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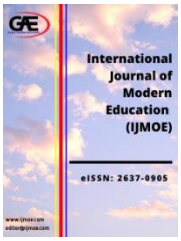

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ASSESSING CHANGES IN THE EXAMINATION CONTENT OF A MATHEMATICS COURSE ON PRE-COMMERCE STUDENTS' PERFORMANCE IN PUBLIC UNIVERSITY

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Abstract:

Previous studies suggest that alterations in examination content may lead to a shift in students' performance and learning outcomes. Despite the importance of these issues, there is a lack of comprehensive research examining how specific changes in exam content affect mathematics student outcomes across different educational settings. Thus, this comparative study examines the impacts of changes in examination content of intensive mathematics course affecting pre-commerce students' performance by comparing the grade distributions and the final exams marks obtained by the students across two semesters. The findings suggest that modifications in the final exam content, such as the exclusion of index and logarithm topics from the final exams alone, do not seem to have a significant impact on the students' marks and grades. The weightage of assessments seems to influence students' final achievement too. This shift occurred alongside significant changes in examination content, including the introduction of new topics, the omission of some topics and a redistribution of marks across subjects in both formative and summative assessments. The analysis highlights the importance of careful curriculum planning and the need for targeted student support when changes to assessment structures are implemented.

Keywords:

Intensive Mathematics, Assessment Weighing, Grade Distribution, Examination Content Changes, Student Performance

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Introduction

Pre-diploma in Commerce program is one of the pre-diploma programs as a Universiti Teknologi MARA initiative, offered to the Sijil Pelajaran Malaysia (SPM) leavers, who do not meet basic requirements to pursue their study at a public institution of higher learning (IPTA). After this pre-university level, students will enroll in diploma programs such as Hotel Management and Business Administration, where basic knowledge in mathematics is required. Intensive mathematics courses are designed to enhance fundamental mathematics skills to prepare pre-commerce students for the diploma courses. The intensive mathematics syllabus covers a wide range of topics that are essential for understanding and applying mathematical principles across various disciplines. Among the topics included are index and logarithm. These topics are classified by course learning outcome and soft skills of critical thinking and problem solving. Each of these topics plays a crucial role in developing mathematical reasoning, problem-solving skills and quantitative literacy. They are fundamental not only for academic study but also for applications in fields such as engineering, economics, natural sciences and technology. Mastering these topics provides a solid foundation for understanding and navigating mathematical concepts and applications throughout academic and professional pursuits. Index and logarithm are widely regarded as a difficult subject for both the instructor and the learner. Research by Wan Bakar and Mohd Kanafiah (2020) found that pre-commerce students often struggle with the conceptual foundations of index and logarithm. Many students exhibit misconceptions regarding the laws of exponents and the relationship between exponential and logarithmic functions. These misconceptions can hinder their ability to apply these concepts accurately in mathematical problems.

Research on assessment within the higher education sector extensively explores its significance in measuring outcomes through various means, including academic performance, the proficiency of students upon graduation, course and learning outcomes and graduates' marketability and employability. Formative and summative assessments are two kinds of testing that serve different purposes in evaluating student learning outcomes. In the classroom, the formative assessment takes place during the course, for example, quizzes, tests, and assignments. Formative assessment is implemented with the goal of monitoring students' progress and delivering timely feedback, which can then be utilized to enhance future performance (Marriot & Lau, 2008). Whereas, the final exam is a classic example of summative assessment, which aims to let the teachers and students know the level of accomplishment attained (Woolfolk et al., 2008).

The transition to new or modified exam content within educational institutions has the potential to significantly impact students' academic performance. Yet, the specific nature and extent of this impact remain unclear. Recent educational reforms often lead to significant changes in examination content, including the introduction of new topics and the redistribution of marks across subjects. However, the impact of these changes on student performance is not fully understood. Understanding how changes in exam content affect students' preparation, comprehension, and ultimately their performance is crucial for educators and policymakers aiming to design assessments that accurately reflect student learning and foster academic success. In this study, students' grades and overall marks were evaluated with the aims to understand the impact of excluding certain mathematical subtopics, specifically index and logarithm, from the final exams on the academic performance of pre-commerce students, enrolled in an intensive mathematics course. Thus, the findings will provide insights into effective strategies for curriculum adaptation and assessment design.

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Literature Review

Studies emphasize the importance of aligning curriculum content with learning objectives and educational standards (Alfauzan & Tarchouna, 2017). Omitting topics like index and logarithm from exams may suggest a misalignment between what is taught and what is assessed, potentially affecting students' preparedness and understanding in mathematics. The relevance of exam content to student performance has been explored in recent studies, which found that changes in curriculum and exam content can significantly impact student learning outcomes (Büchele & Feudel, 2023; Cybinski, 2011). Miller (2019) suggests that simplifying the curriculum can enhance students' understanding of core concepts, leading to fewer errors and improved learning outcomes. Krupa & Confrey (2017) studied the effects of a reform-based curriculum on high school algebra students, revealing that students in integrated mathematics curricula performed better in Algebra I but had similar outcomes in Algebra II compared to those in subject-specific curricula. This indicates that curriculum integration can benefit specific mathematical competencies.

Moreover, the impact of changes in final exam content on student performance varies across studies. While a study on a management accounting subject found that switching from a paper-based mid-term exam to online continuous assessments did not significantly improve student performance (Ahmed, 2016), another study in an introductory biology course showed that optional verbal final exams correlated with higher performance in cell biology content knowledge and subsequent upper-level science courses (Luckie et.al.,2013). Additionally, a study in a medical program by Cohall and Skeete (2014) demonstrated that adjusting the assessment weighting to favour final exams led to significant improvements in student performance.

Mathematics courses are foundational in academic programs, especially for pre-commerce students in public universities. The format of final exams in these courses may significantly influence student performance and outcomes. This literature review explores various studies and perspectives on how changes in final exam formats may impact students' performance in mathematics courses.

Theoretical Framework

This study is grounded in several key theories related to assessment and student performance, providing a structured understanding of how changes in examination formats and assessment methods influence learning outcomes. The review considers theories related to assessment and academic performance, including the cognitive load theory (Sweller, 1988). Extraneous cognitive load, the focus of the current study, suggests that the structure and format of exams can affect how students process and retain information. Additionally, the impact of assessment methods on motivation and learning outcomes is explored through theories of self-determination and achievement motivation.

Application of Theories to Assessment Formats

Traditional Exams vs. Alternative Assessments

Research by Gratchev (2023) compared the performance of engineering students in soil mechanic courses under traditional final exams versus alternative assessments like project-based assessments or continuous evaluation. Findings indicated that alternative assessments

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led to higher engagement and deeper learning among students, translating into improved performance compared to traditional exams.

Effect of Open-Book Exams

A review of the literature shows that open-book assessments are universally recognized to reduce stress and anxiety associated with memorization. The literature is mixed however on whether deeper learning or better preparation occurs with open-book exams. They required higher-order thinking skills and effective application of concepts, influencing overall performance positively for some students but not universally (Brightwell et.al., 2004).

Comparative Analysis of Exam Difficulty Levels

Cohen & Snow (2002) found that the increasing difficulty of the National Assessment of Educational Progress (NAEP) mathematics exam did not significantly affect student performance, suggesting that while exam difficulty has increased, it did not necessarily lead to observable changes in student outcomes. While Rukli (2022) analysed the impact of students assessing the difficulty level of test items in mathematics courses. The author found that the students motivation increased after estimating the level of difficulty on test items, which positively influenced student confidence and performance, suggesting that appropriate challenge levels can enhance learning outcomes without overwhelming mathematics students.

Factors Influencing Performance

Student Preparedness and Engagement

Research consistently highlights the correlation between student preparation and exam performance (Du Preez et.al., 2008). Changes in exam formats that encourage continuous engagement and active learning, such as regular quizzes or interactive problem-solving sessions, have shown to positively impact performance among mathematics students.

Instructor Effectiveness and Support

The role of instructors in guiding students through changes in exam formats cannot be overstated. Effective instructional strategies, timely feedback, and clear communication of expectations are crucial in mitigating potential negative impacts of format changes and fostering a supportive learning environment (Naroth, 2010). Mandeville and Liu (1997) found that students taught by teachers with higher content area preparation outperformed their peers on higher-level mathematics tasks. This underscores the importance of teacher qualifications in enhancing student performance in complex mathematical areas.

In conclusion, the impact of changes in the final exam formats on students' performance in mathematics courses in public universities is multifaceted. While alternative assessments and adjustments in exam difficulty can enhance learning outcomes and reduce stress, the effectiveness of these changes depends on various factors including student preparedness, instructor support, and the alignment of assessment methods with learning objectives. These findings highlight the importance of carefully considering the nature of assessment changes and their potential impact on student outcomes. The theoretical framework illustrates how changes in exam formats and assessment methods, informed by cognitive load theory, motivation theories, and empirical research on alternative assessments, impact student performance. Key factors such as student preparedness, engagement, and instructor support are

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essential in determining the success of these changes, highlighting the need for thoughtful exam design and alignment with educational objectives.

Methodology

Data for the study was gathered based on documents involving two groups of Pre-diploma in Commerce students, from UiTM Permatang Pauh Campus, who were enrolled in an Intensive Mathematics course. The first group of students (Group A) belongs to Semester October 2020 - February 2021, while the second group (Group B) belongs to Semester October 2021 – February 2022. There were 407 students registered in Group A while 207 students registered in Group B. The course was delivered over a 14–week period with a break between weeks. The students attended a five–hour online lecture and a five–hour online tutorial class per week. The classes were conducted online because of the COVID-19 pandemic period.

A comparative study was carried out based on document review to seek evidence whether simplifying the scope of the final exam contents by excluding index and logarithm enhances the students' grade performance.

Research Hypothesis

H_0: The exclusion of index and logarithm has no significant effect on students' overall performance in intensive mathematics course/ There is no significant difference in the mean of overall marks between Group A and Group B students.

H_1: The exclusion of index and logarithm has a significant effect on students' overall performance in intensive mathematics course/ There is a significant difference in the mean of overall marks between Group A and Group B students.

The percentage of marks allocation within all subtopics in the formative assessment and final exam between those two semesters were compared. Next, students' overall achievements were gathered at the end of each semester. The percentage of grades obtained before and after the exclusion of those subtopics from the final exams were analyzed. Moreover, descriptive statistics were employed to understand the characteristics of the assessments' marks obtained and to compare the marks in different items during those two semesters. A hypothesis testing using an independent two-sample t-test was conducted to test whether there is difference in mean marks obtained between the two groups.

Results and Discussions

The assessment items were different in terms of weightage and structure between the two semesters. During Semester October 2020 – February 2021, the weight of the four assessments were: quiz (15%), Test 1 (25%), Test 2 (30%) and final exam (30%). Achieving an overall pass required only 50 out of 100 marks. Therefore, achieving a passing grade might not be too challenging for the students because the formative assessment weightage was 70%. The assessment's structure was revised in the semester October 2021 – February 2022. There was no quiz. The two tests remained the same, however the weightage was changed as each test carrying 25% weightage. A group assignment was added, weighing 10% and the final exam carrying 40% weightage.

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Table 1 below demonstrates the percentage of index and logarithm and other subtopics in the formative and summative assessments for the two semesters, respectively. For both semesters, index & logarithm contribute around 13% to 15% of the whole assessments.

Table 1: Distribution of Percentage of Marks in Final Examination for Two Different Semesters based on Types of Assessment

Group A (October 2020 – February 2021)		Percentage %	Weightage %
Formative Assessment	Index & Logarithm	8	70
	Other subtopics	62	
Summative Assessment	Index & Logarithm	5	30
	Other subtopics	25	
Total		100	100
Group B (October 2021 - February 2022)		Percentage %	Weightage %
Formative Assessment	Index & Logarithm	15	60
	Other subtopics	45	
Summative Assessment	Index & Logarithm	0	40
	Other subtopics	40	
Total		100	100

Source: https://aims.uitm.edu.my/curriculum/

Index and logarithm had a certain percentage in the formative (8%) and summative (5%) assessments on Semester October 2020–February 2021. Meanwhile, for the latter semester, although index and logarithm were excluded from the final exam, these subtopics contributed as much as 15 percent of the whole assessments' contents, reflecting a significant portion of the assessments. This might suggest a shift in instructional focus, or a pedagogical strategy aimed at improving understanding of these concepts during the course. This revision might indicate a strategic decision to assess students on these topics more formative than summative, possibly to reduce pressure or because of these topics were deemed less critical for the final assessment of student capabilities in the broader curriculum context. The percentage of other subtopics included in the final exams for Group B increased despite the omission of index and logarithm, which could imply a broader range of topics or deeper coverage was deemed necessary for the final assessment in the latter group.

Table 2 below illustrates the marks distribution of the subtopics included in the final exams for the two semesters. The duration of the final exam for Group A was 2 hours, while for Group B was 3 hours. Since the total marks in the final exams for Group A was only 60 because some topics were excluded and the number of questions were reduced, therefore the answering period was also shortened.

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Table 2: Distribution of Marks in Final Examination for Two Different Semesters based on Topics.

Group A (October 2020 – February 2021)		Group B (October 2021 - February 2022)	
Equations & Function	15 marks	Arithmetic & Algebra	20 marks
Index & Logarithm	10 marks	Equations & Function	20 marks
Sequence	12 marks	Sequence	10 marks
Business Mathematics	8 marks	Business Mathematics	40 marks
Statistics	15 marks	Statistics	10 marks
Total	60 marks	Total	100 marks
Weightage (%)	30	Weightage (%)	40

Source: https://aims.uitm.edu.my/curriculum/

Based on the students' grade, the percentage of Group A and Group B students that passed the course were 97.3% and 94.2%, respectively. The passing marks are 50, which represents grade C. The slight drop in the passing percentage may be reflected by the different number of students in each group. Figure 1 shows the grade distribution for Group A and Group B students, respectively. The grades percentage fluctuates from high grades to low grades, typically in the academic performance distributions. A comparison analysis indicates that Group A showed a more evenly spread distribution across the grades, with a peak at "A", but significant percentages at "A+" and "A-" grades as well, while Group B had a more pronounced peak at "A", suggesting a higher concentration of students achieving this grade. The drop-off in percentage after "A" was sharper than in Group B. The overall performance shows that Group A had a broader distribution of higher grades, with 72.5% of the students getting "A+ to B" grades, while Group B showed more polarization in grades, with 61.9% of the students achieving "A+ to B" grades but also a slightly increase in lower grades. These changes could be resulted by the exception of some topics from the final exams and the difference in the total marks and the weightage of the final exams for both groups.

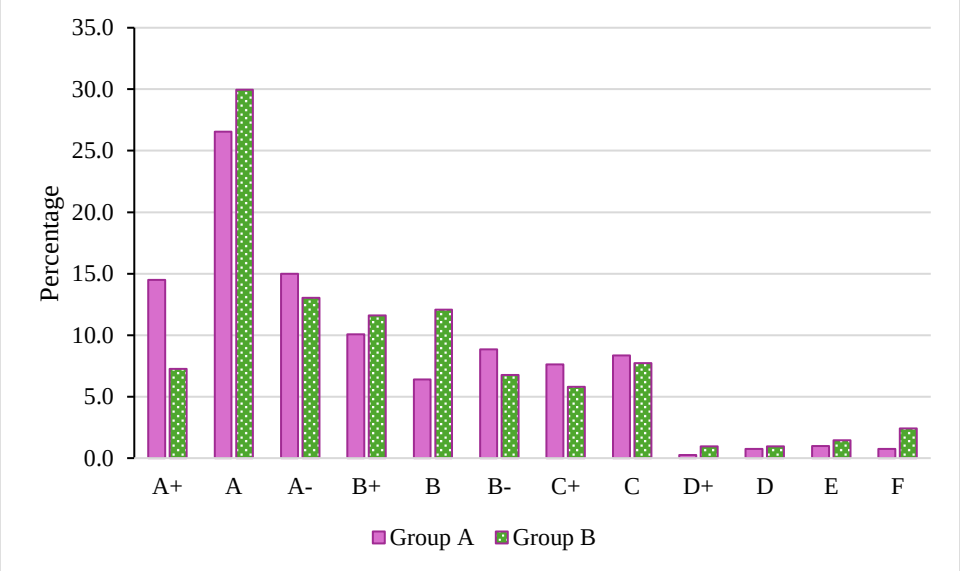

Figure 1: Group A & Group B Students' Grade Performance

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Conversely, the exception of index & logarithm from the final exams for Group B may not significantly influence students' grade performance. This is because the total marks and the weightage of the final exams were higher than that of Group A. These could indicate a variation in the difficulty of assessments, or differences in student preparedness or instructional methods between the two groups.

The descriptive statistics below summarize the marks recorded in the formative assessment and final exams for the respective group. In order to make the comparisons meaningful, the assessment items are converted to Group B weights. Table 3 below shows the marks distribution of the students enrolled in both semesters. Since marks are interval data, interpreting the mean of the data is preferable. The mean or the average marks for Group A were higher than Group B in both types of assessment. Meanwhile, the standard deviation of the data measures the dispersion of the dataset from the mean. Based on the standard deviation obtained, it can be concluded that the formative assessments marks for Group A is more consistent than Group B, while the final exams marks for Group B is more consistent than Group A.

Table 3: Descriptive Statistics of Assessment Marks for Group A and Group B.

	Formative Assessment (60%)		Final Examination (40%)	
Group	A	B	A	B
Mean	43.74	43.08	29.65	28.02
Median	45.00	44.33	31.00	29.60
Maximum	59.96	59.00	40.00	38.80
Minimum	16.50	0.00	0.00	0.00
Std. Deviation	8.86	9.97	7.48	7.18

Nothing much can be conclusive based on the descriptive statistics alone. Therefore, a two-sample t-test was conducted to test the null hypothesis that there is no difference in the mean marks obtained by the two groups. Based on Table 4, since the p-value of the test (0.073) is greater than 0.05, thus fail to reject the null hypothesis. Therefore, there is no sufficient evidence to conclude that there is a difference in marks obtained between the two groups.

Table 4: Independent Sample t-test

Test statistics	p-value	Mean difference	Std Error difference
1.796	0.073	2.2993	1.2803

The final exam for Group A was more challenging in that the questions included all subtopics of the course tested. While simplifying the final exam contents by the omission of index & logarithm subtopics may help the students to focus more on other subtopics during preparation for the final exams, this study found that there was no significant difference in marks obtained between Group A and Group B. This result led to a similar conclusion where Cohen and Snow (2002) found that changes in exam difficulty did not significantly impact student performance. This actively demonstrates that factors other than difficulty level, such as the alignment of exam content with instructional practices, may be more critical in influencing student outcomes. These insights could be valuable for further refining educational strategies and supporting students across a broader performance spectrum.

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Conclusion

This study examined how the changes in examination contents, including the introduction of new topics, or exclusion of some topics, the redistribution of marks across subjects and the weighing between formative and summative assessments, impacted the overall performance of Pre-diploma in Commerce students in an Intensive Mathematics course. Based on the statistical analysis and students' grade comparisons, it was found that the exclusion of index and logarithm from the final exams did not significantly influence the students' overall marks and grades. Furthermore, the difference weightage of assessments between the semesters may have contributed to the variations in students' performance. These findings highlight the importance of carefully designing assessment content to ensure it aligns with the curriculum and adequately supports student learning. While this study provides insights into the effects of modifying exam content, further research is needed to explore the broader impact of such changes on student outcomes and to establish a clearer causal relationship. Additionally, consideration should be given to innovative assessment strategies that promote deeper learning and equitable academic outcomes.

Limitations and Recommendations for Future Research

One of the limitations of this paper is that it primarily focuses on a specific group of students (Pre-Diploma in Commerce) and a particular course (Intensive Mathematics), which limits the generalizability of the findings to other student groups or courses. Additionally, the study does not establish a causal relationship between the changes in exam content and students' performance but rather offers a preliminary analysis based on grades and statistical tests. Another limitation is that the study focuses heavily on the impact of content inclusion/exclusion and weighting of assessments, without considering other factors such as students' prior knowledge, teaching methods, or student engagement, which could also influence performance outcomes. Therefore, future research should aim to establish a clearer causal relationship between changes in exam content and student performance by incorporating a wider range of variables, including teaching methods, student engagement, and learning behaviors. Expanding the study to include different groups of students and courses would also enhance the generalizability of the findings. Moreover, exploring innovative and diversified assessment strategies that promote deeper learning, critical thinking, and equitable outcomes should be prioritized.

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