METHODOLOGY FOR FORMING A SYSTEM OF DIGITAL INDICATORS FOR MONITORING EDUCATIONAL QUALITY IN HIGHER EDUCATION INSTITUTIONS

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ABSTRACT

This thesis scientifically developed a methodology for forming a system of digital indicators for monitoring educational quality in higher education institutions. The study systematized indicator selection, normalization, weighting, aggregation, and statistical and substantive validation stages. Drawing on international standards, national education requirements, and learning analytics approaches, a five-stage methodological sequence was proposed. The findings showed that digital indicators strengthened the reproducibility and transparency of monitoring and improved evidence-based decision-making in higher education quality assurance.

Introduction

Monitoring the quality of education is, in its theoretical core, a measurement problem. The European standards and guidelines require institutions to collect, analyse and use information for the effective management of their programmes, and to subject those programmes to ongoing monitoring and periodic review [1]. The international standard for management systems of educational organisations formulates the same requirement in the language of management systems, obliging institutions to determine what has to be monitored, by which methods and at which intervals, and to base decisions concerning learners on documented evidence [2]. Neither instrument prescribes a concrete set of measures, since the choice of measures belongs to the institution. That silence is deliberate, and it transfers a demanding methodological task to the institutional level.

Three notions must be separated before the task can be addressed. A datum is a recorded observation, meaningful only within the process that produced it. An indicator is an operationalisation of a latent construct: it converts one or several data into a quantity interpretable as evidence about a property that cannot be observed directly, such as teaching effectiveness or curricular coherence. A composite is an aggregation of indicators governed by an explicit normalisation and weighting rule. Confusion between these levels is the most common defect of institutional monitoring: reporting systems accumulate data while quality committees require indicators, and administrative summaries present composites whose construction rules have never been documented.

A digital indicator may accordingly be defined as an indicator whose primary source is a machine-readable institutional record generated as a by-product of a digitally mediated academic process. Its distinguishing property is not the subject matter but the mode of production: the record already exists, so the marginal cost of measurement is low and the measurement frequency can approach the frequency of the process itself. Two consequences follow. Monitoring becomes continuous rather than episodic, and reproducibility improves, since the same computation applied to the same records returns the same result. A counterweight accompanies these advantages: the availability of a record does not establish its validity as evidence about the construct of interest, and a system assembled from whatever happens to be recorded will measure administrative convenience rather than educational quality.

The Uzbek higher education system provides a supportive framework for methodological work of this kind. The Concept for the Development of the Higher Education System of the Republic of Uzbekistan until 2030 places the introduction of digital technologies into the educational process alongside the improvement of specialist training quality [3], and educational legislation establishes state requirements for educational quality together with the corresponding supervisory arrangements [4]. The dimensions of the system make the question practically consequential: official statistics record admission to higher education organisations of the republic in the 2024/2025 academic year at 381.7 thousand persons [5]. An indicator system designed for that scale must be economical in data collection and strict in methodological documentation at the same time.

The article sets out to substantiate a methodology for forming such a system: a defined sequence of stages, a set of admission criteria for individual indicators, and explicit rules governing normalisation, weighting and interpretation. The contribution lies in the transposition of established composite-measurement methodology into the internal quality monitoring of a higher education institution, a domain in which indicator sets are more often inherited from external reporting obligations than constructed from a theoretical framework.

Literature review

The methodological foundation for indicator construction is supplied by the literature on composite measurement. The handbook on constructing composite indicators sets out a sequence of steps - development of a theoretical framework, selection of variables, treatment of missing data, multivariate analysis, normalisation, weighting and aggregation, robustness and sensitivity testing, decomposition into components, linkage to other measures and visual presentation - and establishes that each step must be justified and documented before the result may be interpreted [6]. The multidimensional ranking approach of U-Multirank added an influential constraint: results are reported indicator by indicator and grouped into performance bands rather than compressed into one weighted score, because small changes in weights alter composite outcomes considerably [7]. A comparative reconstruction of the computational pipelines of major international ranking systems supported the same conclusion, showing that normalisation and aggregation choices carry normative content and generate systematic divergence between systems [8].

A second body of work supplies candidate indicators and the evidence on their institutional use. A systematic review of learning analytics adoption in higher education

institutions established that adoption is conditioned simultaneously by stakeholders, institutional and pedagogical processes, technical constraints and ethical considerations, and that many developments do not progress beyond the pilot stage [9]. A review of learning analytics in support of study success concluded that broader institutional use requires standardised measures, visualisations and interventions transferable between digital learning environments [10]. Work on learning outcome evaluation identified the weak standardisation of outcome measures as an obstacle to comparison across programmes and institutions [11]. A synthesis of analytics interventions within learning management systems confirmed that measurement affects practice only when it is bound to a defined action [12]. Research on the critical determinants of adoption placed organisational readiness, data quality and perceived usefulness among the decisive factors [13]. A conceptual framework developed for remote higher education proposed a structured set of key performance indicators derived from a systematic review, illustrating how indicator selection can be grounded in evidence rather than convenience [14]. A review of human-centred learning analytics positioned participation of academic staff and students in indicator design as a condition of sustained institutional use [15].

A third stream concerns the conditions under which indicator-based judgements are considered legitimate. The framework for explainable artificial intelligence in education identified stakeholder orientation, modes of presenting explanations and human-centred interface design as determinants of trust in computed outputs [16]. International guidance on artificial intelligence in education anchored the use of automated processing in a humanistic position that protects data privacy and human agency [17]. A five-dimensional trust framework covering privacy, safety, fairness, explainability and accountability disclosed recurring governance vulnerabilities in educational systems, including insufficient oversight and unclear responsibility [18], and a systematic review of ethical concerns from the perspective of users showed that trustworthiness guidelines function as the principal reference point in educational applications [19].

A fourth stream concerns institutional embedding. A policy-to-practice analysis of a national quality assurance framework demonstrated how computed evidence can be incorporated into accreditation and accountability arrangements through a sequence of readiness assessment, policy development and responsible integration [20]. An empirical study of a decision support system in a university department reported improvement potential in operational decisions while emphasising ethical implications [21]. A cross-national comparative study of university policies established that institutional rules, rather than technical capability, define the admissible uses of computed indicators [22].

The literature therefore offers a well-developed methodology for composite measurement, a rich catalogue of candidate measures and a mature discussion of legitimacy, yet these three bodies of work rarely meet. Composite-indicator methodology has been applied predominantly to cross-country comparison; learning analytics has concentrated on prediction and intervention at the level of individual learners; institutional quality monitoring has drawn its indicator sets largely from external reporting templates. The methodology proposed below joins these strands into a single institutional procedure.

Methodology

The work rests on a conceptual-analytical design. Requirements were derived from normative instruments: the European standards and guidelines for internal quality assurance [1], the international standard for management systems of educational organisations [2], the national strategic framework for higher education development [3] and educational legislation [4]. Methodological rules were derived from the handbook on composite indicators [6] and from the multidimensional assessment principle [7]. Contextual parameters were taken from official statistics on the higher education system [5]. Candidate indicators and evidence on their institutional behaviour were drawn from open-access scholarship.

Six admission criteria were formulated for the inclusion of an individual measure in the system. Conceptual relevance requires that the measure be derivable from a stated quality construct rather than from data availability. Measurability requires that the measure be computable from records that the institution already generates in machine-readable form. Traceability requires that the provenance of every input field, its owner and its update frequency be documented. Non-redundancy requires that the measure add information not already carried by another admitted measure, which presupposes examination of the correlation structure of the candidate set in accordance with the multivariate step of the composite methodology [6]. Actionability requires that a movement of the measure be connectable to an institutional response with an identified owner, since measurement unlinked to action does not change practice [12]. Ethical admissibility requires that computation and use of the measure respect data protection and human agency [17], and that the measure be free of systematic disadvantage to identifiable student groups [18].

Rules for the technical steps were fixed in advance. Normalisation employs min-max rescaling where a meaningful reference range exists, standardisation where the distribution is approximately symmetric and comparison across periods is required, and distance to a declared reference value where a normative target has been established by an institutional or state requirement [4]. Weighting is treated as an explicit and revisable decision rather than a technical default: equal weighting is applied where no defensible ordering of importance exists, expert or participatory weighting where academic bodies have deliberated the priorities, and every scheme is accompanied by a sensitivity check of the kind prescribed for composite indicators [6]. Aggregation is restrained by principle: dimension-level profiles are the primary output, and a single overall value is produced only where a documented weighting rule and a completed sensitivity analysis exist [7], [8].

Validation proceeds along two lines. Statistical validation covers the correlation structure of the admitted set, the stability of results under alternative weighting schemes and the sensitivity of dimension profiles to the treatment of missing values [6]. Substantive validation is performed by the academic bodies that will use the results, whose participation in indicator design has been shown to determine sustained use [15]. A measure that survives statistical testing but is regarded as uninterpretable by those bodies is withdrawn, since interpretability is a condition of use rather than a presentational refinement [16].

Analysis and results

Application of the criteria and rules described above yields a five-stage methodological sequence. Figure 1 presents the sequence and its return path.

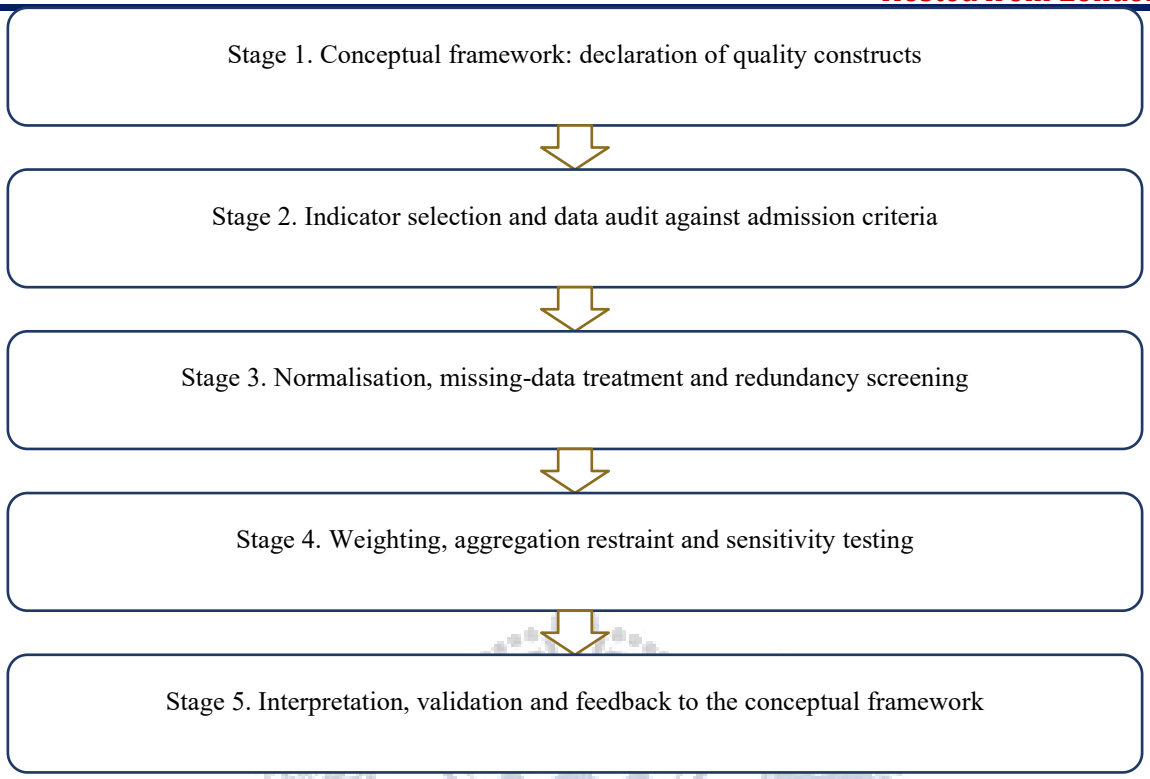

Figure 1. Five-stage methodology for forming a system of digital indicators for monitoring educational quality[1]

The first stage establishes the conceptual framework. The institution declares the quality constructs it intends to monitor and derives them from the requirements it is bound to satisfy: programme design and approval, student-centred learning and assessment, teaching staff, learning resources, information management and public information under the European framework [1], and the process requirements of the management standard [2]. The stage concludes with a documented statement of constructs, without which subsequent selection becomes arbitrary; the composite methodology treats the theoretical framework as the precondition of every later step [6].

The second stage performs indicator selection together with a data audit. Candidate measures are tested against the six admission criteria, and each admitted measure is registered with its formula, its source records, its owner and its update frequency. The audit exposes the characteristic defects of institutional data: fields recorded inconsistently across faculties, identifiers that do not reconcile between subsystems, and records whose completeness varies by period. Since data quality has been identified as a decisive condition of adoption, correction at this stage is less costly than compensation at later ones [13]. Evidence-based derivation of indicator sets from systematic review offers a workable model for this stage [14].

The third stage covers normalisation and screening. Measures expressed in different units are brought to a comparable scale by the rules fixed in the methodology, missing values are treated by a declared procedure rather than by silent exclusion, and the correlation structure of the admitted set is examined so that redundant measures are removed before

[1] Source: compiled by the author on the basis of [1], [2], [6] and [7].

they inflate the apparent weight of a dimension [6]. The limited standardisation of outcome measures reported in the literature obliges institutions to record explicitly what each outcome measure does and does not represent [11].

The fourth stage covers weighting and aggregation. The weighting scheme is adopted by an academic body, recorded with its justification, and tested for sensitivity. Dimension profiles are produced as the primary output in accordance with the multidimensional principle [7], and an overall value is computed only when the institution has both a documented rule and a completed robustness check, given the demonstrated sensitivity of composite results to aggregation choices [8].

The fifth stage covers interpretation, validation and feedback. Results are presented to the academic bodies in a form they can act upon, accompanied by an explanation of what drives each dimension profile and a statement of the uncertainty attached to it [16]. Decisions taken on that basis generate interventions; interventions generate new records; new records re-enter the first stage, where the adequacy of the declared constructs is reconsidered. The return path realises the check-and-act phases of the management cycle [2] and gives operational form to the requirement of ongoing monitoring and periodic review [1].

Table 1 presents the structure of the indicator system across four quality dimensions, together with the record layer that supplies each group of measures and the normative or methodological anchor that authorises it.

Table 1

Structure of the system of digital indicators for monitoring educational quality[2]

Quality dimension	Representative groups of digital indicators	Primary record layer	Normative or methodological anchor
Teaching and learning process	Regularity of course activity, timeliness of assessment feedback, use of digital learning resources, coverage of planned contact activities	Learning management platform, timetable and attendance records	Student-centred learning and assessment requirements [1]; operational process control [2]; action-linked analytics [12]
Learning outcomes and progression	Distribution of assessment results by course, progression and retention rates, timeliness of graduation, achievement of declared learning outcomes	Assessment and enrolment registers	Programme monitoring and periodic review [1]; limits of outcome-measure standardisation [11]; evidence-based indicator derivation [14]
Academic staff and learning resources	Teaching load distribution, qualification structure, participation in professional development, availability of digital learning	Personnel and library information systems	Requirements on teaching staff and learning resources [1]; resource provision in the management system [2]

[2] Source: compiled by the author on the basis of the cited normative documents and open-access scholarly sources.

	materials		
Stakeholder feedback and external relevance	Student satisfaction with courses and services, graduate employment feedback, employer assessment of competences, response time to complaints	Survey platforms and electronic feedback registers	Information management and public information [1]; state quality requirements [4]; ethical treatment of respondent data [17]

Three properties of the resulting system deserve emphasis. It is reproducible: every value can be recomputed from registered formulas applied to identified records, so a disagreement about a result becomes a disagreement about a documented rule rather than about a number of unknown origin. It is proportionate: because the measures are computed from records that already exist, monitoring adds analytical work rather than reporting burden, which matters considerably at the enrolment scale characteristic of the national system [5]. It is revisable: the return path treats the indicator set as a hypothesis about quality that later evidence may amend, in keeping with the observation that indicator systems detached from stakeholder judgement fail to sustain use [15].

Two safeguards accompany the methodology. The first concerns interpretation. A digital indicator measures the trace of a process, not the process itself; engagement records, for instance, describe interaction with a platform and support inferences about learning only under stated assumptions. Institutions that treat traces as direct measures of quality import a validity error into every subsequent decision, and the requirement for explanation and uncertainty statement exists precisely to prevent that substitution [16]. The second safeguard concerns governance. The admissible uses of the system - which bodies see which results, which decisions may rest on them, and which may not - are settled by institutional policy before deployment [22], and the readiness-policy-integration sequence developed for national quality assurance offers a tested template [20]. Experience with decision support in university administration confirms that value is realised in governance quality rather than in computational sophistication [21], and the fairness and accountability dimensions of the trust framework supply the verification agenda for that policy [18]. Ethical concerns identified from the perspective of users are addressed at the same point [19], while the strategic commitment to digitalisation of the educational process gives institutions a clear mandate to proceed [3].

Conclusions and suggestions

The analysis supports the following conclusions. First, the formation of a digital indicator system is a methodological rather than a technological undertaking: the decisive choices concern constructs, admission criteria, normalisation and weighting, and they precede any question of platform. Second, established composite-measurement methodology transfers productively to internal quality monitoring, provided that its documentation discipline is transferred with it [6]. Third, restraint in aggregation preserves the informational content of a multidimensional quality picture and protects results from the instability of weighting schemes [7], [8]. Fourth, an indicator acquires practical value only through its link

to a defined institutional response [12]. Fifth, interpretability and ethical admissibility function as conditions of use rather than as supplementary considerations [16], [17].

Several suggestions follow for higher education institutions of Uzbekistan. It is advisable to open the work with a documented statement of quality constructs derived from the applicable internal quality assurance requirements [1], and to admit measures only against that statement. It is expedient to maintain a formal indicator register recording, for every measure, its formula, source records, owner, update frequency and the institutional response associated with its movement. It is reasonable to conduct a data audit before commissioning any analytical component, since deficiencies at the record layer propagate into every derived value [13]. It is useful to report dimension profiles as the standard output and to compute an overall value only where a documented weighting rule and a completed sensitivity analysis exist. It is productive to involve academic staff and student representatives in indicator selection and in the review of results, since sustained use rests on the perceived usefulness of the system to those who operate it [15]. Adoption of these measures allows an institution to convert the records it already generates into a transparent, reproducible and revisable instrument of quality governance, consistent with the strategic direction set for the national higher education system [3]..

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