(Proc. of 4-th Int. Conf. Computer Aided Engineering Education, ed. M. Chrzanowski, E.Nawarecki (CAEE'97), vol.2, pp.156-164, AGH Krakow)

QUALITY ASSURANCE IN HIGHER EDUCATION

Zbigniew MROZEK [1], Osei ADJEI [2], Ali MANSOUR [2]

Abstract

The philosophy of quality assurance (QA) and total quality management is derived from industrial and commercial practice. We propose the adoption of international standards ISO 9000 (used in industry and commerce) to higher educational institutions to assure and improve the quality, efficiency, and delivery of their programmes and services. This paper examines the scope and structure of a QA system applicable to any educational institution. In particular, it looks at the requirements in terms of the objectives to be achieved, the procedures needed to be undertaken, and the necessary CAE tools and techniques for achieving improved QA in higher education.
The QA techniques should be used to predict, monitor and verify efficiency of any investments or enhancements (new study program, CAL equipment and software, staff trainings) into educational processes. An example of a QA system adopted by one of the new UK universities is outlined as an illustration.

Keywords
teaching quality, quality assurance, ISO 9000 standards, CAL and CAE tools

Acknowledgement

The authors wish to thank Dr. Lynne Dunckley of the Department of Computing, University of Luton, for her helpful comments.

Komentarz [brak1]: 1

[1] *Cracow University of Technology (Politechnika Krakowska), phone (48-12) 130076, zbigniew.mrozek@pk.edu.pl. PL 31-155 KRAKÓW,Poland, Warszawska 24,*

[2] *University of Luton, Park Square, LUTON, Bedfordshire, LU1 3JU, England,*
osei.adjei@luton.ac.uk; phone (44-1582) 734111 ext. 2112
ali.mansour@luton.ac.uk; phone (44-1582) 734111 ext.2635

1 Introduction

The philosophy of **quality assurance (QA)** and **total quality management (TQM)** is derived from industrial and commercial practice. Adoption of international standards ISO 9000 (used in industry and commerce) is proposed to assure and improve the quality and efficiency of the educational process. The QA techniques should be used to predict, monitor and verify efficiency of any investments or enhancements (new study program, **CAL** equipment and software, staff trainings) into educational processes. Several **CAE** tools and techniques for quality improvement and for guidance in establishing and implementing a quality system are described in this paper.

The educational process will be seen as supplying knowledge (skills and understanding) for students - the customers. The customer is free to choose the suitable service provider (educational institution) and customer satisfaction is the most important factor for the commercial success of any service provider. The above philosophy is well understood by most of the new private educational establishments.

In this paper we will discuss our proposed approach, indicating the scope and structure of a QA system for an entire institution. The paper specifies the requirements in terms of the objectives to be achieved, the procedures needed to be undertaken, and the necessary CAE tools and techniques for achieving improved QA in higher education.

2 General quality objectives

The introduction of QA methodology should be considered by all educational institutions. Contrary to quality control (testing the results), QA includes all activities needed to provide effective services for customers during the basic educational process and the full life cycle of the graduate (a graduate is a product of an educational institution).

The official goals [see ISO 9000] of an educational institution should include:

1. customer *(student and his sponsor)* satisfaction consistent with professional standards
2. continuous improvement of service
3. giving consideration to the requirements of industry, commerce and the public sector
4. efficiency in providing the service

On the other hand, this general description should be customised to a set of local quality objectives, according to the mission and circumstances of the educational institution:

- clear definition of customers' *(the student and his sponsor)* needs with appropriate quality measures
- preventive action and controls to avoid customer dissatisfaction
- optimising quality-related costs for the required performance and grade of service
- creation of collective commitment to quality within the educational organisation
- continuous *(and never ending)* review of service requirements and achievements to identify opportunities for service quality improvement

2.1 Top-down approach to educational quality system

Effective QA in large and complex organisations is beyond the capacity of individuals using informal methods. A systematic approach should be based on the requirements of the organisation as a whole rather than the needs of local subsystems. This means that a **top-**

down approach starting from the overall **mission, vision and strategy** of the institution must be taken.

The mission statement, image and quality policy of the institution are the key elements to the success. Burge and Tannock [1992] mentioned two examples of mission statements:

- *"The University intends to strengthen its current position as a provider of undergraduate and postgraduate taught courses of the highest international academic standards in all disciplines."* This is the traditional and non-flexible mission statement.
- *"The college aims to continuously enhance and improve the quality of its entire range of programmes of study to fulfil the needs of students who will be employed by industry, commerce and public sector organisations."* This mission statement identifies students as customers and explicitly defines acceptance of continuous quality improvement processes.

Support (computer centres, libraries, etc.) and administration services are also included in the system, as they play a key role in the quality of education. **Additional administrative effort** should be only undertaken if it will yield **substantial benefits.** This means that the system should avoid the time consuming work commonly found in poorly defined systems and procedures [Burge and Tannock, 1992].

2.1.1 Local level objectives

Responsibility for detailed planning and operation of procedures is devolved to academic units (chairs, departments, units), giving them freedom to define and use methods appropriate to their own disciplines. It may happen, that existing structures and systems should be changed in the light of the agreed objectives. Objectives at the local level should ensure that the overall quality is maintained and improved.

Support and administration quality plan. Each supporting and administrative function within the unit which has an impact on the quality of education, should prepare a quality plan including local objectives, procedures, performance indicators as well as structure, responsibility and review mechanisms.

The academic unit quality plan should also be specified in the same manner as the support and administration quality plan.

2.2 Study programme quality plan

The study programme quality plan should be prepared for each programme of study offered by an academic unit. The following points should be covered:

1. The purpose of the programme of study, with respect to **student demand**
2. The objectives of the programme of study, with respect to the **balance of the knowledge**, understanding and skills to be achieved
3. The content, level, structure and teaching/learning strategy of the programme. Using modern **CAL tools** and introduction of **modular credit scheme** with partial or full freedom in choosing the modules may be essential to attract students and to get feedback on actual students' preferences [Adjei, *et.al*, 1996]
4. **Responsibility** for conducting the programme of study
5. The place of the proposal within the context of already existing programmes
    - availability of resources (academic staff, technicians, buildings, laboratory equipment, **CAL software**, etc.) within the unit, to support the new proposal
    - availability of resources from support and administrative services, (also any external input needed from other institutions, industry, commerce) to support the new proposal

6. The means for **assuring the quality** of teaching and assessment (*polish: szacowanie*)

The new study programme should be validated using officially approved validation procedures and probably a final validation meeting of educational staff and other bodies involved in preparation of the programme. Once the objectives are agreed, the proper activities should be defined and documented.

2.3 Review and administration of study programme

Each programme (new or existing) should be documented in terms of its syllabus, teaching methods, timetable, assessment methods and records. Also codes of practice and guidelines for the staff involved with the programme, may be necessary.

Attention should be given to ensure that the quality of education is maintained. The study programme review should be conducted by the educational staff, taking into account the objectives presented in section 2 above, statistical records (trends of students interest) and other opinions (e.g. external examiners).[3] An important aspect of the administration is monitoring and control of each student during the programme and identification of trends in applications, admissions and effectiveness of the programme of study.

Review and control activities should be documented and audited accordingly to ensure agreement with existing procedures. This implies that supporting CAE tools and techniques (e.g. benchmarking, diagrams, etc.) should be used.

3 Quality Systems and Procedures

A formalised and documented system of QA (as described in the ISO 9000 family of standards) should be designed and developed. For all parts of the educational institution structure (e.g. central administration, academic units, support and administrative services), the relevant activities should be proposed, based on the agreed aims and objectives.

A review and audit process carried out on all levels is an integral part of the concept.

3.1 Quality policy

For quality improvement to be successful, senior management must encourage and motivate the staff and implement their recommendations whole-heartedly. Many industrial organisations have failed to implement effective quality programmes because proposals from staff were not adopted.

To achieve the quality objectives, the highest level of management should establish a quality system with a structure for effective control, evaluation and improvement of service quality. To ensure that critical tasks are not neglected, responsibility for key activities should be assigned to specified staff. The responsibility and authority defined should be consistent with the means and methods necessary for achieving the objectives. However, involvement, commitment and effective collaborative working of all personnel is essential.

3.2 Auditing of quality system

Audits should be planned and evaluated on a regular basis to determine if the activities and related results comply with planned arrangements. The audit should include [see ISO 9000].

- scheduling activities and areas to be audited
- assignment of personnel with appropriate qualifications to conduct audits
- documented procedures for carrying out audits, including:

[3] co-operation with external examiners and professional bodies can help to maintain high educational standards.

- recording and reporting results
- reaching agreement on corrective actions taken on the deficiencies found during the audit
- observations, conclusions and suggestions

Personnel conducting the audit should be independent of those having direct responsibilities in the areas being audited.

4 An Example of a QA System

The following is an example of a QA system presently in use at the University of Luton [Harris and Forsyth, 1995].

Student Representatives	Committee Structure	Executive Structure
Role: Enabling students to influence decisions on academic policy.	Role: Deciding academic policies and priorities, and judges quality.	Role: Ensuring academic leadership and implementing committee decisions.
President and Vice President (Education) of Student Union	Academic Board	Vice Chancellor
President and Vice President (Education) of Student Union	Academic Standards Committee	Dean of Quality Assurance
2 Students elected by course/field representatives	Faculty Boards	Dean of Faculty/Head of Modular Scheme
No student representation	Faculty Academic Standards Committees	Chairs of Faculty Academic Standards Committees
Minimum of 2 representatives elected by students on course/field	Course/Field Committees	Course and Field Managers

In this QA system, for each committee, an executive member of staff chairs the committee in order to ensure that decisions are implemented. In addition, elected student representatives are full members of the committees where their views are actively sought and welcomed. The views of all students are also collected through the use of Student Perception of Module (SPOM) and Student Perception of University (SPQ) questionnaires collected at the end of each semester. The results of these questionnaires are then fed back to the course/field committees and then to the module co-ordinators to act on them.

5 Supporting tools and techniques

There are several tools and techniques recommended by ISO 9000 standards to support decisions based on analysis of numerical and non-numerical data.

Non-numerical data should be identified and presented using **affinity diagrams, benchmarks, brainstorming, cause and effect diagrams, flowcharts** or **tree diagrams**.

Where possible, numerical data should gathered using *data collection forms* and visualised by means of **control charts, histograms, Pareto diagrams, scatter diagrams**. Proper statistical interpretation of data should be used if applicable.

Data collection forms should be developed and used to obtain a clear and reputable picture of facts. This promotes collection of both, numerical and non-numerical data in a consistent manner and facilitates data analysis. Some small amount of data should be collected in advance to find whether the proposed collection forms need updating. Information on data collection must include who collects the data, where it is collected from, at what times and in what ways. This information is relevant to the effective analysis of the data.

5.1 Tools and techniques for non-numerical data

5.1.1 Affinity diagram

Affinity diagrams (*polish: wykres współzaleznosci*) are used to organise large number of ideas, opinions or concerns (about a particular topic) into groups.

The following procedure is described in ISO 9000 standards:

- state the topic to be studied in broad terms - prevent giving any suggestions
- record all individual opinions on separate cards
- mix the cards and spread them randomly on a large table
- group related cards together as follows
    - sort cards that seem related into groups (maximum 10 cards in group)
    - locate or create a header (title) card that captures the meaning of each group
- transfer the sorted information from card onto paper

The described procedure works well for small groups (not more than 8 members).

5.1.2 Benchmarking

Benchmarking (*polish: dzialania porównawcze*) is used to compare a process against recognised processes/techniques to identify opportunities for quality improvement. It helps to identify targets and priorities for preparation of plans.

5.1.3 Brainstorming

Brainstorming is used to identify possible solutions to problems and potential opportunities for improvements. This technique is used for tapping creative thinking of a team to generate and clarify a list of ideas problems and issues.

There are two phrases in the brainstorming procedure:

- during the **generation phase**
    - the purpose (target) of the brainstorming session is clearly stated
    - each team member takes a turn in a sequence, stating a single idea
    - where possible, new ideas are build on others' ideas
    - all ideas are recorded and should be seen by all the participants (using whiteboard or overhead is recommended)
    - at this stage, ideas are neither criticised nor discussed
    - the process continues until no more ideas are generated
- the **clarification phase**
    - list of ideas should be reviewed to make sure that each person understands all the ideas
    - evaluation of ideas will occur after the brainstorm session is completed.

5.1.4 Cause and effect diagram A cause and effect diagram[4] is used to analyse relationships between a given effect and potential cause. The many potential causes are organised into major categories and subcategories. The final diagram looks like a skeleton of a fish. The procedure for preparing the diagram is:

- define the effect clearly and concisely
- identify major categories of possible causes, including people, methods and procedures, measurements, materials, equipment, environment, data and information system
- begin to construct the diagram: effect is in a box on the right-hand side of the fish bone and major categories as 'feeders' to the effect.
- continue to obtain hierarchical skeleton diagram, as described in ISO 9004-4 standard.

5.1.5 Flowchart and tree diagram

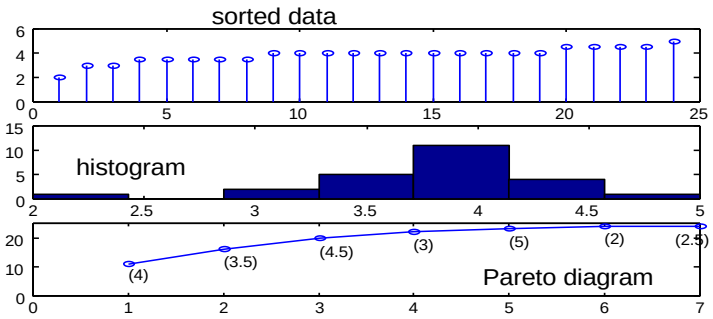
A **flowchart** is a pictorial representation of the steps in a process. It helps to understand how a process actually works (or how it should work). A **tree diagram** is used to show relationships between a topic and its component elements. Ideas generated by brainstorming or presented with affinity diagrams can be converted into tree diagrams to show logical and sequential links.

5.2 Tools and techniques for numerical data

5.2.1 Control chart

A control chart is used to determine when a process needs to be adjusted or may be left as is. It is also used to confirm an improvement to a process. The control chart methodology is based on statistics and to guarantee reliable results, ISO 7870 and ISO 8258 standards should be consulted.

5.2.2 Histogram and Pareto diagram

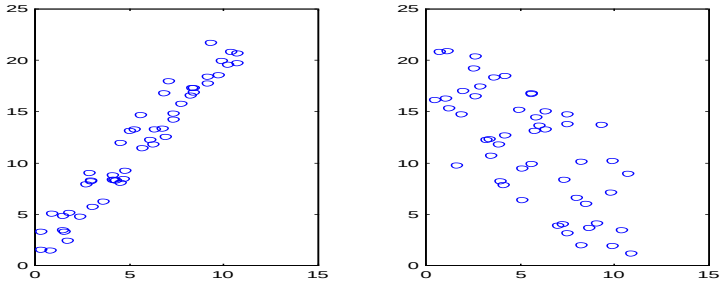


A **histogram** is used to display the pattern of variation of a process. This may help to make decisions on where to focus improvement efforts. A **Pareto diagram** is used to display the contribution of each item to the total effect in order of importance. It helps to rank improvement opportunities. MATLAB [Mrozek, 1996] was used to prepare the above diagrams.

[4] also known as fishbone diagram.

5.2.4 Scatter diagram

A scatter diagram is a graphical technique for studying the relationship between two associated sets of data (e.g. (x,y)). Each point (x,y) is plotted as a point on an x-y plane and the set of points will form two-dimensional cloud of points. The relationship between the associated sets of data are inferred from the shape of the cloud. MATLAB [Mrozek, 1996] was used to prepare the scatter diagram.



. Scatter diagram: strong positive relationship and weak negative relationship

5.3 CAE and presentation tools for numerical and non-numerical data

There are mane **CAE tools** to be considered. **Microsoft Office** (Excel, Word, Power Point) ,is very useful on any level of preparing and implementing QA scheme. **MS Plan** is an excellent tool to prepare schedule and to monitor progress of the work. **Netscape** and **Explorer** (using HTML language) are completely free for educational purposes and seems to be even better than MS Word for documenting, network communication and data collecting. **Excel** or much more powerful and easy to use **MATLAB**, can be used for data processing and visualisation.

6 Conclusions

In this paper we have proposed the adoption of ISO 9000 quality assurance standards to the processes and services offered by educational institutions along the lines of any other institution or organisation offering services to its customers. We believe that this approach promotes efficient educational processes (including use of CAL and computer networks) which in turn facilitates better programmes for customers (i.e. students and their sponsors).

We briefly outlined the various CAE tools and techniques available to QA personnel to improve the quality of the services offered. In this respect, we highlighted the tools and techniques for representing numerical and non-numerical data as part of the documentation and evaluation of a QA system.

Finally, in addition to the various procedures, methods, tools and techniques proposed in this approach, it is essential that maximum effort needs to be utilised on the part of all the personnel and services of the educational institution to make the QA system worthwhile.

References

Adjei O., Mansour A., Mrozek Z., Sojka R., and Vafadari R. (1996) “The Modular Credit Scheme: Organisation and Implementation” (in English), in “Komputerowe Wspomaganie Zarzadzania Uczelnia na poziomie Wydzialu”, AGO Krakow, ISBN 83-86547-11-1.

Burge S.E. and Tannock D.T. (1992), “Quality Assurance in Higher Education”, Engineering Professors Conference Occasional Papers, No.4, March.

Harris, R.W. and Forsyth, K. (1995), “AA Guide: Academic Advice for Students”, University of Luton, UK.

International standards ISO 7870, ISO 8258, ISO 8402, ISO 9000-1, ISO 9000-2, ISO 9000-3, ISO 9000-4, ISO 9001, ISO 9002, ISO 9003, ISO 9004-1, ISO 9004-2, ISO 9004-3, ISO 9004-4, ISO 10011-1, ISO 10011-2, ISO 10011-3.

Mrozek B., Mrozek Z., (1996) ‘’MATLAB, Uniwersalne srodowisko do obliczen naukowo-technicznych’’, 3-rd edition, PLJ Warszawa, ISBN 83-7101-325-6.