UCL ACCESSIBILITY RESEARCH GROUP

ARGnote Vol. 1 No. 1 2014 ISSN 2054-4561

STEM Education: Part 1 What are the criteria for performance at Higher Education institutions?

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Overview

One of the many challenges in Science Technology Engineering and Mathematical (STEM) education is how to evaluate capabilities and functioning knowledge that is transferred to students during teaching-learning interactions. One of the methods to accomplish this is through measurement of the perceptions of the students. This note (1 of 2) explores whether it is enough to measure perceptions through quantitative means. Or perhaps these teaching-learning interactions should be measured both qualitatively and quantitatively through a holistic performance measurement system.

Key Findings

Performance measurement systems that evaluate teaching-learning processes in higher education need to:

- Incorporate a combination of evaluation techniques by providing a qualitative and quantitative analysis of the knowledge transfer teaching setting.
- Support analysis of both the instructor and students during knowledge transfer.
- Provide support documentation, particularly for the identification of knowledge transfer process, as well as a guide to improving teaching effectiveness and performance measurement evaluation.
- Support analysts in the determination of what changes need to be made to improve the effectiveness and efficiency of the knowledge transfer.
- Accommodate scalability from one to many users.

Aims & Objectives

This note poses the following questions:

1. How do we currently measure performance in this setting?
2. Why do we need criteria for measuring performance of engineering education at higher education?
3. What should these criteria cover/measure?

Background

A nation's greatest natural resources can be considered to be an educated population. A catalyst for this resource is higher education [(1)]. It has been acknowledged that higher education skills are increasingly important for both individual and national development [(1)]. However, a survey completed by the Confederation of British Industry (CBI) and Pearson on education and skills in 2013 found that 39% of firms participating in the survey experienced a shortage in employees with STEM skills and knowledge [(2)]. The firms reported that "too many STEM-qualified applicants don't arrive rounded, grounded and ready for work (45%) and lack general workplace experience (39%)" [(2)].The CBI and Pearson survey [(2)] highlights a very complex problem that will need to be examined from various directions. This note will examine the area of performance measurement as a means of improving the quality, efficiency and effectiveness of teaching-learning interactions for all stakeholders (students, instructors, tax payers, government, and university administration) within the teaching-learning interactions that occur in the course of STEM education in lectures, tutorials and laboratories.

Currently, performance is measured in a number of ways, through assignments and examinations. The majority of these existing tools and techniques used to measure the levels of knowledge and experience among the students and instructors only occur at the end of the semester or academic year. This means that any changes that are made based on these measures has less benefit to the students who complete them. This note will examine the area of performance measures that are used to examine the Students' Evaluations of Teaching (SETs) (e.g. Students' Evaluation of Education Quality (SEEQ) [3], Course Experience Questionnaire (CEQ) [4], Learning and Studying Questionnaire (LSQ) [5], Experience of Teaching and Learning Questionnaire (ETLQ) [6]). SETs are the most commonly used form of evaluation of the students perception of their teaching experience. Table 1 shows an evaluation of some of the SETs that are currently in use.

Discussion

Of all the performance measures, only SEEQ in Table 1 compares the results from both students and instructors. The other questionnaires collect no input from the instructor to compare the results to, making it more difficult to analyse and make changes. SEEQ is also the only questionnaire to provide guidance on methods of improving teaching effectiveness if differences are found. However, all the SETs examined are deployed once either during a module or at the end of a course and the window of opportunity to make module or course changes can only be achieved during the summer recess. This does not support continuous improvements during the module or course. All the questionnaires are subjective and quantitative in nature, they all collect data on perception, and none of them collect any objective quantitative data that can support corrective actions being made. If both qualitative and quantitative are collected it provides a more complete picture of the teaching setting being examined. LSQ and ETLQ collect the identification information for the students while SEEQ and CEQ are anonymous. None of the SETs examined individually takes a complete view of the knowledge that is transferred in the teaching setting. Therefore, these issues need to be addressed in the development of a criterion for a performance measurement system that can be used in the measuring of STEM education at higher education institutions.

Future Research Areas

ARGnote Vol 1 No 2 presents the PERMEATE Framework (Process Engineering for Real-time Monitoring, Evaluation and Analysis of Teaching Excellence Framework). It is a holistic performance measurements system that can be used to analyse and make changes during individual lectures, laboratories or tutorials. The PERMEATE Framework evaluates the knowledge transfer process that occurs during the teaching-learning interactions between both students and instructors from both a qualitative and quantitative perspective.

Related ARGnotes

Gill, SK, STEM Education: Part 2 How to measure performance at Higher Education institutions? 2014, Vol 1. No.2

Endnotes: **1**.European Commission. The EU in the world - A statistical portrait. Luxembourg: European Commission, 2010. **2**. CBI, Pearson. Changing the pace: CBI/Pearson education and skills survey 2013. Confederation of British Industry and Pearson, 2013 June 2013.**3**. Marsh HW. SEEQ: A reliable, valid and useful instrument for collecting students evaluations of university teaching British Journal of Educational Psychology. 1982;52(1):77-95. **4**.Ramsden P. A performance indicator of teaching quality in higher education: The course experience questionnaire. Studies in Higher Education. 1991;16(2):129-50. **5**. Economic and Social Research Council. Learning and Studying Questionnaire. In: Universities of Edinburgh CaD, editor. Teaching and Learning Research Programme: Enhancing Teaching-Learning Environments in Undergraduate Courses: ETL Project; 2002. **6**. Economic and Social Research Council. Experience of Teaching and Learning Questionnaire. In: Universities of Edinburgh CaD, editor. Teaching and Learning Research Programme: Enhancing Teaching-Learning Environments in Undergraduate Courses: ETL Project.; 2002.

Table 1 Evaluation of some of the SETs currently in use [3-6]

SETs	Filled in by	Students identified	Measured	When is it measured	Guide to improving teaching	Guide to analysis results
SEEQ [3]	Students & instructor	No	Learning, enthusiasm, organisation, group interaction, individual rapport, breath of coverage, examination, assignment and workload	End of module or course	Yes	Yes
CEQ[4]	Students only	No	Good teaching, clear goals and standards, appropriate workload, appropriate assessment, and emphasis on independence	End of course	No	Yes
LSQ[5]	Students only	Yes	Learning orientations, reason for taking the course unit, and approaches to learning and studying	Beginning of module	No	Yes
ETLQ [6]	Students only	Yes	Approaches to learning and studying, perceptions of the teaching and learning environment, demands made by course unit, and learned achieved	During module	No	Yes

  Acknowledgements**:** I would like to thank my supervisor Prof. Nick Tyler and all who contributed to the design, development and implementation of the study.