Chapter 28
Novel Method of Assessing Practical Intelligence Acquired in Mechatronics Laboratory Classes:
Novices–Experts Methods

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ABSTRACT

Practical intelligence is often referred to as the ability of a person to solve practical challenges in a given domain. The lack of practical intelligence may be due to the way in which explicit knowledge is valued and subsequently assessed in engineering education, namely via examinations, tests, laboratory reports, and tutorial exercises. The lack of effective assessments on practical intelligence indicates implicit devaluation, which can significantly impair engineering students' ability to acquire practical intelligence. To solve this problem, the authors propose a new method of assessment for measuring practical intelligence acquired by engineering students after performing engineering laboratory classes. The novices-experts approach is used in designing the assessment instruments, based on the behaviors' of novices/experts observed and novices/experts representative work-related situations. The practical intelligence can be measured by calculating the difference between participants' and the experts' ratings; the closer the novices to experts, the higher the practical intelligence acquired.

INTRODUCTION

Statistic report by the Ministry of Higher Education in Malaysia on graduates' employments shows, out of the 184,581 students who graduated in 2012, 24% failed to secure permanent jobs six months after graduation. Out of these, 27.7% are from the technical disciplines which include engineering disciplines (Straits Times, July 2012). The high percentage of unemployed graduates from the technical discipline is alarming as heavy financial costs have been incurred in producing technical graduates. Thus the technical sectors must seek the source and solutions to the current situation.

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The engineering education sector in particular, is facing greater challenge in meeting the diverse demands of industries which expect graduate engineers to be well-prepared to provide innovative solutions as technical specialists, system integrators and change agents. A JobStreet survey involving human resource managers in Malaysia on common reasons for turning down job-seekers gave indicators to the problem that need to be resolved by education providers. From this survey 60% percent of the respondents reported that the reason they were forced to turn down job-seekers are poor work skills and weak personality and character.

The unemployed graduates issue is also related to the issue of engineering students' behavior. Experienced engineers have lamented that engineering graduates do not seem to be aware of the kinds of practical intelligence needed in their workplace (Trevelyan, 2010, 2011). This may result from the way in which explicit knowledge is valued in engineering education: practically all assessments measure explicit knowledge. The lack of emphasis on practical intelligence development is prevalent despite research findings on their relevance to career success in engineering. Findings from numerous empirical studies (Christiansen & Rump, 2009; Eraut, Alderton, Cole, & Senker, 2010; Razali & Trevelyan, 2008a, 2008b, 2009) indicate that the acquisition of practical intelligence in workplace settings and mechatronics laboratory classes is just as important as explicit technical knowledge. This implicit devaluation of practical intelligence could significantly impair engineering students' ability to acquire and value practical intelligence. Therefore developing new model to include effective assessment could be one way to overcome this problem.

Many engineering educators (Trevelyan & Razali, 2012; Lindsay, 2010) reports on fundamental learning phenomena in conventional hands-on laboratories. To explore this issue, the educators started a project to understand more about the practical learning outcomes from traditional mechatronics laboratory classes. What they found surprised them. They came across a substantial body of research on the notion of 'practical intelligence' (PI) that relates to the ability of a person to solve practical issues in a given domain. Psychologists (Bijker, 1995) evolved practical intelligence measurement instruments as part of an extended discipline-wide debate on predicting on-the-job performance of people using results from psychometric tests. Trevelyan & Razali (2010) found that they could apply these techniques to measure significant gains in practical intelligence resulting from participation in hands-on mechatronics laboratory tasks. Practical intelligence is unrelated to students' results from conventional assessment (examinations, tests, lab reports, tutorial exercises). More interestingly, they found evidence that suggests the possibility that practical intelligence can predict students' ability to perform fault diagnosis tasks.

In the past, in the evaluation of engineering students' mechatronics laboratory work, most assessment involves only explicitly specified learning outcomes: explicit propositional knowledge that can be written in a mechatronics laboratory report or examination, or tested in a quiz or multiple choice test. Mechatronics should be seen to represent a synergy and fusion of technologies, and should be regarded as a philosophy supporting new way of thinking and innovation. Thus, Mechatronics engineer identifies with systems thinking, and the philosophy that lies behind it. It concentrates on achieving the necessary synergy right through from the conceptual stages of the design process (Habib, 2006). Mechatronics represents a unifying interdisciplinary and intelligent engineering science paradigm which fuses, permeates, and comprehends modern engineering science and technologies (Habib, 2007). Thus in evaluating the mechatronics laboratory class effectiveness, student evaluations or opinions may also be included (Feisel & Rosa, 2008; Hofstein & Lunetta, 2009; Ma & Nickersen, 2009). Explicit learning outcomes, usually written in a handout guide to a mechatronics laboratory class, create intentionality: students perform mechatronics laboratory exercises in order to learn these. Implicit learning, on the other hand, may not