

DEVELOPMENT AND ASSESSMENT OF METACOGNITION IN FIRST YEAR UNDERGRADUATES

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Abstract: This paper describes the theoretical basis and implementation of a delivery and assessment mechanism for student reflection in a first year construction technology course at the University of Newcastle. It discusses the results obtained from the evaluation of the first deployment and concludes with reflections on the implications for development.

Keywords: Problem-Based Learning, Reflection, Metacognition

INTRODUCTION

The ability to reflect on ones own decision making and practice is a quality that is recognised as desirable by many professional bodies: “*Skills in recognising unsuccessful outcomes, diagnosis, fault finding and re-engineering*”, and “*Skills in documenting results, analysing credibility of outcomes, critical reflection, developing robust conclusions, reporting outcomes*” (Engineers Australia Accreditation Board, 2005); “*Learning through reflection on practice and experience*” (Chartered Institute of Building Accreditation Panel, 2005).

To develop these graduate attributes courses must be designed to provide learning experiences that facilitate deep learning, discouraging strategic, shallow approaches, and which recognise that the practice of critical reflection is crucial because it facilitates:

- The evaluation of the *quality* of students' learning by the university
- The development of the students' ability to function at the highest professional level upon graduation

- The encouragement of the students' development as life-long learners (Chen et al, 1999).

Various mechanisms have been developed to nurture and assess the quality of students' reflection (Brewer et al, 2001; Brewer et al, 2003; Brewer et al, 2004) that embody these attributes. This paper documents the implementation of an initiative which was designed to enhance student capacities in reflective practice.

UNDERPINNING CONCEPTS

Metacognition describes the higher order thinking that actively controls the cognitive processes required in order to learn: problem-solving activities such as conceptualisation, analysis, evaluation and synthesis are examples (Schon, 1987). Since it plays a critical role in successful learning it is important to study metacognitive activity and development in order to determine how students can be taught to better apply their cognitive resources.

It is convenient to think of metacognition as *thinking about thinking*, but it is not that simple. All research emphasises the role of executive mental processes in the overseeing and regulation of cognitive processes (Flavell 1979, 1987), requiring both metacognitive knowledge and metacognitive experiences or regulation. The metacognitive knowledge component refers to a person's acquired knowledge about cognitive processes, knowledge that can be used to dictate future cognitive activities. Flavell (1987) further categorises metacognitive knowledge as:

- knowledge of person variables,
- knowledge of task variables
- knowledge of strategy variables.

There are two practical consequences of metacognition in an educational setting. Firstly, having knowledge and awareness of "self-as-learner", and secondly, conscious self-control and self-regulation when engaging in cognitive processes (Anderson & Krathwohl, 2001; Angelo & Cross, 1993). These manifest themselves as self-appraisal and self-management during learning.

Self-appraisal is effected by the students' personal reflections about their own knowledge state and abilities: it requires them to discover the extent of their own knowledge and the processes by which they think in given contexts, using specific knowledge and thinking skills (Fonteyn, 1998).

Self-management requires students to develop the ability to "think-in-action", to develop an awareness of "knowing how they think", which progressively translates into managing their own thinking, increasing their problem-solving skills, ultimately developing as a life-long learner (Fonteyn, 1998).

"Metacognitive knowledge is more strategic than the other types of knowledge [factual, conceptual, procedural]. At the heart of metacognitive knowledge lie analytic strategies, evaluative strategies, and creative strategies. Initially, these strategies may need to be imposed externally, that is, directly taught by teachers" (Anderson & Krathwohl, 2001).

Incorporating the concept and practice of metacognition into course design and delivery promotes an *"emphasis on making students more aware of and responsible for their own knowledge and thought"* (Anderson & Krathwohl, 2001). As students become more aware of their own strategies for learning and thinking, as well as when and why they use them, their generic skills base grows, empowering them to be more effective learners as well as the ability to direct their future learning.

Furthermore it is contended (Prosser, et.al. 1994) that learning involves an interactive process of knowledge construction through the incorporation of new knowledge and experience into prior knowledge, resulting in assimilation and accommodation, similarly referred to as conceptual development and conceptual change. Metacognitive strategies aid in linking the new information, or skills, with prior knowledge.

Birenbaum & Amdur (1999) establish that students who have the ability to reflect have their learning significantly enhanced by the learning experience associated with the development of journaling or the documentation of their decision making.

APPLICATION OF CONCEPTS

It was intended that the application of the theoretical concepts described in the previous section to the design of a new teaching/assessment strategy would result in

- Progressive improvements in student learning strategies
- Increased awareness of the role of reflective practice in the life of a professional
- Increased awareness of the link between the development of vocational and generic skills, and their progress towards achieving the graduate skills profile
- A commitment to incorporating metacognitive development into their learning strategies.

Furthermore it was anticipated that the new teaching/assessment strategy would positively impact on student learning by

- Producing a visible and measurable improvement in student performance between learning event one and two, as a result of
- Increased awareness of
 - The role of reflection as an integral part of professional practice
 - The links between the course content, programme objectives and professional practice (as articulated in the Graduate Skills Profile).

COURSE/ASSESSMENT DESIGN AND IMPLEMENTATION

In the current iteration of the course the students were cast in the role of a final year construction management student who had been asked to tutor in the first year construction technology course. They were asked to develop a document entitled "anatomy of a dwelling" that was intended to provide an integrated overview of domestic scale dwellings in terms of:

- primary and secondary building elements
- site influences on technology choices
- statutory regulation of buildings
- statutory regulation of the construction process

A number of different strategies were suggested in order to provide structure to the eventual documentation, and the various attributes for the document were outlined

(e.g. amount and type of graphics, range of sources, etc). Two diagrams that described a systematic approach to the application of construction technology to resolve design issues were presented in the second week of the course (figure 1).

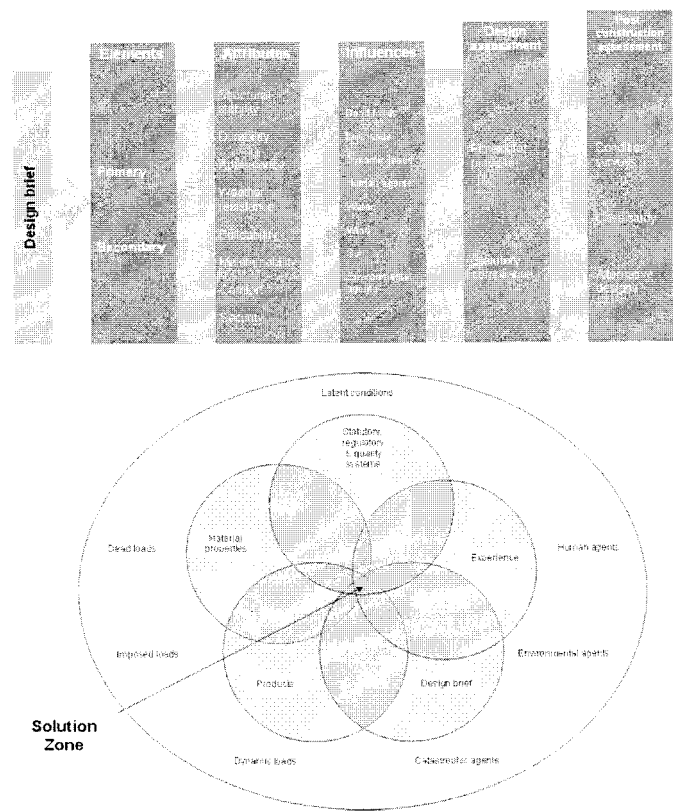


Figure 1. A systems approach to construction technology.

The subtext to this assessment was that the students were being presented with the problem of generating with the comprehensive overview/summary document that they would have wished to receive themselves, at the outset of the course. In this way they were being forced to constantly re-evaluate the scope and detail required to map out the course content in a meaningful and coherent way for novice students of the built environment. This dialogue was to be articulated and assessed in the form of appropriately conceived and positioned footnotes within their reports, which were to be considered to lie outside of the actual report, instead being thought of as accompanying metacognitive commentary. These “reflective footnotes” were defined as “text that provides a metacognitive commentary which:

- Relates to, and augments the adjacent the written/graphical evidence of vocational competence contained in the body of the assessment submissions
- Illuminates the student's decision-making processes
- Links their existing knowledge and skills to new experiences, establishing its suitability
- Describes their strategies for the identification and elimination of knowledge shortfalls"

Specific issues were used to trigger reflective activity although it was stressed that this should not be seen as delineating the scope for reflection, with topics including:

- Extent to which 'assumed knowledge' could indeed be assumed to be correct (e.g. how appropriate would a high school report format be when applied to this problem?)
- Problem conceptualisation skills: how to identify 'what you don't know'.
- Link between course activities and professional skills development.
- Surrounding context.
- Ethical obligations to younger students.

A specific grade allocation of 10% was given to this activity, which was assessed against a five point rubric:

1. Fail: Little or no evidence of reflective practice; Absence of metacognitive commentary.
2. Pass: Some evidence of the use of reflective practice; Occasional metacognitive support for report content.
3. Credit: Some evidence of the use and development of reflective practice; Some metacognitive support for report content.
4. Distinction: Consistent evidence of the use and development of reflective practice throughout; Substantial metacognitive support for report content.
5. High Distinction: Comprehensive and consistent evidence of the use and development of reflective practice throughout; Exhaustive metacognitive support for report content.

The first lecture in the course included the concepts and importance of development of professional competence, and reflective practice as an essential component of the

complete professional as described in the Graduate Skills Profile for the programme. Thereafter, reflective practice was discussed on a fortnightly basis, being linked to/triggered by the course content. Reflective practice formed the core content of three tutorials, one of which explored the contextual relationship between the technical professional and academic requirements of the course problems. The development of metacognitive awareness was underpinned by three core course readings, and augmented by periodic holistic summaries posted to the announcements area of Blackboard. Triggers to reflection on the first half of the course formed the basis of a lecture item in week 9, to allow an element of reflection-on-action

EVALUATION STRATEGY

As an integral part of the development and quality assurance processes for the course student evaluation of teaching (SET) questionnaires are regularly deployed. In addition to generic questions about course experiences and teacher performance, targeted questions (both five point Likert scale and open ended free response questions) are used to ascertain the effectiveness of the delivery of the reflective component of the course. In addition, statistical analysis of the impact of the reflective component of the assessments on overall student grading has been undertaken for each offering. The current cohort is mid-way through the course: results for the last are presented.

RESULTS

Eight statements were presented to the students in a questionnaire (see Figure 2). Likert responses were analysed for mean values and standard deviations. One question was discarded as being flawed as a result of an ambiguous trigger statement. The mean values for the remaining questions are shown in Figure 2.

Uptake rates for reflective footnotes and their consequent impact upon students' grades were recorded at the time of marking and are summarised in Figure 3.

Written responses to the question "Is there any other comment that you would like to make regarding Reflective Footnotes?" are reproduced verbatim below:

"JUST TELL US WHAT TO DO AND GIVE NO SPACE FOR THINKING. IT

MAY NOT AID PROFESSIONAL DEVELOPMENT, BUT IT ASSURE[sic] EASY MARKS."

"Reflection is an important part of our professional development but it is not part of any other subjects."

"Don't fully understand their relevance."

"It got better as time went by!"

"It is hard to see the linked between what we write and how we are assessed but the process is useful. I can see why Graham keeps on about it."

"This course has been inspirational. School was so limiting."

"Reflective footnotes are a good way to learn however they are not entirely inductive [sic] to honesty. People will not reflect that they were lazy or board. Sometimes people NEED to be told this."

DISCUSSION

In order to determine the minimum viable response rate for a known class size an online sample size calculator (EZsurvey, 2006) was used. A margin of error of 10% was selected, at a confidence level of 95%, giving an acceptable sample size of 28 responses. . At the point of survey (the day of final lecture, in week 13 of semester) 32 respondents (out of a cohort of 95 who remained enrolled on that day) returned questionnaires, making the study statistically valid. An analysis was then conducted of the mean response values for each question.

When analysing the data summarised in the previous section it could be seen that the students indicated a significant level of understanding and acceptance of the benefits of reflection as part of professional practice, and reflective footnotes as a suitable means of metacognitive review. More specifically:

- When considered in isolation the generic act of reflection was recognised as being worthy of inclusion in the array of learning strategies to be employed in future courses, albeit at a less emphatic level (58%).
- Nearly 80% of those surveyed recognised that reflective practice had benefited their performance in the course.
- The majority (61%) of those students surveyed indicated an understanding of the links between the course content and the Graduate Skills Profile and 67%

of them suggested that the reflective footnotes had helped them in this regard.

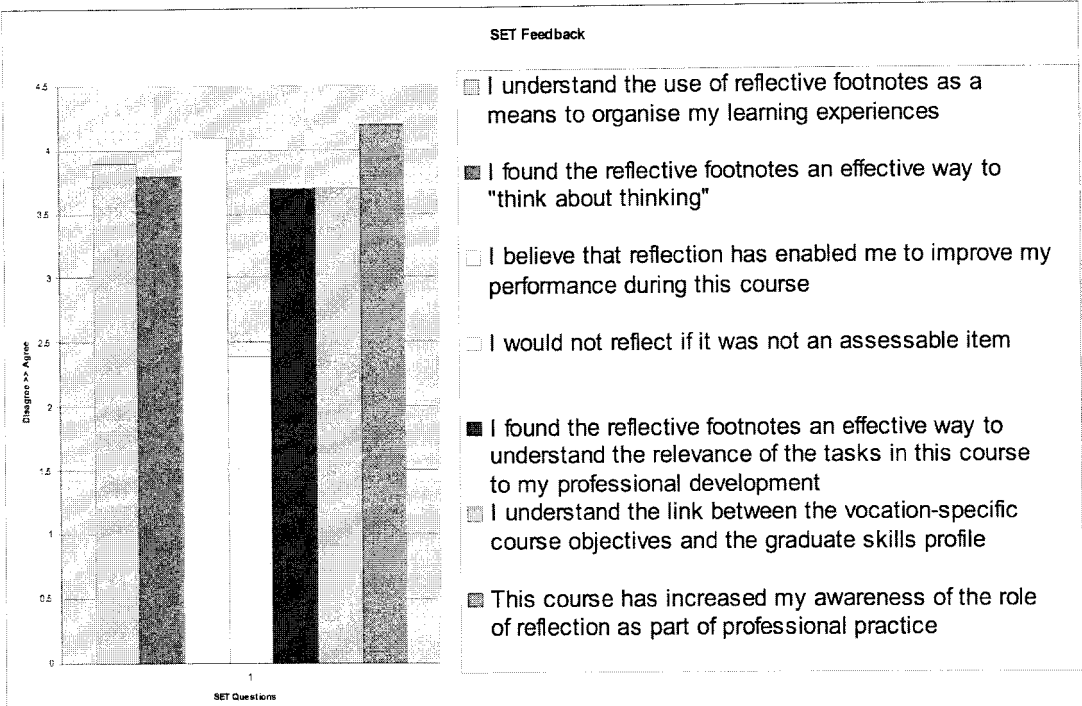


Figure 2. SET questions and mean value responses.

Nett adoption and benefit rates (2006)	
Extent of adoption of reflective footnotes by students in their work	52.6% of students (50/95)
Extent of positive impact of reflection upon their grade	11.6% of papers (11/95)

Figure 3. Adoption and benefit rates for reflective footnotes.

Thus it appears that the teaching of reflective practice was widely appreciated, as was its link to professional practice. Tangible appreciation of the use of reflective footnotes was evident, albeit at a lower level.

Comparison of the survey responses with the explicit outcomes from the assessment

process proved to be interesting. The student uptake rate for reflective footnotes in the first learning event was 52.6%, resulting in a positive benefit for slightly less than 12% of the class.

It should be noted that assessment of the reflective component was integrated into a composite rubric item, which described the quality of analysis and synthesis evident in the assessment product. By taking a holistic assessment approach it had been hoped to empower the students to exercise their creativity in addressing the course. Upon reflection it was decided that in the current offering of the course, assessment of the reflective component would be given a separate line item in the rubric. This decision was taken on the basis that, for the majority of a given class, assessment drives student learning: students are expedient and will be more inclined to devote energy to addressing assessment issues that attract an overt tranche of marks.

Paradoxically a significant majority of those students surveyed reported satisfaction with the concept of reflection and the positive effect it had produced in their performance on the course. This seeming contradiction can be explained if a significant number of students, after exposure to the reflective component of the learning event, saw fit to reflect internally/informally on their learning approaches, and adjusted their strategies for the course as a result. Assessor feedback confirmed that several of the students receiving High Distinction grades had chosen not to use reflective footnotes.

Examination of the qualitative feedback provided as a response to the open-ended question revealed the whole gamut of possible responses, from the inspired and energised, through the strategic, to the hostile and frustrated.

CONCLUSIONS

This initiative is believed to align with the extensive body of previous research, which indicates that the teaching and assessment of reflective practice is beneficial to student performance and is valued by the students themselves, as it helps them to develop a skill set that will be beneficial to them in their professional life. Further, it appears to offer support to previous research indicating that the rate at which this development

occurs varies from student to student, resulting in a wide range of emotions being present in a student cohort.

The assessment of reflective practice is probably beneficial in encouraging student engagement with reflective practice, especially at the beginning of their undergraduate career. The current deployment of reflective footnotes has been designed to overcome the shortcomings identified by analysis of the 2006 cohort: specifically, an overt tranche of marks has been assigned to the act of writing reflective footnotes; footnote writing has been scaffolded with the series of targeted tutorials and examples.

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