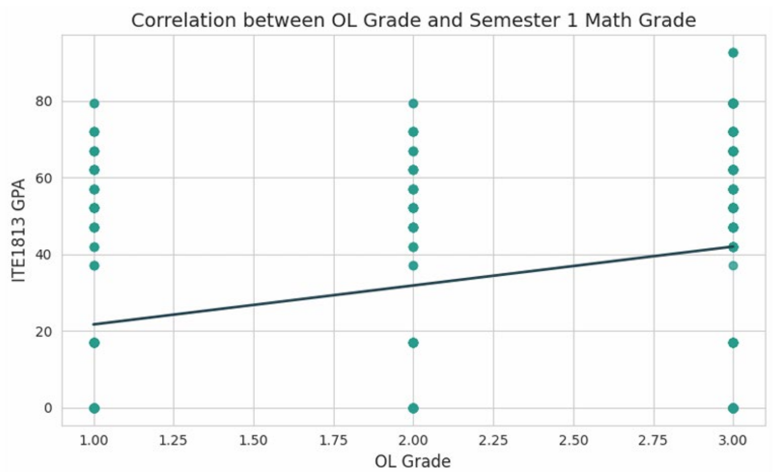

Figure 2: Correlation between O/L Grade and Semester 1 mathematics grade

The closeness of the Pearson and Spearman coefficients implies an approximately linear and monotonic relationship. However, the relatively low magnitude of these coefficients suggests that O/L mathematics performance accounts for only a small portion of the variance in university mathematics outcomes.

4.2 Normality Testing

To determine the suitability of applying parametric statistical methods, a Shapiro-Wilk normality test was conducted on students' O/L Mathematics grades and their Semester 1 Mathematics scores. In both cases p=0.000 was observed, indicating strong rejection of the null hypothesis of normality. Consequently, non-parametric statistical approaches are deemed more appropriate for this dataset.

4.3 Geographical Performance Analysis

A map-based visualisation (shown on Figure 3) was created to illustrate average university Semester 1 Mathematics scores by district. Marker size represented the average Semester 1 Mathematics score, while colour denoted the average O/L Mathematics grade for each district. High-performing districts such as Galle (47.21), Ratnapura (42.13), Matara (41.58), and Kandy (41.80) demonstrated strong prior academic foundations. In contrast, districts like Badulla (23.18), Anuradhapura (24.26), and Puttalam (24.43) had lower average scores. Interestingly, regions such as Trincomalee (29.92) and Batticaloa (29.98) exhibited moderate university-level performance despite weaker O/L results, implying the influence of additional contributing factors.

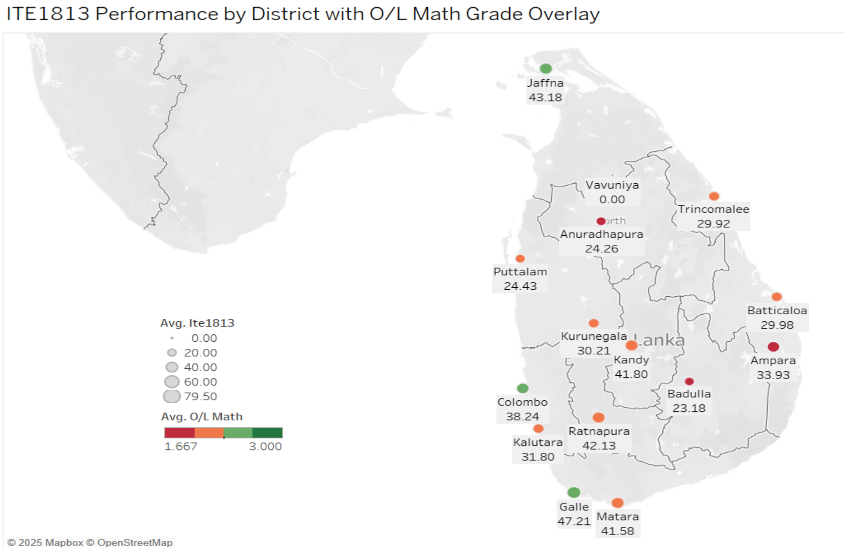

Figure 3: Semester 1 Performance by District with O/L Mathematics Overlay

4.4 Impact of A/L Stream on Semester 1 Mathematics Performance

An analysis of average Semester 1 mathematics scores by A/L stream as displayed on Figure 4 reveals the impact of prior subject specialisation. Students from Combined Maths (54.50) and Maths (53.46) streams exhibited the highest performance, underscoring the advantages of strong mathematical foundations. Conversely, students from the Arts (26.37) and Engineering Technology (25.89) streams scored the lowest, likely due to limited prior exposure to abstract mathematical concepts. Notably, students from No Stream (46.20) and Other (44.23) categories performed relatively well, suggesting that attributes such as digital readiness, motivation, and adaptability may significantly influence success in asynchronous learning environments.

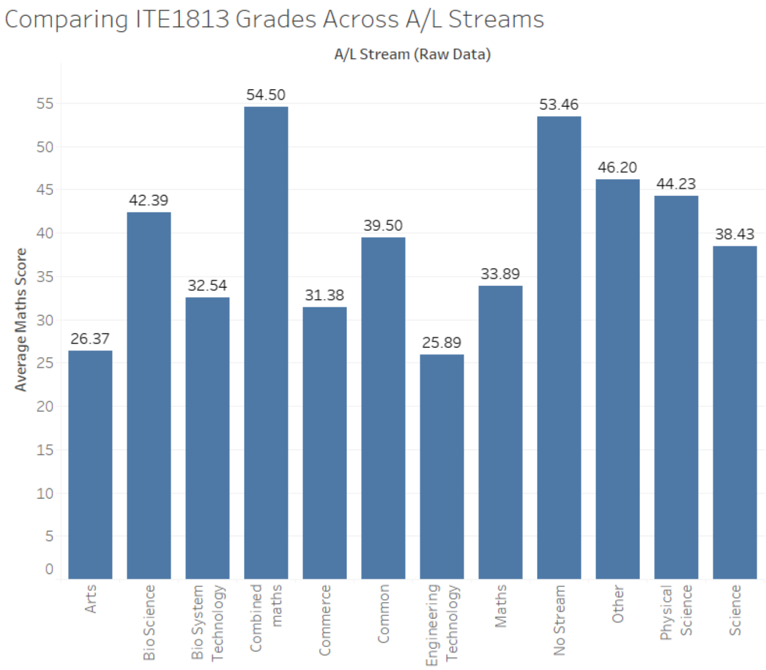

Figure 4: Comparing Semester 1 Mathematics Grades Across A/L Streams

4.5 Distribution of 'A' Grades in O/L Mathematics by Stream in A/L

A breakdown of students who earned an 'A' in O/L Mathematics and their subsequent A/L streams as indicated on Figure 5 reveals dominance by Physical Science (88) and Bio Science (51) students. Commerce (39) and Engineering Technology (26) also had notable contributions, while Arts (23), Maths (15), and other streams showed lower numbers. As these students move into asynchronous university-level mathematics, the disparities suggest a need for targeted interventions to support learners from less mathematically intensive backgrounds.

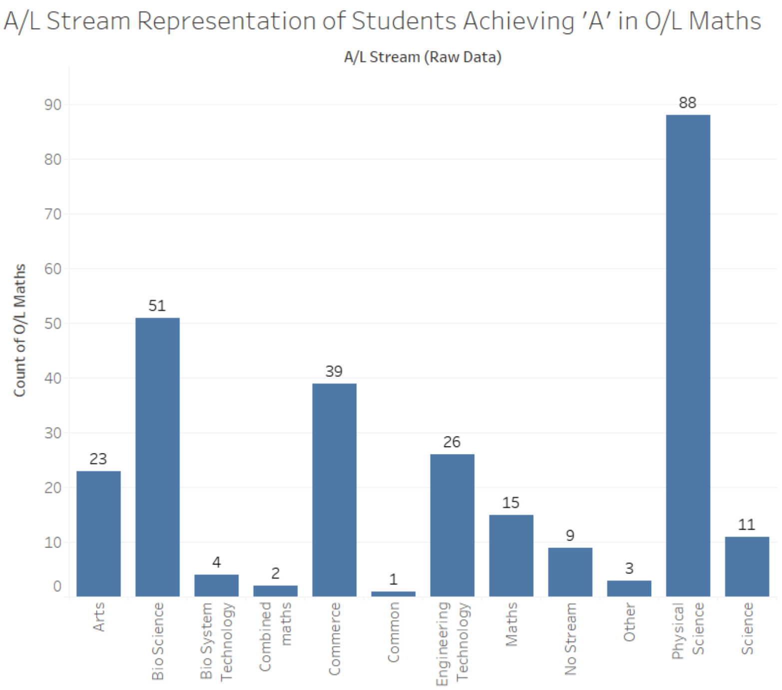

Figure 5: A/L Stream Representation of Students Achieving 'A' in O/L Maths

4.6 Failure Analysis by O/L Mathematics Grade

The pie chart analysis shown on Figure 6 indicates that 57.14% of students who failed the first-year mathematics module had received a C in O/L Mathematics. Surprisingly, 23.21% had achieved an A, and 19.64% had a B. These findings challenge the assumption that high academic achievement in the past guarantees success in asynchronous learning suggesting that success in such environments also relies heavily on skills like self-directed learning, time management, and the ability to understand abstract mathematical concepts.

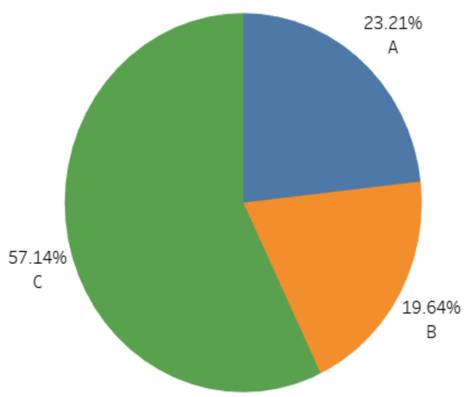

Figure 6: Failure analysis by O/L Mathematics Grade

4.7 O/L Performance of High Achievers in Semester 1 Mathematics Module

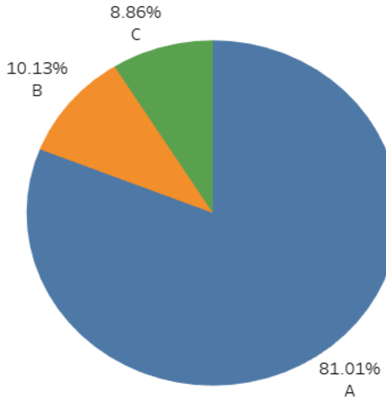

Figure 7: Performance of High Achievers in Semester 1 Mathematics Module

Among students who earned higher grades (A+, A, A-) in the Semester 1 mathematics module, 81.01% had previously secured an A in O/L Mathematics. Meanwhile, only 10.13% had a B and 8.86% had a C. This reinforces the idea that a strong foundation in synchronous O/L learning provides a significant advantage in adapting to the demands of asynchronous university education.

4.8 Failure Distribution by A/L Stream

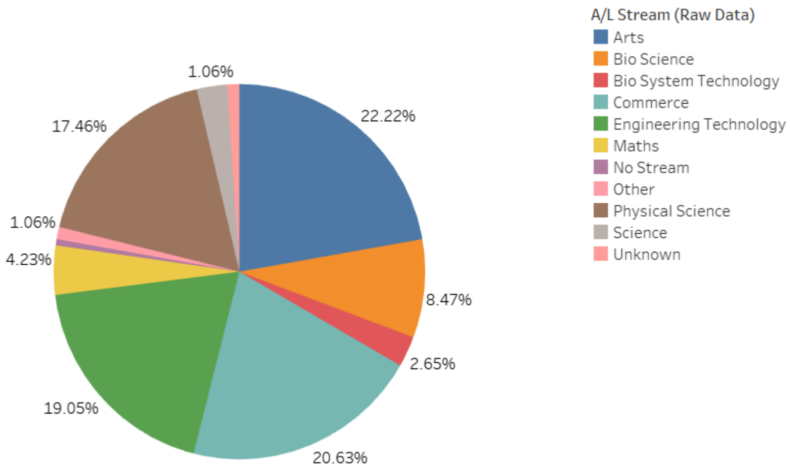

Figure 8: Failure distribution by A/L stream

The chart shown in Figure 8 presents the A/L stream background of students who failed the first-year university mathematics module. The largest proportions come from Arts (22.22%), Commerce (20.63%), and Engineering Technology (19.05%), followed by Physical Science (17.46%). These figures indicate that failure is not isolated to any single stream but is notably higher among those from non-mathematics intensive backgrounds.

Interestingly, even students from mathematically rigorous streams such as Physical Science and Maths (4.23%) are represented, suggesting that prior exposure alone is not sufficient to guarantee success in an asynchronous learning environment.

The presence of students from Arts, Commerce, and Technology among those who failed highlights the potential challenges faced by students who may lack deep mathematical grounding or are less accustomed to independent learning structures. These findings reinforce the need for adaptive support strategies that go beyond prior academic stream and focus on strengthening self-regulated learning skills.

5. Conclusion

This study examined the transition from teacher-centred to asynchronous online learning by analysing the performance of first-year IT students in university mathematics module. The analysis incorporated prior academic indicators, including secondary school mathematics grades, subject stream chosen in high school, and district-level background. These findings, while contextually grounded in Sri Lanka, may hold broader relevance for regions undergoing similar transitions from teacher-centred to asynchronous learning models.

The results revealed a statistically significant but weak correlation between prior mathematics performance and university-level outcomes, indicating that foundational knowledge alone is not a strong predictor of success in asynchronous settings. Students from mathematically intensive A/L streams and higher-performing districts generally achieved stronger results; however, variation was evident, with some students from less intensive backgrounds also performing well.

The occurrence of low performance among students with great prior qualifications, as well as success among those with weaker academic backgrounds, emphasises the need of self-directed learning, adaptability, and digital readiness. These findings underscore the need for enhanced academic support structures that account not only for prior attainment, but also for the skills required to navigate independent, technology-mediated learning environments effectively.

6. Limitations

This study is subject to several limitations that should be considered when interpreting the findings.

The analysis relied exclusively on quantitative data extracted from institutional academic records. As such, it did not account for qualitative variables such as motivation, digital competency, or study habits which are factors that could play a substantial role in asynchronous learning. This limitation is particularly important when considering diverse regions, where socio-economic background, digital access, and cultural attitudes toward independent learning may strongly influence outcomes.

The dataset was limited to a single group of students enrolled in the Bachelor of Information Technology programme at the University of Moratuwa. As a result, the generalisability of the findings to other academic disciplines, institutions, or learning contexts may be constrained. As such, the findings may not fully represent students from other Sri Lankan universities, or learners in different countries where infrastructure, institutional support, and student preparedness vary widely.

Finally, the focus on a single first-year mathematics module provides only a snapshot of academic performance. A longitudinal study incorporating multiple modules and semesters would offer a more comprehensive understanding of the dynamics involved in adapting to asynchronous learning environments. Moreover, regional differences in curriculum design and delivery methods may further limit the transferability of these results to other contexts.

7. Future Work

Building on the findings of this study, several directions for future research are proposed.

Firstly, incorporating qualitative methods such as student surveys or interviews would provide richer insights into learner experiences, particularly regarding self-regulated learning, motivation, and digital literacy in asynchronous environments.

Secondly, extending the scope to include students from multiple disciplines or institutions would enhance the generalisability of results and allow for comparisons across different educational contexts and technological infrastructures.

Future studies may also adopt a longitudinal approach, tracking the performance of students across multiple modules and academic years. This would help assess how adaptation to asynchronous learning evolves over time and whether initial academic background continues to influence long-term success.

Finally, including learning analytics such as engagement measures from learning management systems may provide a more comprehensive picture of student behaviour and its relationship to academic success in asynchronous situations.

Ethics Declaration

Ethical clearance was not required for this research.

AI Declaration

AI-based tools were used solely for formatting assistance and language refinement. All intellectual content, analysis, and conclusions presented in this paper are the original work of the authors.

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