SUBJECT BENCHMARK STATEMENT

IN

CHEMISTRY

Quality Assurance and Accreditation Council
University Grants Commission
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CONTENT

FOREWORD

The work in connection with the development of Subject Benchmark Statements was begun in August 2003 as a part of the overall quality assurance framework that supports academic standards and the furtherance and dissemination of good practice in Universities in Sri Lanka. Subject Benchmark Statements will support and promote quality and standards by:

- Providing universities with a common and explicit reference point for internal and external programme approval and review;

- Guiding and promoting curriculum development, especially in new departments and new universities, and in other institutions of higher education;

- Evolving over time to take account of changes and innovations that reflect subject development and new expectations;

- Providing an authoritative and widely recognized statement of expectations of what is expected of a graduate in a specific (or designated) subject area in a form readily accessible to students, employers and others with a stake in higher education;

- Providing a clear and transparent reference point for External Examiners;

- Assisting international comparison and competitiveness of higher education awards and student achievement.

SUBJECT BENCHMARK STATEMENT

CHEMISTRY

1. INTRODUCTION

1.1 Subject Benchmark Statement – Scope and Purpose

Subject Benchmarking is one of the key components of Quality Assurance and Accreditation in Higher Education. It provides the general nature and the essential subject components that should be covered within a given subject at the tertiary level of education. Academic programs at different higher education institutions may have their own aims and objectives and relevant detailed curricula. However, knowledge, skills, attitudes and competencies that have to be developed by a student at the end of a given subject course at the tertiary level, can be framed irrespective of such detailed subject curricula. Subject Benchmarking is the result of such an exercise.

This subject benchmarking statement refers to Chemistry as a subject in Bachelor of Science degree programs in public universities in Sri Lanka.

1.2 Nature and Content

Subject benchmark statements are important in many ways and can be used as a guideline for many academic activities within the subject. These are as follows.

1. It can be used by new institutions and academic departments as a guideline for introducing new chemistry courses.
2. It provides a base for comparing different chemistry curricula adopted by different public and private higher education institution in the country as well as in foreign institutions.
3. It can be used as a reliable source of information for students who intend to follow chemistry as a subject at the tertiary level.
4. The information can be used by employers to check whether the graduates are properly fitting to their job requirements at the level of recruitment.
5. This provides a broad guideline for reviewers in the subject review process to check whether the courses are fitting to an accepted academic level and also to compare the teaching programs in different higher educational institutions.

2. SUBJECT AIMS

This document provides details of the followings:

1. The objectives of introducing chemistry as a subject for a B. Sc. Degree programs.
2. The general subject content of chemistry that supposed to be covered in the program.
3. Skills, attitudes and competencies that a student should have developed at the end of the program.
4. Strategies that can be adopted in order to achieve the intended objectives of the program.
5. The assessment procedures.

6. Performance indicators and grading.

The above aspects will be discussed in the following sections.

The objectives of introducing chemistry as a subject for B. Sc. Degree programs.

1. To produce graduates having a higher chemical knowledge, suitable for multipurpose subject related activities.
2. To provide students with a sound and clear knowledge on basic theory that can be used for understanding the different aspects of the subject.
3. To provide students with practical chemistry knowledge that covers the whole spectrum of basic chemical techniques required for different purposes.
4. To develop skills of combining theory and practice to understand and to solve basic problems related to the subject.
5. To provide the students with knowledge on how to use traditional and modern information sources related to the subject.
6. To provide them with a knowledge on chemical research and relevant literature.

3. SUBJECT KNOWLEDGE AND UNDERSTANDING

The general subject content that supposed to be covered in the program will be discussed in the following section.

The curricula of an individual institution may depend on several factors. Availability of the academic staff and their subject specializations, the laboratories and other facilities, library and information sources, number of students following the course and also the needs of the people in the society specially under the concept of "university village" as applicable to some universities of the country. However, in order to recognize chemistry as a subject in any B. Sc. program, it will be necessary to ensure that the programs will cover the following learning outcomes to be achieved at the end of the course.

- Structure of atoms and molecules, nature of chemical bonding based on classical as well as basic quantum mechanical interpretations.
- Structure and properties of matter in different states (including new developments) and the theories used to describe them.
- The principles behind the techniques used for structural investigation and chemical analysis. (spectroscopic methods, chromatographic methods, nuclear methods, thermal methods, electroanalytical methods, kinetic methods, optical methods etc.)
- Principles of thermodynamics and their applications to chemistry including equilibrium and surface chemistry.
- Chemical kinetics including reaction mechanisms and catalysis.
- Electrochemistry including electrolytic and galvanic cells and electroanalytical techniques.
- Group relationships and trends of properties of elements and their compounds (in all four blocks) in the modern Periodic Table.
- Structure and general properties of aliphatic, aromatic, heterocyclic, inorganic complexes and organometallic compounds.
- Structure, properties and reactions of functional groups in organic compounds.
- Chemistry of polymers, proteins, carbohydrates, enzymes, lipids, nucleic acids and fundamentals of natural product chemistry.

- Principles of large scale production of materials, chemical processes and unit operations.

The following practical skills and abilities are expected to be developed by students at the end of the chemistry course.

- Use of titrimetry and gravimetry as traditional analytical methods.
- Analysis of inorganic mixtures for simple cations and anions.
- Analysis of organic compounds for elements and functional groups.
- Techniques of purification of organic and inorganic compounds.
- Synthesis of simple organic compounds and inorganic complexes.
- Instrumental methods of analysis (Potentiometry, coulometry, conductometry, amperometry, spectrophotometry, chromatography etc.)
- Calibration and use of simple instruments and use of guidelines supplied by manufacturers for maintaining such instruments.
- Error calculations and significant figures.
- Report writing based on laboratory experiments.
- Laboratory safety and good practices of handling chemicals and laboratory glassware and instruments.

The following transferable skills are expected to have developed by students towards the end of the course of study. The teaching and learning process should be designed to support gradual development of the following skills throughout the course.

- Study skills needed for the development of knowledge for personal career.
- Time management and organizational skills required for better performance of the employment.
- Interpersonal skills required for term-work in a work place.
- Skills on efficient and proper use of information technology and traditional information sources.
- Communication skills to exchange knowledge and ideas using both oral and written forms.

4. SKILLS AND ATTITUDES

The objectives and the learning outcomes mentioned above cannot definitely be achieved through traditional teacher centered education system. Competency based, activity oriented and student centered pedagogical strategy is definitely required for this purpose. The following teaching and learning processes are proposed accordingly.

- Teacher centered delivery of subject matter using traditional as well as modern methods of presentation.
- Motivation of students for self studies by assignments, group presentation, poster presentations, discussions and other processes.
- Designing of laboratory practical classes with specific and well defined objectives and conducting the majority of classes on continuous assessment basis.
- Submission of tutorials in written form by students and tutorial classes for small number of students conducted by a tutor after correcting the tutorials and returning them back to students.

- Different types of practical sessions planned for two students and also for a group of students – to develop the skills of group working.
- Group projects for students
- Seminar presentations based on selected topics including a literature survey.
- Industrial training, report writing and presentation based on the industrial experience.
- Industrial visits which are properly planed with specific objectives and motivation of students to interact with the personnel in industry when and after the visit.

5. ASSESSMENT METHODS

The following assessment methods are proposed to evaluate the performance of students on different aspects. The procedures must always be based on standard evaluation principles of education (eg. Bloom's educational taxonomy)

- Written examinations – Both MCQ type and essay type to measure different abilities. Support of external examiners and pre-prepared marking schemes will ensure reasonable evaluation process.
- Practical examinations- High percentage of marks should be assigned to practical conducted as continuous assessments. Practical examination can be held only for testing time management and special skills related to the subject.
- Presentations - Presentations can be done for an audience consists of academic staff and students. Different aspects of presentation (facts and content, transferable skills, response to questions, eye contact, use of suitable supporting materials etc.) can separately be evaluated. Averaging of marks given by different staff members avoids possible subjective errors.
- Oral examination - Different types of skills can be evaluated by a group of staff and marks can be allocated separately by the staff to avoid subjectivity of the evaluation.

6. MAINTENANCE OF STANDARDS AND GRADING

At the end of each course unit or module grades (A+, A, A-, B+, B, B-, C+, C, C-, D+, D and E) which are based on the standardized raw marks will be allocated. Each grade corresponds to a grade point (4..0, 4.0, 3.7, 3.3, 3.0, 2.7, 2.3, 2.0, 1.7, 1.3, 1.0, 0.0 respectively according to the UGC Circular Number 901). At the end of the course the grade point average (GPA) will be calculated for the subject. Depending on the GPA, a grade will be reassigned to indicate the performance of the overall subject. The final GPA or the corresponding grade can be used to indicate ones performance.

7. LEVELS OF ACHIEVEMENTS

7.1 General degree programs

All criteria discussed in above sections are applicable to the general degree chemistry programs conducted by the universities. However, a majority of the chemistry departments of state universities conduct B. Sc. Chemistry Special courses in addition to above chemistry courses. The percentage of students who are following the special degree courses will be only about 10 % of the total chemistry

students. In most cases, as implied by the subject review reports, at present, no considerable attention has been paid to promote the skills and competencies of the majority- the non special students. This issue was seriously considered when preparing this subject benchmarking statement.

7.2 Additional topics and activities for Special Degree Programs

All the course content, practical and other activities mentioned above will also be applicable to the special degree programs as well. However, the depth and the width of the content can be expanded according to the special objectives. In addition, following subject topics, practical work and activities will be proposed as a part of the subject benchmarking of chemistry in the special degree programs.

- Detailed quantum mechanical treatment of chemical bonding.
- Statistical thermodynamics
- Symmetry, group theory and crystallography
- Inorganic and organometallic complexes
- Computer applications in Chemistry
- Chemical instrumentation
- Synthetic organic chemistry
- Physical organic chemistry
- Analysis of natural inorganic materials (soil, clay, minerals)
- Research project carrying over a full semester, report writing and a research presentations based on the project.
- Spectroscopic methods and Separation techniques
- Natural product chemistry

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