Steps Toward Mastery Learning in a First Year Mathematics Service Subject
Layna Groen. School of Mathematical Sciences
University of Technology, Sydney

PURPOSE
Student retention and progression have been identified as two of the most pressing concerns for higher education (Krause et al, 2005), and for students of Science, Technology, Engineering and Mathematics (STEM) in particular (Universities Australia, 2012; Office of the Chief Scientist, 2012). Coincidentally, the research literature points to the fact that for many first-year students experiences are neither personally satisfying nor academically successful (Mcninis, 2001; Tinto, 1993). Perhaps surprisingly, “Missing from the literature are clear mechanisms for assisting or enabling the [first-year] transition” (Bowles et al, 2011, p64). It is proposed that the introduction of elements of mastery learning (if not mastery learning itself) into first-year mathematics subjects will go a long way to address these concerns.

BACKGROUND
Mastery Learning is “both a philosophy of instruction and a set of methods for teaching and assessing” (Gentile & Lalley, 2003, p. 172). As a philosophy, it endorses the belief that all students can learn and achieve the same level of content mastery when provided with the appropriate learning conditions but within personal time frames. As a set of teaching and assessing methods, it requires that each student be assessed in a criterion-referenced manner based on the required instructional objectives. The research literature seems to indicate positive effects of mastery learning on students, especially in the areas of achievement, attitudes toward learning, and the retention of content (Anderson, 1994; Chan, 1981; Guskey & Pigott, 1988; Kulik, Kulik, & Bangert-Drowns, 1990). Mastery Learning seems to work best with the traditional curriculum, one based on well-defined learning objectives organized into smaller, hierarchically organised units. Mastery Learning is then ideally suited to mathematics education.

Mathematical Modelling for Science (MMS) is a first year, first semester, service subject for Physics, Chemistry and Forensic Science students at the University of Technology, Sydney. The majority of students undertaking the subject have studied two units of Mathematics at high School with ATARs in excess of 72. Students are recommended to undertake a diagnostic test to assess their readiness for mathematical study. Students failing the test are recommended to enrol in Foundation Mathematics and attempt MMS at a later date. MMS exhibits many of the traits of first year service subjects including high failure rates and high attrition as well as poor preparedness for later subjects.

DESIGN/METHOD
Subject objectives have been a long established part of the administration of subjects at UTS. The subject curriculum is subdivided into learning units and further organized into a logical sequence of smaller objectives. Learning materials, instructional strategies and activities (including assessments) are identified and sequenced over the teaching period. Following instruction on the first and second units of work, criterion-referenced tests are developed and administered to assess the degree to which students have acquired knowledge and skills. Unlike most mastery approaches precise, measurable performance criteria were not set. Instead, students judged their own performance and determined whether, with further learning activities, their understanding and skills could be improved. Immediate feedback was supplied in both instances and remedial activities were made available to all students. Students could also engage in other corrective activities individually, with peers (including formalised peer learning), or with an educator in the Mathematics Study Centre, thereby receiving additional time and practice to learn the material. Bloom proposed second formative assessments should be administered to again assess progress towards satisfaction of the unit objectives. Unlike mastery learning, students could proceed to the next instructional unit without demonstrating mastery.

RESULTS

What did you like particularly in this subject?

... the “second chance” tests. I think this is a really good direction ... fundamentally the point of the subject (any subject, really) is to help people understand the material and help them study it, and I think these second chances do both of those things. Showing exactly where people aren’t doing so well and (importantly) letting them see the results of study very soon after. I think it’s not only a really good way to help people target their study most effectively and understand their own learning process, but also just a great way to reinforce the value of study in people’s minds – you can see your marks improving almost immediately.

... this does wonders to a student’s confidence in a subject that leaves very few standing tall

... [a] creative way to offer and encourage students to practice the problems they struggled with

CONCLUSIONS
When mastery learning was applied during the course of the semester, it was received very favourably by the students. However, due to the fact that changes could not be made to the overall assessment structure without Faculty approval, it was not possible to use mastery assessment with the final exam. It was felt that this reinforced old patterns of performance, and not surprisingly final results failed to display the learning benefits that mastery learning had achieved in the first four units of work. The results of the mastery tests suggested that a full program of mastery learning be trialled (meaning that the final exam become optional and used for grade discrimination purposes only). A working party has been established to look at the viability of this approach across first-year maths subjects.