Reviewing and developing course descriptions to comply with accreditation requirements

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ABSTRACT: Engineering degree programmes at the University of Botswana (UB) have been offered for about two decades. During this period, the programmes were reviewed and modified in response to employers' needs and also to incorporate modern developments in ICT and digital technology. The programmes are now to be presented for accreditation by the Engineering Council of South Africa (ECSA). Discussed in this article is the process of designing and developing a course outline that would fit the requirements of accrediting bodies. The pedagogical model, which describes the process of developing courses, is presented. Elements of the model are described in relation to Bloom's revised taxonomy. As a starting point for designing a course template, the requirements of accrediting bodies (ABET, ECSA) on course outline was used in this article. A typical course template is presented. Finally, the model can also be used for developing a new programme as the pedagogical framework covers more general aspects than the course design.

Keywords: course description, course template, accreditation, Bloom's taxonomy, pedagogy

INTRODUCTION

Since 1990, the University of Botswana (UB) has been offering four engineering programmes, all leading to a BEng degree in Construction Engineering & Management, Civil Engineering, Electrical/Electronic Engineering and Mechanical Engineering and BDes degrees in Industrial Design and Design & Technology Education. The programmes have been reviewed over the years to enhance flexibility, promote student-centred learning, incorporate modern developments in Information and Communication Technology (ICT) and digital technology, introduce general education courses and respond to the desires of stakeholders (e.g. industry). The current programmes, which have been operating since 2002, were the result of a change from a typical British year-long system to a semester-based system with course credits and grade point averages.

The vision of UB is to continually review its programmes and improve quality standards to comparable international benchmarks. Therefore, UB intends to have its engineering programmes accredited by the Engineering Council of South Africa (ECSA).

There has been a general move by many university faculties of engineering to get their programmes accredited by professional bodies. This development is borne not only out of a desire for recognition but also to attract students to consider a particular programme of study. Having a programme accredited may give some competitive edge over similar programmes at other institutions, as accreditation assures that a programme has met quality standards set by some professional bodies.

Accrediting bodies impose several requirements on programmes. A programme dossier presented for accreditation will include a number of documents to provide evidence of achieving prescribed goals. One of the fundamental documents is the course description or course profile. There are several requirements on how such course description should look and what it should contain but there is no prescribed format.

The process of preparing a course description can be used as an opportunity to review and modify both the course content and the pedagogical aspects of the course. Such a process can have the benefit of encouraging lecturers to reconsider or rethink the educational aims and the understanding of educational issues, such as objectives, outcomes, and assessments. Unfortunately, many engineering lecturers are not keen on such a demanding process. They may not be familiar or fully conversant with the educational issues, their role and advantages of the process. Some academics may even question the rationale for such a protracted exercise. They are then reluctant to make changes, possibly

because of insufficient commitment or understanding of the educational issues, or benefits related to the process. The process may not be treated seriously and often considered a burden rather than an opportunity for programme improvement.

Some studies have been reported on preparing and presenting engineering programmes for accreditation. For example, Fielder and Brent observed paucity of information on how to translate American Board of Engineering and Technology (ABET) accreditation system requirements to empower or equip students with the skills, attitudes and competencies embedded in the ABET outcomes [1]. The authors reviewed the accreditation process and explained the key terminologies, such as outcomes and objectives, which must be thoroughly understood when designing an engineering programme/course. They, then, described typical instructional techniques and proposed how programme and course activities can be integrated to comply with ABET criteria.

Carter et al considered the preparation of Programme Educational Objectives (PEO) of any engineering programme seeking accreditation as the most important part of documents to be submitted to the accrediting body, e.g. ABET [2]. They observed that the ABET materials do not provide clear guidelines of what should be contained in the PEO and how they should be generated and assessed. They, then, presented a two-part procedure for defining, generating and assessing a PEO. They concluded that PEO provides a central nexus point for the assessment of each programme.

El-Ariss et al stated that engineering programmes submitted for accreditation must include the following documents: a PEO that addresses institutional and programme mission statements and also responds to stakeholders' interests; programme outcomes which specify the knowledge, skills and attitudes that graduates will possess; assessment procedure and a plan for continuous programme improvement [3]. They opined that all teaching staff must be involved actively in the accreditation process. The authors then described in detail the development of a technique to assess individual course outcomes in relation to ABET criteria.

The purpose of this article is to develop a template, which will capture the information required for individual courses in engineering programmes to be presented for accreditation by ECSA. It also provides the educational background involved in the preparation of the course description.

THE PEDAGOGICAL MODEL

The design or redesign of a new or existing course for any purpose requires some fundamental understanding of the cyclical process to be followed. Figure 1 is a pedagogical model, which can be used to create courses in the programme. The model shows a sequential relationship between programme and course features such as educational objectives and learning outcomes, and also other elements such as instruction activities and assessment. The *programme educational objectives* should be developed after extensive interaction and consultation with the stakeholders involved in the educational process [4]. The key element of the model is the students, who are at the heart of the educational process and should be aware and involved throughout.

The model starts with the *programme educational objectives*, which are initially transformed into *programme learning outcomes* to describe graduates' attributes, i.e. their knowledge, skills and attitudes. It is rare and not desirable that a particular course addresses all programme learning outcomes, so it is necessary to specify *course learning outcomes* when a particular course is designed. Such course learning outcomes can be converted into outcome-related course learning objectives. These are objectives, which specifically address one or more programme outcomes and should be attained in the course irrespective of the lecturer. The course also can have some individual *course objectives* not related to the specific outcomes. Those may reflect the special course content or individual interest of the instructor.

Thereafter, it will be necessary to design the *learning and teaching* activities (e.g. group or individual project, design exercises, experiments and industrial training) to achieve the learning objectives. These activities should prepare the student for *assessment*, which measures whether certain criteria or standards have been reached in a course. This also contributes to the summative assessment, that is, whether students have achieved the learning outcomes specified for the programme. Assessment can be performed by the instructor, or the student's peers. Assessment provides information about the graduate and can be used to review the course or the whole programme.

ELEMENTS OF A PEDAGOGICAL MODEL

It is common for lecturers of engineering courses to have a problem in fully understanding certain educational terms used in programme and course descriptions, such as the differences between learning outcomes and learning objectives.

Outcomes and Objectives

Learning outcomes are broad goals that describe *what the learners are supposed to know or be able to do*. Therefore, *outcomes* are different abilities and competencies which students are to acquire. They may be specified for the whole programme or for the individual course but they list knowledge, skills and attitudes expected of the student who passed the programme or the course. There are several pre-defined outcomes, which engineering graduates are to achieve. Such

outcomes are usually prescribed by the accrediting body. It is the norm for the programme seeking accreditation to prove that all required outcomes have been addressed and achieved in the programme.

Learning outcomes are stated in general terms because they are broad goals. However, general learning outcomes cannot be observed, measured or evaluated. Therefore, each learning outcome must be supported and defined by one or more specific objectives that are appropriate, measurable, achievable and realistic within the given time period. Learning objectives are about the curriculum and not the instruction or mode of delivery. They provide descriptions of intended learning outcomes [5].

Learning objectives are statements of students' actions that can be observed, scrutinised and monitored. Objectives serve as evidence that certain outcomes (knowledge, skills and attitudes) have been acquired. Therefore, in describing the objectives, it is necessary to use statements that can be observed. The literature states that to qualify as objective statements, *observable action verb* (*explain, calculate, derive, design, critique* ...) should be used whereas *non-observable actions such as learn, know, understand and appreciate* can be used for outcomes [6][7]. In education environments, learning outcomes and objectives are often loosely arranged into three groups or *domains which* were identified in *Bloom's taxonomy* [8][9].

Bloom's Revised Taxonomy

Bloom's Taxonomy is a hierarchical system of educational objectives developed by Benjamin Bloom in the 1950s. It provides the means of expressing qualitatively different kinds of thinking. It continues to be one of the most universally applied models to organise thinking skills into six levels, i.e. from the most basic to the higher order levels of thinking [8]. Categories were formulated for cognitive (thinking and problem-solving skills), affective (attitudes, value systems), and psychomotor (physical movement) domains. The levels for the cognitive domain are arranged from the least to the most complex levels of thinking and each level is illustrated by action words.

In the 1990s, Lorin Anderson (former student of Bloom) presented the Revised Taxonomy, in which major categories were changed from noun to verb forms (as the taxonomy reflects different forms of thinking, characterised as an *active* process more accurately described by verbs). The other changes involved the renaming of some of the categories, i.e. *knowledge* to *remembering*, *comprehension* to *understanding* and *synthesis* to *creating*. There was also a change in the order of arranging the categories. For example, *creating* (or old *synthesis*) became the top category, above *evaluating* [8][9]. The Revised Bloom's Taxonomy is shown in Figure 2.

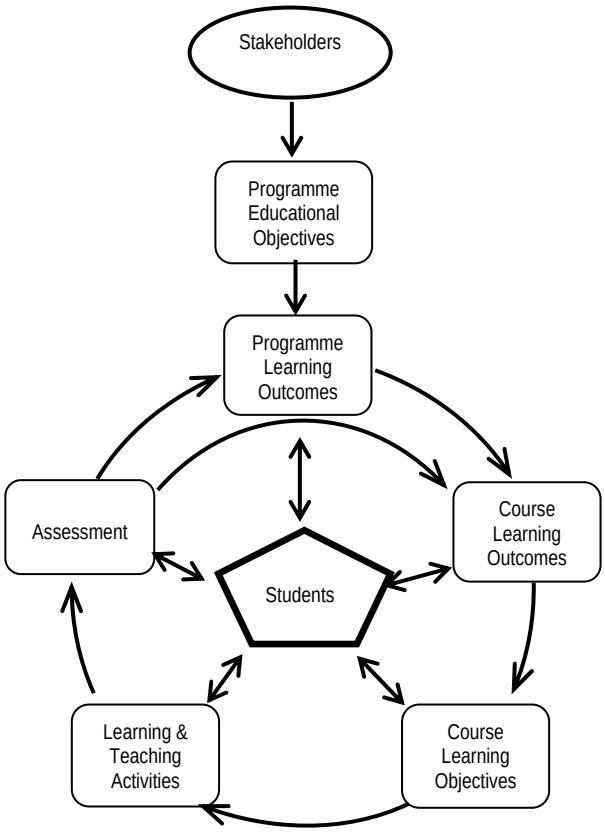

Figure 1: Pedagogical model of course design.

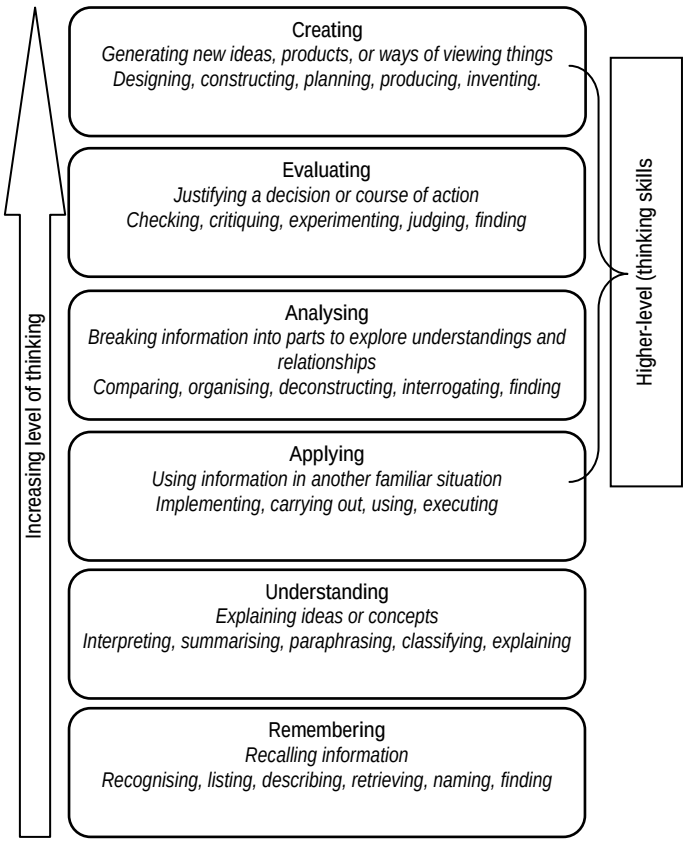

Figure 2: Revised Bloom's Taxonomy.

In a properly designed syllabus, a variety of cognitive levels should be included in the objectives. To create a well-balanced university learning experience, objectives in each course should cover the full range of thinking skills, i.e.

from lower levels of thinking (such as *remembering*, *understanding* and *applying*) to higher levels of thinking (i.e. *analysing*, *evaluating* and *creating*) [10].

Learning and Teaching Activities

The learning and teaching element covers the normal instructions used in a course to achieve learning objectives. A number of learning and teaching strategies can be employed including traditional instructional techniques, such as lectures, tutorials, class discussions, case studies, laboratory experiments and use of different instructional technology. However, other instructional techniques such as problem- or project-based learning (PBL), active learning or collaborative/cooperative learning can be used that have the potential to effectively address the educational outcomes.

Assessment

The assessment in the model presented in Figure 1 has a dual functionality and should be applied at two levels: for a course and for a programme.

First, learning objectives can be assessed for the course by using traditional and modern classroom techniques, such as tests (performance, true-false, short answer), quizzes (multiple-choice tests), problem sets, and examinations. It is important to use different assessment methods and formats to enhance the validity and reliability of assessments and also to ensure that the students have a mastery of the course. Multiple-choice or short-answer questions are appropriate for assessing students' comprehension of details and interpretation skills, while tests would assess their problem-solving skills and written project reports assess their ability to integrate and synthesise. The use of different methods for assessment is called *triangulation* [11].

The second function of assessment is to assess programme outcomes. Although certain information derived from the course assessment can be used also to evaluate the whole programme, the programme assessment requires more tools, such as surveys and interviews with graduating students, alumni and employers, self and peer evaluations, students' portfolios and final year project reports. The *triangulation* concept applies to programme assessments as well.

Designing the assessment tool is not an easy task because it requires specifying *outcome indicators*, as well as *the performance targets*. The former term describes methods to be used to assess the level of attainment of the outcomes and the latter targets criteria for the outcome indicators.

There is an additional problem when assessing outcomes. As one outcome may include different abilities to be acquired by students, there should also be different assessment methods to measure them and they should be linked to an appropriate level on the Bloom's Taxonomy.

ACCREDITATION REQUIREMENTS FOR PROGRAMMES

Most university engineering programmes seek accreditation to ensure that a programme has met quality standards set by professional bodies. Therefore, accreditation should be a central interest of all engineering professionals working at universities. The engineering programmes in different countries are designed or reviewed in order to meet the accreditation requirements imposed by professional bodies to enable the graduates to achieve Professional Engineer status. The Washington Accord governs the recognition and equivalency of the engineering programmes in member countries. The Washington Accord is an agreement between national engineering bodies responsible for accrediting professional engineering degree programmes and it states that graduates of accredited programmes in any of the signatory countries be recognised by the other member countries as having met the academic requirements for engineering practice. The Washington Accord covers engineering undergraduate degrees [12].

There are several requirements (sometimes called *criteria* – ABET), which programmes seeking accreditation should demonstrate to have achieved. One of the fundamental requirements for accreditation is that the students should attain a list of prescribed outcomes. All accrediting bodies list those outcomes and they are very similar but differ slightly in formulation or their number (e.g. ABET Criterion 3 has 11 outcomes while ECSA has 10 outcomes).

However, there are some differences in approach between accrediting bodies. ABET for instance requires …*there must be an assessment and evaluation process that periodically documents and demonstrates the degree to which the programme outcomes are attained* [13]. The requirement for ECSA is more stringent as it requires evidence that all graduates satisfy each outcome at the required level of performance. Additionally, ECSA emphasises, on outcomes at their *exit level, which implies* that *each outcome must be explicitly addressed in terms of the means of assessment and the criteria for satisfaction of each outcome and the required level at exit level*. It also requires evidence about the method of assessment (including the assessment criteria) of the course in each exit level outcome and the expected level of performance. However, the use of summative assessment is allowed for the exit level outcomes: *Clearly identified components of assessment must address summative assessment of the exit level outcomes* [14].

As it is important to provide evidence on the educational aspects of the programme, a suitable course description template must be designed to address all the required information for a course. The ideal format would encompass the

requirements imposed by a specific accrediting body, which has been agreed upon *a priori*. However, it may not be difficult to modify the course format to suit any other accrediting body because requirements by accrediting bodies, especially those in the League of the Washington Accord, are very similar.

REQUIREMENTS OF COURSE TEMPLATE

There are no specific forms prescribed by ECSA for the course description. However, it is expected that each course dossier will provide at least the following information [15]:

a) course outcomes;
b) how the students are assessed against the outcomes;
c) detailed course content;
d) list of prescribed books and other supporting materials.

ECSA also stated that: *This information should preferably be in the form provided to each student*.

Supposedly, because of the last statement, the practice in South African universities is to provide a Course Study Guide (CSG) for the students and it usually contains more information than is prescribed by ECSA. The CSG normally includes information on the class schedule, the instructor, course plan and detailed plan for the continuous assessment. Information on the attainment of the programme outcomes (including exit level) must be included in the course description to show that a particular exit level outcome is achieved.

It also includes the criteria for assessment; how students have been assessed and how performance is achieved. It is to be noted that the ECSA requirement is primarily to provide course outcomes (and the assessment) and not the programme outcomes. Although certainly related, they may not necessarily be the same.

ABET provides more detailed information on the content of the course syllabus but still does not prescribe any format. The course syllabus should contain *at a minimum* the following [16]:

- Department, course number, and title of course;
- Designation of course, e.g. a required or elective course;
- Course (catalogue) description;
- Prerequisites;
- Textbook(s) and/or other required materials;
- Course learning outcomes;
- Topics covered;
- Class/laboratory schedule, i.e. number of sessions each week and duration of each session;
- Contribution of course to meeting the requirements of the curriculum;
- Relationship of course to programme outcomes;
- Person(s) who prepared the description and date of preparation.

ABET also requires that the format be consistent for each course and must not exceed two pages per course [17]. However, ABET insists on provision of information for programme outcomes, relationship of programme outcomes to programme educational objectives, relationship of courses in the curriculum to the programme outcomes and, finally, achievement of programme outcomes.

A quick survey of a few self-reports of programmes seeking accreditation by ABET reveals there are different formats engineering programmes use [19-21].

DESIGN OF COURSE TEMPLATE

In order to design a course template, it is necessary to decide the purpose of the template. The primary purpose is to present uniformly courses' content of all engineering programmes at UB for accreditation by ECSA. However, the following additional rationales are also important:

1. Improve the standard of course descriptions available to students;
2. Improve the standard of course information available to students;
3. Improve awareness of the contribution of different courses;
4. Trace graduate attributes across the programme;
5. Recognise good pedagogical practice;
6. Increase collaboration among academic staff.

It is pertinent to mention that the template has been designed to fit the requirements of both ECSA and ABET for accreditation. This flexibility is to ensure that the engineering programmes can be accredited by any of the bodies without reviewing the template again.

The multi-purpose requirement of the course description makes it difficult to achieve a compact, short form which would satisfy the requirements of accrediting bodies and also provide enough detailed information for the students. Therefore, it is quite pragmatic to split the form into two parts.

One would contain information required for accreditation, and, which would not be changed every time the course is offered. The second part of the template would provide information related to the offering of the course and that is flexible, allowing a lecturer to modify the instruction of the course (schedule, topic plan, assessment details etc). The accreditation part of the template would contain the information shown in Table 1.

Table 1: Accreditation part of course template.

Section	Summary of Content
Course Detail	Faculty Department Course Code and Title
Basic Information	Number of Credits Number of SAQA Credits Number of Hours per Week Type of the course (Core, Optional) Semester in which the course in normally offered Pre-requisite course(s) Co-requisites course(s) Examinable (and the Exam Mark contribution to the Final Mark) Name of person who prepared the course description and Date
Contribution to Knowledge Areas	Specifies the percentage of content in any of the following knowledge areas: • Mathematics • Basic Science • Engineering Science • Design and Synthesis • Computing and IT • Complementary Studies
Contribution to Programme Learning Outcomes	Specifies contribution to pre-defined learning outcomes (i.e. using ECSA Qualification Standard for BEng programmes): • Engineering Design • Investigations, experiments and data analysis • Engineering methods, skills and tools, including Information Technology • Professional and technical communication • Impact of engineering activity • Individual, team and multidisciplinary working • Independent learning ability • Engineering Professionalism • Problem Solving • Application of scientific and engineering knowledge Contribution to be specified as High, Medium, Low or None (blank). There should be a separate indication as to whether the course is to be considered in assessing Exit Level outcome.
Aims of the Course	Describes broad vision and statements of what is to be achieved in the course. Fairly general information giving students an indication of the scope of the course and its relationship to other courses in the programme.
Course Learning Outcomes	Course Learning Outcomes in relation to Programme Learning Outcomes
Contents of the Course	Description of course content
Methods of Teaching and Learning	Description of teaching and learning methods applied in the course
Assessment of Learning Outcomes	Specifies in a tabular form specific measurable learning objectives for Course Learning Outcomes, assessment criteria and range statement for individual objectives.
Modes of Assessment	General description of the assessment methods to be used in the course
Learning Resources	Specifies: • Recommended Textbook • Reading List • Other Resources (such as Blackboard, past exam papers available in library

The instruction part of the course template would contain information presented in Table 2:

Table 2: Instruction part of course template.

Section	Summary of Content
Course Detail	Faculty Department Course Code and Title
Course Lecturer/Co-ordinator	Information on the course lecturer/co-ordinator, including contact details
Course Timetable	Class schedule for the course
Teaching and Learning Activities	• Lecture & Tutorial Plan - detailed description of topics and schedule (dates/weeks) with reference to Learning Resources • Laboratory plan - detailed description of topics and schedule (dates/weeks) with reference to Learning Resources • Other Teaching & Learning Activity specific for the course
Assessment Plan	Detailed description and schedule for the assessment in the course, which should include: • Assessment format and its description (test, quiz, lab report, submission format and method) • Date of Assessment (or due date) • Weighting
Supplementary Information	Any additional information relevant to the course

The information in the above section can be used to develop complete course templates for a programme. A collation of the course templates for a programme constitutes the dossier to be presented to the accrediting body. The success of preparing a dossier of high quality requires good leadership to drive the process and also the active commitment of all teaching staff in the programme. This model can be used for programmes at the Faculty of Engineering and Technology at the UB.

CONCLUSIONS

The drive to review and accredit the University of Botswana engineering programmes is to incorporate stakeholders' input (industry and accrediting bodies), as well as to infuse soft skills and changes in ICT and digital technology into the curriculum. Innovative pedagogical methods need to be explored to respond effectively to emerging international trends in engineering education. This article is a step in responding to how engineering programmes can be reviewed or developed to satisfy accrediting bodies' requirements. However, the multi-purpose requirement of the course description makes it difficult to achieve a compact, short form, which would satisfy the requirements of accrediting bodies and also provide enough detailed information for the students.

The principal outcome of the article is the development of a template for use in creating the course outlines that would satisfy accreditation requirements of ECSA. Therefore, it is pragmatic to split the form into two parts. The first part would contain information required for accreditation, and, which would not be changed every time the course is offered. The second part of the template would provide information related to the offering of the course and that is flexible, allowing a particular lecturer to modify the details of the course (schedule, topic plan, assessment details etc).

The template follows a pedagogical model, with elements identified and described. The revised Bloom's Taxonomy has been used to create a well-balanced university learning model that covers cognitive, affective and psychomotor domains. The model can be used to design course descriptions in all existing engineering programmes and also new programmes.

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