

Tracking discipline mastery: The development of an online program assessment and evaluation tool

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An online formative program assessment and evaluation tool was created by discipline leaders covering five discipline-specific domains as well as transferrable skills and personal dispositions. Students in first year complete this program assessment, often failing, but the experience is used to motivate them to start their learning journey - that's why they've come to University. Second year students participating in the same program assessment can see their annual progress. Third year students participating in program assessment can confirm how far they have progressed towards discipline mastery, as defined by their discipline leaders. The tool can also evaluate the overall effectiveness of the multiple course-based teaching and learning environments that make up the students' program and provide evidence to support external accreditation requirements. An initial trial of the tool in environmental science and geospatial science has been conducted.

Keywords: program assessment, mastery, evaluation, perseverance, passion

Introduction

Mastery is the attainment of a high degree of competence and the ability to fluently apply this to the chosen discipline (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010). The development of mastery progresses over time. Novices at the first state of mastery may not even be aware that they are incompetent (Figure 1). When they first meet challenges in their learning, novices become aware of how little they really do know. This signifies that they have moved on to the second state of mastery - conscious incompetence. From here the learner is motivated to engage in studies to develop their competence. Through various assessments, learners become aware of their growing achievements and reach the third state of mastery, conscious competence. They can think through and analyse situations when provided with adequate support. The final fourth state of mastery occurs when learners are fluent in the discipline and are able to apply their craft wisely in a variety of contexts. This final state is called unconscious competence, as the discipline and its practices have been internalised in the professional (Ambrose *et al.*, 2010).

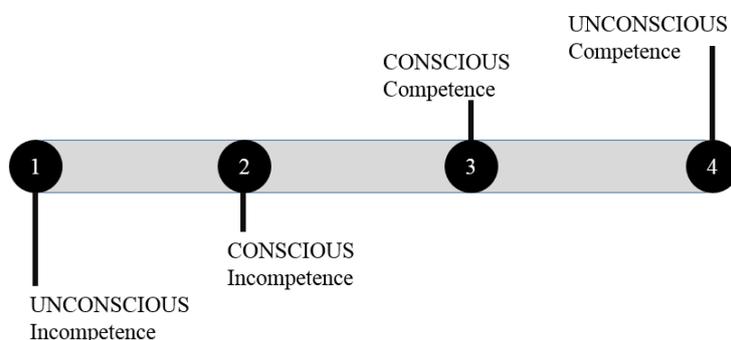


Figure 1: Stages in the development of Mastery (Ambrose *et al.*, 2010)

University students need to work through these four stages as they complete their course assessments, ideally progressing beyond conscious competence by the time they graduate. While the time taken to reach the various stages of competence will vary among students, and may not correlate conveniently with the stages in a degree program, it is important motivator for students to be able to see their progressive development.

It has been argued that academic staff (Arum & Roksa, 2011) and professional societies (Arum, Roksa, & Cook, 2016) are ideally placed to define the essential discipline concepts and competencies for tertiary graduates. As an example, the professional society, Engineers Australia, has defined 16 mandatory elements that they believe describe the stage one competencies for graduating professional engineers. These are grouped into three areas – knowledge and skill base, engineering application ability and professional and personal attributes that encapsulate discipline mastery. Other disciplines do not have well-defined professional competencies for which learners can strive.

At the University level, well-written program and course learning outcomes capture the contribution each course makes towards the development of each of these desired graduate qualities. Aggregations of constructively-aligned course assessments presumably lead to the development of suitable graduates (Biggs & Tang, 2011). But how can program teams be sure that their programs are doing what they say they are doing?

To get a sense of the effectiveness of a degree program, it can be useful to indirectly assess what learning gains students have made during their time studying a program. A classic example of this type of test is the Collegiate Learning Assessment (CLA), which is a critical thinking, moral reasoning and writing assessment. Arum & Roksa (2011) compared student performance in 24 institutions using the CLA and found that 45% of the 2300 students examined did not show a statistically significant improvement in their performance over the first 2 years of their program (Arum & Roksa, 2011). While there is a need to collect longitudinal data across whole degree programs, as learning may be unlikely to accrue in a perfectly linear nature, these results, which were verified by others (Pascarella, Blaich, Martin, & Hanson, 2011), raise serious questions about the value for students and society of the university experience (Arum & Roksa, 2011).

In an effort to assure that these qualities are being realised in our Environmental Science and Geospatial Science graduates, an online formative program assessment tool was created by discipline leaders. There were 13 component parts to the Tracking Mastery Tool (TMT) that aimed to assess the discipline knowledge, skills and attitudes of a graduating student. This paper is a work-in-progress report of the initial implementation of the TMT in an online environment for program assessment and evaluation purposes.

Method

Five domains of knowledge common to the two programs of study were identified. To assess students' knowledge of each of these domains, a bank of 25 multiple-choice questions was created for each domain using Moodle-based quizzes. The Moodle feedback tool was used to collate students' responses to questions in relation to how confident respondents were in their responses and where they had learnt this discipline knowledge (in, or outside of the program). In a similar way, students' motivation to study and confidence in a range of graduate qualities was assessed including attributes such as effective teamwork, the pursuit of lifelong learning, and the consideration of social and ethical perspectives in professional contexts. In parallel, students completed the validated survey of perseverance and passion (GRIT-S) as these elements have been linked to positive academic outcomes such as grades and program retention (Duckworth, Peterson, Matthews, & Kelly, 2007; Duckworth & Quinn, 2009).

Students studying a core first year course (n=126) were invited to participate in the 13 components of TMT during their first weeks of university study. Quiz scores and Feedback responses were analysed using embedded statistics reports within the Moodle tools and thematic analysis of text (Bryman, 2015).

Results

Student respondents (n=126) to the TMT indicated that they were largely motivated to study the programs as it matched their personal interests (42.5%; data not shown). In answer to the question 'How you believe your university education will change you?', the responses (n=371) could be categorised into 4 broad themes; knowledge (26%), career (28%), personal development (21%) and a range of graduate attributes (25%). When respondents self-assessed their current development of seven defined graduate attributes, they indicated that they were least prepared in the body of knowledge and international perspectives, and were best prepared for ethical action and social responsibility within professional contexts (Figure 2).

Student score results to the five knowledge domain quizzes are presented in Table 1 as percentages of average grade, median and standard deviation (SD). The proportion of students who identified that their learning about the subject matter had occurred outside of the program ranged from 6.6 to 29.4%. In addition respondents indicated how confident they were with their responses to the quiz questions as a whole. Students were most confident about the topics assessed in the Eco-literacy quiz and less confident about the topics assessed within the Geospatial Science quiz (Table 1).

Respondents also self-assessed their current knowledge of a range of graduate skills (Figure 3). Statistical analyses associated with professional practice was identified as an area where students identified they had inadequate skills (Figure 3). The average grade for the GRIT-S quiz was 69.67% (mostly gritty); median 71.2% and SD 11.24%.

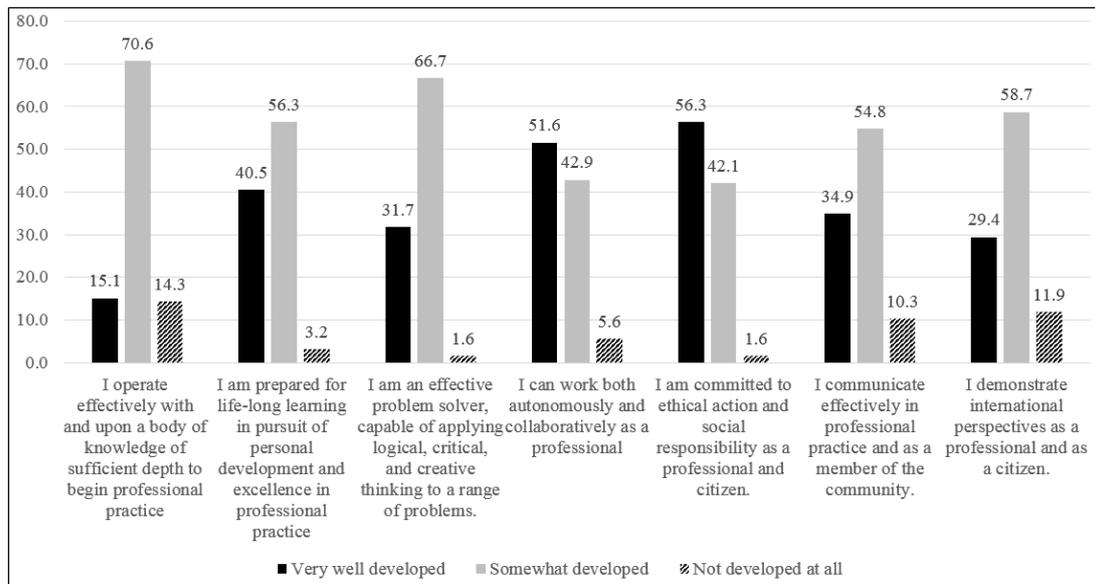


Figure 2: Student self-assessment of their development of seven defined Graduate Qualities – one component of the Tracking Mastery Tool

Table 1: Student results and confidence within the five knowledge domain quiz components within the Tracking Mastery Tool

	Average grade %	Median %	SD %	Previous studies %	Very confident %	Somewhat confident %	Not very confident %
Human Dimensions	49.9	52.0	10.0	19.2	1.6	48.8	49.6
Earth Science	46.9	44.0	12.9	20.2	1.6	39.5	58.9
Geospatial Science	37.1	36.0	12.5	6.6	1.6	20.5	77.9
Ecological Science	58.4	56.7	12.0	24.8	3.4	53.9	42.7
Eco-literacy	65.0	66.7	11.5	29.4	6.9	58.4	34.7

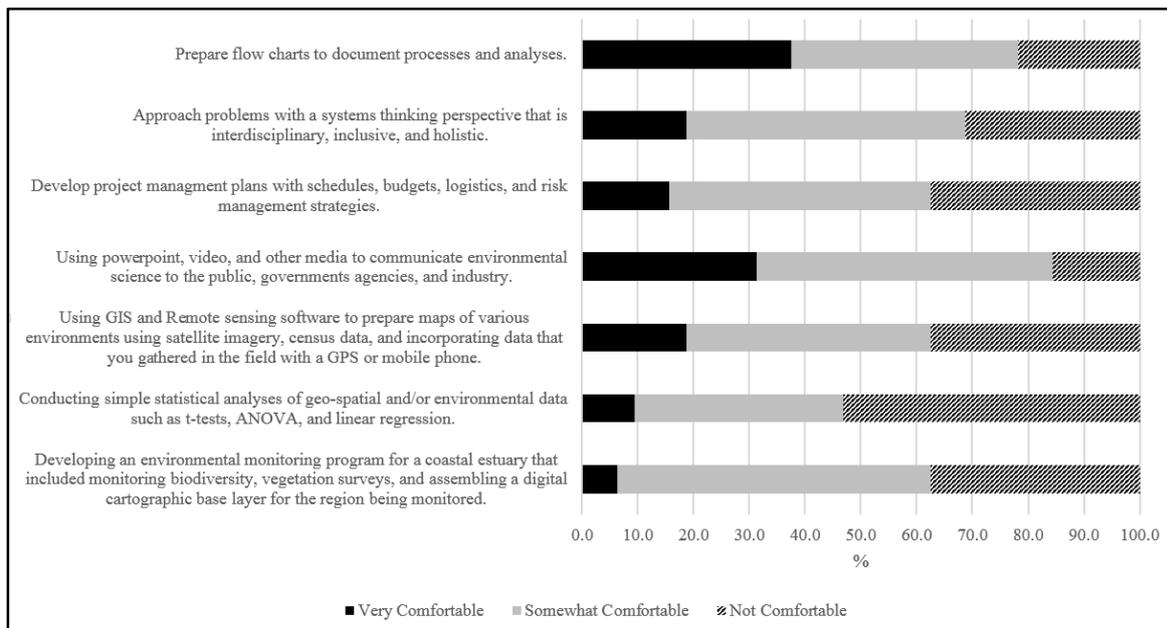


Figure 3: Student comfort with performing discipline specific skills (%) – a component of the Tracking Mastery Tool

Discussion

This paper represents a work-in-progress report for tracking mastery using a discipline-specific program assessment and evaluation tool. Its eventual aim will be to measure annual achievement of key discipline-specific competencies over a program. The tool fills a gap in those disciplines where professional competencies are yet to be defined. Similar indirect assessment approaches have been used in Information Technology and Business (Joseph, Nair, & Kumar, 2015).

Tool design

The CLA used by Arum and Roska (2011) is a standardised test used in the United States to measure advanced analysis, critical thinking and communication skills. No equivalent tool is available in Australia. In this study we have used a simple performance tool (quizzes and surveys) to track students' progress towards mastery. We admit that tests are not necessarily a perfect assessment of anything that students do, but they do offer us hope of some level of external validity of our programs. We need to continue to verify that the quiz items in the TMT are accurately representing the achievement of the desired program learning outcomes with internal and external stakeholders. We will also need to correlate data from the TMT with actual grades in each of the five domains and students' grade point averages, as in Major Field Tests in IT and Business (Joseph *et al.*, 2015).

Another limitation of this indirect assessment strategy is that there is no control group, that is the annual assessment of the discipline-specific learning gain in age-matched adults who are not doing university study (Pascarella *et al.*, 2011). As such we need to interpret changes in scores and confidence levels with caution.

A Tool for Assessment

The data collected by the TMT in this study of students studying a core first year course represents a baseline for each participant and can be used as a reference point to track their development of mastery in successive years of their program. Quantitative changes in the five knowledge domain quiz score components of TMT can be used to indicate students' learning gains and thus growing competence. Comparative changes in the self-assessment of confidence in quiz responses, as well as self-reported career relevant skills and motivators, can be interpreted as measures of growing conscious competence, the third state on the mastery development spectrum (Ambrose *et al.*, 2010).

One of the components of the TMT is the validated GRIT-S survey. Grit is a measure of willingness to persevere and passion for long term goals and is validly measured using a 8-item survey (Duckworth & Quinn, 2009). Academic success requires focus, commitment and stamina. People with Grit are less likely to change direction as situations become challenging or when they experience setbacks. The first round of TMT participants were found to be 'mostly gritty'. As Grit has been correlated to higher grades, higher completion rates and fewer career changes (Duckworth *et al.*, 2007) this finding augurs well for student retention and perseverance with their programs.

Our intention is to ask students undertaking courses within their final year of these programs, to assess their state of mastery using the TMT. Used in this way, the TMT can confirm for graduating students that they have mastered the discipline-specific knowledge, skills and attitudes to make a positive difference to their communities. The students will have a clearer sense of what they are getting from their tertiary education as they collect their reports to demonstrate their progress and accomplishment.

Ultimately the TMT will reside within program-specific online environments allowing students to have a ready litmus test of where they are in their development of the core competencies and concepts in their chosen discipline. The application of the TMT also serves as an approach that encourages student ownership of the learning process and in the long term, will be linked to a celebration of mastery.

A Tool for Evaluation

The university experience prepares people for the rigors of professional life. Graduates need a range of discipline-specific skills and knowledge, accepted behaviours and attitudes that can be applied fluently in their chosen professional context (Ambrose *et al.*, 2010). University program evaluation is a systematic method for collecting, analysing and using information to answer questions about programs, particularly about their effectiveness, but also efficiency. In Australia, the Australian Qualifications Framework (AQF) regulates the purpose, knowledge, skills, application and volume of learning associated for each level of qualification (AQFC, 2013). Within this framework, program development teams decide what graduate learning outcomes are required and what course assessments would be needed to demonstrate achievement in any given program.

A secondary purpose for the TMT is to support program evaluation. Used over time, TMT can demonstrate and track the learning gain of students over successive years of a program. However, if students show little or no learning gain, as represented by the component quiz scores and confidence levels, then it is reasonable to conclude that there are issues with the program design and assessment (or of course, with the tool design itself). As the academic staff themselves have been involved in the design and development of the TMT, their involvement in the analysis and interrogation of current courses to reveal any deficiencies, is more likely, helping to drive appropriate course and program development. In effect, TMT provides academic staff with an annual reminder to evaluate the effectiveness of the program outcomes using a tool that allows systematic review of where and when problems have arisen. Given the busy context within most academics operate, TMT can help engage course-based academic staff in meaningful program assessment activities.

Program evaluation tools such as the TMT are a useful counterbalance to the more widely-used student perceptions of "overall satisfaction" surveys that are commonplace in Australian universities. These types of surveys can inadvertently shift actual program outcomes away from the intended program outcomes. These type of program learning outcome shifts originate because individual academic staff have lost awareness of how their course contributes to the achievement of the program objectives. Re-engaging current academic staff in program evaluation using the TMT is one way to help reconnect course delivery teams with the overall program direction and avoid this type of curriculum drift from the intended program learning outcomes.

The TMT can also be used to support accreditation audits. Data demonstrating student learning gains can complement the body of evidence required to satisfy auditors. Another evaluation application of the TMT is in benchmarking of similar programs nationally and internationally.

Conclusion

Programs are large and complex structures for both staff and students to navigate. By attempting to track the development of discipline mastery over time using simple Moodle quizzes and surveys aggregated into the TMT, academic staff are able to sense the pulse of their program and their students' progress through it. In turn, students also gain an appreciation of what they do and don't know within their discipline and have the capability to demonstrate their mastery and justify their investment in the university experience. In time these specific disciplines and their professional societies may define assessments of competencies and skills, but in their absence, the TMT goes some way to capturing these desired attributes for a range of stakeholders. The TMT provides a very tangible way to demonstrate to students that they are learning and growing in their competence, and provides a valuable evaluation tool for academic staff to pinpoint areas within a program requiring greater attention.

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