



Developing a Multidimensional Mathematical Framework for Assessing Secondary-School Performance in Jamaica: Conceptualisation, Operationalisation, Measurement and Validation of the Jamaica Multidimensional Secondary-School Performance and Quality Index (J-MSSPQI)

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Abstract

Assessment of secondary-school performance in Jamaica has traditionally placed considerable emphasis on students' outcomes in external examinations such as the Caribbean Secondary Education Certificate (CSEC) and Caribbean Advanced Proficiency Examination (CAPE), and the Ministry of Education publishes external examination performance reports to support decision-making. However, an average examination result primarily represents attained academic performance at one point in time and cannot, by itself, determine how much learning a school generated, whether progress was equitably distributed, whether students remained engaged in schooling, whether they completed secondary education, or whether the institutional environment supported their academic and personal development. International research increasingly conceptualises school performance as multidimensional and distinguishes attainment from growth, graduation, attendance, discipline, equity, school climate, teaching quality and institutional effectiveness (OECD, 2008; Sun et al., 2020). Jamaica's National Education Inspectorate similarly recognises multiple dimensions of school quality, including leadership and management, teaching, student progress, student performance, personal and social development, resource use, and safety, security, health and well-being, demonstrating that a broader conceptualisation is already compatible with the country's educational quality-assurance architecture (Ministry of Education, Youth and Information [MOEYI], 2018). This conceptual and methodological paper proposes the **Jamaican Multidimensional Secondary School Performance and Quality Framework (J-MSSPQF)**, which integrates academic attainment, student growth/value added, educational equity, attendance and engagement, progression and completion, post-secondary readiness, student well-being and school climate, and institutional quality in a mathematically explicit assessment architecture. The framework provides student-,

school- and regional-level measures, standardises indicators to comparable scales, assigns transparent weights, incorporates minimum-domain safeguards and measurement uncertainty, and is intended to complement rather than replace external examination results, school inspection and professional educational judgement.

Keywords: secondary education; school performance; Jamaica; value added; school effectiveness; educational equity; external examinations; school quality; multidimensional assessment; accountability

Introduction

Secondary-school performance is consequential because the quality and effectiveness of schools influence students' opportunities for further education, employment, citizenship and social participation. In Jamaica, external examinations administered through the Caribbean examination system occupy a prominent position in reporting secondary educational outcomes, and the Ministry of Education makes CSEC and CAPE performance reports available specifically to guide stakeholder decision-making. Examination performance is undeniably important because students should leave secondary school with demonstrable mastery of academic and technical knowledge, and national systems require comparable evidence of achievement. Nevertheless, using school-level examination averages as the primary indicator of school performance creates a conceptual problem because observed attainment reflects both what students brought into the institution and what subsequently occurred in the school. A school enrolling academically advantaged students may record high examination averages even if students make comparatively modest progress, whereas another school serving students entering with substantial educational disadvantage may produce exceptional learning growth while retaining a lower final examination average. Consequently, a scientifically defensible framework must distinguish **what students ultimately attain from how much educational progress schools help them make.**

This distinction corresponds with international developments in educational measurement, where value-added approaches were developed specifically to improve on comparisons based solely on observed performance levels. The OECD has argued that value-added estimates can provide a more informative quantitative basis for school improvement and accountability because they examine progress while considering differences in students' prior achievement and circumstances (OECD, 2008). Ladd and Walsh (2002) similarly demonstrated that value-added measures can strengthen assessments of school effectiveness, although their implementation requires careful attention to model specification and incentives. More recent research shows that attainment levels and student-growth measures are correlated only imperfectly, meaning that schools performing strongly on one dimension need not perform equally strongly on another (Sun et al., 2020). It follows that examination averages should remain in school assessment but cannot legitimately be treated as synonymous with school effectiveness.

School performance is broader still because schools are expected to produce outcomes beyond examination scores. Sun et al. (2020) empirically demonstrated the multidimensionality of school performance by examining academic attainment, growth, graduation, chronic absenteeism and disciplinary outcomes, showing that these measures represent related but distinct components of

institutional performance. A systematic review by Javornik and Klemenčič Mirazchiyski (2023) similarly concluded that school effectiveness is multifaceted and reflects leadership, teaching practices, school culture, parental involvement, student engagement and other organisational conditions alongside academic achievement. OECD evidence further emphasises that effective educational systems must combine quality with equity rather than allowing high average achievement to coexist with persistent disadvantage among student populations (OECD, 2012). These findings imply that a Jamaican school cannot be classified comprehensively merely according to how highly its strongest students perform in terminal examinations. A scientifically defensible assessment should also consider whether the school promotes progress, participation, completion, equity, well-being and readiness for life beyond secondary education.

Importantly, Jamaica already possesses institutional foundations compatible with such a multidimensional approach. The National Education Inspectorate has assessed schools across eight areas that include leadership and management, teaching in support of learning, students' progress, students' performance, personal and social development, use of human and material resources, and student safety, security, health and well-being (MOEYI, 2018). The Ministry's Student Assessment Unit also describes its responsibility in terms of implementing objective and accurate assessment systems rather than simply reporting one examination statistic. Jamaica does not lack recognition that school quality is multidimensional; rather, the methodological gap concerns the absence of a **single transparent mathematical architecture that integrates student outcomes, growth, equity, engagement, completion and institutional quality into a defensible school-performance index while preserving the separate meaning of each dimension**. Such an architecture could support school self-evaluation, regional planning, targeted intervention and public accountability without collapsing educational quality into examination rank ordering. The present paper proposes such a framework.

Problem Statement

A school examination average can be represented as the mean terminal attainment of students in school s :

$$\bar{A}_s = (1/N_s) \times \sum_{i=1}^{N_s} A_{is}$$

where A_{is} represents the external examination attainment of student i in school s and N_s represents the number of students included in the calculation. This quantity is mathematically legitimate as a description of average attainment, but its interpretation becomes problematic when it is relabelled as a complete measure of school quality. Students differ before entering secondary school in prior learning, household resources, educational support, health, disability, attendance histories and numerous other characteristics associated with achievement. OECD research consistently demonstrates that socioeconomic composition is associated with school-level performance and that disadvantaged schools generally record lower average attainment than more advantaged schools (OECD, 2018). Consequently, a raw mean combines **student intake, social context and school contribution**, making attribution of the entire observed score to the school scientifically indefensible.

The conceptual problem may be stated as:

$$\text{Observed School Attainment} = \text{Prior Student Achievement} + \text{Student/Family Characteristics} + \text{School Contribution} + \text{Contextual Influences} + \text{Measurement Error}$$

This formulation does not imply that schools are powerless because school leadership, classroom practice, school culture and instructional organisation remain meaningfully associated with student performance. OECD analyses identify classroom characteristics, instructional practices, leadership, teacher well-being, working-time use and school culture among important correlates of between-school differences in achievement. The systematic school-effectiveness literature likewise identifies strong leadership, effective teaching and positive culture among recurring characteristics of effective institutions (Javornik & Klemenčič Mirazchiyski, 2023). The measurement requirement is not to abandon accountability but to estimate school contribution more accurately while acknowledging factors outside immediate institutional control. A comprehensive framework should consequently evaluate both **absolute achievement** and **contextually informed progress**.

A second limitation of relying on examination averages is that averages conceal the internal distribution of achievement. Two schools can obtain the same overall examination mean even though one achieves relatively similar results across socioeconomic, sex, disability or prior-attainment groups while the other contains severe internal disparities. Educational equity requires attention not merely to average outcomes but to the extent to which schools support students who begin at different levels of advantage. OECD's equity framework emphasises that high-quality educational systems combine strong overall performance with reduced effects of disadvantage on educational outcomes (OECD, 2012). A school that raises already high-performing students while consistently failing its most vulnerable learners should not receive the same quality judgement as an institution achieving comparable averages with substantially smaller internal inequalities. A multidimensional framework must make these distributional differences visible.

A third limitation concerns students who do not appear in the final external examination average. Chronically absent students, leave school prematurely, fail to enter examinations, or remain enrolled but disengaged educationally can disappear partially or entirely from statistics calculated only from examination candidates. This creates the possibility of an **examination-selection problem**, because school performance may appear stronger when the outcome denominator contains only students who remain sufficiently engaged to sit external assessments. International multidimensional accountability research incorporates graduation and chronic absenteeism alongside academic outcomes rather than treating test performance as the entire construct (Sun et al., 2020). OECD's recent work on school attendance similarly treats attendance problems as multidimensional educational challenges requiring governance, school-level intervention and systematic monitoring (OECD, 2026). A Jamaican framework should follow students from enrolment through participation, progression, examination entry, completion and transition rather than evaluating only the performance of eventual examination candidates.

Literature Review

Attainment versus School Effectiveness

Raw academic attainment remains an important educational outcome because schools must ultimately help students achieve recognised levels of knowledge and competence. Examination performance can inform curriculum review, instructional planning and comparisons with national standards, and Jamaica's Ministry of Education explicitly disseminates CSEC and CAPE performance reports to support educational decision-making. The conceptual difficulty arises only when attainment is interpreted as equivalent to school effectiveness, because schools differ substantially in the academic profiles of students they receive. Value-added research emerged precisely because comparing final attainment without considering starting points can reward schools for favourable intakes and penalise institutions serving academically disadvantaged populations (OECD, 2008). Accordingly, final attainment should remain one dimension of performance but should be interpreted alongside growth.

Value-added assessment estimates whether students make more or less progress than expected after accounting for prior attainment and, where appropriate, relevant contextual variables. OECD guidance describes value-added approaches as potentially more accurate and useful for school improvement and accountability than raw performance measures alone (OECD, 2008). Ladd and Walsh (2002), however, caution that value-added systems require careful implementation because specification choices and accountability incentives can affect resulting estimates. Subsequent work continues to demonstrate that value-added estimates represent a useful but imperfect statistical approximation of school contribution rather than direct observation of causal school quality. A comprehensive framework should include value-added but should not permit a single statistical residual to become the replacement for a single examination average. The appropriate strategy is triangulation across several dimensions.

Multidimensionality of School Performance

The multidimensionality argument is particularly well supported by Sun et al. (2020), who examined multiple measures of school performance and demonstrated that attainment, growth, graduation, chronic absenteeism and disciplinary outcomes do not collapse neatly into one empirical dimension. Their findings are especially relevant because they show that schools can occupy different positions depending on whether the evaluator examines absolute achievement, growth, persistence or behavioural outcomes. This means that a ranking based only on one outcome will systematically omit other dimensions on which schools may perform strongly or poorly. Such omission becomes particularly consequential when school-performance measures are attached to reputational judgements, resource allocation or intervention decisions. The present proposal treats the final composite score as a summary of explicitly retained dimensions rather than assuming that all school-quality information is naturally represented by examination performance. Dimension-level results must always be published alongside the overall index.

Systematic-review evidence supports this broad conception of school effectiveness. Javornik and Klemenčič Mirazchiyski (2023) found that effective schools are associated with multiple

institutional and relational characteristics, including school leadership, teaching, culture, parental involvement, student engagement and broader organisational conditions. This evidence is consistent with OECD findings that school leadership, classroom practice, teacher well-being and school culture explain meaningful portions of between-school variation in academic outcomes (OECD, 2021). These factors should not all be interpreted as direct outcome measures because some are institutional processes that contribute to educational outcomes. Nevertheless, assessing school quality without considering the quality of the environment producing those outcomes is incomplete. The proposed framework separates **student performance outcomes** from **institutional quality indicators** while incorporating both in the broader evaluation architecture.

Equity as School Performance

Equity must be incorporated because educational quality cannot reasonably be defined as maximising averages while accepting persistent failure among identifiable groups of learners. OECD research shows that socioeconomic disadvantage remains strongly associated with educational achievement and that disadvantaged schools generally record lower average performance than schools serving more advantaged populations. This creates two measurement requirements: schools should not be penalised mechanically for serving disadvantaged students, but they should still be held responsible for whether internal disparities narrow or widen during students' time in the institution. Value-added modelling can address part of the first problem by conditioning expected achievement on starting points and student characteristics. Equity-gap indicators address the second by directly estimating differences in progress or outcomes across relevant groups. The proposed framework consequently distinguishes **context adjustment from equity performance**, because statistically accounting for disadvantage is not equivalent to demonstrating that disadvantage has been reduced.

Equity also requires attention to students with educational vulnerabilities that may not be captured adequately by household socioeconomic position alone. Relevant dimensions may include disability, sex, geographic disadvantage, prior academic attainment, school-entry age and other nationally defensible categories for which sufficiently reliable data exist. The specific characteristics used in official accountability should be determined through Jamaican policy, ethical and statistical review rather than imported mechanically from another national system. Small subgroups must be protected against unstable estimates through minimum cell-size rules and multi-year pooling where necessary. Schools should not receive extreme equity classifications based on very small numbers of students. The broader principle is that a high-performing school should demonstrate both strong outcomes and reasonable distribution of opportunity to succeed.

Attendance, Engagement and Completion

Attendance is a foundational educational outcome because students cannot benefit consistently from instruction when they are persistently absent. OECD's recent analysis of school attendance treats attendance problems as complex phenomena requiring system monitoring and coordinated school-level responses rather than as simple student misconduct (OECD, 2026). Sun et al. (2020) similarly demonstrate that chronic absenteeism constitutes a distinct school-performance

dimension rather than merely a duplicate of examination attainment. Jamaica's ongoing development of education management systems to track attendance further reflects the practical importance of monitoring student presence systematically. Attendance should enter a comprehensive framework as an independent indicator with appropriate adjustment for documented circumstances outside school control. Persistent absenteeism should lower the institutional performance score because a school cannot be considered fully effective when substantial proportions of students remain disconnected from learning.

Completion is equally important because the purpose of secondary schooling extends beyond producing examination grades among those who persist successfully. A school must retain students, support progression through grades and maximise meaningful completion of the secondary cycle. Graduation or completion rates are widely used alongside attainment and growth in multidimensional school accountability because they capture an aspect of institutional performance that examinations alone cannot represent (Sun et al., 2020). For Jamaica, completion measurement should distinguish students who transfer legitimately from those who drop out or become untraceable, because treating all exits identically would bias institutional comparisons. Cohort tracking should follow each entering secondary cohort through expected completion and educational transition. This would produce a substantially more defensible picture of the school's ability to sustain students through the educational process.

School Climate, Safety and Well-Being

School climate matters because learning occurs in social and organisational environments rather than in isolation from them. International literature links school climate with academic, behavioural and psychosocial outcomes, while multidimensional measurement approaches increasingly incorporate safety, belonging, engagement and relationships into school evaluation. Jamaica's own National Education Inspectorate already recognises students' personal and social development and their safety, security, health and well-being as dimensions of school quality (MOEYI, 2018). UNESCO's work on positive school environments similarly connects students' experience of school with participation and persistence. Consequently, a school producing respectable examination results in an unsafe, alienating or highly exclusionary environment should not automatically be classified as possessing exceptional overall quality.

Climate measurement must nevertheless be methodologically rigorous because perceptions can vary between students, teachers and parents. Research on school climate demonstrates that different informants can perceive the same school differently and that aggregating all perceptions into a single undifferentiated score may conceal meaningful variation. A valid Jamaican framework should collect climate data from multiple sources and preserve separate subscales for safety, belonging, teacher-student relationships, expectations and engagement before constructing an overall climate measure. School-level estimates should include sufficiently large random or census samples to reduce instability and selective participation. Survey instruments should undergo reliability and measurement-invariance testing before incorporation into accountability. Climate should consequently function as an evidence-based component of school quality rather than a loosely defined satisfaction score.

Leadership, Teaching and Institutional Quality

Schools influence students through institutional mechanisms such as leadership, curriculum implementation, teaching quality, teacher collaboration, resource management and learning support. OECD evidence identifies leadership, classroom practices, school culture and teacher conditions among meaningful correlates of between-school achievement differences. The systematic effectiveness literature reaches similar conclusions, highlighting strong leadership, effective teaching, positive culture and stakeholder involvement as recurring features of effective schools (Javornik & Klemenčič Mirazchiyski, 2023). Jamaica's NEI framework already assesses leadership and management, teaching in support of learning and the use of human and material resources, providing locally relevant indicators that can be integrated rather than reinvented. The proposed mathematical framework incorporates an institutional-quality domain derived partly from validated inspection and administrative evidence.

Institutional process indicators should not receive unlimited weight because school accountability should remain centred ultimately on student educational outcomes. A school could theoretically produce highly rated procedures, plans and leadership documentation while student learning remains persistently weak. Conversely, unusually strong student outcomes in a selective school should not lead evaluators to ignore deficient teaching or organisational processes simply because favourable student intake masks weaknesses temporarily. The framework requires both outcome and process evidence and introduces minimum-domain rules to prevent exceptional performance on one side from compensating completely for failure on the other. This balance is consistent with a conception of school effectiveness as the capacity to transform institutional resources and practices into equitable student development. The resulting index is neither purely examination-based nor purely inspection-based.

Research Gap

The major gap addressed by this paper is not the absence of multidimensional thinking about education in Jamaica because the National Education Inspectorate already evaluates several dimensions of school quality. Nor is the gap an absence of school-performance data because external examination reports, student assessment systems and administrative information already generate substantial evidence about Jamaican schools. The unresolved methodological problem is that these data sources are not presently represented in a unified, transparent and empirically testable mathematical architecture capable of distinguishing attainment, progress, equity, engagement, completion, readiness and institutional quality. International literature demonstrates that these dimensions are empirically distinct and that value-added measures offer information beyond raw attainment, but no single international model should be transplanted mechanically into Jamaica (OECD, 2008; Sun et al., 2020). The scientific contribution of the proposed J-MSSPQF is **integration with preserved dimensionality**, allowing an overall school index to be produced without erasing the individual indicators from which that index is constructed.

A second gap concerns the distinction between student performance and school performance. Examination results are student outcomes, but they become school indicators only after aggregation, and the meaning of that aggregation depends on student selection, prior

achievement, participation and context. A comprehensive framework should construct student-level educational-performance profiles first and subsequently estimate the contribution and effectiveness of schools using longitudinal and contextual information. Regional performance should then be derived from school-level estimates rather than by simply averaging school rankings, because school size and student composition differ substantially. The framework proposed here consequently contains three nested levels: **student performance, school performance and regional educational performance**. This multilevel structure provides a more scientifically defensible foundation for comparisons and intervention.

Aim and Objectives

The principal aim of this conceptual study is to develop a mathematically explicit multidimensional framework for assessing secondary-school performance and educational quality in Jamaica. The framework is intended to supplement external examination results with measures of student growth, equity, attendance, progression, completion, readiness, climate and institutional quality. It further seeks to distinguish student achievement from school contribution so that schools are not evaluated simply according to the prior advantages or disadvantages of their incoming students. A third objective is to establish transparent procedures for combining multiple performance dimensions without allowing exceptional performance in one area to conceal serious deficiencies elsewhere. A fourth objective is to develop an aggregation method capable of producing regional educational-performance estimates while preserving information about variation between schools. Finally, the paper proposes an empirical validation programme that should be completed before the framework is used for consequential national accountability.

Conceptual Framework

The proposed framework begins with a simple educational-production proposition:

Student Outcome = Prior Achievement + Student Characteristics + Family/Community Context + School Contribution + Random/Measurement Error

The school's contribution is only one component of the final observed educational result. This distinction does not minimise institutional responsibility but prevents the final examination score from being attributed entirely to the school. OECD value-added methodology explicitly builds on this principle by comparing observed progress with expected progress given students' starting points and relevant characteristics (OECD, 2008). The proposed Jamaican framework extends this reasoning beyond examination growth to attendance, equity, completion, readiness and school environment. School quality is consequently defined as the institution's demonstrated capacity to produce **high, improving, equitable and sustainable student outcomes through effective and supportive educational processes**.

The conceptual pathway is:

Student Starting Conditions → School Processes → Student Engagement → Learning Growth → Attainment and Completion → Post-School Readiness

with:

Equity operating across all stages

and:

Leadership, teaching, resources, climate and safety shaping the educational process.

This framework means that final examination results remain important but are interpreted as one endpoint in a longer educational pathway. Attendance and engagement provide evidence that students remain connected to learning, while growth measures estimate progress after starting conditions are considered. Completion captures persistence through secondary schooling, and readiness indicates whether students leave with qualifications and capabilities appropriate to further education, training or work. Institutional-quality measures then identify whether observed outcomes are being produced in an educational environment capable of sustaining improvement.

The Jamaican Multidimensional Secondary School Performance and Quality Framework

The proposed J-MSSPQF contains eight principal domains: **academic attainment (A), student growth/value added (G), equity and inclusion (E), attendance and engagement (P), progression and completion (C), post-secondary readiness (R), student well-being and school climate (W), and institutional quality (I)**. Each domain represents a conceptually distinguishable aspect of school performance and should be constructed from several validated indicators wherever feasible. The framework deliberately allocates the greatest combined importance to academic outcomes and growth while preserving substantial weight for equity and the broader conditions necessary for sustainable educational performance. Equal weighting is not assumed because the purpose of secondary schooling provides legitimate grounds for weighting educational outcomes more heavily than administrative processes. However, all proposed weights remain hypotheses requiring empirical and policy validation rather than permanent mathematical truths. The final national weights should be established through stakeholder consultation, sensitivity analysis and predictive-validity testing.

Table 1: Proposed J-MSSPQF Domains and Preliminary Weights

Domain	Symbol	Proposed Weight
Academic attainment	A	0.15
Student growth/value added	G	0.20
Equity and inclusion	E	0.15
Attendance and engagement	P	0.10
Progression and completion	C	0.10
Post-secondary/career readiness	R	0.10
Student well-being and school climate	W	0.10
Institutional quality	I	0.10
Total		1.00

The preliminary weighting structure allocates 35% of the total index to academic attainment and growth because learning remains a central purpose of secondary education. Equity receives 15% because average achievement should not be rewarded independently of the distribution of educational success. Attendance, completion and readiness collectively receive 30% because schools must retain students, support progression and prepare them for the next stage of life rather than simply generate grades among examination candidates. Well-being/climate and institutional quality each receive 10%, ensuring that process and environmental conditions influence the final assessment without dominating student outcomes. Reasonable alternative weights must be evaluated through sensitivity analysis before implementation. If rankings change dramatically under small weight changes, the composite measure should be considered insufficiently robust for high-stakes use.

Domain 1: Academic Attainment

Academic attainment should incorporate more than the simple mean grade across examination subjects. A school should receive credit for the proportion of its eligible cohort entering recognised examinations, the breadth of subjects attempted, the proportion achieving defined proficiency standards, high-level mastery and performance in foundational areas such as English and mathematics. Examination results from CSEC, CAPE, vocational certifications and other nationally approved secondary credentials may be incorporated according to school programme level. Jamaica already reports external examination results and performance information across several qualifications, making attainment data a realistic component of the framework. The central methodological requirement is that the denominator should refer to an eligible cohort rather than only successful candidates wherever possible. This reduces incentives to improve reported results by restricting weaker students' examination participation.

For school s , define normalised academic attainment as:

$$A_s = \sum_{m=1}^M \alpha_m a_{sm}$$

subject to:

$$\sum_{m=1}^M \alpha_m = 1$$

and:

$$0 \leq a_{sm} \leq 1$$

where a_{sm} represents a standardised attainment indicator and α_m represents its in-domain weight. Possible indicators include cohort examination-entry rate, proportion meeting proficiency thresholds, average subject performance, English proficiency, mathematics proficiency and breadth of successful certification. Scores should be standardised relative to stable national performance benchmarks rather than recalculated in a manner that guarantees some schools must fail every year. The attainment domain would measure absolute academic outcomes while remaining broader than one average grade.

Domain 2: Student Growth and Value Added

Growth should estimate the educational progress made by students between entry into secondary education and later assessment. Prior achievement may be represented by PEP or another validated baseline assessment, while later outcomes may include lower-secondary assessments, CSEC performance or other standardised measures. The simplest growth indicator is the difference between later and earlier standardised achievement, but this approach does not fully account for differences in expected trajectories. A stronger approach is multilevel value-added modelling in which students are nested in schools and observed achievement is predicted from prior performance and relevant contextual characteristics. OECD guidance supports value-added approaches precisely because they can improve estimates of school contribution beyond raw achievement comparisons (OECD, 2008). The resulting school effect should nevertheless be treated as an estimate with uncertainty rather than a perfectly observed causal quantity.

A proposed model is:

$$Y_{ist} = \beta_0 + \beta_1 Y_{is(t-1)} + \beta_2 X_i + u_s + \varepsilon_{is}$$

where:

Y_{ist} = later achievement of student i in school s

$Y_{is(t-1)}$ = prior achievement

X_i = vector of approved student/context characteristics

u_s = estimated school value-added effect

ε_{is} = individual residual.

The value-added estimate u_s identifies whether students in school s perform above or below the outcome predicted from prior achievement and approved contextual variables. This model should preferably use several cohorts because one-year estimates can be unstable for smaller schools. Empirical-Bayes shrinkage can further reduce the risk that extreme estimates based on small samples are interpreted as precise school effects.

The normalised growth score may be expressed as:

$$G_s = \Phi(u_s / \sigma_u)$$

where Φ represents the standard normal cumulative distribution function and σ_u represents the between-school standard deviation in estimated value added. This transformation places value-added estimates on a 0-1 scale while preserving relative differences. Alternative transformations may be used provided that they are transparent and validated. Confidence intervals around u_s should always accompany the reported growth measure because school effects are statistical estimates. Schools whose confidence intervals overlap substantially should not be presented as definitively different merely because their point estimates differ. This requirement reduces false precision in league-table comparisons.

Domain 3: Equity and Inclusion

The equity domain evaluates whether students from different starting positions experience reasonably similar opportunities for progress and successful outcomes in the school. Equity should not reward uniformly low outcomes merely because all groups perform equally poorly, meaning that it must operate jointly with attainment and growth rather than replacing them. Possible subgroup comparisons include lower versus higher prior attainment, lower versus higher socioeconomic circumstances, male versus female students, students with versus without identified special educational needs, and other nationally approved classifications. OECD evidence demonstrates the importance of assessing both quality and equity because disadvantaged students and disadvantaged schools often experience systematically weaker educational outcomes (OECD, 2012, 2018). A strong school should demonstrate that achievement and progress are not excessively concentrated among already advantaged students. Equity becomes an observable characteristic of institutional effectiveness rather than a separate social aspiration.

For school s , define the standardised subgroup gap for characteristic g as:

$$\text{Gap}_{s,g} = |\bar{Y}_{s,g_1} - \bar{Y}_{s,g_2}|$$

where the two terms represent adjusted average outcomes for the relevant comparison groups. Convert the gap into an equity score:

$$E_{s,g} = 1 - \min(1, \text{Gap}_{s,g} / T_g)$$

where T_g represents a predetermined maximum tolerable standardised gap. The overall equity score becomes:

$$E_s = \sum_g \gamma_g E_{s,g}$$

subject to:

$$\sum_g \gamma_g = 1$$

and:

$$0 \leq E_s \leq 1.$$

A school with very small adjusted gaps receives a score approaching 1, whereas widening disparities lower the equity score.

Domain 4: Attendance and Engagement

Attendance should measure the extent to which enrolled students remain connected to instructional time. The domain should incorporate average attendance, chronic absenteeism, unexplained absence and possibly student-engagement survey indicators rather than relying on one attendance percentage. OECD's school-attendance framework demonstrates that persistent absence is a multidimensional educational issue associated with governance, support capacity

and school-level intervention (OECD, 2026). Jamaica's development of information systems for attendance monitoring makes systematic measurement increasingly feasible. The framework should distinguish authorised or unavoidable absences from patterns suggesting disengagement wherever administrative data permit. Schools should also be evaluated on improvement in attendance among high-risk students rather than only overall attendance levels.

A proposed participation score is:

$$P_s = \lambda_1 AR_s + \lambda_2(1 - CAR_s) + \lambda_3 ENG_s$$

where:

AR_s = normalised attendance rate

CAR_s = normalised chronic-absence rate

ENG_s = normalised student-engagement measure.

The weights satisfy:

$$\lambda_1 + \lambda_2 + \lambda_3 = 1$$

and each component ranges from 0 to 1. If engagement data are not initially available, the domain may begin with attendance measures and expand following survey validation. Multi-year averages should be considered where one-year attendance data are affected by unusual disruptions.

Domain 5: Progression and Completion

The progression and completion domain measures whether students move successfully through secondary schooling and reach recognised completion points. Relevant indicators include grade progression, on-time progression, retention, dropout, Grade 11 completion, upper-secondary transition and legitimate transfer tracking. Students transferring to another recognised institution should not be coded as dropouts because such misclassification would penalise schools for continued educational participation elsewhere. Conversely, students whose educational status becomes unknown should not simply disappear from the denominator. Cohort-based measurement is preferable because it follows the educational trajectory of a defined entering group rather than combining unrelated students across years. This approach makes persistence itself part of the definition of school effectiveness.

The domain may be represented as:

$$C_s = \delta_1 PR_s + \delta_2 CR_s + \delta_3(1 - DR_s)$$

where:

PR_s = progression rate

CR_s = completion rate

DR_s = verified dropout rate.

The weights satisfy:

$$\delta_1 + \delta_2 + \delta_3 = 1.$$

All indicators are scaled between 0 and 1 before aggregation. Schools should receive additional diagnostic reporting showing which component drives a low completion-domain score rather than receiving only the combined number.

Domain 6: Post-Secondary and Career Readiness

Secondary education should prepare students for multiple pathways rather than assuming that university admission is the only legitimate successful outcome. Jamaica's secondary system includes academic, technical and vocational routes, and Ministry programmes have explicitly sought to strengthen school-to-work and technical/vocational transitions. Readiness indicators can include attainment of required English and mathematics credentials, successful technical/vocational certification, entry into CAPE or sixth form, tertiary enrolment, approved training, apprenticeships or verified employment transitions. Because schools serve different programme profiles, the metric should reward successful progression into recognised pathways rather than impose a university-centred hierarchy. Follow-up surveys and administrative data linkage may be necessary to measure destinations reliably. This dimension extends school-performance evaluation beyond the final examination sitting into the educational and economic relevance of secondary completion.

A proposed readiness score is:

$$R_s = \theta_1 ACA_s + \theta_2 TVET_s + \theta_3 TRANS_s$$

where:

ACA_s = academic readiness indicator

$TVET_s$ = technical/vocational readiness indicator

$TRANS_s$ = verified successful-transition indicator.

The weights satisfy:

$$\theta_1 + \theta_2 + \theta_3 = 1.$$

The precise indicators should depend on school programmes, and denominators must reflect student eligibility. Schools should not be penalised for not offering pathways that are outside their official educational mandate.

Domain 7: Well-Being and School Climate

The well-being and climate domain should combine student perceptions with objective safety and disciplinary indicators. Relevant constructs include physical safety, emotional safety, bullying, belonging, teacher-student relationships, academic expectations, engagement and access to support. Jamaica's NEI framework already includes students' safety, security, health and well-being as part of school inspection, providing a strong locally grounded basis for this

domain. International research likewise treats school climate as multidimensional and cautions against relying on a single informant or undifferentiated summary measure. A Jamaican instrument should gather evidence from students and staff and, where feasible, parents, while maintaining separate subscales before aggregation. The resulting climate score should complement rather than override independently verified incident and safety data.

The climate domain can be written as:

$$W_s = \eta_1 \text{SAFE}_s + \eta_2 \text{BEL}_s + \eta_3 \text{REL}_s + \eta_4 \text{SUP}_s + \eta_5 \text{DISC}_s$$

where:

SAFE_s = safety

BEL_s = belonging

REL_s = relationships

SUP_s = academic/pastoral support

DISC_s = positive disciplinary climate.

The weights satisfy:

$$\Sigma \eta = 1.$$

All scales should undergo reliability and measurement-invariance testing before cross-school comparison. Serious safety failures may additionally function as minimum-domain safeguards rather than being fully compensable through high scores elsewhere.

Domain 8: Institutional Quality

Institutional quality captures whether the school possesses organisational conditions capable of sustaining student development. Jamaica's existing inspection architecture provides directly relevant components, including leadership and management, teaching in support of learning, curriculum and enhancement programmes, use of human and material resources, and related quality indicators. The proposed framework should use validated NEI-style evidence rather than creating a parallel inspection bureaucracy unnecessarily. Institutional-quality scoring should combine inspection ratings, teacher stability, curriculum delivery, instructional observation and resource-management indicators where statistically defensible. Because some resources reflect allocations beyond the school's control, resource availability should be distinguished from the effectiveness with which available resources are deployed. The purpose of the domain is to assess institutional capacity and educational processes rather than reward wealthier schools simply for possessing more facilities.

A proposed institutional score is:

$$I_s = \kappa_1 L_s + \kappa_2 T_s + \kappa_3 \text{CUR}_s + \kappa_4 \text{RM}_s$$

where:

L_s = leadership and management
 T_s = teaching quality
 CUR_s = curriculum implementation
 RM_s = effective resource management.

The weights satisfy:

$$\kappa_1 + \kappa_2 + \kappa_3 + \kappa_4 = 1.$$

Inspection scales should be normalised to 0-1 before incorporation. Where inspection occurs less frequently than annual outcome measurement, the most recent validated inspection score may be used with appropriate ageing rules or rolling updates.

Overall School Performance and Quality Index

After each domain is placed on the common interval $0 \leq D \leq 1$, the proposed overall score for school s is:

$$J\text{-MSSPQI}_s = 100[0.15A_s + 0.20G_s + 0.15E_s + 0.10P_s + 0.10C_s + 0.10R_s + 0.10W_s + 0.10I_s]$$

where:

A = academic attainment
G = student growth/value added
E = equity and inclusion
P = attendance and engagement
C = progression and completion
R = post-secondary/career readiness
W = well-being and climate
I = institutional quality.

The resulting score ranges from 0 to 100. Higher scores represent stronger multidimensional educational performance rather than merely higher examination achievement. The score must always be published with the eight domain results because the composite alone is insufficient for school improvement planning.

Minimum-Domain Safeguard

A purely additive model creates a compensation problem because exceptionally high examination results could mathematically conceal severe deficiencies in equity, attendance, safety or completion. The framework requires a minimum-domain safeguard. Define:

$$D_s^{\min} = \min(A_s, G_s, E_s, P_s, C_s, R_s, W_s, I_s)$$

A school should not receive the highest overall classification if one of the critical domains falls below a nationally validated minimum threshold. For example, policymakers might determine after validation that no school with serious safety failure or extremely weak completion should receive an “exceptional” classification regardless of examination results. The specific threshold

should not be chosen arbitrarily in the conceptual stage because its consequences require empirical simulation. The important principle is that some educational failures should be treated as non-compensable.

Proposed School Classification

Table 2: Illustrative J-MSSPQI Classification

J-MSSPQI	Proposed Classification
85-100	Exceptional multidimensional performance
70-84.99	Strong performance
55-69.99	Satisfactory/developing performance
40-54.99	Performance requiring targeted improvement
<40	Performance requiring intensive support

These categories are illustrative and should not be adopted before validation. A national pilot should examine the distribution of scores, stability over time, relationship with independent educational outcomes and consequences of alternative cut-points. Classification should also incorporate confidence intervals so that a school scoring 69.8 is not treated as fundamentally different from another scoring 70.2 when measurement uncertainty is substantial. Multi-year evidence should be considered for consequential classification decisions. The purpose of categories should be diagnostic support and differentiated intervention rather than public stigmatisation of schools.

Measurement Uncertainty

Every school indicator contains measurement error, and the precision of school estimates differs according to cohort size and data quality. Value-added estimates are particularly uncertain for small schools, but survey-based climate results and subgroup equity measures can also be unstable when based on few observations. Accordingly, the framework should estimate a standard error for the overall index wherever statistical propagation is feasible. If SE_s represents the estimated standard error of the school score, an approximate interval may be reported as:

$$95\% \text{ CI}_s = \text{J-MSSPQI}_s \pm 1.96(SE_s)$$

The school should be represented as occupying an estimated range rather than an infinitely precise point on a league table. This approach discourages exaggerated interpretations of trivial rank differences.

Where domain estimates are approximately independent, an initial composite standard error may be approximated as:

$$SE(\text{J-MSSPQI}_s) = 100 \times \sqrt{[\sum_k w_k^2 SE(D_{sk})^2]}$$

Although covariance terms should be incorporated where domains are statistically dependent. Bootstrapping may provide a more practical alternative because several domain scores are derived from nonlinear transformations and administrative indicators. Schools should also be

classified using several years of data where annual instability is high. Large year-to-year changes should trigger diagnostic investigation rather than automatic claims of dramatic improvement or deterioration. Uncertainty is treated as part of performance measurement rather than an inconvenience to be ignored.

School Performance Versus Student Performance

The framework should avoid describing students themselves as “high-quality” or “low-quality” because educational measurement evaluates performance rather than human worth. Student educational performance can nevertheless be represented multidimensionally to produce diagnostic profiles. For student i , a Student Educational Performance Profile could include academic attainment, growth, attendance, progression, certification breadth and readiness. The individual score should be used primarily for support and intervention rather than high-stakes ranking because student outcomes depend on substantial family, social, health and contextual factors. School performance should then be derived through aggregated and adjusted student outcomes combined with institution-level measures. This distinction protects the conceptual boundary between evaluating educational performance and making value judgements about students.

A student-level index could be expressed as:

$$SEPI_i = 100[\omega_1 A_i + \omega_2 G_i + \omega_3 P_i + \omega_4 C_i + \omega_5 R_i]$$

subject to:

$$\sum \omega = 1.$$

This measure would not replace subject-specific reports because students require detailed information about strengths and weaknesses. Its principal research use would be to examine distributions in schools and identify whether school averages conceal substantial internal variation. Student-level data then become the empirical foundation for school-level value-added and equity analysis.

Regional Performance Framework

Jamaica's educational administration requires regional as well as national evidence, and a regional score should reflect the performance of students and schools in the region rather than simply averaging school rankings. If a school s belongs to region r , let N_s represent the eligible student population used for regional weighting. The region's multidimensional index may initially be calculated as:

$$RPI = \sum_s \epsilon (N_s / N) \times J\text{-MSSPQI}_s$$

where:

$$N = \sum_s \epsilon N_s.$$

This student-weighted method prevents a very small school from exerting the same regional influence as an institution serving several times as many students. However, both weighted and unweighted school summaries should be reported because the weighted result describes the average student's institutional environment while the unweighted result describes the average school.

A regional assessment should also include dispersion because identical regional averages can conceal very different patterns of inequality between schools. Define the weighted between-school variance:

$$V = \sum_s \epsilon w_s (J\text{-MSSPQI}_s - RPI)^2$$

where:

$$w_s = N_s / N .$$

A region with a respectable mean but very high variance may contain both outstanding schools and severely underperforming institutions, requiring a different policy response from a region in which schools cluster closely around the same average. Regional dashboards should report the mean, median, variance, proportion of schools below support thresholds and domain-specific distributions. Regional quality is consequently conceptualised as both **average performance and consistency of educational opportunity across schools**.

Equity-Adjusted Regional Performance

Regional quality should additionally reflect whether performance is distributed equitably across schools and students. One possible regional equity adjustment is:

$$EARPI = RPI \times (1 - \lambda CV)$$

where:

$$CV = SD / \text{Mean}$$

and λ is a validated penalty parameter between 0 and 1. This approach reduces the regional score when performance disparities between schools are exceptionally large. However, such adjustment should be used only after policy simulation because an automatic inequality penalty may produce unintended incentives. An alternative is to publish regional average performance and inequality as separate indicators rather than combine them. The conceptual framework recommends separate reporting initially, with equity-adjusted composites treated as an empirical research extension.

Data Requirements

Implementation requires longitudinal student identifiers linking baseline achievement, annual enrolment, attendance, progression, examination participation, examination results and eventual transition outcomes. School-level information should include inspection evidence, staffing, leadership, curriculum provision, safety incidents and validated climate surveys. Socioeconomic

adjustment should rely only on variables collected consistently and ethically across the national school population. Administrative datasets should be audited for missingness because schools with weaker information systems should not receive systematically biased performance scores merely because their records are incomplete. Data quality must itself become a monitored component of implementation. The framework requires integrated educational information infrastructure rather than isolated annual spreadsheets.

The Ministry's development of education information and attendance-monitoring systems provides an institutional basis on which a more integrated performance architecture could be built. External examination reports already provide terminal academic outcome information, while inspection systems provide institutional-quality evidence. The principal data-development challenge lies in longitudinal linkage rather than the absence of all necessary information. A unique anonymised student identifier would permit progress to be measured from entry through completion without publicly disclosing individual records. Governance rules should strictly separate research and accountability uses from unauthorised disclosure. The framework must consequently include technical, legal and ethical data-governance standards before implementation.

Empirical Validation Strategy

The framework should initially be implemented as an experimental statistic rather than an official national ranking. A multi-year pilot should include secondary schools from different regions, sizes, socioeconomic compositions, school types and historical achievement profiles. The first validation question is whether the eight domains demonstrate sufficient conceptual distinctiveness to justify separate measurement, which can be examined through correlations, exploratory and confirmatory factor analysis and multilevel modelling. Sun et al. (2020) provide a precedent for investigating whether school-performance indicators represent distinct dimensions rather than assuming unidimensionality beforehand. The second question is whether the proposed composite predicts meaningful future student outcomes more effectively than external examination averages alone. The third is whether the framework produces stable and interpretable school assessments across consecutive cohorts.

Weight validation should compare the proposed policy weights with equal weighting and alternative theoretically plausible structures. Let $J_s(\mathbf{a})$ and $J_s(\mathbf{b})$ represent the school score under weighting systems $\mathbf{a}$ and $\mathbf{b}$. Weight sensitivity can then be examined through:

$$\Delta_s(\mathbf{a}, \mathbf{b}) = |J_s(\mathbf{a}) - J_s(\mathbf{b})|$$

and through rank correlations across specifications. If relatively small changes in weights move large numbers of schools across performance categories, the composite index should not be used for consequential decisions without additional refinement. Researchers should also estimate which domains predict independent outcomes such as later educational participation, tertiary entry and successful completion. Weighting should combine educational values with empirical evidence rather than being derived mechanically from statistical associations alone.

The value-added model requires particularly rigorous validation. Alternative specifications should compare prior-achievement-only adjustment with models incorporating approved socioeconomic and demographic variables, because overadjustment can potentially remove school-relevant educational processes while underadjustment can preserve intake bias. Ladd and Walsh (2002) emphasise that value-added implementation choices have important implications for school-effectiveness estimates and resulting incentives. Estimates should also be compared across one-year and multi-year windows to determine their stability. Empirical-Bayes shrinkage or related multilevel estimators should be considered to reduce extreme estimates driven by small cohorts. No school should receive a consequential judgement from a value-added estimate whose uncertainty is too large to support that conclusion.

Reliability

Reliability must be evaluated separately for each data source. External examination outcomes possess their own assessment reliability; administrative attendance and completion indicators depend on accurate record-keeping, climate measures require psychometric reliability, and inspection ratings involve professional judgement that may vary between inspection teams. The composite score cannot be more trustworthy than the weakest data incorporated without appropriate safeguards. Inter-rater reliability should be examined for inspection components, while internal-consistency and multilevel reliability should be evaluated for survey-based climate scales. Administrative indicators should undergo periodic verification and audit. School-performance measurement should consequently be treated as a measurement system rather than simply an arithmetic formula.

Temporal reliability is equally important because school quality should not fluctuate dramatically merely because one cohort happened to be unusually strong or weak. Three-year rolling averages may be appropriate for some indicators, particularly small schools and subgroup equity measures. However, excessive averaging can conceal genuine rapid improvement or deterioration, creating a trade-off between stability and responsiveness. The validation programme should estimate year-to-year correlations and determine appropriate reporting windows empirically. Schools showing sustained improvement should be distinguishable from institutions experiencing random annual fluctuation. Longitudinal reliability should ultimately influence how frequently high-stakes classifications are revised.

Fairness and Context Adjustment

The framework explicitly rejects the idea that fairness requires holding schools harmless for every contextual disadvantage. Schools exist partly to reduce educational inequalities and should remain accountable for student progress and equitable outcomes. Context adjustment is intended instead to prevent raw attainment from being interpreted as though schools selected randomly equivalent student populations. The OECD's value-added rationale and equity literature support distinguishing the contribution of schools from characteristics students bring into them (OECD, 2008, 2012). The framework uses contextual information primarily in growth modelling while independently rewarding schools that narrow rather than reproduce disparities. This preserves both statistical fairness and educational responsibility.

Context variables should be selected according to clear principles. A variable may be included where it is measured before the outcome, predicts achievement, lies substantially outside the school's immediate control and does not represent an outcome schools are expected to improve. Prior achievement is appropriate, whereas current attendance should generally not be controlled away because improving attendance is itself a school-performance objective. Likewise, school climate should remain an outcome rather than a contextual adjustment because schools contribute directly to climate. Decisions of this type require explicit causal reasoning rather than automatic inclusion of every available variable. A published technical manual should document all adjustment choices so that school-performance estimates remain reproducible and contestable.

Avoiding Perverse Incentives

Any accountability system can alter behaviour, and poorly designed metrics may encourage schools to maximise scores rather than improve education. Examination-only systems can create incentives to focus disproportionate attention on students near proficiency thresholds, restrict weaker students' examination entry or narrow curricula towards tested subjects. Value-added systems can create different incentives and can also be misunderstood if statistical estimates are treated as exact causal rankings. Ladd and Walsh (2002) specifically emphasise the importance of incentive design in value-added accountability. A multidimensional system reduces dependence on any single indicator but does not eliminate gaming because schools may respond strategically to attendance coding, transfer classification or climate-survey administration. Independent verification and balanced weighting are essential.

The framework should consequently apply several anti-gaming safeguards. Examination indicators should use eligible-cohort denominators, transfers should require documented receiving institutions, attendance definitions should be standardised nationally, and climate surveys should use protected administration procedures. Schools should not control which student responses are included in accountability surveys. Indicators demonstrating implausible year-to-year changes should trigger data-quality review rather than immediate performance rewards. High-stakes decisions should combine statistical evidence with professional review, especially where quantitative indicators conflict sharply. The framework is intended as structured evidence for educational judgement rather than an automated mechanism replacing judgement.

Proposed School Dashboard

Each school should receive an eight-domain radar or profile chart, the overall J-MSSPQI, confidence interval, three-year trend and national/regional comparison. The dashboard should show attainment and growth separately because these answer fundamentally different questions. Equity gaps should be presented directly so schools can identify which groups require additional intervention. Attendance and completion trends should reveal whether engagement is improving, while readiness measures should show destinations beyond secondary school. Climate and institutional scores should provide diagnostic evidence concerning the environment and processes through which outcomes are produced. A composite score without this dashboard should not be considered an adequate implementation of the framework.

Table 3: Illustrative School Performance Dashboard

Domain	Score (0-100)	National Benchmark	Regional Benchmark	Three-Year Trend
Academic attainment	—	—	—	—
Growth/value added	—	—	—	—
Equity/inclusion	—	—	—	—
Attendance/engagement	—	—	—	—
Progression/completion	—	—	—	—
Readiness	—	—	—	—
Well-being/climate	—	—	—	—
Institutional quality	—	—	—	—
Overall J-MSSPQI	—	—	—	—

Worked Mathematical Illustration

Consider a hypothetical Jamaican secondary school with the following normalised domain scores:

$$A = 0.78$$

$$G = 0.84$$

$$E = 0.70$$

$$P = 0.80$$

$$C = 0.76$$

$$R = 0.72$$

$$W = 0.81$$

$$I = 0.85$$

The overall index is calculated as:

$$J\text{-}MSSPQI_s = 100 [w_A A_s + w_G G_s + w_E E_s + w_P P_s + w_C C_s + w_R R_s + w_W W_s + w_I I_s]$$

subject to:

$$A_s, G_s, E_s, P_s, C_s, R_s, W_s, I_s \in [0, 1]$$

and:

$$w_A + w_G + w_E + w_P + w_C + w_R + w_W + w_I = 1$$

where s represents the secondary school being assessed.

With the **proposed weights** from the study, the equation becomes:

$$J\text{-}MSSPQI_s = 100 [0.15A_s + 0.20G_s + 0.15E_s + 0.10P_s + 0.10C_s + 0.10R_s + 0.10W_s + 0.10I_s]$$

The components are: A_s = Academic Attainment; G_s = Student Growth/Value Added; E_s = Equity and Inclusion; P_s = Attendance and Engagement; C_s = Progression and Completion; R_s = Post-secondary/Career Readiness; W_s = Student Well-being and School Climate; and I_s = Institutional Quality.

The weighted contributions are:

$$0.117 + 0.168 + 0.105 + 0.080 + 0.076 + 0.072 + 0.081 + 0.085 = 0.784$$

$$:J\text{-MSSPQI} = 100 \times 0.784 = 78.4$$

Under the illustrative classification, the school would fall in the **strong-performance** category.

This worked example also demonstrates why the overall score should not replace domain interpretation. The school's strongest areas are institutional quality and growth, while its comparatively weakest area is equity. A traditional examination-only evaluation might emphasise its attainment score of 78, whereas the proposed framework recognises that students are making particularly strong progress relative to their starting positions. At the same time, the equity score indicates that benefits may not be distributed equally across the student population. School improvement should prioritise narrowing internal gaps rather than assuming that a strong overall index demonstrates uniform success. The mathematical architecture produces both an overall judgement and a diagnostic explanation of that judgement.

Comparison With Traditional Examination Ranking

The traditional approach may be simplified as:

Traditional School Performance = Mean External Examination Achievement

The proposed framework instead states:

Comprehensive School Performance = Attainment + Growth + Equity + Engagement + Completion + Readiness + Well-Being + Institutional Quality

This is not merely the addition of more variables because the proposed model distinguishes outcomes from processes, incorporates prior student achievement, adjusts for measurement uncertainty and prevents complete compensation between essential dimensions. External examinations remain indispensable because they provide standardised evidence of curriculum-related attainment. However, they cease to function as the sole proxy for educational quality. The result is a framework capable of identifying different forms of successful and unsuccessful schools.

A school may be classified as **high attainment/high growth**, **high attainment/low growth**, **low attainment/high growth** or **low attainment/low growth** before the other six domains are even considered. The high-attainment/low-growth school may be benefiting substantially from academically advantaged intake, while the low-attainment/high-growth school may be generating strong educational value despite inherited disadvantage. Neither conclusion can be drawn confidently from final averages alone. Equity, completion and climate then provide further distinctions between institutions with superficially similar academic profiles. This multidimensional typology is more useful for intervention because different patterns imply different problems and policy responses. Ranking every school from first to last obscures these substantive differences.

Policy Applications

The proposed framework could transform school accountability from a reputational ranking exercise into a differentiated school-improvement system. Schools demonstrating low attainment but high growth may require additional resources and time rather than punitive intervention because evidence suggests that teaching and learning are producing meaningful progress. Schools displaying high attainment but weak growth may require investigation into whether strong outcomes primarily reflect selective intake rather than exceptional institutional contribution. Schools with satisfactory academics but severe absenteeism or climate problems require different interventions again. Regional offices could allocate technical assistance according to the specific domains generating weakness. This approach makes performance assessment actionable rather than merely descriptive.

Resource allocation could also become more equitable because the framework distinguishes low performance arising from weak institutional processes from low attainment associated with severe contextual disadvantage despite positive value added. OECD evidence emphasises that equitable resourcing is foundational to educational quality and that disadvantaged schools frequently require appropriate support rather than simple comparison with more advantaged institutions. Regions could identify schools generating unusually high growth among disadvantaged students and investigate their instructional and organisational practices for potential transfer. The framework supports learning from effective schools rather than using metrics only to identify failure. Performance measurement becomes part of an evidence cycle linking diagnosis, support, intervention and reevaluation.

Strengths of the Proposed Framework

The first strength is conceptual validity because school performance is represented as multidimensional rather than equated with one terminal examination outcome. This approach aligns with empirical research showing that attainment, growth, graduation, absenteeism and behavioural indicators capture distinct aspects of school performance (Sun et al., 2020). A second strength is contextual fairness because value-added modelling distinguishes students' starting achievement from subsequent progress. A third strength is the explicit inclusion of equity, preventing schools from being rewarded only for average performance while substantial groups remain behind. A fourth strength is diagnostic usefulness because each overall score can be decomposed into eight domain contributions. A fifth strength is local compatibility because Jamaica's existing inspection framework already contains several institutional and well-being dimensions incorporated into the proposed model.

A further strength is mathematical transparency. The exact contribution of each domain to the overall score is known in advance, and alternative weightings can be tested through sensitivity analysis. Minimum-domain safeguards prevent severe failure in essential areas from being hidden through averaging, while uncertainty intervals reduce false precision. Regional aggregation is student-weighted and accompanied by measures of between-school dispersion, allowing regional performance to reflect both level and inequality. The framework also preserves original examination results, inspection evidence and domain indicators rather than replacing

them with an opaque algorithm. Consequently, stakeholders can interrogate the basis of any classification.

Limitations

The principal limitation is that the proposed J-MSSPQF remains a conceptual framework and has not yet been empirically validated. The eight domains, internal indicators, weights and cut-points require testing with Jamaican longitudinal data before they can support consequential policy decisions. Value-added estimates can be sensitive to model specification, student mobility, missing baseline data and cohort size, meaning that statistical adjustment does not eliminate all uncertainty (Ladd & Walsh, 2002; OECD, 2008). Climate and institutional-quality indicators introduce additional measurement challenges because perception surveys and inspection ratings contain their own sources of error. The framework requires substantial technical infrastructure and statistical capacity beyond simply averaging examination grades. Complexity is justified only if empirical validation demonstrates that the additional dimensions produce more accurate and useful school assessments.

A second limitation concerns weighting because no purely statistical procedure can determine how much society should value attainment relative to equity, completion, safety or readiness. These are partly normative educational decisions requiring public and professional deliberation. Data-driven weighting could identify dimensions that predict future outcomes but would not establish automatically which educational goals ought to receive the greatest moral or policy importance. The proposed weights should be regarded as transparent starting hypotheses rather than scientifically proven constants. Sensitivity analysis can determine whether conclusions depend excessively on those choices. If classification proves highly sensitive, domain profiles may be more defensible than a single composite score.

A third limitation is the danger that any composite accountability measure can generate unintended incentives. Schools may alter examination entry, attendance coding, transfer documentation or survey participation if these actions influence consequential performance scores. Multidimensionality reduces the possibility of optimising one indicator but increases the number of indicators potentially subject to manipulation. Independent audits, consistent definitions and data-quality monitoring are indispensable. Quantitative results should be triangulated with inspection and professional review rather than allowed to operate as an automated sanctioning mechanism. The framework should remain an instrument for educational improvement, not a substitute for contextual human judgement.

Future Research

The immediate next stage should be a retrospective validation study using several years of Jamaican student-level longitudinal data. Researchers should calculate raw examination attainment and compare it with value-added, attendance, completion and other proposed dimensions to determine empirically how strongly the indicators correlate. If Jamaica demonstrates the multidimensional structure observed internationally, factor and latent-profile analyses could identify recurring school-performance patterns. Predictive studies should then test

which combination of domains best forecasts subsequent tertiary entry, training completion, employment transition or other recognised outcomes. Regional analyses should investigate whether performance disparities occur primarily between regions or between schools in the same regions. These findings would permit refinement of the conceptual architecture before prospective implementation.

A prospective pilot should subsequently select schools across different Ministry regions and historical achievement levels. Schools should receive experimental dashboards without immediate high-stakes consequences, allowing administrators and teachers to evaluate the interpretability and usefulness of the information. The Ministry should assess whether domain-specific feedback generates different improvement decisions from those produced by examination averages alone. Student and parent representatives should participate in evaluating climate and well-being measures, while teachers and principals should contribute to interpreting institutional-quality indicators. Statistical results should be examined for differential validity by school size, school type, geographic context and student population. Only after successful pilot evaluation should the framework be considered for official accountability.

Conclusion

Assessing secondary-school performance exclusively or predominantly through external examination averages is conceptually insufficient because final academic attainment represents only one dimension of educational effectiveness and does not, by itself, identify the contribution that a school makes to students' development. International scholarship increasingly supports multidimensional approaches to school evaluation, recognising that educational performance encompasses multiple outcomes that may not move uniformly across schools or student populations (Sun et al., 2020). Raw examination outcomes may also reflect differences in students' prior attainment and socioeconomic circumstances, whereas value-added approaches seek to estimate progress over time and thereby provide additional information about schools' contributions to learning (Organisation for Economic Co-operation and Development [OECD], 2008). Jamaica's own school-inspection architecture similarly extends beyond examination results by examining leadership and management, teaching and learning, student performance and progress, personal and social development, resource utilisation, curriculum provision, and students' security, health, safety, and well-being (National Education Inspectorate [NEI], 2017). Accordingly, the proposed **Jamaican Multidimensional Secondary School Performance and Quality Framework (J-MSSPQF)** integrates attainment, academic growth, equity, engagement and attendance, completion, readiness for subsequent education or employment, well-being and school climate, and institutional quality in a unified analytical structure intended to explain not simply which schools obtain higher examination averages, but how effectively and equitably schools contribute to student development.

The central theoretical proposition of the J-MSSPQF is that **school quality is not equivalent to the external examination average**, because schools with similar examination outcomes may differ substantially in student progress, equity, attendance, completion, readiness, institutional effectiveness, and the conditions under which educational outcomes are produced. This distinction can be represented mathematically as **School Quality $\neq$ External Examination**

Average, and more comprehensively as **School Quality = f(Attainment, Growth, Equity, Engagement, Completion, Readiness, Well-Being, Institutional Quality)**, thereby treating educational effectiveness as a multidimensional construct rather than a single examination statistic. This approach is consistent with empirical evidence demonstrating the multidimensionality of school performance and the value of using multiple measures for accountability and school improvement rather than presuming that one indicator adequately represents overall institutional effectiveness (Sun et al., 2020). At the regional level, the framework further proposes that **Regional Educational Quality = f(Average School Performance, Student-Weighted Outcomes, Between-School Equity)**, because a region containing a small number of exceptionally high-performing schools alongside substantial concentrations of educational disadvantage should not necessarily receive the same evaluation as a region producing comparable average outcomes with substantially greater between-school equity. Consequently, the J-MSSPQF moves beyond the traditional logic of ranking schools according to final examination results and towards evaluating educational contribution, multidimensional student development, distributive equity, and institutional effectiveness, while preserving examination attainment as an important but non-exclusive component of school quality (OECD, 2008; Sun et al., 2020).

The proposed framework nevertheless acknowledges that no mathematical formulation can eliminate all professional, policy, or normative judgement from educational evaluation because decisions concerning valued outcomes, indicator selection, criterion weights, minimum performance thresholds, equity penalties, and acceptable standards necessarily embody educational and social priorities. Mathematics can, however, make these decisions explicit, transparent, reproducible, empirically testable, and amenable to sensitivity analysis, thereby providing a more scientifically defensible alternative to allowing school quality to remain implicitly determined by whichever external examination statistic is most readily available. The J-MSSPQF should be regarded as a proposed measurement architecture requiring empirical validation through analyses of reliability, construct validity, criterion validity, sensitivity to alternative weighting schemes, longitudinal stability, school-level classification consistency, and robustness across Jamaican educational regions and different school types. Such validation is particularly important because value-added estimates and other school-effect measures contain uncertainty and must be interpreted carefully when they are used for accountability, comparison, and institutional decision-making (OECD, 2008). The principal contribution of the J-MSSPQF is not the creation of a more elaborate league table, but the establishment of a transparent, multidimensional, equity-sensitive, and empirically testable framework for evaluating what Jamaican secondary schools achieve, how much educational progress they facilitate, how equitably their outcomes are distributed, and how effectively their institutional environments support the development of the students entrusted to them.

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Appendices

Appendix A

Operationalisation of the Jamaican Multidimensional Secondary School Performance and Quality Framework

Domain	Symb ol	Operational definition	Illustrative indicators	Primary data source	Scal e	Propose d weight
Academic attainment		Level of demonstrated academic achievement among the eligible student cohort	CSEC/CAPE performance; English proficiency; mathematics proficiency; certification rate; examination participation	External examination and school records	0-1	0.15
Student growth/value added		Progress achieved relative to students' prior attainment and expected achievement	Baseline achievement; subsequent achievement; estimated school value-added effect	Longitudinal student assessment data	0-1	0.20
Equity and inclusion		Extent to which educational outcomes and progress are equitably distributed across student groups	Socioeconomic gaps; sex gaps; prior-attainment gaps; SEN/disability gaps	Student records and assessment data	0-1	0.15
Attendance and engagement		Extent to which students participate consistently and remain engaged in schooling	Attendance rate; chronic absenteeism; engagement score	Attendance system and student survey	0-1	0.10
Progression and completion		Extent to which students progress through grades	Promotion; retention; dropout; Grade 11 completion	Longitudinal enrolment records	0-1	0.10

		and successfully complete secondary education				
Post-secondary/career readiness		Extent to which students leave school prepared for further education, training or employment	Required qualifications; TVET certification; sixth-form/tertiary entry; employment/training transition	Examination, tracer and administrative records	0-1	0.10
Well-being and school climate		Quality of students' social, psychological, safety and relational experiences within school	Safety; belonging; relationships; support; disciplinary climate	Student/staff surveys and administrative records	0-1	0.10
Institutional quality		Effectiveness of school leadership, teaching, curriculum delivery and resource management	Leadership; teaching quality; curriculum implementation; resource management	NEI/inspection and administrative data	0-1	0.10
Overall J-MSSPQI	—	Weighted multidimensional measure of secondary-school performance and quality	Eight domains above	Integrated database	0-100	1.00

Note. All domain scores should be transformed to a common 0-1 metric before aggregation. The proposed weights are theoretical starting values and should be subjected to empirical validation and sensitivity analysis before national implementation.

Appendix B

Academic Attainment Domain Calculation Worksheet

The academic attainment domain should avoid evaluating a school solely according to the average performance of students who actually sat an examination. The denominator should, wherever possible, represent the **eligible cohort**, thereby reducing the possibility that examination results improve artificially through selective examination entry.

Table B1: Proposed Academic Attainment Indicators

Indicator	Symbol	Calculation	Example	Standardised score
Examination participation		Candidates sitting examination ÷ eligible students	$180 \div 200$	0.900
English proficiency		Students meeting standard ÷ eligible candidates	$150 \div 180$	0.833
Mathematics proficiency		Students meeting standard ÷ eligible candidates	$126 \div 180$	0.700
Overall certification		Students achieving certification threshold ÷ eligible candidates	$144 \div 180$	0.800
Subject breadth		Standardised measure of successful subject breadth	—	0.670

The general equation is:

subject to:

For an illustrative equal-weight model:

Using the illustrative data:

Thus, the school's Academic Attainment Domain Score would be approximately **78.1/100**.

Appendix C

Student Growth and Value-Added Calculation

Growth should answer a fundamentally different question from attainment: **How much educational progress did students make given where they started?**

Table C1: Variables Required for Estimating Value Added

Variable	Symbol	Level	Description
Later achievement		Student	Student's subsequent standardised academic outcome
Prior achievement		Student	Baseline academic performance before the outcome

Student/context characteristics		Student	Approved pre-existing characteristics used for adjustment
School effect		School	Estimated contribution associated with school
Individual residual		Student	Unexplained individual variation

The proposed multilevel model is:

The estimated school effect can subsequently be converted to the common 0-1 metric:

Table C2: Illustrative Interpretation of Value-Added Scores

	Approximate interpretation
0.80-1.00	Exceptionally strong relative growth
0.60-0.79	Above-expected growth
0.40-0.59	Approximately expected growth
0.20-0.39	Below-expected growth
0.00-0.19	Substantially below-expected growth

Important: These bands are illustrative. Empirical Jamaican data should determine final interpretation thresholds.

Appendix D

Equity and Inclusion Calculation

Table D1: Illustrative Equity-Gap Assessment

Equity dimension	Group 1 adjusted outcome	Group 2 adjusted outcome	Absolute gap	Equity interpretation
Lower vs higher socioeconomic group	0.71	0.78	0.07	Small gap
Male vs female students	0.73	0.77	0.04	Small gap
Lower vs higher prior attainment	0.68	0.82	0.14	Moderate gap
SEN vs non-SEN students	0.65	0.78	0.13	Moderate gap

For subgroup :

and:

where is the predetermined maximum tolerable gap.

The overall equity score becomes:

subject to:

This construction means that larger educational disparities produce progressively lower equity scores.

Appendix E

Attendance and Engagement Calculation

Table E1: Attendance and Engagement Indicators

Indicator	Symbol	Raw information	Transformation	Illustrative score
Attendance rate		92%	$92 \div 100$	0.920
Chronic absenteeism		12%		0.880
Student engagement		Standardised survey score	Convert to 0-1	0.760

For example:

If the proposed internal weights are 0.40, 0.35 and 0.25:

The school would therefore receive an illustrative attendance and engagement score of **86.6/100**.

Appendix F

Progression and Completion Calculation

Table F1: Progression and Completion Indicators

Indicator	Symbol	Illustrative raw value	Normalised score
Grade progression rate		91%	0.91
Secondary completion rate		87%	0.87
Dropout rate		7%	

The domain is:

If the internal weights are 0.30, 0.50 and 0.20:

Thus, the illustrative Progression and Completion score is **89.4/100**.

Appendix G

Post-Secondary and Career Readiness

Table G1: Readiness Indicators

Component	Symbol	Description	Illustrative score
Academic readiness		Qualifications required for further academic study	0.80
TVET readiness		Successful technical/vocational certification	0.74
Successful transition		Verified education, training or employment transition	0.69

The domain score is:

For example, using weights of 0.40, 0.30 and 0.30:

The illustrative readiness score is therefore **74.9/100**.

Appendix H

Student Well-Being and School Climate Instrument

Readers could use a short student survey to operationalise this component.

Table H1: Proposed School Climate Survey Items

Dimension	Proposed survey statement	Response scale
Safety	I feel physically safe while I am at school.	1 = Strongly disagree to 5 = Strongly agree
Safety	I can attend classes without fear of violence or intimidation.	1-5
Belonging	I feel that I belong at this school.	1-5
Belonging	I feel accepted by other members of the school community.	1-5
Relationships	Teachers treat students with respect.	1-5
Relationships	I can approach a teacher when I need academic help.	1-5
Support	Teachers encourage me to perform to the best of my ability.	1-5
Support	The school provides help when students experience learning difficulties.	1-5
Discipline	School rules are applied fairly.	1-5
Discipline	Disruptive behaviour is handled effectively.	1-5

A respondent's mean can first be converted from the 1-5 scale to 0-1:

Thus, a mean score of 4.2 becomes:

School-level subscale means can subsequently be combined as:

Appendix I

Institutional Quality Assessment Rubric

Table I1: Proposed Institutional Quality Rubric

Dimension	1 = Weak	2 = Developing	3 = Effective	4 = Highly effective
Leadership and management	Serious deficiencies; limited instructional direction	Basic systems exist but inconsistently implemented	Clear leadership with effective monitoring	Strategic, evidence-driven leadership producing sustained improvement
Teaching quality	Predominantly ineffective instructional practice	Variable instructional quality	Consistently effective teaching	Highly effective, adaptive and evidence-informed teaching
Curriculum implementation	Major curriculum gaps	Partial/inconsistent implementation	Curriculum delivered effectively	Highly coherent curriculum with strong enrichment and differentiation
Resource management	Resources poorly managed	Basic resource management	Resources allocated effectively	Resources strategically targeted according to student need

The rubric may be converted to a 0-1 metric using:

The overall institutional-quality score is then:

with:

Appendix J

Complete J-MSSPQI School Calculation Sheet

This is perhaps the most important practical appendix because it demonstrates the complete procedure.

Table J1: Worked Example for One Hypothetical Secondary School

Domain	Symbol	Domain score	Weight	Weighted score
Academic attainment		0.78	0.15	0.117

Student growth/value added		0.84	0.20	0.168
Equity and inclusion		0.70	0.15	0.105
Attendance and engagement		0.80	0.10	0.080
Progression and completion		0.76	0.10	0.076
Post-secondary/career readiness		0.72	0.10	0.072
Well-being and school climate		0.81	0.10	0.081
Institutional quality		0.85	0.10	0.085
Total			1.00	0.784

Therefore:

Substituting the proposed weights:

For the hypothetical school:

The school would therefore be provisionally classified as demonstrating **strong multidimensional performance**.

Appendix K

Minimum-Domain Safeguard

A high overall score should not conceal serious failure in an essential dimension.

Table K1: Minimum-Domain Assessment for the Hypothetical School

Domain	Score	Below proposed minimum of 0.50?
Academic attainment	0.78	No
Growth	0.84	No
Equity	0.70	No
Attendance/engagement	0.80	No
Progression/completion	0.76	No
Readiness	0.72	No
Well-being/climate	0.81	No
Institutional quality	0.85	No
Minimum domain	0.70	No

The mathematical rule is:

For this school:

The school therefore passes an illustrative 0.50 minimum-domain requirement.

Appendix L

Comparison of Two Schools with Identical Examination Performance

This appendix demonstrates the principal advantage of the proposed framework.

Table L1: Why Examination Averages Alone Can Produce Misleading Conclusions

Performance dimension	School A	School B
Academic attainment	0.80	0.80
Growth/value added	0.45	0.85
Equity	0.50	0.82
Attendance/engagement	0.68	0.88
Progression/completion	0.72	0.90
Readiness	0.76	0.84
Well-being/climate	0.60	0.87
Institutional quality	0.65	0.86
Traditional examination conclusion	Equal	Equal
Approximate J-MSSPQI	64.4	84.9

Under a traditional examination-based approach, both schools would appear equally effective because their academic attainment score is 0.80. The multidimensional framework reveals a substantially different conclusion because School B produces stronger student growth, greater equity, better attendance, stronger completion, better readiness and a more favourable educational environment. School A's final examination attainment may partly reflect the achievement characteristics of the students entering the institution rather than exceptional school contribution. School B, by contrast, combines strong final attainment with considerably stronger educational processes and intermediate outcomes. This example illustrates why **equal examination results do not necessarily represent equal school effectiveness**.

Appendix M

Regional Application of the J-MSSPQI

Table M1: Illustrative Regional Calculation

School	Students ()	J-MSSPQI	Regional weight	Weighted contribution
School A	800	72.0	0.200	14.40
School B	1,200	81.0	0.300	24.30
School C	600	65.0	0.150	9.75
School D	1,400	78.0	0.350	27.30
Total	4,000	—	1.000	75.75

The regional equation is:

Therefore:

This procedure gives each student equal implicit representation rather than giving every school equal weight regardless of enrolment.

Appendix N

Recommended Interpretation Matrix

Table N1: Using Domain Patterns for School Improvement

Attainment	Growth	Other domains	Interpretation	Recommended policy response
High	High	Strong	Strong comprehensive performance	Sustain and examine transferable practices
High	Low	Strong	High attainment but limited additional growth	Examine intake effects and instructional value added
Low	High	Improving	Strong school contribution from a low starting point	Provide continued support; recognise progress
Low	Low	Weak	Persistent multidimensional underperformance	Intensive intervention and diagnostic review
High	High	Weak equity	Strong averages but unequal outcomes	Target disadvantaged student groups
High	High	Weak attendance	Strong outcomes among participants but engagement concern	Investigate absenteeism and participation
Moderate	High	Strong climate	Developing attainment with positive institutional trajectory	Maintain improvement strategy
High	Moderate	Weak climate/safety	Academic success with institutional risk	Immediate climate and safety intervention

Appendix O

Proposed Data-Collection and Assessment Cycle

Table O1/: Annual J-MSSPQF Implementation Cycle

Stage	Activity	Responsible data source	Output
1	Identify eligible student cohort	School/MOE administrative system	Cohort denominator
2	Retrieve prior achievement	National assessment system	Baseline achievement
3	Collect attendance and engagement	School information system	Participation indicators
4	Record progression, transfer and dropout	Longitudinal administrative records	Completion indicators

5	Obtain external examination outcomes	CXC/MOE records	Attainment indicators
6	Estimate student growth/value added	Statistical analysis	
7	Estimate subgroup outcome gaps	Statistical analysis	
8	Conduct climate/well-being assessment	Student/staff surveys	
9	Incorporate inspection evidence	NEI/inspection system	
10	Collect destination outcomes	Administrative linkage/tracer study	
11	Standardise all indicators	Statistical unit	0-1 domain measures
12	Calculate eight domain scores	Statistical unit	School profile
13	Calculate J-MSSPQI	Statistical unit	0-100 composite
14	Estimate uncertainty	Statistical unit	Confidence interval
15	Apply minimum-domain safeguard	Statistical/policy unit	Final classification
16	Aggregate schools by region	MOE/regional unit	Regional performance profile
17	Develop intervention plan	School/regional leadership	Evidence-based improvement programme
18	Repeat longitudinally	MOE/schools	Performance trend

Appendix P

Data Template for Researchers Applying the Framework

Table P1: School-Level Dataset Structure

Variable	Variable name	Measurement	Example
School identifier	SCHOOL_ID	Nominal	105
Region	REGION	Nominal	Region 2
Eligible cohort	ELIGIBLE_N	Count	200
Attainment score	ATTAINMENT	0-1	0.78
Growth score	GROWTH	0-1	0.84
Equity score	EQUITY	0-1	0.70
Attendance/engagement	PARTICIPATION	0-1	0.80
Completion	COMPLETION	0-1	0.76
Readiness	READINESS	0-1	0.72
Well-being/climate	WELLBEING	0-1	0.81
Institutional quality	INSTITUTION	0-1	0.85

Overall score	JMSSPQI	0-100	78.4
Minimum domain	MIN_DOMAIN	0-1	0.70
Standard error	JMSSPQI_SE	Continuous	—
Lower 95% CI	CI_LOWER	0-100	—
Upper 95% CI	CI_UPPER	0-100	—
Performance category	CATEGORY	Ordinal	Strong

This structure would permit the framework to be implemented readily in **SPSS, R, Stata, Python or Excel** once the individual domains have been constructed. More importantly, it makes the proposed J-MSSPQF reproducible: a reader can identify the required raw information, calculate each component, standardise the indicators, generate the eight domain scores, calculate the overall J-MSSPQI, apply the minimum-domain safeguard, and finally aggregate the results to the regional level. For a Scopus submission, I would particularly recommend retaining **Appendices A, J, L, M, O and P** in the main supplementary material because together they demonstrate operationalisation, calculation, comparative validity, regional application, implementation and reproducibility.