Chapter 16
An Evaluation of Students’ Practical Intelligence and Ability to Diagnose Equipment Faults

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ABSTRACT
Empirical studies suggest that practical intelligence acquired in engineering laboratories is valuable in engineering practice and could also be a useful learning outcome that is a result from a laboratory experience. To prove this, the author started a project to understand further about the practical learning outcomes from traditional laboratory classes. When tools used by psychologists were applied to measure practical intelligence in an electronics laboratory class, not only could a significant gain in hands-on practical intelligence be measured, but students’ ability to diagnose equipment faults could also be predicted. For the first time, therefore, the author can demonstrate that there are real advantages inherent in hands-on laboratory classes, and supported by Outcome Based Education (OBE) method, it is possible to measure this advantage. It is possible that measurements of practical intelligence may reveal new and more powerful ways for students to acquire practical knowledge. The results firstly demonstrate the ability to devise effective ways to assess the outcomes of practical intelligence acquired by engineering students from their laboratory experiences. The results from the study show that the score on practical intelligence outcomes is proportional with the outcomes of the ability in diagnosing equipment faults. Therefore, the novel results suggest that practical intelligence scores predict the ability to diagnose experiment faults for similar laboratory equipment.

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INTRODUCTION

Engineers seek to manipulate material and energy for the benefit of mankind. This task can successfully be achieved if the engineers, technicians and others have knowledge and experience related to the specific engineering field. Therefore, at university or college level, engineering education helps students gain the foundation for acquiring knowledge and experience that will help them in engineering practice.

With the development of more complex technologies, there has been an increasing need for new approaches to engineering education (Brown & Brown, 2002), especially for global collaboration in engineering projects (Lucena, 2006). The modern university seeks to extend learning opportunities to its students at any time and any place, (for example via online laboratories), to be successful in the global educational marketplace (Sivakumar, 2004). However, there have been increasing reservations expressed about the practical skills and competencies of engineering graduates. These concerns have led to the introduction of generic outcome definitions for engineering education in 2000 in several countries (ABET, 2003; Lattuca, Terenzini & Volkwien, 2006). These changes have led to some improvements, but concerns about graduate abilities are still voiced by many practising engineers.

Among the issues generally voiced are about the quality of experience possessed by engineering graduates in handling technical or laboratory tasks. Even though the expected outcomes from experiments tasks during the laboratory sessions are stated learning objectives, the elements of informal learning gained by the students by performing the laboratory cannot be denied. Therefore, in this article, the authors discussed an attempt to measure the informal learning elements or “Practical Intelligence” by developing them as objective-stated learning. The finding of the research demonstrates that effective ways can be devised to assess the outcomes of practical intelligence acquired by engineering students from their own laboratory experiences. The results show the score in practical intelligence outcomes is proportional with the outcomes of the ability in diagnosing equipment faults.

ISSUES CONCERNING LABORATORY CLASSES

One of the most important factors in forming engineering graduate qualities is the practical component of the engineering curriculum (Feisel & Albert, 2005) such as laboratory class. Laboratory classes are valuable learning experiences which can be used to effectively link theory and real-world behaviour of engineering systems and materials. By attending laboratory classes and handling (working with) the equipment, the students are likely to appreciate the details about appearances and functions. The underlying reason for the value of laboratory classes is that lab work is a fundamentally different context for the students’ learning. In a laboratory class, the environment is different compared to other learning environments, such as lectures or tutorials. Students engage with real hardware, components and materials. They embed their learning into different contexts, and construct different knowledge as a result. Working in an engineering laboratory environment provides students with opportunities to validate conceptual knowledge, work collaboratively, interact with equipment, learn by trial and error, perform analysis on experimental data, and operate tools and equipment safely (Feisel & Albert, 2005).

The value of hands-on laboratory classes, however, has not been easy to quantify. Virtual laboratories, simulation, and remote access laboratories offer alternatives from which students seem to learn as well or better. Although the main aim of laboratory work is to provide opportunities to learn and gain experience, we understand