Enhancing the Quality of Multi-campus Delivery of Engineering Programmes – A Blended Learning Approach

Essam S Hamdi
School of Science and Engineering
Teesside University, Middlesbrough TS1 3BA, UK
e.hamdi@tees.ac.uk

Abstract— **The paper reviews typical arrangements of multi-campus delivery of Engineering Programmes and identifies Quality Assurance (QA) issues that need to be addressed. A blended learning model, integrating both face-to-face and online delivery is proposed. The proposed model is shown to bridge the gap between learning experiences of students following an engineering programme at different geographical locations.**

Index Terms—**Accreditation, computer aided instruction, curriculum development, engineering education, distance learning, power engineering education.**

I. Introduction

In today's global economy, more emphasis is being placed on the mobility of learning; as opposite to students' mobility. In recent years, we have seen a rapid expansion of franchised programmes. Such an arrangement would enable students following an education programme in one country to gain the same award as that of their peers at the parent Higher Education Institution (HEI). The parent HEI has the responsibility for ensuring the quality and standard of the education leading to the award. Currently, the majority of UK universities are engaged, to varied degrees, with franchised arrangements.

Quality Assurance (QA) issues arise with all franchised programmes. A common franchise arrangement involve an agreement with an overseas provider, to deliver a specific programme following the parent institute's specifications (e.g. learning outcomes and indicative contents). Normally, such an arrangement would involve staff exchange (aimed at achieving some degree of convergence of academic cultures), and approval of examination paper and moderation of marks by the parent institute. The main flaw of such a franchise lies in the assumption that examinations standards fully reflect students' learning experience.

Some HEIs adopted a different approach to internationalisation. This involves establishing overseas campuses that are centrally 'run'; delivering identical contents and adopting the same assessment as the home campus. While this is not a franchise in the commercial sense, it is treated, here, as one from the QA dimension.

In some developing countries, a central higher education administration is responsible for delivery of programmes at a number of different geographical locations (colleges), and all students receive the national award. While the same curricula is adopted, delivery often relies on staff recruited internationally; with different backgrounds and widely different teaching experiences. While, in such a system, learning resources are specified (e.g. textbooks), individual educators are responsible for the preparation of the in-class delivery material and assessments. Inevitably, this leads to a wide variations of students' learning experience.

This paper attempts to address QA issues that are common to multi-campus delivery of engineering programmes while, at the same time, recognising the different learning styles of today's students, industry expectations and recent technology advances. To this end, a brief review of teaching and learning theory is provided.

II. Pedagogical Foundation

A. *Learning Styles*

Cognitive scientists have learned much about the processes whereby people take in information, search through their long-term memories for patterns that match it, and select rules and procedures with which to operate on it. The basic principle behind the theory of learning styles is that different people learn in different ways [1].

Deep learning and surface learning are the two fundamental approaches to learning [2]-[4]. Students with a reproducing orientation tend to take a surface approach to learning; relying on note memorisation and formula substitution. On the other hand, learners with a meaning orientation tend to adopt a deep approach; exploring the applicability of new material.

Surface learning is not encouraged in higher education as, in this approach, learners aim is to get the task completed just by memorizing facts without understanding their meaning. Much of the material would be totally forgotten after examination and the difference between first year and final year students would be that the latter group had memorised and forgot more times.

If the educators' role is indeed to facilitate learning and not merely to cover the syllabus, then they should try to understand how people learn. Unfortunately, traditional teaching styles of engineering professors address only a small subset of the learning styles of students; professors confronted by inattentive classes and poor student performance become discouraged or hostile. Here, it suffices to emphasise that students learn in different ways and, therefore, we must teach in a variety of ways in order to accommodate different learning styles.

It must be recognised that learners would, by instinct, adopt the learning approach that would yield the highest grade. Therefore, instruction and assessment should be designed to encourage students to adopt a deep approach to the subjects that are important for their professional development [5].

B. Research Informed Teaching (RIT)

Research Informed Teaching (RIT) has important implications for student learning and teaching practice, particularly in terms of engaging students with research and enhancing their experience and employability skills. As illustrated in Fig. 1, RIT has a number of facets; depending on whether the emphasis is on the research content or process, and whether students are participants or audience [6],[7].

Similar to students' learning styles, university professors adopt various teaching styles. To be effective teachers, university professors not only need to be knowledgeable and familiar with latest development in their subjects but they should also be informed by current teaching ideas and concepts. They need to continually research into the effectiveness of their teaching and must be prepared to adopt teaching techniques that are suitable for their learners.

Over the years, the author has come across colleagues who were highly regarded by students and then seem to have 'lost their touch'. This is because they continued to use the same 'successful formula' and failed to realise the change of the students' learning style. This has become more visible during the last decade with uptake of technology based on hand-held devices.

Undertaking pedagogic research and reflecting on one's own teaching would involve [7]:

- peer review of teaching activity;
- evaluation of teaching and learning practice based on student and/or external feedback;
- module and/or programme evaluation; and,
- evaluation of new teaching methods.

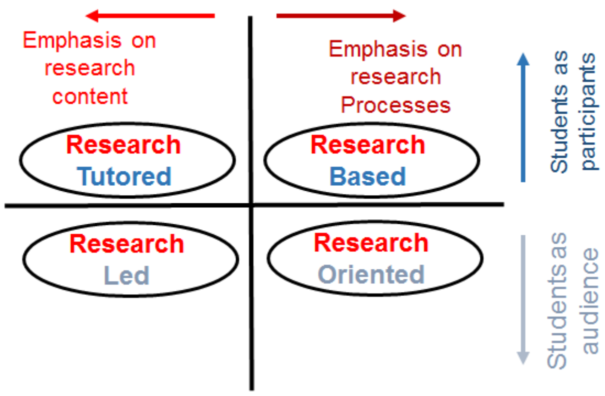

Fig. 1. Curriculum and the research teaching nexus.

C. Student-Centered Learning (SCL)

This term is widely used in teaching and learning literatures and many terms such as flexible learning, experiential learning and self-directed learning have been associated with it [8]. The term would also imply that students can construct their own learning with the professor/teacher acting as the facilitator. Therefore, one can conclude that the term 'student–centred learning' means different things to different people. Here, implementation is considered to include:

- making students more active in acquiring knowledge and skills (i.e. Active Learning); and
- making students more aware of what they are doing and why they are doing it.

Active learning; a term that would cover laboratory classes, projects, group discussions and computer-aided engineering activities is discussed in the following sections as is applied to teaching of electrical power system analysis and protection,

D. Blended Learning (BL)

Blended (or hybrid) learning is learning based on various combinations of classical face-to-face lectures, learning over the Internet, and learning supported by other technologies, aimed at creating the most efficient learning environment. In designing blended learning, we should choose the combination that will adequately cover the intended learning outcomes and motivate the students [9], [10]. From this variety of BL education two fundamental approaches can be singled-out: the program-flow model and the core-and-spoke model [9].

The program-flow model is model adopted here to facilitate the transition from conventional face-to-face to BL. In the example discussed in the following sections, some conventional 'teaching' events are replaced by e-learning activities that not only promote active learning, but also, in the author's view, better prepare the students for employment in the power industry. Additionally, introduction of e-learning resources and activities will serve to provide similar learning experience irrespective of the learners' location; thereby, enhance quality of provisions.

III. Course Design

Although technological advances have changed the way we live and work, their impact on the way we teach and assess is still minimal. Most university professors' teaching and examination practices are out of step with the needs of both today's learners and industry. By a way of an example, teaching of electrical power system (power system analysis) is considered.

A. Content

It is universally recognised that the size and complexity of real-life power system problems rules out the use of traditional network analysis. This is demonstrated, for example, by the introduction of the application of advanced numerical methods to the solution of the power flow problem. However, in some cases, both teaching and examination place more emphasis on the 'procedures' rather than the application. Indeed, the numerical methods that are employed in the solution of nonlinear problems still occupy a significant space within the power system analysis curricula (although they can't be, nor they should be, examined properly).

It is not uncommon to find an exam question related to the calculation of the bus bar admittance matrix (a step of the power/load flow calculations) of a simple network [11]. While this calculation is of no value in the real world, this is the type of question that lends itself to conventional teaching and assessment methods. It should be noted that in [11] treatment of the power/load flow problem using industrial-grade software is adequately covered and a number of examples that would be relevant to graduate practice are given. However, if the assessment criteria places more emphasis on the unseen exam, then students are likely to construct their learning around activities relevant to the examination method.

The assessment methods and teaching and learning activates should be designed to encourage students to adopt a deep learning approach in their studies. Of course they also need to be aligned to the intended learning outcomes [12]. Additionally, if the programme or module is a part of multi-campus provision, then this has to be considered at the curricula design stage when QA issues are identified and addressed.

B. Learning Outcomes (LOs)

Learning outcomes (LOs) specify what students will be able to do on completion of the programme/module. In UK, the university must be able to satisfy both the Quality Assurance Agency (QAA) and the accrediting body (in this case, IET) that LOs are met. Therefore, at least some thought should be given to how LOs are going to be assessed.

Specifying a large number of learning outcomes dealing with small parts of the curricula would lead to assessments that cover these small, and, inevitably, disjoined parts. This, in turn, would encourage surface learning. For example, if some of the LOs are (students will be able to-):

- describe the per unit system of calculation;
- analyse balanced and unbalanced three-phase power systems by using symmetric components;
- analyse balanced and unbalanced three-phase short circuit currents and perform associated calculations; and
- list the equipment used in a typical power system protection scheme.

then, in this case, the exam will have to contain questions on all these 'topics'. The total number of LOs in the above example is 18 (and all are narrowly specified). Therefore, it is not unreasonable to expect students to memorise answers to typical related questions without really understanding why they studies this module or how they can apply their knowledge as practicing engineers.

It may be noted this example relates to a real situation that the author has encountered but, for obvious reasons, the source will not be disclosed.

C. Assessment

Assessment is an essential element in the learning cycle, and is central to an understanding of how learning outcomes are achieved. As discussed above, summative assessments are directly related to LOs and course designers must avoid over assessing. Scheduling frequent assessments (e.g. quizzes and test) would, almost certainly, shift the emphasis from 'learning' to 'assessing' and encourages surface learning.

Over-reliance on a narrow range of types of assessment methods (particularly examinations, essays and reports) is a common weakness of today's assessment methods.

While it is understandable that university professors tend to rely on the tried and trusted unseen examination, this method does not allow examination of students' abilities to perform as practicing engineers in today's technology-rich industry.

While summative assessments are used to provide certification (i.e. they are 'assessment of learning'), formative assessments are 'assessments for learning' as their aim is to provide constructive feedback and, therefore, assist students to structure their learning [13].

In [14], it is argued that, as in the real world one is expected to provide high quality work with minimum supervision, students need to develop high-level evaluative skills and regular feedback would leave many students unprepared for life beyond the university.

The author's experience suggests that all students need feedback but with varied degrees of regularity. Students in the early stage of the programme, especially those who returned to university after a break from studies, need more regular feedback than senior students. In other words, while the point raised in [14] is valid, it is part of the learning process to build the learners' confidence and their ability to evaluate their work.

In the model presented in this paper, much of the formative assessments is carried out with the aid of a specially designed web-based application. This enables students to assess their learning by themselves and facilitates monitoring of individual student's learning. Also, it makes it possible to establish whether or not students have acted on the feedback and how it helped them to structure their learning. Another important feature is that data can also serve to provide feedback to professors on their teaching and to identify strength and weakness of the module/programme.

IV. A Case Study

By a way of an example one module (that is designed for multi-campus delivery) is described here. The level 6 Power Systems module is a core module in the BEng/MEng programme offered at a number of locations.

A. Module Aim and Intended Learning Outcomes

The aims of the module convey the purpose of the module and what the module is trying to achieve from the perspective of the teacher [15]. The module aim is "to broaden the students' knowledge of the elements of modern electrical power systems in terms of system stability, power flow control, and protection arrangements. It also aims to give a sound grounding in the essentials of power system analysis, design, operation and control under both normal and abnormal conditions".

The learning outcomes convey the nature of the knowledge and the skills that students are expected to gain and demonstrate by the time they complete the module.

The module learning outcomes are given in Table 1. It is may be noted that these LOs are developed in line with the recommendations of section III above and they allow adjustment of contents and scope of coverage to respond the changing industrial needs. Module revision would, therefore, focus on its contents.

TABLE I
INTENDED LEARNING OUTCOMES – POWER SYSTEMS

On completion of this module students will be able to:	
Knowledge and Understanding	
LO1:	Demonstrate a comprehensive and detailed knowledge of key aspects of modern electrical power systems and use appropriate elements of this knowledge to appraise and evaluate the operation of power system components.
Cognitive and Intellectual Skills	
LO2:	Critically analyse power system problems with respect to the power flow and economic dispatch, frequency/voltage control, stability and protection.
LO3:	Identify and define complex power problems and apply appropriate knowledge and tools to their solution.
Practical and Professional Skills	
LO4:	Operate ethically in situations of varying complexity and predictability requiring the analysis of the power system components and system-wide issues.
Key Transferable Skills	
LO5:	Select and apply appropriate numerical methods.
LO6:	Select and apply appropriate software to aid analysis of electrical power systems.

B. Content and Learning Activities

The module is expected to cover the following topics:

- Power flow;
- Transmission lines;
- Power faults;
- Transient operation;
- Power system control; and
- System protection.

The learning activities can be divided into lectures, tutorials and laboratory classes. The lectures serve to provide explanation of principles and discussion of applications. However, as this module is offered at more than one site, same lecture resources are used by the different module tutors. This yields a situation similar to that when the cohort is divided into sections taught by different tutors.

The tutorials will involve guided exercises and practical tasks incorporating examples of current industry practice. While similar examples will be considered, the depth of the discussion could vary. Therefore, tutorial sessions are captured and made available, on line, to all students.

Laboratory classes comprise hands on activities that reinforces the concepts covered in lectures and design exercises using industrial grade software.

In order to provide similar learning environments at different campuses, laboratories are equipped to the same standards (although the number of units differ, depending on the number of students and scheduling issues). Laboratory experiments are jointly designed by the module tutors with the module leader, at the main campus, acting as a moderator.

As discussed above, formative assessments are regarded as an integral part of learning. Therefore, these are incorporated within laboratory learning activities. The interactive nature of the feedback is illustrated in Fig. 2. Students work is saved on the central server and this enables module tutor to identify, for example, how many attempts were needed to arrive at the correct answer of each question. These data can then be used to determine additional readings/activities needed for individual students and to improve coverage of specific topics.

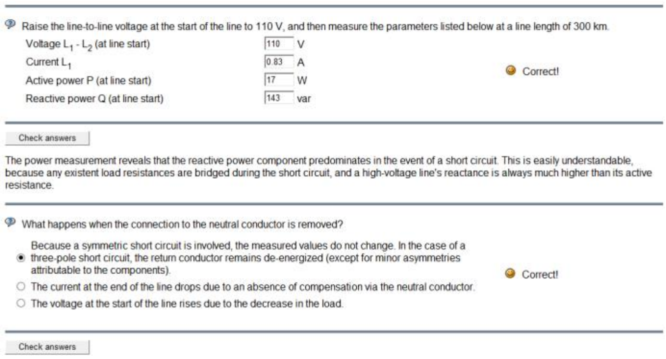

Fig. 2. An example of formative assessment during a laboratory class.

During the computer laboratory activities, students make use of industrial-grade software to, firstly, investigate operation of power systems and then extend and existing system in order to meet increased demand. Indeed, the latest editions of most power system textbooks present numerous relevant examples [11], [16].

In order to facilitate learning activities, two different suites of software are available on the central server. Learning activities would begin by assigning a simple system, as is illustrated in Fig. 3, and students are asked to perform power flow studies and investigate the effect of reactive compensation on line loading. Afterwards, students are asked to modify the network to supply an additional load at a specified location. Thereafter, economic dispatch and transient stability are investigated.

C. Assessment Strategy

The module assessment method must be aligned to the learning outcomes and teaching and learning activities [17]. In addition to the principles of constructive alignment, this module is designed for multi-campus delivery and this needs to be taken into consideration.

The computer laboratory activities cover all the intended learning outcomes (excluding protection, LO2). Therefore, the assessment method include an open-ended CAD problem concluding with individual presentations and discussion. This attracts 50% of the available mark.

Power system protection (LO2) is assessed via conventional laboratory work and it attracts 25% of the available mark. Aspects of the learning outcomes that are not otherwise assessed, are covered in a conventional unseen examinations (25%). For this purpose, a question bank is established and the exam is compiled with the aid of a software; the module leader specifies the number of questions related to particular LOs and the exam paper is then generated without the need of inputs from campuses' tutors.

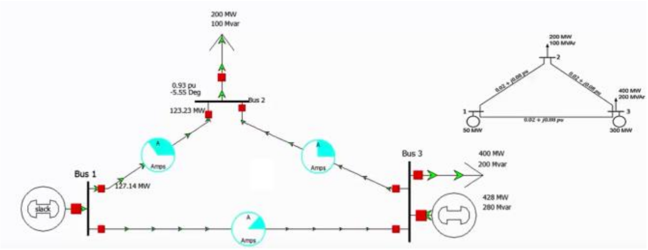

Fig. 3. An example of a software-based learning activity.

V. CONCLUSIONS

Although technological advances have changed the way we live and work, their impact on the way we teach and access is still minimal. Most university professors' teaching and assessment practices are out of step with the needs of both today's learners and industry. Indeed, some would associate the increased use of technology in teaching and assessment with a possible rise in plagiarism and learners' engagement in unfair practices. While this may well be true, the fact remains that the majority of today's learners have not experienced living without computers, internet and handheld devices. Therefore, many loose interest and/or underachieve when placed in a conventional learning environment.

Another challenge relates to the increasing international presence of universities and the QA issues this raises. While some might see international presence as risking the university's 'brand name', globalisation of education is here to stay; the status quo is not an option.

This paper proposes a blended learning model that makes use of technology not only to provide learners with a more interesting environment but also to prepare them for the demands of today's industry. The model lends itself well to multi-campus delivery; providing students at different geographical locations with similar learning experiences.

Introduction of blended learning is not without challenges. Obviously it would involve infrastructure investment and would require staff training. Staff training may not be as straightforward as it seems; professors and academics accustomed to traditional modes of instruction are likely to be reluctant to change.

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