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Research article

Education

ANALYSES ON PROGRAMME OUTCOMES MEASUREMENTS FOR CONTINUOUS QUALITY IMPROVEMENT OF AN UNDERGRADUATE ENGINEERING PROGRAMME

本科生工程项目持续质量改进的项目成果测量分析

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Abstract

This article discusses new methods for the analyses of program outcome measurements of an engineering undergraduate program, enabling a robust effort to continually improve the quality of the program. The analyses were conducted on an undergraduate engineering program at University Malaysia Sarawak (UNIMAS), based on program outcome achievements of 80 students undertaking selected courses from 2015–2019. Three techniques were utilized: i.e., graphical visualization of data using boxplots, association analysis using Spearman's rank correlation coefficient, and consistency analysis using Cronbach's alpha. Using these techniques, the authors identified trends among the courses measuring the same program outcome. Boxplots are very effective in gaining an overview of the achievements of courses measuring the same program outcome, and in highlighting outliers and anomalies in the data. It was also found that the Cronbach's alpha result is coherent with that of the rank correlation coefficient. The techniques reported in this study can be applied to enhance data analysis for quality improvement of any academic program focusing on outcome-based education. Therefore, the study presented in this paper is both relevant and valuable to engineering programs working towards obtaining international accreditation.

Keywords: Outcome-Based Education, Engineering Education, Continuous Quality Improvement, Correlation Coefficient, Consistency Analysis

摘要 本文讨论了用于分析工程学本科课程的课程结果测量的新方法，从而为不断提高课程质量做出了有力的努力。这项分析是根据砂拉越大学（UNIMAS）的一项本科工程课程进行的，该课程

基于 2015 年至 2019 年间选修课程的 80 名学生的课程成果。使用了三种技术：即使用箱形图对数据进行图形可视化，使用长矛兵的秩相关系数进行关联分析以及使用克龙巴赫的 alpha 进行一致性分析。使用这些技术，作者确定了测量相同程序结果的课程之间的相似性。箱线图对获得可衡量同一程序结果的课程成绩的概述，以及突出显示数据中的异常值和异常值非常有效。还发现，克朗巴赫（克龙巴赫）的 alpha 结果与秩相关系数的结果一致。这项研究中报告的技术可以用于增强数据分析，以提高任何注重结果教育的学术课程的质量。因此，本文中的研究对于努力获得国际认可的工程计划既相关又有价值。

关键词: 成果教育，工程教育，持续质量改进，相关系数，一致性分析

I. INTRODUCTION

In many countries, engineering undergraduate programs are governed by respective local accreditation bodies. Accreditation bodies, such as the Accreditation Board of Engineering and Technology (ABET) in the United States, European Network for Accreditation of Engineering Education (ENAEE), and Japan Accreditation Board of Engineering Education (JABEE), enforce and monitor the quality of engineering education within their regions. The Engineering Accreditation Council (EAC), a body under the Board of Engineers Malaysia (BEM), oversees the accreditation of engineering degree programs offered within Malaysia. In 2009, the BEM was listed as the 13th signatory of the Washington Accord (WA), making Malaysia's EAC accredited engineering programs equal to the engineering degrees of other WA signatories [3].

Aligning local engineering education to the WA requires that programs produce graduates who are equipped with professional engineer attributes. The graduate attribute profile adopted by the WA outlines the knowledge, skills, and attitudes required of a graduate in order to practice as an engineer. The WA graduate attribute profile has 12 elements: i.e., (i) engineering knowledge, (ii) problem analysis, (iii) design and/or development of solutions, (iv) investigation, (v) modern tool usage, (vi) the engineer and society, (vii) environment and sustainability, (viii) ethics, (ix) individual and teamwork, (x) communication, (xi) project management and finance, and (xii) life-long learning [4].

The requirement of outcome-based education (OBE) by engineering accreditation bodies is evident as the OBE model is consistent with WA educational objectives. Spady [5] stated that "outcome-based education means starting with a clear picture of what is important for students to be able to do, then organizing the curriculum, instruction, and assessment to make sure that this learning ultimately happens." In other words, OBE is based on the principle that a curriculum is developed, implemented, and assessed based on the learning outcomes expected of the students upon the completion of their study. The continuous quality improvement (CQI) process in OBE requires input from direct and indirect assessments. Direct assessments usually refer to graded assessments such as tests, final exams, assignments, oral presentations, etc. Indirect assessments are mostly obtained from surveys, stakeholders' feedback, and accreditation bodies' input.

A high-quality assessment is defined by its reliability and validity. Past researches on engineering education mostly focus on the implementation of OBE and the process of CQI in general [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16]. As will be discussed in section 2, consistency is one of the aspects of a reliable assessment.

Thus, this study aimed to investigate techniques for evaluating program outcomes (PO) measurements within courses in the Mechanical and Manufacturing Engineering (MME) program, Universiti Malaysia Sarawak (UNIMAS). To the best of the authors' knowledge, there is limited study highlighting the importance of reliable and valid learning outcome measurements in engineering education, thus providing an impetus for the authors to carry out this study. Furthermore, the current PO achievements analysis method done in the MME program is limited to bar charts and line graphs, which lacks information on the data distribution. Hence, three techniques are included in this paper, i.e., data exploration through boxplots, association analysis using Spearman's rank correlation coefficient and consistency analysis