Interdisciplinary Journal of Education, Vol. 8, No. 1, May 2025

Assessing Topic Alignment in Pre-tertiary TVET Core Mathematics: A Ghanaian Case Study (2011-2023)

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Abstract

Mathematics plays a pivotal role in Technical and Vocational Education and Training (TVET). However, persistent underperformance in the subject limits the academic and career progression of many Ghanaian learners. While various studies have investigated factors influencing achievement, little attention has been paid to the alignment between exit examinations and the curriculum. This study examines the alignment of topics in Ghana's pre-tertiary TVET Core Mathematics curriculum and exit examinations from 2011 to 2023. Using content analysis and Porter's alignment model, the study analysed topic distributions in both Paper 1 and Paper 2, computing alignment indices for each year. The results revealed significant variation, with 2017 achieving the highest index (0.807) and 2019 the lowest (0.563). Number and Numeration emerged as the most frequently assessed topic, while areas such as Coordinate Geometry and Trigonometry were minimally represented. Correlation analysis indicated that alignment had a weak, statistically insignificant relationship with learner pass rates. This suggests that while topic alignment is necessary, it alone cannot drive academic success. Other factors. such as instructional quality, resource availability, and cognitive alignment. may also be critical. The study highlights imbalances in topic coverage and misalignment between curriculum intent and assessment practices, offering empirical evidence to inform curriculum and assessment reforms in Ghana's TVET sector.

Article History

Received 8 March 2025
Accepted 10 May 2025
Published 31 May 2025

Keywords

curriculum standards
exit examination
mathematics alignment
topics
TVET

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Introduction

Mathematics occupies a central position in nearly every academic discipline. It is fundamental to the curricula of pre-tertiary education systems worldwide. Among STEM subjects, Mathematics is especially vital in Technical and Vocational Education and Training (TVET) (Adelabu & Pharamela, 2024). As Maass et al. (2019) argue, Mathematics underpins fields such as engineering, finance, and data security. Within TVET, Mathematics equips learners with critical skills essential for the workforce.

UNESCO (2016) emphasizes the role of TVET in national development and workforce preparation. Nonetheless, a persistent challenge in Ghana is the poor performance of pre-tertiary TVET learners in Core Mathematics exit examinations (Boafo, 2017). According to Ayene et al. (2010), this underachievement fosters negative attitudes toward Mathematics, further exacerbating learners' struggles.

Although various factors have been identified in the Ghanaian literature as causes of poor performance, the issue of alignment between the curriculum and examination content has received little attention (Fokuo et al., 2022). Bhaw and Kriek (2020) contend that misalignment between curriculum standards and assessment content contributes significantly to underperformance. When a disconnect exists between what is taught and what is tested, academic progression is hindered—undermining the development of skilled labor and engineers vital to national progress. Therefore, aligning exit examinations with curriculum standards is essential (Adu, 2019; Oti-Boadi, 2017).

Brown et al. (2017) highlight the need for a well-structured curriculum that is accurately reflected in assessments. However, current research shows no consensus on the emphasis given to different Mathematics topics in Ghanaian exit examinations (Gökdağ & Özmantar, 2024). This misalignment raises concerns about the coherence of the education system and its capacity to assess learners' true mathematical competencies. Curriculum alignment is essential to ensure that TVET programs effectively address workforce needs (Smith, 2014; Wong et al., 2022).

In Ghana, there is a paucity of research on the misalignment between the TVET curriculum and Mathematics exit examinations, particularly at the pre-tertiary level. Martone and Sireci (2009) and Polikoff et al. (2011) suggest that when curriculum standards align with assessments, learner achievement improves, as instruction becomes more targeted. Effective alignment allows for valid evaluations of student outcomes, school performance, and education reforms (Cil, 2015).

Ghana's pre-tertiary TVET Mathematics curriculum was revised in 2008, with the first cohort assessed under it in 2011. The exit examination comprises two papers: Paper 1 consists of 50 multiple-choice questions assessing lower-order cognitive skills across all curriculum topics, and it lasts 1 hour and 15 minutes. Paper 2 assesses higher-order cognitive skills through a written test lasting 2 hours and 30 minutes. It includes Section A (five compulsory questions) and Section B (three parts, from which candidates select questions based on topics like Statistics, Probability, Vectors, and Bearings). Learners must answer nine questions in total. The examinations are conducted in May/June, with resits in November/December.

In education, alignment refers to the consistency between curriculum standards and the tools used to evaluate learners (Roach, Niebling, & Kurz, 2008). Researchers use alignment indices to assess the degree of this consistency. Nortvedt and Buchholtz (2018) argue that alignment ensures the fairness and relevance of Mathematics education and supports the improvement of assessment practices.

Globally, most alignment studies focus on grammar schools, with little attention given to TVET (Wang et al., 2018; Kober, 2023; Seitz, 2017). This neglect represents a research gap. Studies by Jones et al. (2020) and Wang & McDougall (2019) emphasize the importance of monitoring exit examinations over time to ensure fairness and consistency. Without a clear understanding of alignment, interpretations of learner performance may be unreliable.

This study aims to fill this gap by systematically examining the alignment between Ghana's pre-tertiary TVET Mathematics curriculum and exit examinations. It analyses the emphasis placed on different topics and provides insights for policymakers, educators, and examination designers. The findings can inform improvements in assessment practices and reveal inconsistencies in content delivery and evaluation.

In summary, this research investigates the alignment between curriculum content and assessment in Ghana's pre-tertiary TVET Mathematics exit examinations. It is guided by the following research questions:

1. What is the measure of the relative emphasis of topics in Paper 1 of the Core Mathematics exit examination?
2. What is the measure of the relative emphasis of topics in Paper 2 of the Core Mathematics exit examination?
3. What is the overall alignment between the Core Mathematics exit examination and the curriculum standards?
4. How does the alignment of curriculum topics with exit examinations predict learner pass rates in TVET Core Mathematics in Ghana?

Methods

This study adopted a positivist paradigm, enabling the researchers to objectively measure and quantify reality and apply statistical analysis to identify patterns (Krippendorff, 2018). Content analysis was used to code both the curriculum objectives and the examination questions. This approach allowed for the quantification of textual content such as curriculum goals and exam items (Creswell & Plano-Clark, 2018). The study focused on eleven Core Mathematics examination papers administered in May/June between 2011 and 2023, excluding the November/December resit papers. These resits were excluded based on the assumption that returning candidates might perform better due to increased familiarity with the examination process. The analysis, therefore, concentrated on first-time test takers.

Sample and Sampling Technique

A simple random sampling technique was used to select eleven out of the thirteen available pre-tertiary TVET Mathematics exit examination papers. This technique gives each element of the population an equal chance of selection, thereby minimizing selection bias (Kuranchie, 2021). The Cochran formula was applied to determine a sample size of eleven, suitable for the small population size of thirteen, with a 10% margin of error. Analysing eleven out of thirteen samples enhances representativeness and reduces potential sampling error (Creswell & Creswell, 2018). The lottery method was used to randomly select the examination papers, ensuring fairness in selection within the small population.

Data Collection Instruments

Two researcher-developed instruments were employed to facilitate data collection: specification tables for the pre-tertiary TVET Mathematics curriculum and the exit examination papers. The first table (Appendix A) consisted of three columns with headings, Main Topics, Sub-topics, and Number of Learning Outcomes, used to document the structure of the curriculum. The second table (Appendix B) included thirteen columns to unpack the contents of each examination paper by documenting the main topics, sub-topics, and the number of questions asked per year from 2011 to 2023. This structured framework enabled systematic data extraction and analysis.

Validity and Reliability of Instruments

Content validity was established by aligning the examination questions with the curriculum topics. Experts rated the alignment using a 4-point scale. These ratings were used to calculate the Item-Level Content Validity Index (I-CVI) for each item and for the overall instruments. The I-CVI values were 0.89 and 0.91 for the two instruments, exceeding the recommended threshold of 0.78 and confirming their suitability (Ghahramanian et al., 2015). The instruments also demonstrated strong construct validity, with convergent validity at r = 0.83 and discriminant validity at r = 0.22. Face validity was confirmed through expert reviews to ensure relevance and appropriateness (Fang et al., 2022).

A pilot study was conducted using 100 multiple-choice questions from the two Paper 1 years not selected in the sample. Two independent raters categorized all the questions using the instruments. Inter-rater reliability was assessed using Cohen's Kappa and yielded a coefficient of 0.91 ($n = 100$, $p < 0.000$), indicating a high level of agreement in topic classification and quantification.

Data Collection Procedure

Following ethical clearance approval, the researchers collected and cleaned data from official Core Mathematics exit examination papers and the national pre-tertiary TVET curriculum. The cleaned data were processed statistically to identify trends in the emphasis of Mathematics topics. In the analysis, each multiple-choice question in Paper 1 was assigned a value of 1, while Paper 2's open-ended questions were coded based on their allocated marks. Inter-rater reliability for topic classification was re-confirmed, yielding a Cohen's Kappa value of 0.87 ($n = 100$, $p < 0.000$), indicating a high degree of consistency between coders.

The data sources were as follows:

- Research Question 1: Content analysis of Paper 1 and the curriculum
- Research Question 2: Content analysis of Paper 2 and the curriculum
- Research Question 3: Porter's alignment model was used to assess the alignment between intended curriculum outcomes and examination content
- Research Question 4: Correlation and Granger causality tests were used to evaluate the relationship between topic alignment and academic achievement

Alignment Index Computation

To assess the alignment between the pre-tertiary TVET Core Mathematics curriculum and the exit examinations, two specification tables were created. The first table (Appendix A) outlines the curriculum, with rows representing topics and columns representing learning outcomes. The second table (Appendix B) maps the distribution of examination questions across the same topic categories. Values in the first table reflect the total number of objectives per topic, while values in the second table represent the number of examination questions per topic, standardized as ratios. From these data, Porter's alignment index was computed.

$$P.I. = 1 - \frac{\sum_{i=1}^{n} |x_i y_i|}{2}$$

The index ranges from 0 (no alignment) to 1 (perfect alignment) (Matthews & Kyi, 2019). Bhaw and Kriek (2020) note that Porter did not specify a universal threshold

for determining good alignment. Therefore, this study adopts Webb's interpretive ranges: values below 0.6 indicate poor alignment; 0.6 to 0.7 signify weak alignment; values above 0.7 denote acceptable alignment; and 1.0 indicates perfect alignment (Webb, 2007). Porter's model was selected over Webb's Depth of Knowledge (DOK) approach because it offers a quantitative, matrix-based methodology that measures topic coverage and supports objective comparison across years (Porter, 2002).

Content Areas and Learning Outcomes of Mathematics Curriculum and Core Mathematics Exit Examinations

This study focuses on the alignment between the pre-tertiary TVET Mathematics Curriculum standards and the exit examination questions. Alignment indexes for the examination period were calculated using Porter's alignment method. The curriculum encompasses nine key areas, including Number and Numeration, Algebraic Processes, and Statistics and Probability. Main topics were used for the alignment index calculation, as literature suggests they are more reliable than sub-topics (Fulmer & Polikoff, 2014). Table 1 presents the main topics along with their percentage proportions.

Table 1

Main Topics and Number of Learning Outcomes

Main Topic	No. of L.O.s in the curriculum	Percentage
Number And Numerations	29	24.58%
Algebraic Processes	21	17.80%
Mensuration	8	6.78%
Plane Geometry	31	26.27%
Coordinate Geometry Of Straight Lines	2	1.69%
Trigonometry	10	8.47%
Introductory Calculus	2	1.69%
Statistics And Probability	8	6.78%
Vectors And Transformation	7	5.93%
	118	100%

Results

The relative emphasis of topics in Paper 1 Core Mathematics Exit examination

Table 2

Frequency of Topics in the Paper 1

TOPIC	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023	Sub-Total
Number and Numeration	22	15	21	22	18	18	19	17	20	17	18	**207**
Algebraic Processes	12	14	8	13	7	10	11	12	8	8	12	**115**
Mensuration	4	3	9	0	6	4	2	3	2	2	2	**37**
Plane Geometry	5	6	3	3	5	6	7	4	6	6	5	**54**
Coordinate Geometry of Straight Lines	2	3	1	0	2	2	2	2	2	4	0	**20**
Trigonometry	0	2	3	0	2	3	3	2	3	2	3	**23**
Introductory Calculus	0	0	0	0	0	0	0	0	0	0	0	**0**
Statistics and Probability	2	2	2	12	2	6	6	7	5	3	6	**53**
Vectors and Transformation	3	5	3	0	8	1	0	3	4	8	4	**39**
SUBTOTAL	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**550**

As shown in Table 2, Paper 1 consistently emphasizes *Number and Numeration*, with a total of 207 questions over the study period. This topic significantly outweighs others, confirming its dominance in the assessment. Conversely, *Introductory Calculus* was never examined, and *Coordinate Geometry of Straight Lines* and *Trigonometry* had minimal coverage with 20 and 23 questions respectively.

Table 3

Balance of Representation in the Mathematics Curriculum and Paper 1

TOPIC	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023
Number and Numeration	0.19	0.05	0.17	0.19	0.11	0.11	0.13	0.09	0.15	0.09	0.11
Algebraic Processes	0.06	0.10	0.02	0.08	0.04	0.02	0.04	0.06	0.02	0.02	0.06
Mensuration	0.01	0.01	0.11	0.07	0.05	0.01	0.03	0.01	0.03	0.03	0.03
Plane Geometry	0.16	0.14	0.20	0.20	0.16	0.14	0.12	0.18	0.14	0.14	0.20
Coordinate Geometry of Straight Lines	0.02	0.04	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.06	0.02
Trigonometry	0.08	0.04	0.02	0.08	0.04	0.02	0.02	0.04	0.02	0.04	0.02
Introductory Calculus	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Statistics and Probability	0.03	0.03	0.03	0.17	0.03	0.05	0.05	0.07	0.03	0.01	0.05
Vectors and Transformation	0.00	0.04	0.00	0.06	0.10	0.04	0.06	0.00	0.02	0.10	0.02
SUBTOTAL	**0.58**	**0.48**	**0.58**	**0.90**	**0.58**	**0.45**	**0.50**	**0.50**	**0.46**	**0.52**	**0.50**

Table 3 presents the balance of topic representation by computing the difference between each topic's examination frequency and its proportional presence in the curriculum. The values reveal significant inconsistencies, with several topics either overemphasized or underrepresented in different years.

Table 4

Alignment Index of Paper 1 to the TVET Mathematics Curriculum

YEAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023
$\sum_{i=1}^{n} \lvert X_i - Y_i \rvert$	0.58	0.48	0.58	0.90	0.58	0.45	0.50	0.50	0.46	0.52	0.50
A.I.	0.71	0.76	0.71	0.55	0.71	0.78	0.75	0.75	0.77	0.74	0.75

The computed alignment indices using Porter's method are shown in Table 4. With the exception of 2014, where the alignment index was 0.55 (indicating weak alignment), all other years exceeded 0.7, signifying acceptable alignment. The highest index was recorded in 2016 (0.78), indicating a relatively strong match between assessed topics and curriculum standards for that year.

The relative emphasis of Paper 2 Core Mathematics Exit examination

Table 5

Distribution of Mathematics Paper 2 Topics Among the Main Topics in the Curriculum

TOPIC	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023
Number and Numeration	45	50	37	41	19	43	29	59	50	29	23
Algebraic Processes	14	27	17	15	38	26	31	33	9	40	36
Mensuration	0	0	8	15	0	14	8	0	0	15	33
Plane Geometry	14	15	15	12	15	9	19	0	10	8	0
Coordinate Geom. of Straight Lines	12	8	0	12	20	0	5	0	0	0	0
Trigonometry	15	0	23	20	23	15	16	10	0	7	15
Introductory Calculus	0	0	0	0	0	0	0	0	0	0	0
Statistics and Probability	30	30	30	30	30	38	30	30	38	38	30
Vectors and Transformation	30	30	30	15	15	15	22	43	53	23	23
SUBTOTAL	**160**	**160**	**160**	**160**	**160**	**160**	**160**	**175**	**160**	**160**	**160**

Table 5 displays the distribution of Paper 2 marks by topic. *Number and Numeration* remains the most assessed topic, followed by *Statistics and Probability*, and *Vectors and Transformation*. *Coordinate Geometry of Straight Lines* and *Introductory Calculus* were the least represented, with the latter receiving no marks at all across all years.

Table 6

Ratio Distribution of Mathematics Paper 2 Topics Among the Main topics in the Curriculum

TOPIC	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023
Number and Numeration	0.28	0.31	0.23	0.26	0.12	0.27	0.18	0.34	0.31	0.18	0.14
Algebraic Processes	0.09	0.17	0.11	0.09	0.24	0.16	0.19	0.19	0.06	0.25	0.23
Mensuration	0.00	0.00	0.05	0.09	0.00	0.09	0.05	0.00	0.00	0.09	0.21
Plane Geometry	0.09	0.09	0.09	0.08	0.09	0.06	0.12	0.00	0.06	0.05	0.00
Coordinate Geom. of Straight Lines	0.08	0.05	0.00	0.08	0.13	0.00	0.03	0.00	0.00	0.00	0.00
Trigonometry	0.09	0.00	0.14	0.13	0.14	0.09	0.10	0.06	0.00	0.04	0.09
Introductory Calculus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Statistics and Probability	0.19	0.19	0.19	0.19	0.19	0.24	0.19	0.17	0.24	0.24	0.19
Vectors and Transformation	0.19	0.19	0.19	0.09	0.09	0.09	0.14	0.25	0.33	0.14	0.14
SUBTOTAL	**160**	**160**	**160**	**160**	**160**	**160**	**160**	**175**	**160**	**160**	**160**

Table 6 provides the proportional distribution of topics by computing the ratios of marks allocated per topic relative to total available marks per year. This offers insight into the relative weight each topic carried annually.

Table 7

Balance of Representation in the Mathematics Curriculum and Paper 2

TOPIC	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023
Number and Numeration	0.04	0.07	0.02	0.01	0.12	0.02	0.07	0.09	0.07	0.07	0.11
Algebraic Processes	0.09	0.01	0.07	0.08	0.06	0.02	0.02	0.01	0.12	0.07	0.05
Mensuration	0.07	0.07	0.02	0.03	0.07	0.02	0.02	0.07	0.07	0.03	0.14
Plane Geometry	0.18	0.17	0.17	0.19	0.17	0.21	0.14	0.26	0.20	0.21	0.26
Coordinate Geometry of Straight Lines	0.06	0.03	0.02	0.06	0.11	0.02	0.01	0.02	0.02	0.02	0.02
Trigonometry	0.01	0.09	0.06	0.04	0.06	0.01	0.02	0.03	0.09	0.04	0.01
Introductory Calculus	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Statistics and Probability	0.12	0.12	0.12	0.12	0.12	0.17	0.12	0.10	0.17	0.17	0.12
Vectors and Transformation	0.13	0.13	0.13	0.03	0.03	0.03	0.08	0.19	0.27	0.08	0.09
SUBTOTAL	**0.70**	**0.70**	**0.61**	**0.58**	**0.76**	**0.51**	**0.49**	**0.78**	**1.02**	**0.70**	**0.80**

The deviations between the examination and curriculum standards are illustrated in Table 7, where the computed differences reveal overrepresentation of certain topics and near-exclusion of others, especially in years with misalignment.

Table 8

Alignment Index of Paper 2 to the TVET Mathematics Curriculum

YEAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023
$\sum_{i=1}^{n} \lvert X_i - Y_i \rvert$	0.701	0.695	0.614	0.578	0.762	0.512	0.487	0.784	1.017	0.704	0.797
A.I.	0.650	0.652	0.693	0.711	0.619	0.744	0.757	0.608	0.492	0.648	0.601

Table 8 presents the alignment indices for Paper 2. The year 2017 had the highest index (0.757), while 2019 recorded the lowest (0.492), falling into the poor alignment category. Most other years indicated moderate alignment ranging between 0.601 and 0.693.

How aligned is the assessed curriculum to the Exit Examinations?

Table 9

Distribution of Mathematics Examination Topics Among the Main Topics in the Curriculum

TOPIC	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2023**	**Sub-Total**
Number and Numeration	67	65	58	63	37	61	48	76	70	46	41	632
Algebraic Processes	26	41	25	28	45	36	42	45	17	48	48	401
Mensuration	4	3	17	15	6	18	10	3	2	17	35	130
Plane Geometry	19	21	18	15	20	15	26	4	16	14	5	173
Coordinate Geometry of Straight Lines	14	11	1	12	22	2	7	2	2	4	0	77
Trigonometry	15	2	26	20	25	18	19	12	3	9	18	167
Introductory Calculus	0	0	0	0	0	0	0	0	0	0	0	0
Statistics and Probability	32	32	32	42	32	44	36	37	43	41	36	407
Vectors and Transformation	33	35	33	15	23	16	22	46	57	31	27	338
SUBTOTAL	**210**	**210**	**210**	**210**	**210**	**210**	**210**	**225**	**210**	**210**	**210**	**2325**

To measure overall alignment, Paper 1 and Paper 2 question distributions were aggregated. Table 9 shows the combined frequency of examined topics over the years. *Number and Numeration* remained the most assessed topic, followed by *Statistics and Probability*, and *Vectors and Transformation*. *Introductory Calculus* remained unexamined throughout the entire period.

Table 10

Ratio Distribution of Entire Paper Topics Among the Main Topics in the Curriculum

TOPIC	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023
Number and Numeration	0.32	0.31	0.28	0.30	0.18	0.29	0.23	0.34	0.33	0.22	0.20
Algebraic Processes	0.12	0.20	0.12	0.13	0.21	0.17	0.20	0.20	0.08	0.23	0.23
Mensuration	0.02	0.01	0.08	0.07	0.03	0.09	0.05	0.01	0.01	0.08	0.17
Plane Geometry	0.09	0.10	0.09	0.07	0.10	0.07	0.12	0.02	0.08	0.07	0.02
Coordinate Geom. of Straight Lines	0.07	0.05	0.00	0.06	0.10	0.01	0.03	0.01	0.01	0.02	0.00
Trigonometry	0.07	0.01	0.12	0.10	0.12	0.09	0.09	0.05	0.01	0.04	0.09
Introductory Calculus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Statistics and Probability	0.15	0.15	0.15	0.20	0.15	0.21	0.17	0.16	0.20	0.20	0.17
Vectors and Transformation	0.16	0.17	0.16	0.07	0.11	0.08	0.10	0.20	0.27	0.15	0.13
SUBTOTAL	**0.32**	**0.31**	**0.28**	**0.30**	**0.18**	**0.29**	**0.23**	**0.34**	**0.33**	**0.22**	**0.20**

Table 10 presents the topic distribution ratios across both papers, highlighting patterns of overrepresentation in topics like *Number and Numeration* and underrepresentation in *Mensuration* and *Coordinate Geometry*.

Table 11

Balance of Representation in the Mathematics Curriculum and Entire Paper

TOPIC	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023
Number and Numeration	0.07	0.06	0.03	0.05	0.07	0.04	0.02	0.09	0.09	0.03	0.05
Algebraic Processes	0.05	0.02	0.06	0.04	0.04	0.01	0.02	0.02	0.10	0.05	0.05
Mensuration	0.05	0.05	0.01	0.00	0.04	0.02	0.02	0.05	0.06	0.01	0.10
Plane Geometry	0.17	0.16	0.18	0.19	0.17	0.19	0.14	0.24	0.19	0.20	0.24
Coordinate Geometry of Straight Lines	0.05	0.04	0.01	0.04	0.09	0.01	0.02	0.01	0.01	0.00	0.02
Trigonometry	0.01	0.08	0.04	0.01	0.03	0.00	0.01	0.03	0.07	0.04	0.00
Introductory Calculus	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Statistics and Probability	0.08	0.08	0.08	0.13	0.08	0.14	0.10	0.10	0.14	0.13	0.10
Vectors and Transformation	0.10	0.11	0.10	0.01	0.05	0.02	0.05	0.15	0.21	0.09	0.07
SUBTOTAL	**0.61**	**0.62**	**0.53**	**0.51**	**0.59**	**0.44**	**0.39**	**0.71**	**0.87**	**0.56**	**0.65**

Table 11 provides the balance of topic representation relative to curriculum expectations, while Table 12 reports the computed overall alignment indices. The highest alignment was observed in 2017 (0.807), the only year to achieve a "strong alignment" classification. The lowest alignment index occurred in 2019 (0.563), indicating poor alignment. Other years showed moderate alignment, with indices mostly ranging between 0.644 and 0.694.

Table 12

Alignment Index of Paper 2 to the TVET Mathematics Curriculum

YEAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023
$\sum_{i=1}^{n} \lvert X_i - Y_i \rvert$	0.611	0.617	0.530	0.506	0.587	0.444	0.387	0.711	0.873	0.563	0.647
A.I.	0.695	0.692	0.735	0.747	0.707	0.778	0.807	0.644	0.563	0.718	0.677

The strength of the relationship between alignment index and pass rate

To answer this research question, the alignment indexes for Paper 1, Paper 2, and Overall were correlated with Pass rate in the examination.

Table 13

Correlation Data for Topic Alignment Index and Pass Rate

	ALIGNMENT INDEX			
YEAR	PAPER 1	PAPER 2	OVERALL	PASS RATE
2011	0.708	0.650	0.695	100.00
2012	0.760	0.652	0.692	84.75
2013	0.710	0.693	0.735	98.21
2014	0.552	0.711	0.747	69.19
2015	0.710	0.619	0.707	46.21
2016	0.776	0.744	0.778	33.28
2017	0.749	0.757	0.807	42.71
2018	0.748	0.608	0.644	65.24
2019	0.770	0.492	0.563	54.86
2020	0.742	0.648	0.718	42.33
2023	0.751	0.797	0.677	45.73

Table 13 presents the necessary data for this endeavour. Since normality assumptions failed for the data, Spearman’s rho was used to compute the correlation coefficients for the data.

Table 14

Correlation Results Among Paper 1, Paper 2, Overall and Pass Rate

			PAPER 1	PAPER 2	OVERALL	PASS RATE
Spearman's rho	PAPER 1	Correlation Coefficient	1.000	.091	-.219	-.515
		Sig. (2-tailed)	.	.790	.518	.105
		N	11	11	11	11
	PAPER 2	Correlation Coefficient	.091	1.000	.591	-.245
		Sig. (2-tailed)	.790	.	.056	.467
		N	11	11	11	11
	OVERALL	Correlation Coefficient	-.219	.591	1.000	-.309
		Sig. (2-tailed)	.518	.056	.	.355
		N	11	11	11	11
	PASS RATE	Correlation Coefficient	-.515	-.245	-.309	1.000
		Sig. (2-tailed)	.105	.467	.355	.
		N	11	11	11	11

Table 14 shows the correlation between alignment and pass rates for the eleven cases analysed. The correlation coefficient for Paper 1 alignment and pass rate is -0.515, indicating a moderate negative relationship, meaning that as Paper 1 alignment increases, the pass rate tends to decrease. However, with a significance value of p=0.105, this result is not statistically significant at the 0.05 level. Paper 2 shows a weak negative correlation of -0.245 with a significance value of 0.467, indicating no statistical significance. The overall Paper alignment has a correlation of -0.309 with a significance value of p=0.355, also not statistically significant. The coefficient of determination (obtained by squaring the r value and multiplying the results by 100%) reveals that Paper 1 alignment accounts for 26.52% of the pass rate variance, Paper 2 accounts for 6.00%, and overall alignment accounts for 9.55%, indicating varying impacts of alignment on pass rates.

Discussion

Relative Emphasis of Topics in Paper 1 of the Core Mathematics Exit Examination

The analysis of Paper 1 questions reveals a clear emphasis on *Number and Numeration*, followed by *Algebraic Processes* and *Plane Geometry*. This persistent dominance suggests an assessment framework that prioritizes foundational computational skills. While this emphasis aligns with early mathematical literacy goals (Sa'di et al., 2023), it raises concerns about the underrepresentation of higher-order and spatial reasoning topics, such as *Trigonometry* and *Coordinate Geometry*.

This pattern may be explained by the nature of Paper 1, which targets lower-order cognitive skills. However, this focus risks narrowing the taught curriculum, thereby undermining broader educational goals that promote advanced mathematical thinking essential for technical careers. These findings resonate with Sa'di et al. (2023), who argue that basic numeracy is a prerequisite for deeper mathematical learning. They also align with the National Council for Curriculum and Assessment (2021), which advocates

more instructional time for *Number and Numeration*, *Algebraic Processes*, and *Plane Geometry*.

Algebraic Processes, for example, are instrumental in developing conceptual understanding and mathematical skills. Nevertheless, the consistently low emphasis on *Trigonometry* and *Coordinate Geometry* suggests a gap in comprehensive curriculum coverage, potentially affecting learners' readiness for more advanced Mathematics and practical applications in technical fields (Wares, 2019). Learners often engage in surface learning in preparation for Paper 1, as noted by MacFarlane and Boulet (2017). This trend may stem from pre-service teachers' undervaluing of foundational topics (O'Meara et al., 2017), which ultimately impacts classroom instruction and learner performance.

Comparatively, countries like Singapore and Finland integrate geometry and measurement early in the curriculum to cultivate spatial reasoning skills essential in engineering and design (Wang & McDougall, 2019). Ghana's current emphasis lacks this balance, potentially placing TVET learners at a disadvantage in global contexts.

Relative Emphasis of Topics in Paper 2 of the Core Mathematics Exit Examination

Unlike Paper 1, Paper 2 exhibits broader topic coverage, with increased attention to *Statistics*, *Probability*, and *Vectors*. This reflects an attempt to assess a more diverse skill set, which is essential for comprehensive mathematical competence (Niss, 2015). The strong representation of *Statistics and Probability* aligns with global shifts in Mathematics education, which emphasize data literacy as a critical 21st-century skill (Watson & Smith, 2022).

However, the persistent underrepresentation of topics like *Coordinate Geometry* and *Mensuration,* despite their relevance in fields such as construction and surveying, indicates a disconnect between the curriculum and real-world vocational competencies. Even more striking is the complete omission of *Introductory Calculus*, despite its presence in the curriculum. This could reflect examiners' assumptions about learners' readiness or systemic limitations in delivering complex content.

This mismatch between curriculum intent and assessment practice undermines the goal of presenting TVET as both technically relevant and academically rigorous. Without assessing higher-level content, the examination system may inadvertently lower expectations for what TVET learners are capable of achieving.

Overall Alignment Between the Core Mathematics Exit Examination and the Curriculum Standards

The study found that only one year, 2017, achieved a strong alignment index (>0.8) between the examination and curriculum standards. Most other years exhibited moderate alignment, with a few showing weak alignment. This variability echoes findings from previous studies (Edwards, 2010; Seitz, 2017; Wiberg, 2019; Ayenew & Yohannes, 2022), which point to the challenges of maintaining consistent curriculum-assessment alignment.

The notable misalignment observed in 2019 supports concerns raised in the literature about discrepancies between what is taught and what is tested (Wang et al., 2018; Kober, 2023). These inconsistencies may affect student learning and outcomes by exposing learners to topics that are either underrepresented or absent in assessment.

Webb (1997) warns that such misalignments compromise the validity of test interpretations. Without periodic alignment audits, these discrepancies may persist unnoticed, leading to unfair advantages or disadvantages across different cohorts of students.

Effect of Topic Alignment on Learner Pass Rates in a Pre-tertiary TVET Institution

Spearman's rho correlation was used due to non-normal data distribution, with a significance level set at $\alpha = 0.05$. The correlation results showed weak and statistically insignificant relationships between alignment indices and pass rates for all cases. The strongest relationship was a moderate negative correlation between Paper 1 alignment and pass rates ($\rho = -0.515$), but it did not reach statistical significance.

These findings challenge the assumption that alignment alone drives performance. Instead, they suggest that other variables, such as instructional quality, resource availability, and cognitive alignment, may have a stronger influence on learner achievement (Blömeke et al., 2016; Porter, 2002).

Moreover, the weak correlations raise the possibility that learners may not be adequately prepared to handle examination demands, even when the assessments are aligned with the curriculum. This could result from teaching gaps, limited access to resources, or insufficient attention to higher-order thinking skills (Pervez et al., 2022). The complexity of these relationships highlights that while alignment is essential for fairness and validity, it is not a standalone determinant of academic success.

Policy Implications for NABPTEX

The findings underscore the urgent need for policy reforms in assessment design and curriculum monitoring. NABPTEX, as the primary body responsible for examination quality assurance, must implement test specification blueprints that ensure proportional representation of all curriculum topics, particularly those currently under-assessed.

Additionally, routine alignment audits should be institutionalized as part of the examination validation process. These audits should be transparent and publicly reported to foster accountability and continuous improvement.

Conclusion and Suggestions for Further Studies

Conclusion

This study assessed the extent to which topics in Ghana's pre-tertiary TVET Core Mathematics curriculum are reflected in exit examinations over a 13-year period. Beyond identifying patterns of topic emphasis, the analysis uncovered systemic inconsistencies in the alignment between the curriculum and assessment. Notably, only one year (2017) met the threshold for acceptable alignment. The findings reveal a persistent imbalance, with topics such as *Number and Numeration* receiving disproportionate emphasis, while others, such as *Coordinate Geometry* and *Trigonometry*, remain underrepresented.

The observed weak and statistically insignificant correlations between alignment indices and learner pass rates suggest that alignment, while important, does not alone account for performance outcomes. Instead, achievement appears to depend on a combination of factors, including curriculum relevance, cognitive demands, instructional quality, and assessment design. These insights underscore the need to

move beyond surface-level content alignment and toward reforms that integrate cognitive complexity and pedagogical coherence.

Importantly, this study contributes to the relatively underexplored area of curriculum-examination alignment in TVET. It highlights how misalignments can perpetuate educational inequities and compromise the validity of high-stakes assessments. The evidence presented can guide examination bodies, curriculum developers, and policymakers in efforts to improve standards-based education systems. Ultimately, this research offers a replicable framework for diagnosing alignment gaps and provides actionable evidence for designing more equitable and balanced Mathematics assessments in pre-tertiary TVET education.

Limitations

While this study provides valuable insights into topic alignment in Ghana's pre-tertiary TVET Core Mathematics exit examinations, several limitations must be acknowledged. First, the study examined only content/topic alignment, without assessing cognitive demand alignment, a key dimension of curriculum fidelity. As such, the analysis may not capture the extent to which assessments reflect the intended depth and complexity of learning outcomes. Also, the analysis was based on eleven out of thirteen examination papers. Although the sampling method ensured representativeness, the limited dataset may reduce the statistical power of the correlation findings, particularly in relation to pass rates (Creswell & Creswell, 2018). Furthermore, some examination questions spanned multiple content areas, making classification difficult. While inter-rater reliability was high, the process still involved subjective interpretation, which may introduce bias. Finally, the exclusive focus on written exit examinations neglects other forms of assessment, such as coursework and practicals, which may better capture learner competencies and the full intent of the curriculum.

Implications and Recommendations

Policy Recommendations

The findings of this study carry important implications for curriculum development and assessment policy in Ghana's pre-tertiary TVET sector:

First, the persistent imbalance in topic representation calls for a systematic review of assessment practices. Examination bodies should adopt test blueprints that ensure proportional coverage of all curriculum topics, thereby addressing the overemphasis on content such as *Number and Numeration*.

Again, assessment frameworks should align not only with content specifications but also with the intended learning outcomes and cognitive demands. Policymakers should integrate alignment audits into routine quality assurance processes to ensure comprehensive and equitable evaluation.

Furthermore, curriculum planners and teacher professional development programs must prioritize standards-based instruction. Teachers should be equipped with strategies to deliver content that aligns with both the topic distribution and the cognitive complexity outlined in the curriculum. This will foster more coherent instruction across schools and ensure fairer assessments of learner performance.

Recommendations for Further Research

To build on the findings of this study, future research should:

1. examine how well exit examinations align with the cognitive levels intended in the curriculum. Frameworks such as Bloom's Taxonomy or Webb's Depth of Knowledge (DOK) can be used to evaluate whether learners are assessed not only on what they know but also on how deeply they understand and apply their knowledge.
2. combining quantitative alignment analysis with qualitative data (e.g., classroom observations, teacher interviews, learner feedback) can offer deeper insights into how curriculum implementation influences assessment outcomes.
3. include more examination cycles, such as November/December resits, and a broader range of institutions will improve the generalizability of findings. Regional or institutional variations in alignment and achievement can also be explored.
4. conduct long-term studies to examine how alignment trends evolve over time and assess their impact on educational equity, teaching practices, and workforce readiness in the pre-tertiary TVET sector.

References

Adelabu, F. M., & Pharamela, S. (2024). *Teaching relevant mathematics topics to prepare Technical and Vocational Education Training college students for workforce: Lecturers' perspective*. IntechOpen. https://doi.org/10.5772/intechopen.1005459

Adu, P. (2019). *A step-by-step guide to qualitative data coding*. Routledge. https://doi.org/10.4324/9781351044516

Aga, F. J. (2023). Learning outcomes, instruction, and assessment alignment: The case at two Ethiopian universities. *International Journal of Research Publications, 135*(1), 206–217. https://doi.org/10.47119/IJRP100135110202355 73

Ayene, M., Damtie, B., & Kriek, J. (2010). Mismatch between the progression of the mathematics course and the level of mathematics required to do advanced physics. *Latin-American Journal of Physics Education, 4*(3), 538–546. https://dialnet.unirioja.es/servlet/articulo?codigo=3696853

Ayenew, E., & Yohannes, A. G. (2022). Assessing higher education exit exam in Ethiopia: Practices, challenges and prospects. *Science Journal of Education, 10*(2), 79. https://doi.org/10.11648/j.sjedu.20221002.15

Bhaw, N., & Kriek, J. (2020). The alignment of the Grade 12 Physics examination with the CAPS curriculum: (November 2014–March 2018). *South African Journal of Education, 40*(1), 1–9. https://doi.org/10.15700/saje.v40n1a1676

Blömeke, S., Olsen, R. V., & Suhl, U. (2016). Relation of student achievement to the quality of their teachers and instructional quality. In S. Blömeke, J. Gustafsson, & R. V. Olsen (Eds.), *Modeling student achievement* (pp. 21–50). Springer. https://doi.org/10.1007/978-3-319-41252-8_2

Boafo, F. A. (2017). The impact of Mathematics on academic performance of students in TVET institutions in Ghana. *African Journal of Applied Research, 2*(2), 110–120. https://ajaronline.com/index.php/AJAR/article/view/223

Brown, B., Nuberg, I., & Llewellyn, R. (2017). Stepwise frameworks for understanding the utilisation of conservation agriculture in Africa. *Agricultural Systems, 153*, 11–22. https://doi.org/10.1016/j.agsy.2017.01.012

Cil, E. (2015). Alignment between Turkish middle school science curriculum standards and high school entrance examination. *Journal of Turkish Science Education, 12*(2), 33–48. https://doi.org/10.36681/

Creswell, J. W., & Plano-Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

Edwards, N. (2010). An analysis of the alignment of the Grade 12 Physical Sciences examination and the core curriculum in South Africa. *South African Journal of Education, 30*(4), 571–590. https://hdl.handle.net/10520/EJC32253

Fokuo, M., Lassong, B. S., & Kwasi, S. F. (2022). Students' poor mathematics performance in Ghana: Are there contributing factors? *Asian Journal of Education and Social Studies*, 16–21. https://doi.org/10.9734/ajess/2022/v30i430729

Fulmer, G. W., & Polikoff, M. S. (2014). Tests of alignment among assessment, standards, and instruction using generalized linear model regression. *Educational Assessment, Evaluation and Accountability, 26*, 225–240. https://doi.org/10.1007/s11092-014-9196-z

Ghahramanian, A., Rezaei, M., & Mohammadi, E. (2015). Content validity and reliability of the patient satisfaction scale with nursing care. *Iranian Journal of Nursing and Midwifery Research, 20*(6), 660–665. https://doi.org/10.4103/1735-9066.170001

Gökdağ, K., & Özmantar, M. F. (2024). Emerging research themes in mathematics education: A topic modeling analysis of most influential journals (2019–2023). *International Journal of Progressive Education, 20*(6), 16–32. https://doi.org/10.29329/ijpe.2024.1078.2

Jones, J. B., Kim, M., & Park, B. G. (2020). The wage penalty for married women of career interruptions: Evidence from the 1970s and the 1990s. *Oxford Bulletin of Economics and Statistics, 82*(4). https://doi.org/10.1111/obes.12356

Kellaghan, T., & Greaney, V. (2019). *Public examinations examined*. World Bank Group. https://openknowledge.worldbank.org/handle/10986/32352

Kober, K. L. (2023). *The alignment between the algebra curriculum at a Texas high school and the mathematics section of the Texas Success Initiative Assessment* [Doctoral dissertation, Walden University]. Walden Dissertations and Doctoral Studies. https://scholarworks.waldenu.edu/dissertations/14267/

Krippendorff, K. (2018). *Content analysis: An introduction to its methodology* (4th ed.). SAGE Publications. https://doi.org/10.4135/9781071878781

Kuranchie, A. (2021). *Research made easy* (3rd ed.). Bookworm Publications.

Maass, K., Geiger, V., Romero Ariza, M., & Goos, M. (2019). The role of Mathematics in interdisciplinary STEM education. *ZDM – Mathematics Education, 51*(6), 869–884. https://doi.org/10.1007/s11858-019-01100-5

MacFarlane, L. A., & Boulet, G. (2017). Multiple-choice tests can support deep learning! *Proceedings of the Atlantic Universities' Teaching Showcase, 21*, 61–66. https://ojs.library.dal.ca/auts/article/view/8430

Martone, A., & Sireci, S. G. (2009). Evaluating alignment between curriculum, assessment, and instruction. *Review of Educational Research, 79*(4), 1332–1361. https://doi.org/10.3102/0034654309341375

Matthews, R., & Kyi, W. W. (2019). Alignment between the learning objectives and examination: A comparative analysis of high-school physics curricula in Myanmar and South Australia. *Scholars Bulletin, 5*(11), 671–680. https://doi.org/10.36348/sb.2019.v05i11.011

National Council for Curriculum and Assessment. (2021). *Mathematics Common Core Programme (CCP) for JHS 1 (B7) – JHS 3 (B9)*. Ministry of Education. https://nacca.gov.gh/wp-content/uploads/2023/06/MATHEMATICS.pdf

Niss, M. (2015). Mathematical competencies and the learning of mathematics: The Danish KOM project. In Y. Li & G. Kaiser (Eds.), *Mathematical competencies in the mathematics curriculum* (pp. 115–129). Springer. https://doi.org/10.1007/978-3-319-15581-5_8

Nortvedt, G. A., & Buchholtz, N. (2018). Assessment in mathematics education: Responding to issues regarding methodology, policy and equity. *ZDM – Mathematics Education, 50*(4), 555–570. https://doi.org/10.1007/s11858-018-0931-2

O'Meara, N., Fitzmaurice, O., & Johnson, P. (2017). Old habits die hard: An uphill struggle against rules without reason in mathematics teacher education. *European Journal of Science and Mathematics Education, 5*(1), 91–109. https://eric.ed.gov/?id=EJ1129985

Oti-Boadi, M. (2017). Exploring the lived experiences of mothers of children with intellectual disability in Ghana. *SAGE Open, 7*(4), 1–12. https://doi.org/10.1177/2158244017745578

Pervez, K., Muhammad, Y., & Waqar, Y. (2022). Higher-order thinking: An analysis of the prescribed versus tested curricula in private secondary schools in Pakistan. *Journal of Social Sciences Advancement, 3*(3), 165–175. https://doi.org/10.52223/jssa22-030308-44

Polikoff, M. S., Porter, A. C., & Smithson, J. L. (2011). How well aligned are state assessments of student achievement with state content standards? *American Educational Research Journal, 48*(4), 965–995. https://doi.org/10.3102/0002831211410684

Porter, A. C. (2002). Measuring the content of instruction: Uses in research and practice. *Educational Researcher, 31*(7), 3–14. https://doi.org/10.3102/0013189X031007003

Roach, A. T., Niebling, B. C., & Kurz, A. (2008). Evaluating the alignment among curriculum, instruction, and assessments: Implications and applications for research and practice. *Psychology in the Schools, 45*(2), 158–176. https://doi.org/10.1002/pits.20282

Sa'di, D. R., Firdaus, N. P. N., Sinaga, R. D. H., & Yonvitra, N. H. (2023). Kemampuan siswa SMP dalam menyelesaikan persoalan matematika dasar. *Jurnal Pendidikan Matematika*. https://doi.org/10.47134/ppm.v1i2.232

Seitz, P. (2017). Curriculum alignment among the intended, enacted, and assessed curricula for Grade 9 Mathematics. *Journal of the Canadian Association for Curriculum Studies, 15*(1), 72–94. https://doi.org/10.25071/1916-4467.40286

Smith, T. S. (2014). Curricula alignment strategies to support student success in Algebra I: Research brief. U.S. Department of Education. https://www2.ed.gov/programs/dropout/curricularalignment092414.pdf

Spath, Y., & Christene, E. (2015). Alignment between the California Common Core Content Standards for Higher Mathematics (9–12) and the California State University Entry-Level Mathematics Placement Test. *ProQuest Dissertations Publishing*. https://www.proquest.com/openview/e9ff072f7c3880f138236995720bb733/1

UNESCO. (2016). *Strategy for technical and vocational education and training (TVET) 2016–2021*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000245239

Wang, H., Zhang, C., Qin, G., Liu, Y., Jiang, J., & Li, Y. (2018). Alignment between the curriculum standards and mathematics academic proficiency test in junior middle school. *Kexue Jiaoyu Yanjiu*. (in Chinese)

Wang, Z., & McDougall, D. (2019). Curriculum matters: What we teach and what students gain. *International Journal of Science and Mathematics Education, 17*(6), 1129–1149. https://doi.org/10.1007/s10763-018-9922-0

Wares, A. (2019). Geometry and trigonometry interplay. *Mathematics Teacher: Learning and Teaching PK–12, 112*(5), 400. https://doi.org/10.5951/MATHTEACHER.112.5.0400

Watson, J., & Smith, C. (2022). Statistics education at a time of global disruption and crises: A growing challenge for the curriculum, classroom, and beyond. *Curriculum Perspectives, 42*(2), 171–179. https://doi.org/10.1007/s41297-022-00167-7

Webb, N. L. (1997). *Determining alignment of expectations and assessments in mathematics and science education*. NISE Brief, 1(2). https://files.eric.ed.gov/fulltext/ED405190.pdf

Webb, N. L. (2007). Issues related to judging the alignment of curriculum standards and assessments. *Applied Measurement in Education, 20*(1), 7–25. https://doi.org/10.1080/08957340709336738

Wiberg, M. (2019). The relationship between TIMSS mathematics achievements, grades, and national test scores. *Education Inquiry, 10*(4), 328–343. https://doi.org/10.1080/20004508.2019.1607702

Wong, M. K., Hong, D. Z. H., Wu, J., Ting, J. J. Q., Goh, J. L., Ong, Z. Y., ... & Krishna, L. K. R. (2022). A systematic scoping review of undergraduate medical ethics education programs from 1990 to 2020. *Medical Teacher, 44*(2), 167–186. https://doi.org/10.1080/0142159X.2021.1970729

Appendix A

Curriculum Specification Table

MAIN TOPIC	SUB-TOPIC	Number of learning outcomes
NUMBER AND NUMERATIONS	Number bases	
	Modular arithmetic	
	Fractions, Decimals and Approximations	
	Indices	
	Logarithms	
	Sequence and Series	
	Sets	
	Logical Reasoning	
	Positive and negative integers, rational numbers	
	Surds (Radicals)	
	Matrices and Determinants	
	Ratios, Proportions, and Rates	
	Percentages	
	Financial Arithmetic	
	Variation	
ALGEBRAIC PROCESSES	Algebraic expressions	
	Simple operations on algebraic expressions	
	Solution of Linear equations	
	Change of Subject of a Formula/Relation	
	Quadratic Equations	
	Graphs of Linear and Quadratic Equations	
	Linear inequalities	
	Algebraic fractions	
	Functions and Relations	
MENSURATION	Lengths and Perimeters	
	Areas	
	Volumes	
PLANE GEOMETRY	Angles	
	Angles and Intercepts on parallel lines	
	Triangles and Polygons	
	Circles	
	Construction	
	Loci	
COORDINATE GEOMETRY OF STRAIGHT LINES		
TRIGONOMETRY	Sine, Cosine, and Tangent of an Angle	
	Angles of elevation and depression	
	Bearings	
INTRODUCTORY CALCULUS	Differentiation	
	Integration	
STATISTICS AND PROBABILITY	Statistics	
	Probability	
VECTORS AND TRANSFORMATION	Vectors in a Plane	
	Transformation in the Cartesian Plane	

Appendix B

Examination Questions Specification Table

		QUESTION NUMBERS										
MAIN TOPIC	SUB-TOPIC	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2023
NUMBER AND NUMERATIONS	Number bases											
	Modular arithmetic											
	Fractions, Decimals and Approximations											
	Indices											
	Logarithms											
	Sequence and Series											
	Sets											
	Logical Reasoning											
	Positive and negative integers, rational numbers											
	Surds (Radicals)											
	Matrices and Determinants											
	Ratios, Proportions, and Rates											
	Percentages											
	Financial Arithmetic											
	Variation											
ALGEBRAIC PROCESSES	Algebraic expressions											
	Simple operations on algebraic expressions											
	Solution of Linear equations											
	Change of Subject of a Formula/Relation											
	Quadratic Equations											
	Graphs of Linear and Quadratic Equations											
	Linear inequalities											
	Algebraic fractions											
	Functions and Relations											
MENSURATION	Lengths and Perimeters											
	Areas											
	Volumes											
PLANE GEOMETRY	Angles											
	Angles and Intercepts on parallel lines											
	Triangles and Polygons											
	Circles											
	Construction											
	Loci											

Cont …

Appendix B (continued)

		QUESTION NUMBERS										
COORDINATE GEOMETRY OF STRAIGHT LINES												
TRIGONOMETRY	Sine, Cosine, and Tangent of an Angle											
	Angles of elevation and depression											
	Bearings											
INTRODUCTORY CALCULUS	Differentiation											
	Integration											
STATISTICS AND PROBABILITY	Statistics											
	Probability											
VECTORS AND TRANSFORMATION	Vectors in a Plane											
	Transformation in the Cartesian Plane											