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A Framework for Measuring the Sustainability of Academic Programs in the Technical Fields: Initial Validity Study Findings

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Abstract

The term *sustainability* aims to describe the capacity of meeting the needs of the present without compromising the future. Sustainability is a key characteristic of continuous improvement, a criterion required by numerous outcomes-based quality assurance and accrediting bodies, such as ABET. It is well known that "closing the loop" of assessment and evaluation processes remains a significant challenge for academic programs worldwide. In efforts to address this issue, the Sustainability of Technical Education (SoTE) framework was developed. The SoTE framework consists of criteria, measures, indicators, and a set of analytic rubrics that aid the calculation of discrete performance indicators that can result in one primary indicator called the Sustainability Indicator. This framework can be used by programs, colleges and/or institutions to guide them in system-wide development and measurement of policies, practices and procedures to ensure not only sustainability, but also to positively impact student, faculty and staff learning for continuous improvement purposes. In this paper, we focus on student learning by coursework program and present the results and analysis of a pilot study using a case study methodology. Included is a discussion on the presented comprehensive evaluation tool's usefulness for the continuous improvement at programmatic and institutional levels, as well as for collecting and providing evidence for quality assurance and accreditation organizations, such as ABET.

Introduction

From development, ecology, energy, to biology, *sustainability* has become a byword in modern times. A common dictionary definition for sustainability is the noun form of the verb to sustain, and it means to keep up, prolong, endure, etc. The term sustainability is, at times, coupled with the word *maintainability* which means to keep in an appropriate condition or to sustain against opposition or danger[1]. To sustain necessitates more energy to actively provide support to keep up and improve. However, to maintain is a less demanding action that has no necessary expectations for improvement. Without sustainability or maintainability, a collapse is expected.

Sustainable development pro-dominates the public use of the term Sustainability. The World Commission on Environment and Development (WECD) defined sustainable development as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs[2]". Barbier[3] interpreted the definition of the WECD by describing sustainable development as indistinguishable from the total development of society. Other definitions of sustainable development include: "Sustainable means using methods, systems and materials that won't deplete resources or harm natural cycles[4]." Teaching for sustainable development is usually referred to as Sustainability Education, Education for Sustainability, or Education for Sustainable Development (ESD). The United Nations adopts the term ESD[5, 6].

Sustainability has only recently become an overarching goal in higher education. Little work has been reported to address the sustainability of education (SoE) and/or the sustainability of academic programs within a higher education setting. Damaj et al.[7, 8, 9] presented the first use of the term Sustainability of Education (SoE) within an engineering context. Damaj et al. promoted the idea of looking into how sustainable an educational institution is in terms of the continuity of functioning with quality. In addition, the authors presented a framework for measuring the SoE. The investigation addressed issues related to SoE in general and for the Sustainability of Technical Education (SoTE) in Particular. Here, technical education is concerned with Engineering, Engineering Technology, Computing, and Applied Science. Damaj et al.[10] promoted for a new perspective that serves quality education and covers wide aspects related to Leadership and Governance. The developments touched at critical current challenges for leadership and governance through a carefully developed set of measurable indicators, such as, investment in quality education, handling the effect of change of people in positions, etc.; all within an SoTE framework.

As we enter the second decade of the 21st century, higher education is witnessing an increased need and demand for effective program assessment frameworks. Typically, the demand comes in conjunction with pursuit for internal improvement or external programmatic accreditation. One of these accrediting bodies is ABET, the global leader in accreditation of technical education programs. ABET reports that it accredits over 3,400 applied science, computing, engineering, and engineering technology programs at nearly 700 colleges and universities in 28 countries worldwide. Nearly 85,000 students graduate from ABET-accredited programs per year[11, 12].

ABET provides extensive criteria to guide program review and enable sound accreditations. The aims for professional accreditation is beyond proving that a collegiate program has met certain standards or verifying the readiness of the produced graduates to enter their professions. For graduates, accreditation enables access to enhanced opportunities in employment, licensure and certification, graduate education, and global mobility. For programs and institutions, accreditation enables international recognition[12].

Program effectiveness in colleges is increasingly judged on the basis of effective student attainment of learning outcomes and the fulfillment of the program's mission and objectives. Information from sound measurements is critical to knowing whether a program is delivering solid performance and to providing feedback for improvement in student learning. The authors believe that program effectiveness can be guided by the principles of SoTE and the practical framework described here.

In this paper, we focus on student learning by coursework program and present the results and analysis of a pilot study using a case study methodology. Student Learning by Coursework Program is presented as a pillar criterion for the SoTE. The criterion is expanded into a rich set of key performance measures and indicators. The indicators are based on an extensive and strong foundation of analytic score rubrics. The measurement aims to assess the sustainability of student learning by coursework program within a higher education context. Included is a discussion on the presented evaluation tool's usefulness for the continuous improvement at programmatic and institutional levels, as well as for collecting and providing evidence for quality assurance and accreditation organizations, such as ABET.

This paper is organized so that Section 2 defines SoTE and explains the measurement framework. Section 3 presents the development of the Student Learning by Coursework Program Criterion. Section 4 is dedicated for analysis and evaluation. The fifth and final section concludes the paper and outlines future work.

The Measurement Framework

In terms of education, we define Sustainability as the ability to continuously improve without reducing the capacity to endure. In other words, the SoTE is Improvability and Endurance. The SoTE is achieved at two levels, namely, the system and approach levels. At the system level, the educational institution should be able to improve without reducing its ability to endure. The institution should adopt an approach that strives to produce professionals that have sustainable values. Sustainable values include being self-directed, self-learner, lifelong learner, etc. Although Sustainable Development has inspired the creation of the term SoTE, it is not to be mixed with the term ESD.

In Figure 1, we depict the desirable SoTE, the possible realities of being sustainable, partially sustainable, barely sustainable, and the change needed. Being partially sustainable means having a satisfactory ability to improve with a growing capacity to endure. Being partially sustainable also means having a satisfactory capacity to endure with a growing ability to improve. The attribute of being barely sustainable means having growing ability to improve and capacity to endure.

The proposed measurement framework of SoTE defines nine different criteria. Each criterion covers one part of the educational system and also the approach. Accordingly, each criterion has its own set of key performance measures (KPMs). For every KPM, there is one or more key performance indicator (KPI) to enable the measurement. Every KPI has its own analytic rubric that will aid the calculation of different indicators including a one main indicator called the Sustainability Indicator (SI) – See Figure 2. The nine criteria are expanded into 34 KPMs.

The sustainability criteria upon which we judge SoTE is shown in Table 1. Criterion 1, Leadership and Governance, measures the sustainability of the institutional strategic plans and the degree of its adoption of the principles of SoTE. Criterion 1 aims to widely cover governance issues, accreditation effort, quality assurance, policy management, review systems, and fundraising - all within the context of sustainability. The KPMs, and accordingly the criteria, are best understood in terms of the detailed KPIs.

Criterion 2, Student Learning by Coursework Program is detailed in the Section 3. Criterion 3, Student Learning by Research Program, measures the sustainability of the research program including research support. Faculty Research and Consultancy, Criterion 4, looks mainly into the sustainability of faculty research objectives, professional development for research, consultancy activities, and research-teaching nexuses. Criterion 5, Industry and Community Engagement, focus on the sustainability of the relationship between the institution and the community in general including the industry and the alumni. Criterion 6, Academic Support Services, measures the sustainability of different administrative services, such as, the registrar, admissions, etc.

Criterion 7, Student Support Services, evaluates student activities, behavior, grievance, and career and employment services. Criterion 8, Faculty and Staff Support Services, measures the organization climate, retention, professional development, promotion, and other incentives. Criteria 9, measures campus services, public relations, and marketing.

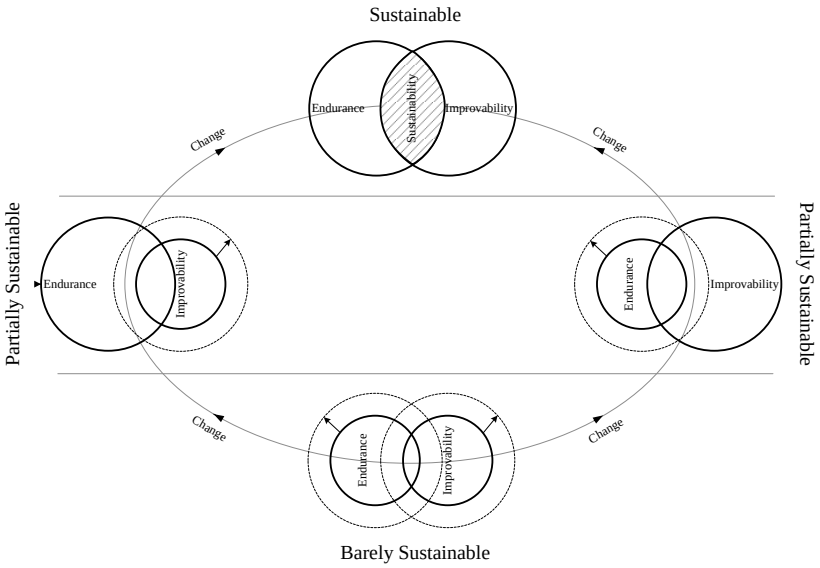

Figure 1. The two objectives of SoTE; the desirable sustainability, the reality of being partially or barely sustainable, and the change needed.

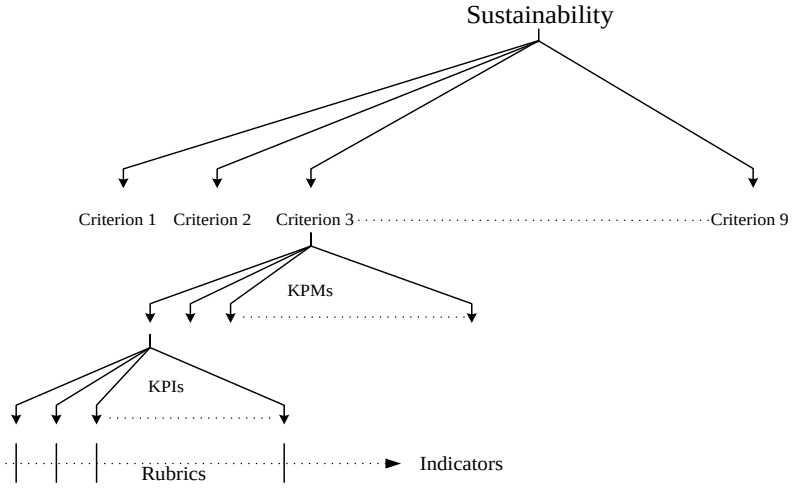

Figure 2. The measurement framework for SoE.

Table 1. The SoTE criteria.

No.	Criterion	No.	Criterion
1.	Leadership and Governance	6.	Academic Support Services
2.	Student Learning by Coursework Program	7.	Student Support Services
3.	Student Learning by Research Program	8.	Faculty and Staff Support Services
4.	Faculty Research and Consultancy	9.	General Support Services and Facilities
5.	Industry and Community Engagement		

The KPIs and their analytic rubrics are the most extensive part of the measurement framework. The KPIs and the rubrics are very carefully developed within the context of SoTE. The first version of KPIs includes 79 indicators of which 18 are for Criterion 2 "Student Learning by Coursework Program."

The rubric uses the scale Nascent, Beginning, Developing, Competent, and Accomplished. All the scale points are defined but the Nascent; it is defined as level below the B-level. The design rationale of every KPI is area-specific and requires deep understanding of the technicalities of the measured area. Due to the wide coverage of the framework, we had to deal with many different areas related to higher education. The following strategies are adopted to insure the adequacy and verify the developed rubrics:

- Interviews with experts
- External reviews
- Comparisons with existing rubrics
- Developing a rich and standardized set of rubric descriptors

The measurements could be interpreted per criteria, KPM, KPI, and/or combined forms. The 5-point rubric scale of KPIs – Nascent, Beginning, Developing, Competent, and Accomplished is mapped onto constant values (6.25, 12.5, 37.5, 62.5, and 87.5). The constant values are assigned with the focus of enabling wider number ranges at higher scale points. The constant values double for every higher scale point. The narrowest progression is for growing from Nascent through Developing. The widest range is for exceeding the level of Competent to reach the level Accomplished. However, since the statistical findings are mapped back to the scale points and uses ratios, changing the constant values has a negligible effect on the evaluation. The measured KPIs are then each divided by measurements from a reference institution for normalization and for producing performance ratios. One of the combined measurement forms is the SI, which is the Geometric Mean of all ratios. Although the SI requires the normalization with respect to reference measurements, other indicators are absolute.

The Sustainability of Student Learning by Coursework Program

The key measures we propose for assessing the sustainability of student learning by coursework program are the program educational objectives, student outcomes, curriculum, assessment, and plagiarism. Although the measures are carefully selected to cover the aspects that can lead to sustainable student learning by coursework program (See Table 2), the framework is scalable and upgradeable. Parts of the presented rubric adopts the style presented by Washington State University's Office of Assessment and Innovation[13] and the WASC Senior College and University Commission[14].

Table 2. The list of developed KPIs showing the Criteria, KPM, and KPI numbers.

No.	KPM/KPI	No.	KPM/KPI
2.1	**Program Educational Objectives**	**2.4**	**Assessment**
2.1.1	Develop Program Educational Objectives	2.4.1	Plan assessment
2.2	**Student Outcomes**	2.4.2	Probe quality
2.2.1	Develop Student Outcomes	2.4.3	Build a culture of assessment
2.3	**Curriculum**	**2.5**	**Plagiarism**
2.3.1	Align curriculum	2.5.1	Control plagiarism

The measure Program Educational Objectives focuses at the program objectives development and presents it as the sole indicator (See Table 3). The indictor comprises an investigation on the sufficiency in number and the public sharing of the objectives. In addition, the indicator reflects the relevance of the objectives to the strategic and learning goals of the university and their situation and breadth of discussion. The measurement inspects the frequency of verifications of the objectives, assessment process, performance criteria, and the used tools. Moreover, the measurement observes the level of engagement in refining the objectives. Indeed, the indication and consideration of relevant sustainability attributes, as related to improvability and endurance, are core parts of the rubric.

Table 3. The Program Educational Objectives KPM, its KPI, and rubric.

Criterion		**Criterion 2 – Student Learning by Academic Program**			
General		**Rubric** (**N**ascent: Below the Beginning level, **B**eginning, **D**eveloping, **C**ompetent, **A**ccomplished)			
KPM	**KPI**	**Beginning**	**Developing**	**Competent**	**Accomplished**
2.1. Program Educational Objectives	2.1.1. Develop Program Educational Objectives	The program is in the process of articulating its own program goals. Relevant sustainability attributes as related to improvability and endurance are mostly not considered.	A manageable number of program educational objectives have been defined and are publicly shared. Program objectives may be revised periodically as the program works to align them with the university's core themes (i.e., strategic and learning goals). It occasionally verifies the relevance of its objectives, performance criteria, measurement tools, and assessment processes by soliciting feedback from multiple stakeholders, course evaluations and surveys target information relevant to program objectives. Stakeholders, including faculty and students are limitedly engaged in refining program objectives and measures. Relevant sustainability attributes as related to improvability and endurance may be considered.	An adequate number of program educational objectives have been defined and are publicly shared. The program has defined and mapped its goals in relation to the university's core themes (i.e., strategic and learning goals). It frequently verifies the relevance of its objectives, performance criteria, measurement tools, and assessment processes by soliciting feedback from multiple stakeholders, course evaluations and surveys target information relevant to program objectives. Stakeholders, including faculty and students are adequately engaged in refining program objectives and measures. The objectives include relevant sustainability attributes as related to improvability and endurance.	A large number of program educational objectives have been defined and are publicly shared. The program clearly demonstrates how its objectives support the university's core themes (i.e., strategic and learning goals). The program situates its objectives in the national, regional, and international discussions around teaching and learning in the discipline. It routinely verifies the relevance of its objectives, performance criteria, measurement tools, and assessment processes by soliciting feedback from multiple stakeholders, course evaluations, and surveys target information relevant to program objectives. Stakeholders, including faculty and students are highly engaged in refining program objectives and measures. The objectives clearly indicate the sustainability attributes as related to improvability and endurance.

The second measure for Criterion 2 is Student Outcomes and its indicator focuses on their development. The indicator inspects the alignment of the student outcomes with the program educational objectives and the university core themes. Moreover, the indicator examines the depth and the breadth of the developed student outcomes. The depth is related to the quality of the developed learning outcomes, their performance indicators, and its adoption of the sustainability characteristics. However, the breadth is related to the number of outcomes and the

wide involvement of constituents in their discussion. For student outcomes to be sustainable, the institution should routinely verify the relevance of its curriculum, performance indicators, assessment tools, assessment process, and involve all stake holders. The indicator is presented in Table 4. The student outcomes should include sustainability outcomes as related to improvability and endurance (e.g., lifelong learning, critical thinking, etc.).

Table 4. The Student Outcomes KPM, its KPI, and rubric.

Criterion		**Criterion 2 – Student Learning by Coursework Program**			
General		**Rubric** (**N**ascent: Below the Beginning level, **B**eginning, **D**eveloping, **C**ompetent, **A**ccomplished)			
KPM	**KPI**	**Beginning**	**Developing**	**Competent**	**Accomplished**
2.2. Student Outcomes	2.2.1. Develop Student Outcomes	The program is in the initial stages of defining its student learning outcomes. Relevant institution-wide learning outcomes and/or sustainability outcomes as related to improvability and endurance are not necessarily considered.	The program has articulated a manageable number of observable, measurable student learning outcomes within the context of the curriculum. The program may be developing performance criteria connected to the outcomes. Relevant institution-wide learning outcomes and/or sustainability outcomes as related to improvability and endurance may be considered.	Student learning outcomes are aligned with program goals and are defined by a manageable number of performance criteria. Outcomes are contextualized in the curriculum and reflect the national, regional, and international conversation on teaching and learning in the discipline. Outcomes are publicly shared and they include relevant institution-wide learning outcomes and/or sustainability outcomes as related to improvability and endurance (e.g., lifelong learning, critical thinking, etc.).	The program clearly demonstrates how its student learning outcomes support the program objectives and the university's core themes (i.e., strategic and learning goals). The program situates its outcomes in the national, regional, and international discussion around teaching and learning in the discipline. It routinely verifies the relevance of its curriculum, performance criteria, measurement tools and assessment processes by soliciting feedback from multiple stakeholders. Stakeholders, including faculty and students, engage in refining student learning outcomes and measures. The student learning outcomes include sustainability outcomes as related to improvability and endurance (e.g., lifelong learning, critical thinking, etc.).

Curriculum is the third measure for sustainable student learning by coursework program. The indicator studies the alignment of the pedagogy, grading, relevant student support services, etc. with the student outcomes. The indicator is presented in Table 5.

The key measure Assessment is built upon three indictors of which are divided into ten sub-indicators (SKIPs); See Table 6. The indicators are planning assessment, probing quality, and building a culture of assessment. The Plan Assessment indicator looks at the clarity of purpose, broad and diverse participation, publicity of communication, and the credibility of measurements. The Probe Quality indicator scrutinizes the availability of relevant evidence of assessment, sound analysis, and an evidence-based action plans. The assessment KPM is a key to the achievement of SoE of student learning by coursework program; accordingly, it warrants an exhaustive treatment.

Table 5. The Curriculum KPM, its KPI, and rubric.

Criterion		**Criterion 2 – Student Learning by Coursework Program**			
General		**Rubric** (**N**ascent: Below the Beginning level, **B**eginning, **D**eveloping, **C**ompetent, **A**ccomplished)			
KPM	**KPI**	**Beginning**	**Developing**	**Competent**	**Accomplished**
2.3. Curriculum	2.3.1. Align Curriculum	There is no clear relationship between the outcomes, including those for sustainability, and the curriculum that students experience.	Students appear to be given reasonable opportunities to develop with respect to outcomes in the required curriculum including sustainability outcomes.	The curriculum is designed to provide opportunities for students to learn and to develop increasing sophistication with respect to each outcome including sustainability outcomes. This design may be summarized in a curriculum map.	Pedagogy, grading, the curriculum, relevant student support services, and co-curriculum are explicitly and intentionally aligned with each outcome including sustainability outcomes. Curriculum map indicates increasing levels of proficiency.

Table 6. The Assessment KPM, its KPIs, SKPIs, and rubric.

Criterion			**Criterion 2 – Student Learning by Coursework Program**			
General			**Rubric** (**N**ascent: Below the Beginning level, **B**eginning, **D**eveloping, **C**ompetent, **A**ccomplished)			
KPM	**KPI**	**SKPIs**	**Beginning**	**Developing**	**Competent**	**Accomplished**
2.4. Assessment	2.4.1. Plan Assessment	2.4.1.1. Purpose	The assessment team reviews and recommends academic program policies, including degree requirements, course offerings, academic advising, and program assessment for accreditation.	The team uses assessment to identify strengths and weaknesses of program curricula, course design, and focuses on teaching and learning strategies. The team identifies shared questions of interest about teaching and student learning to plan or refine assessment.	The team engages in a continual cycle of intentional inquiry through outcomes assessment to refine and improve program practices. Assessment is focused, realistic, and manageable. Assessment may be situated in the national, regional, and international discussions of teaching and learning in the discipline.	The assessment system is guided by a shared understanding of the following: (1) Assessment is essential for continuous program improvement; (2) The program team is a responsible steward of the public trust. Assessment is systematic, realistic, and manageable. It is strategically embedded at key points in the curriculum and focused on improving the students' learning and learning experiences. The assessment is situated in the national, regional, and international discussion of teaching and learning in the discipline and guided by questions that are of genuine concern to program members.

… Continue Table 6.

2.4. Assessment	2.4.1. Plan Assessment	2.4.1.2. Participation	Stakeholders have been identified. The program has identified one or two members to investigate and fulfill assessment requirements. The program systematically measures demographics (GPAs, retention, graduation rates, and career placement).	Some stakeholders are involved identifying, developing, implementing, and/or evaluating the program's assessment system. Some external stakeholders may be involved in interpreting assessment findings. Multiple program members are involved in developing and piloting an assessment system.	Multiple stakeholders are involved in affirming, refining, and/or evaluating the program's assessment system. Program members, as well as external stakeholders, review assessment results and help inform or guide next steps. A broad and representative range of program members meet frequently to review and refine the program's assessment system.	A broad and representative range of program members meet regularly to evaluate the program's assessment system. Diverse stakeholders engage continuously in ways that are transparent and accessible beyond the program. Students are respected partners and use program criteria to self - and peer-assess in ways that feed back into curriculum.
		2.4.1.3. Communication	Internal reports of assessments are made on a regular basis.	Reporting is two-way. Many program members involved in reviewing assessment results and identifying next steps.	Reporting is transparent, engages participants in ongoing dialogue, and is accessible beyond the program.	The assessment system and its team purpose and findings are reported publicly.
		2.4.1.4. Measurement	The program may be exploring realistic, useful, and effective ways to measure its outcomes and move beyond grades as measures.	The program has begun to develop core course assignments that prompt outcomes. The chosen measures are being piloted at strategic points across the curriculum. An attempt at using direct and indirect measures is made to focus questions or issues that concern faculty.	Multiple and credible direct and indirect measures are used to provide useful information about teaching and learning in the program. The performance criteria used in a program-level rubric or other assessment tool are designed to be useful for improved teaching and learning. Assessment measures and how they are used by the program are frequently verified by independent review.	Multiple, credible, and complementary direct and indirect measures are used to provide useful information about teaching and learning in the program. The performance criteria used in a program-level rubric or other assessment tool are designed to be highly useful for improved teaching and learning. Assessment measures and how they are used by the program are routinely verified by independent review.
	2.4.2. Probe Quality	2.4.2.1. Evidence	The program collects some baseline information such as number of students retained, graduation rates, course grades, and course evaluations. The program is exploring strategies for collecting more focused information about student learning.	The program summarizes core findings generated from a few measures of student learning. The measures possibly include student work, syllabi, and/or assignment prompts that inform issues or questions that concern faculty.	The program summarizes core findings generated from a variety of direct and indirect measures of student learning in ways that can be confirmed and verified. Evidence is drawn from representative samples of student and faculty work across the curriculum. The information collected has been focused to provide evidence and is useful for considering next steps.	The program systematically collects representative, relevant and verifiable measures of students learning from strategic points in the curriculum over multiple cycles to identify patterns and discrepancies.
		2.4.2.2 Analysis	Assessment data are clearly sorted and ranked, and ready to be analyzed by a few key program members with direct responsibilities for the assessment.	Assessment data are reviewed and analyzed by teaching faculty and administrators that have opportunities to implement change.	Assessment data are reviewed and analyzed by all relevant stakeholders who meet to reflect on the findings and identify next steps, including identifying data gaps.	This data is analyzed by program members and stakeholders to gain a clear picture of program strengths and weaknesses, and to consider if evidence of student learning represents an acceptable level of achievement.

… Continue Table 6.

2.4. Assessment	2.4.2. Probe Quality	2.4.2.3 Action Plan	The action plan focuses on general goals or minor changes in course sequencing or pre-requisite requirements. Proposed actions may be identified as ready for discussion in order to determine next steps and priorities.	The action plan focuses on concrete strategies such as refining the assessment system, addressing holes in the data, and considering how the curriculum or even coordinating teaching practice might change in response to future assessments that confirm the results of assessment. Next steps have been identified and prioritized.	The action plan is guided by the Scholarship of Teaching and Learning (SoTL), stakeholder input, and solid evidence that changes will lead to the improvement of teaching and learning. Next steps, constraints, timeline, resources, as well as roles and responsibilities of participants have been identified and prioritized.	The program refines the assessment system and measures to provide evidence that is both informative and actionable. It uses evidence from SoTL to guide cycles of action and assessment. Program changes are made and assessed. Changes to the student learning outcomes, learning experiences and the learning environment are documented and discussed by the assessment team.
	2.4.3. Build a culture of assessment	2.4.3.1 Policy	Leadership acknowledges a commitment to developing an effective assessment system and outlines plans for how it will commit time and resources.	Leadership ensures the program has explicit policies and guidelines for the kinds of support available for assessment.	Leadership provides incentives in the form of time, money, other resources and recognition to program members involved in assessment and encourages member involvement.	Leadership has established a foundation of robust and long-term support that endorses a culture of ongoing, effective assessment. It provides resources for professional development related to assessment.
		2.4.3.2 Scholarship of teaching and learning (SoTL)	Leadership has plans to encourage the Scholarship of Teaching and Learning (SoTL) in the program.	Leadership identifies and disseminates information about the Scholarship of Teaching and Learning (SoTL) and about the national discussion around learning in the discipline. It encourages the adoption of research-based practices and organizes SoTL workshops and seminars.	Leadership invites guest speakers on the Scholarship of Teaching and Learning (SoTL), recognizes faculty publications on SoTL, and encourages program members to participate in local, regional, national, and international opportunities to advance their knowledge of research in teaching, learning, and assessment.	Leadership engages in and encourages attention to the national, regional, and international discussions of teaching and learning challenges in the discipline. It stewards this effort by rewarding program members involved in the Scholarship of Teaching and Learning and corresponding innovation.
		2.4.3.3 Environment	Leadership is exploring ways to create an environment where teaching is valued.	Leadership encourages a culture of inquiry and seeks to build shared values and vision among program members. It creates an environment that values innovation, lessons learned, and risk-taking.	Leadership actively supports and endorses faculty learning communities. Leadership encourages participation from all program members in an effort to experiment, explore, take risks, and share insights from innovative teaching. Leadership identifies and manages constraints when prioritizing. Program members take risks and share insights from lessons learned.	Leadership demonstrates recognition of efforts to improve student learning and acknowledges the risks associated with those efforts. Leadership provides a safe environment where open inquiry about student learning is encouraged. Leadership builds capacity in current students and alumni to partner in the assessment dialog.

The last indicator under Assessment presents it as a culture; it investigates the establishment of long-term support of assessment by the institution leadership, the endorsement of continuous

assessment, and providing professional development related to assessment. The indicator investigates the leadership engagement in and encouragement of the Scholarship of Teaching and Learning (SoTL) and its corresponding innovation. Ultimately, the indicator examines the creation of an environment where teaching is valued and improved, and provide a safe environment for open inquiry.

Plagiarism is another cornerstone measure for the sustainability of student learning by coursework program. Table 7 presents the rubrics of the single indicator Control Plagiarism. The sub-indicators for controlling plagiarism include implementation, involvement, agency, promotion, and contribution. Sustainability is found to be accomplished if the implementation and handling of the plagiarism control is effective, systematic, and thorough. It is expected that plagiarism control procedures, code of conduct, and sanctions are consistently implemented and enforced across the institution. A sustainable control of plagiarism is best supported by the involvement and partnership of counselors, faculty, staff, and students; the focus of the effort is to cure causes.

Table 7. The Plagiarism KPM, its KPI, SKPIs, and rubric.

Criterion			**Criterion 2 – Student Learning by Coursework Program**			
General			**Rubric** (**N**ascent: Below the Beginning level, **B**eginning, **D**eveloping, **C**ompetent, **A**ccomplished)			
KPM	**KPI**	**SKPIs**	**Beginning**	**Developing**	**Competent**	**Accomplished**
2.5. Plagiarism	2.5.1. Control plagiarism	2.5.1.1 Implementation	Plagiarism is poorly handled. Plagiarism control procedures, code of conduct, and sanctions are minimally implemented and enforced.	Plagiarism is sporadically handled. Plagiarism control procedures, code of conduct, and sanctions are adequately implemented and enforced.	Plagiarism is soundly handled. Plagiarism control procedures, code of conduct, and sanctions are somewhat consistently implemented and enforced institution-wide.	Plagiarism is effectively, systematically, and thoroughly handled. Plagiarism control procedures, code of conduct, and sanctions are consistently implemented and enforced institution-wide.
		2.5.1.2. Involvement	Counselors, faculty, staff, and students are little involved in the efforts to cure causes.	Counselors, faculty, staff, and students are somewhat involved in the efforts to cure causes.	Counselors, faculty, staff, and students are involved in the efforts to cure causes.	Counselors, faculty, staff, and students partner in the efforts to cure causes.
		2.5.1.3 Agency	Students are limitedly assisted to create an agency, self-efficacy, self-propel, and internal motivation to avoiding plagiarism.	Students are somewhat assisted to create an agency, self-efficacy, self-propel, and internal motivation to avoiding plagiarism.	Students are adequately assisted to create an agency, self-efficacy, self-propel, and internal motivation to avoiding plagiarism.	Students are well-assisted to create an agency, self-efficacy, self-propel, and internal motivation to avoiding plagiarism.
		2.1.5.4. Promotion	Plagiarism avoidance is rarely promoted as an indication of high ethical and moral value, and an important aspect of lifelong learning.	Plagiarism avoidance is occasionally promoted as an indication of high ethical and moral value, and an important aspect of lifelong learning.	Plagiarism avoidance is promoted as an indication of high ethical and moral value, and an important aspect of lifelong learning.	Plagiarism avoidance is regularly promoted as an indication of high ethical and moral value, and an important aspect of lifelong learning.
		2.1.5.5. Contribution	Curriculum and teaching methods are rarely current, relevant, and engaging to students. Assignments rarely require evidence of individual student contribution.	Curriculum and teaching methods are occasionally current, relevant, and engaging to students. Assignments infrequently require evidence of individual student contribution.	Curriculum and teaching methods are frequently current, relevant, and engaging to students. Assignments often require evidence of individual student contribution.	Curriculum and teaching methods are always current, relevant, and engaging to students. Routinely, assignments require evidence of individual student contribution.

The Control Plagiarism indicator investigates the level of assistance provided to students in order to create agency, self-efficacy, self-propel, and internal motivation to avoiding plagiarism. The indicator looks at the frequency of promotion of plagiarism avoidance as an indication of high ethical and moral value, and an important aspect of lifelong learning. Indeed, the indictor studies the currency, relevancy, and the level of engagement to students of the curriculum and teaching methods. The indicator observes the availability of evidence of individual student contribution to an assignment.

The presented measures and indicators are not meant to limit the assessment of sustainability of student learning by coursework program. The presented structure of the measurement framework enable extendibility and expandability at the rubric, indicator, and/or measure levels.

Analysis of Results and Evaluation

Sustainability, in its general meaning and also as defined in development, inspires the creation of a framework for quality education. The SoTE could be defined in terms of the ability, of the educational system and the approach, to continuously improve without reducing the capacity to endure. Here, sustainability is not defined over a specific period of time; it is a property that continues with no stop. Improvability and endurance are considered as the basis upon which sustainable education can be built.

The framework we propose provides reference criteria for institutional measurements of the SoTE. Accordingly, the SoTE criteria enable the development, probing, and tuning of broad aspects of the educational system and the approach. The criteria are made specific with the choice of KPMs, and made more specific by the choice of KPIs. The way we specify the criteria allows for widening the coverage by expanding the criteria, KPMs, and/or the proposed KPIs. In a hierarchal structure, the criteria, KPMs, KPIs, and rubrics construct a framework that enables the measurement of the SoE/SoTE.

The sustainability of Student Learning by Coursework Program in educational institutions is assessed through Criterion 2. The assessment provides concrete results per KPM and/or KPI. Different KPMs could be composed together to assess a specific part, or composed altogether to produce a single measurement for Criterion 2. If divided by a reference measurement, the SI for Student Learning by Coursework Program is produced to provide a relative indicator and a ground for classification and benchmarking.

Several returns are noted for the developed framework including the following:

- Its conceptual base promotes for a new perspective that serves quality education
- Its conceptual base is refined into a clear measurement structure
- It formulates a novel methodology for measurement based on the modern concept of sustainability
- It well defines and captures the intended meaning of the term sustainability with simplicity
- The tree structure of measurement enables the drawing of conclusions at different measurement levels of abstraction, namely, the criteria, KPM, and KPI levels

- It supports, combines, and hybridizes both quantitative and qualitative measurement styles
- It is scalable and upgradable without changing the statistical computation or the structure of the measurement
- The KPIs and rubrics are extensive, comprehensive, and provide a rich reference
- The developed rubrics follow a smooth iteration of descriptors through the different scale points
- It provides opportunities for inter-institutional measurements and cross-institution benchmarking
- It could contribute to the standards of quality education and technical education

The main priority is advocating for and the cultivation of the SoTE principles, where all aim to build a sustainable education that can improve and endure endlessly. In addition, the proposed framework shares several common challenges with the regular efforts of providing quality education. The following challenges are pinpointed to be important to the adoption of the proposed methodology with focus on leadership and governance:

- The commitment, adequate investment, and support of the governing body of the institution
- The application of an educated change management
- The change dynamics of the institution
- The spreading of SoTE awareness institution-wide
- The ensuring of institutional effectiveness
- The creation of a culture of assessment
- The creation of a positive organizational climate

In this project, the theoretical proposition is that the presented measurement tool accurately a) describes the content and constructs that comprise sustainability of technical education in a higher education setting, and b) measures the sustainability.

The developed framework is applied through a pilot study for a single institution using a case-study methodology. The pilot study included faculty and staff, in regular and key administrative positions, from a private institution of higher education. The selected institution follows the American model of higher education and offers Bachelor degrees for a variety of programs. The chosen institution is relatively young and located in a developing country. The steps of data collection is as follows:

1. An initial test drive. The test drive included refining the plans, procedure, documents, forms, and ensuring artefacts balance
2. Baseline perception data collection using the holistic version of the rubric
3. Data collection using the analytic version of the tool
4. Calibration of raters through training sessions
5. Data collection after raters calibration for both the holistic and analytic versions of the rubrics

The results from the pilot study, and after calibration, places the assessed institution in the rank of Developing with respect to the sustainability of student learning by coursework program (See Table 8). Many of the measured indicators were found to be Beginning and Developing. The sustainability as measured by the sub-indicator Contribution, under Control Plagiarism, was found to be accomplished. The institution was not found to be nascent in any of the measured indicators.

Table 8. Results for the analytic version of the tool before calibration (BC), after calibration (AC), their mapping to the numerical pointes, and the average (AV) numerical and letter grades.

#	BC	#	AC	#	#	BC	#	AC	#
2.1.1.1	Developing	37.5	Competent	62.5	2.4.3.1	Competent	62.5	Competent	62.5
2.2.1.1	Competent	62.5	Competent	62.5	2.4.3.2	Beginning	12.5	Beginning	12.5
2.3.1.1	Developing	37.5	Developing	37.5	2.4.3.3	Developing	37.5	Developing	37.5
2.4.1.1	Developing	37.5	Developing	37.5	2.5.1.1	Beginning	12.5	Beginning	12.5
2.4.1.2	Beginning	12.5	Beginning	12.5	2.5.1.2	Beginning	12.5	Beginning	12.5
2.4.1.3	Beginning	12.5	Beginning	12.5	2.5.1.3	Beginning	12.5	Beginning	12.5
2.4.1.4	Beginning	12.5	Beginning	12.5	2.5.1.4	Competent	62.5	Competent	62.5
2.4.2.1	Developing	37.5	Developing	37.5	2.5.1.5	Accomplished	87.5	Accomplished	87.5
2.4.2.2	Beginning	12.5	Beginning	12.5					
2.4.2.3	Beginning	12.5	Beginning	12.5	AV	≈ Developing	31.94	≈ Developing	33.3

The results from the study reflected a minimal difference in average scores upon the rater calibrations. The difference in average scores before and after calibration is 1% for the analytic rubric, and 0% for a holistic of the rubric. The holistic rubric is a shorter version that combines all sub-KPIs and only includes the essence of the measurement without deep details. The difference in average score between the analytic and holistic rubrics is 14%; the average holistic score is 47.5. Calibration is important as it shows reliability between raters and also serves as an indicator for validity of the measurement tool. As expected, the analytic rubric provided deeper and more detailed description for the measured indicators. In general, analytic rubrics provide more accurate measurement if raters are calibrated; it also provide a foundation for continuous improvement because the descriptors are more fine-grained, thus more actionable.

In reference to an institution that is assumed to be competent in its sustainability of student learning by coursework program, the SI for the assessed institution is 0.41. The SI for student learning by coursework program needs to increase by 0.59 to match the reference institution, and should become above 1 to outperform it.

Conclusions

The paper presents a modern concept that defines SoTE. A structured measurement framework is refined from the pillars of Sustainability, namely, Improvability and Endurance. The measurement framework has 9 criteria, 34 KPMs, and a total of 171 indicators with their analytic rubrics and a bouquet of statistical indicators. The development of the second criterion Student

Learning by Coursework Program is presented. The presented methodology promotes for a new perspective that serves quality education and covers wide aspects related to student learning by coursework program. The developments touches at critical current challenges through a carefully developed set of measurable indicators, such as, developing educational objectives and learning outcomes, probing the quality of assessment, building a culture of assessment, controlling plagiarism, etc. The paper included the results and analysis of a pilot study from a single institution using a case-study methodology. The sustainability of student learning by coursework program in the assessed institution is found to be developing. The tool highlighted several points of strengths and weaknesses. Work in progress aims to execute a multistage data collection procedure for a pilot study using a case-study methodology for one case that targets a single institution and for the complete set of criteria.

The SoTE framework is comprised of 9 criteria that programs, colleges, and institutions can use to determine current strengths and weaknesses and plan for continuous improvement. Because the framework is a direct measurement tool, it can be used to generate baseline data and gauge progress on attainment of goals and benchmarks. Because the tool is standardized, it can be used at the college or institutional level to help determine allocation of resources for everything from professional development to increased laboratory space.

Most quality assurance organizations including national, regional and programmatic accrediting bodies require programs to show evidence of adequacy against a set of standards or criteria similar to those in the SoTE, as well as continuous improvement. New programs, schools, colleges and institutions can use the SoTE framework to guide their strategic planning across all important sectors. Those who are preparing for initial accreditation can use the SoTE framework as they prepare the self-study report to submit for consideration. Well established programs need to remain current and relevant and the SoTE framework provides a tool for programs to ensure agility and responsiveness to internal and external fluctuations and variables.

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