Quality Assurance and Assessment in Technical Education System: A Web Based Approach

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Abstract - **Engineering education quality embraces the activities through which a technical institution satisfies itself that the quality of education it provides and standards it has set are appropriate and are being maintained. There is a need to develop a standardised approach to most aspects of quality assurance for engineering programmes which is sufficiently well defined to be accepted for all assessments.**
We have designed a Technical Educational Quality Assurance and Assessment (TEQ-AA) System, which makes use of the information on the web and analyzes the standards of the institution. With the standards as anchors for definition, the institution is clearer about its present in order to plan better for its future and enhancing the level of educational quality.
The system has been tested and implemented on the technical educational Institutions in the Karnataka State which usually host their web pages for commercially advertising their technical education programs and their Institution objectives, policies, etc., for commercialization and for better reach-out to the students and faculty. This helps in assisting the students in selecting an institution for study and to assist in employment.

INTRODUCTION

Engineering education is now subject to a range of formalised mechanisms as part of an overall process by which quality is assured in its various activities. These features are: Teaching; Research; Entry Standards; Student-to-staff ratio; Library and computer spending; Facilities; percentage of high degrees; graduate destinations; and completion rate.

QUALITY ASSURANCE IN TECHNICAL EDUCATION

The quality of engineering and technology education is complex and challenging due to various reasons, and can be analogous to industry, as illustrated in Figure 1. Any standard industrial activity includes three different stages, such as the input, the process and the output, where feed-back closes the loop. In this process, feedback gained from the output can be utilized to improve the quality of the process. This model has also been adopted for the quality assessment of education structures. The three stages of an educational process cycle are further elaborated on below.

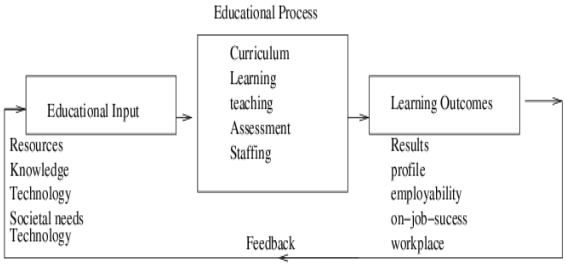

Figure 1: The block diagram of an educational cycle

- **Educational Input:** The Input parameters relate to various components, including the student's intake or student's enrollment into an engineering educational process, etc, and may be comprised of the following aspects: Societal needs; New knowledge; Advancing technologies; Human and material resources; Student enrollment process; Student fees structure and Student eligibility criteria, etc.
- **Educational Process:** The educational process lies in between the input and the output, and this is where teaching/learning is faciliated. It may consist of the following important factors:· Curriculum design; Learning styles; Learning methods;· Teaching/learning facilities; Assessment methods and Staffing, etc.
- **Learning Outcomes:** The Output component is associated with the student output after finishing the course curricula. It consists of the following elements: Academic results; Professional profile;· Employability; On-the-job success rate and Social and workplace activities, etc. The quality of engineering education can be controlled and assessed according to three different approaches:
- On the exit where the knowledge, skills, arrangements, values acquired by the students at the time of training are verified (absolute quality assessment).

- Method of added value, at which the difference between the input and output level is sought. From this difference is rated about the effectiveness at the process of training and the quality of educational product.
- About quality is rated indirectly on separate parts , elements and processes, conditions and preconditions, through which the educational process passes. The presumption of this approach is that if all these ones responds at the most to the quality requirements then the quality will possess a high assessment.

QUALITY ASSURANCE IN SOME OF THE EXISTING TECHNICAL UNIVERSITIES

Quality assurance in Danish higher education: The Danish higher education system is divided into short-cycle, medium-cycle and long-cycle higher education programmes; 44% of an age group completes a higher education programme. `Of these, 9% complete a short cycle, 23% complete a medium-cycle and 12% complete a long-cycle higher education. Institutions can be grouped into two different sectors: the college sector, that is, the professionally oriented higher educations sector, the university sectors. According to the Ministry of Education, the Danish approach to quality involves a number of elements, including:

- **Examination system**: External examiners attend examinations at all educational levels in Denmark. The use of external examiners is a defining and characteristic feature of the entire educational system.
- **Quality legislation:** The Academies are obliged to employ a system of continuous quality development and assessment of results. Accordingly, these institutions must have procedures for systematic self-evaluation of all institutional activities.
- **Transparency and openness:** Transparency and openness in education aims to constitute an asset for potential students and their parents, in particular, in providing improved access to comparable information on education and institutions, thus enabling individuals to make an informed choice of education and institution.

Quality Assurance in Madras: Beginning in 1996, IIT-Madras has embarked on two initiatives, one for the evolution of a Strategic Plan and the other of ISO-9001 certification, essentially of the support services. In this process, a quality policy for the institute activities has been generated, essentially through a bottoms up decentralized approach:

- Impart quality education in technology and science for professional excellence and instill commitment to sustainable development. Perform world class research to advance the frontiers of knowledge.
- Provide innovative solutions through research, consultancy and continuing education for satisfying current and future industrial and R&D needs.
- Extend expertise towards improvement in the quality of technical education.
- Achieve excellence in the support services of the institute through continuous improvement and teamwork. At the moment the strategic plan is getting ready and the mission statement for the institute is being evolved, again through institute-wide participation.

Quality assurance in Finland: Quality assurance in the Finnish higher education comprises three elements:
national higher education policy, national evaluation and the higher education institutions' own quality assurance. The higher education institutions bear the main responsibility for the quality of their activities. They have national higher education policy, national evaluation, Auditing of quality assurance systems of the higher education institutions.

PROPOSED METHOD

We have proposed Technical Educational Quality Assurance and Assessment (TEQ-AA) System which will be done by using the web pages of the education institution. The TEQ-AA System each technical education institute should have their website with mandatory minimum information about their infrastructure, faculty, etc; and these information will be used by TEQ-AA System. TEQ-AA system has been developed with the following objectives:

- To understand the infrastructure, faculty profiles, students back-ground, performance and management of a technical education institution.
- To deduct the strength and weaknesses of the technical education institution.
- To provide the advices to management, faculty and students of the technical education institution for improvement. To periodically check the performance of technical education institution.

ORGANIZATION OF THE REST OF THE PAPER

The rest of the paper is organized as follows. Section 2 describes some of the standard quality measurements which are useful to measure, assess the technical education institution. Section 3 describes the architecture and functionality of the proposed TEQ-AA System, Section 4 illustrates some of the experiments conducted and discusses the results and finally Section 5 concludes the paper.

SOME OF THE STANDARDS FOR QUALITATIVE TECHNICAL EDUCATION.

In this section we describe some of the standards to establish qualitative and a technical education. These also give an opportunity to make judgments on the nature and purposes of the institution, the appropriateness of objectives in terms of the institution's structure, the degree to which objectives are realized, and the institution's compliance with the current technical development in the field.

Standards and guidelines for internal quality assurance within higher education institutions:
These are some of the indicators of institutional quality**:** The utilization of strategic planning processes, Interaction with the environment, industry, profession, community.

Mobilization of resources for institutional, development Diversity of external financial support, Demand from outside agencies for R & D, and continuing education, Adjunct appointments with Industry, Inter-disciplinary activities Self-assessment and accreditation, processes, Alumni involvement, Perceived reputation, nationally and internationally, Use by national agencies as think tanks and for technology development, Leadership in education and research.

Assessment of students: Students should be assessed using published criteria, regulations and procedures which are applied consistently.

Some of indicators of student quality are:

Number of applications per seat, Diverse preparation and background of entering students, Number completing degree, Time to complete degree, Proportion undertaking practical training, Proportion participating in research and development, Employment profiles and salaries on graduation, Number taking up post-graduate studies, Satisfaction levels of students and employees, Perceived reputation of graduates and alumni, nationally and internationally, Proportion of foreign students, Number becoming entrepreneurs.

Quality assurance of teaching staff: Institutions should have ways of satisfying themselves that staff involved with the teaching of students are qualified and competent to do so. They should be available to those undertaking external reviews, and commented upon in reports.

Some of indicators of faculty quality are:

Number of applications for faculty position, at different levels, Academic quality, in terms of publications, honors, awards, patents, sponsored projects and consultancy. Retention success; turn-over , Teaching quality, innovative initiatives

Publication records , Sponsored research, consultancy and continuing education activities, Professional society and public service, involvement , Ability to mobilize resources for department and institution, Internal and external (national and international) honors and awards, Quantum of practical experience , Effectiveness of student counseling, Faculty career satisfaction levels.

- **Learning resources and student support:** Institutions should ensure that the resources available for the support of student learning are adequate and appropriate for each programmer offered.
- **Information systems:** Institutions should ensure that they collect, analyze and use relevant information for the effective management of their programmers of study and other activities.
- **Public information:** Institutions should regularly publish up to date, impartial and objective information, both quantitative and qualitative, about the programmers and awards they are offering.

Standards for the external quality assurance of technical higher education

- **Use of internal quality assurance procedures**: External quality assurance procedures should take into account the effectiveness of the internal quality assurance processes.
- **Development of external quality assurance processes:** The aims and objectives of quality assurance processes should be determined before the processes themselves are developed, by all those responsible technical education institutions and should be published with a description of the procedures to be used.
- **Criteria for decisions:** Any formal decisions made as a result of an external quality assurance activity should be based on explicit published criteria that are applied consistently.

Processes fit for purpose: All external quality assurance processes should be designed specifically to ensure their fitness to achieve the aims and objectives set for them.

- **Reporting:** Reports should be published and should be written in a style, which is clear and readily accessible to its intended readership. Any decisions, commendations or recommendations contained in reports should be easy for a reader to find.
- **Follow-up procedures:** Quality assurance processes which contain recommendations for action or which require a subsequent action plan, should have a predetermined follow-up procedure which is implemented consistently.
- **Periodic reviews:** External quality assurance of institutions and/or programmers should be under- taken on a cyclical basis. The length of the cycle and the review procedures to be used should be clearly defined and published in advance.
- **System-wide analyzes**: Quality assurance agencies should produce from time to time summary reports describing and analyzing the general findings of their reviews, evaluations, assessments , etc.
- **Accreditation Agencies:** Apart from the fixed situation, where there is choice, the major concern in the accreditation of engineering education for an institution is to select an appropriate accreditation body. Since there are several accreditation agencies and systems established at the national, regional and international levels, the institution has to approach an appropriate authority for assessment. In order to avoid this confusion, there is a strong need to establish a dedicated accreditation and quality assurance forum for engineering and technology education in different regions.

THE TEQ-AA SYSTEM

The proposed TEQ-AA system uses mobile agents to access the web pages of the technical institutions or colleges and collect relevant quality measurement information. The collected information is analyzed and deducted into the qualitative facts of the institution, Standard Measurement by using (RARM) Realistic Abductive Reasoning Model. Figure 2. shows the components of TEQ-AA System:

***A*. Web page analyser:** It contains the information about the URLs of the Technical Education Institutions' websites.

Through the URL the system collects the required information.

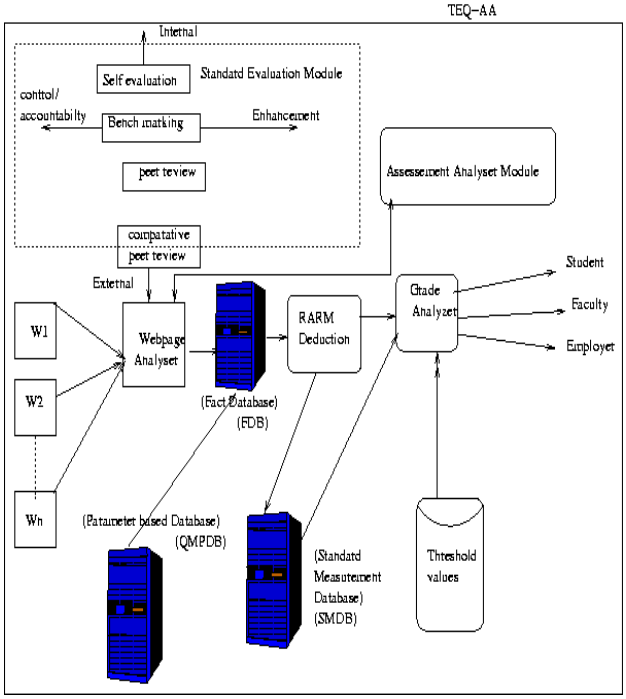

Fig. 2. Functional components of TEQ-AA System

B. **Standard Evaluation Module has the following process for evaluation:**

- Self evaluation: The Institution or program under-going the process is asked to respond to the standard in a written report.
- Peer review: Institutions checks the work performed by one's equals (peers) to ensure it meets specific criteria.
- Comparative peer review: A team of experts, representative of the technical education community review the self evaluation report prepared by the institution as compared the standards for accreditation.
- Bench marking: Quality is measured according to specified standards and they try to work on this accountability to improve on that for better Enhancement.

C. **Assessment and Assurance Module:** Assessment and Assurance Module is responsible for quantitative measurement, qualitative measurement and improvement. Checks by evaluation, whether an institution qualifies for a certain status for technical systems of quality assurance.

D. **Databases used in the TEQ-AA system:**

- Fact Database (FDB): is a database containing the facts of all the institutions extracted from the respective institute website.
- Quality Measurement Parameters Database (QMPDB): is the data containing the values derived manually from the associated facts by the TEQ-AA System administrator, Standard measurements.
- Database (SMDB): is a database containing the values which is derived automatically by TEQ-AA System from FDB and QMPDB as an opportunity to make judgments on the nature and purpose of the institution.

E. **Grade Analyzer:** Grade Analyzer evaluates the results in a grade, whether numeric (e.g., a percentage or a shorter scale of, for example, 1 through 4); literal (e.g. A to F) or descriptive (excellent, good, satisfactory, unsatisfactory).

F. **Mobile Agents:** The Mobile agents and an autonomous software programs which migrate from one host to another to accomplish its tasks. Mobile agents visits the specified institute website collects the facts about them related to the parameters to be measured to access the quality of technical education.

G. **The Realistic Abductive Reasoning Model (RARM):** The facts collected by the mobile agents and parameter list are computed and it is grouped into their corresponding Standard Measurement category. Abduction is used in "common sense" reasoning and in expert-level problems solving. Abductive inference or abduction means "inferring the best or most plausible explanations for a given set of facts". Abduction is frequently used in everyday "common sense" reasoning and in expert-level problem solving. Abduction involves not only making hypotheses, but also discriminating among them based on their plausibility.

Human diagnostic reasoning often involves "hypotheses generation, "hypothesis updating' and "hypothesis testing". Hypothesize-and-test cycles continue until the plausibility of one or more hypotheses pass some given criteria and they are accepted as reasonable explanations for given criteria. It is convenient to view the sequential, repetitive hypothesize-and test process as consisting of three steps:

- **Faulty evocation**, in which a set of individual hypotheses elements are evoked through associations with a newly given manifestation;
- **Hypotheses formation,** in which the hypotheses elements so generated are combined with previously formed hypotheses to form a set of new hypotheses such that each hypotheses can account for both old and new manifestation;
- **Question generation** or Hypothesis testing, in which a new question is generated whose answer may be used to test and further disambiguate the existing hypotheses.

Strength and weakness analyzer

The strength and weakness of the technical education institution are analyzed using RARM. Figure 3 shows the strength and weakness table.

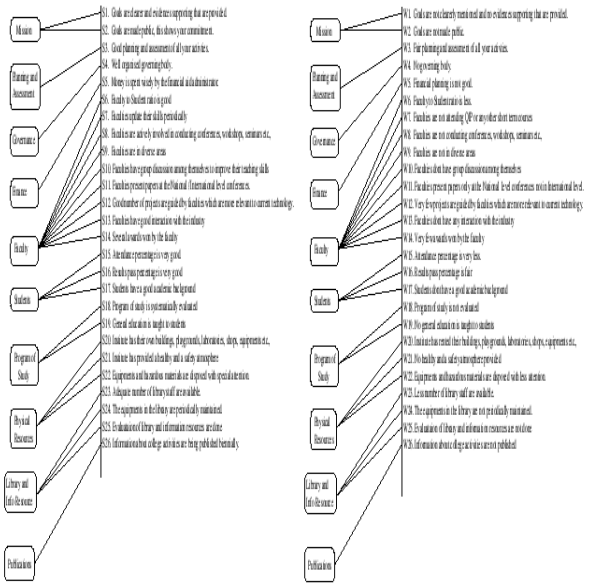

Figure 3: Strength and weakness of a Technical Institution

H. Expectations:

We expect the following from the Technical educational institutions, to improve the education quality assurance and assessment.

a. We should ensure that they collect, analyze and use relevant information for the effective management of their programmes of study and other activities.

b. It is important that Institutions have the means of collecting and analyzing information about their own activities. Without this they will not know what is working well and what needs attention, or the results of innovatory practices.

c. There is also value in institutions comparing themselves with other similar organizations and beyond. This allows them to extend the range of their self-knowledge and to access possible ways of improving their own.

d. Institutions should regularly publish up to date, impartial and objective information, both quantitative and qualitative, about the programmes and awards they are offering.

e. Before hosting the web page, technical universities are inspected by a team of Inspectors to assess the overall effectiveness of their university. Inspection will place more emphasis on checking the capacity of the college to accurate quality and assure its provision and improve or maintain high standards. Only after proper inspection and monitoring, permission will be given to the Universities for hosting their web pages.

I. Quality Index : Some of the Quality Indexes of Technical educational institutions are:

Mission: Every institution shall state in its mission statement its general purpose and specific objectives. There shall be evidence supporting the fact that the programs of the institution are consistent with these objectives and promote the intellectual growth.

- **Planning and Assessment**: Every institution develops and implements a broad-based and integrated system of planning and assessment which involves all appropriate constituencies. The results of assessment data are used to determine institutional effectiveness and modify institutional plans as appropriate.
- **Governance**: Every institution has legal authority to operate from all jurisdictions in which services are delivered. It has a system of governance that facilitates the successful accomplishment of its mission and purposes.
- **Finance**: Since the financial resources of an institution influence, in part, the quality of instructional program, an institution shall present evidence that financial resources are available to achieve and maintain the objectives of the institution. Every institution must province evidence of the reasonable financial viability of the institution and a plan that outlines how the institution intends to continually improve its financial position.
- **Faculty**: The primary responsibility for the development and improvement of educational programs lies with the faculty. The professional qualifications, employment responsibilities and effectiveness of teaching are paramount factors in consideration of an institution for membership.
- **Students**: Each institution provides an environment which fosters academic success and intellectual and personal academic success and intellectual and personal growth by offering appropriate student support services and co-curricular activities.
- **Physical resources**: like building and grounds, utilities, laboratories , shops, equipments and materials whether owned or rented, at both on-campus or off-campus locations, are adequate to enable the institution to fulfill its stated purposes and objectives.
- L**ibrary and Information resources**: The institution provides library resources and services to support its educational programs and the intellectual, cultural and personal development and its students and staff.
- R**esearch/ sponsored projects/ collaborations**:

As a comprehensive institution, the University seeks to encourage quality research and research training in all academic areas. There must be some selectivity and strategic priority must be resourced so that they can achieve excellence at an international standard.

EXPERIMENTS

The TEQ-AA system has been implemented in the Protocol Engineering and Technology Unit where we have wired and wireless networks. This system has been accessing more than 51 Engineering institutions throughout the Karnataka state to get the information from the various web pages. This system has been experimented periodically, randomly and also as and when the need occurs to compare a specific requirements. For example, if the Government would like to start a new programs or research projects in particular thrust areas to evaluate the institute infrastructure and core expertise available in institute can be identified by running

TEQ-AA over the latest web sites of all the Institutions in the State.

RESULTS

In this section, we describe some of the results obtained from the various experiments.
Figure 4 and 5 shows the institute core competences in the two quality measurement parameters (Student and Faculty) and gives the strength and weakness and also provides the advices. Also Figure 6 and Figure 7 shows the comparative statement of publications for the past 5 years in ECE and Physics Department in the Institute.

College 1

Quality measures for SM	Strength	Weakness	Advice
Research Students	Many research QIP & Staff registrants	few PhD registrants	Increase the intake of PhD
	Produce very good Project records	Students not attending attending departmental seminars	Encourage students to attend seminars that are relavent to their research.
Faculty	Faculty have good interaction with students	Very less PhD's	Increase the placement activity.
	Faculty have many publications	Faculty do not have industrial interaction	Encourage faculty for industrial trips and interaction

Figure 4: Institution-wise comparative strength and weakness and advice.

College 2

Quality measures for SM	Strength	Weakness	Advice
Research Students	Many external registrants	few MSc registrants	Increase the intake of QIP and Staff registrants.
	very good CGP score	Students not good in Project work	Encourge students to attend seminars and practical sessions.
Faculty	Faculty have good interaction with Industries	faculty do not interact with students	Interact well with students
	Faculty have many awards	Faculty do not have attend to short term courses	Encourage faculty to attend short term course for diverse knowledge

Figure 5. Institution-wise comparative strength, weakness and advice.

ECE Department

Status	Year	Books	Journal papers	Book chapters	Conference Papers
Submitted	Until date	0	45	0	26
Accepted	Until date	0	24	0	18
Appeared	2007	0	2	0	5
Appeared	2006	1	17	0	66
Appeared	2005	2	16	0	60
Appeared	2004	2	37	2	97
Appeared	2003	1	31	2	66

Figure 6: Institution-wise comparative statement of publications for the past 5 years in ECE Department

ECE Department

Status	Year	Books	Journal papers	Book chapters	Conference Papers
Submitted	Until date	0	45	0	26
Accepted	Until date	0	24	0	18
Appeared	2007	0	2	0	5
Appeared	2006	1	17	0	66
Appeared	2005	2	16	0	60
Appeared	2004	2	37	2	97
Appeared	2003	1	31	2	66

Figure 7: Institution-wise comparative statement of publication for the past 5 years in Physics Department.

The system has been tested by considering several engineering institutions web pages in the State of Karnataka, India.

CONCLUSION

In this paper, we have designed and developed TEQ-AA system for technical education assessment and improvement. This TEQ-AA system will provide comparison standard rating of each institute .
The results demonstrates that we can have the technical education institution assessment and improvement system on day-to-day basis and provide the system for the improvement aid in future planning of technical education in the state and in the country. The system also enables planning of new curriculum/research programs since it provides strengths and capabilities of every institution in that particular thrust areas.

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