

Mastery Learning in MATH1013 at ANU

An assessment structure to foster success in tertiary mathematics

Griffith Ware

Adam Piggott



Australian
National
University



A little about us



THE CONTEXT



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MATH1013

1st Year, 1st Semester, introductory Calculus and Linear Algebra mostly taken by students whose passion is another discipline.

Typically: 300 – 400 enrolments in Semester 1, and 150-200 enrolments in Semester 2

Historically (prior to 2024), assessment was:

- 70% exams:
 - 20-30% mid-semester exam;
 - 40-50% final exam;
 - hurdle requirement on final exam;
- 30% from online quizzes, tutorial activities, and assignments.



MATH1013

Things we didn't like

- Students at the minimum-passing level seemed underprepared for subsequent courses.
- Hurdle requirement on final exam was very low, and seemingly ineffective.
- Some difficulty with asking enough depth questions, in an exam that also acted as a hurdle.
- Final exam mostly only covered material from the second half of the course.



Case study: The Semester 1, 2019 Final

Exam

- Exam hurdle of 35% on Calc and 35% on LA
- Approximately 40% of the marks on the final exam were at the pass level.
- Partial credit “pity marks” on deeper questions offset marks lost on basic skills so students can scrape by without all of the basic skills.
- At the other end, stronger students were able to get enough marks for an HD without necessarily demonstrating the deeper understandings that we want to promote.
- Some students were realising on the day of the exam, when there was nothing to be done about it, that their approach to learning mathematics at university was ineffective.



MASTERY LEARNING



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Transition Pedagogy

“The curriculum and its delivery should be designed to be consistent and explicit in assisting students’ transition from their previous educational experience to the nature of learning in higher education and learning in their discipline as part of their lifelong learning. The first year curriculum should be designed to mediate and support transition as a process that occurs over time.”

Nelson, Creagh, Kift, Clarke, Transition Pedagogy Handbook: A Good Practice Guide for Policy and Practice in the First Year Experience, 2010, p. 12 https://cms.qut.edu.au/__data/assets/pdf_file/0008/226529/transition-pedagogy-handbook.pdf



Habits/skills/traits of the most successful students in tertiary mathematics

- Algebra
 - Keep up!
 - Ability to read and write in the language of mathematics (requires precision)
 - Accept the standards we set, and then strive to meet them.
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- Develop skills in conversational mathematics
 - Recognise narrative structure in material



Mastery Learning

- First formally suggested in the 1960s.
- Key features include:
 - An assumption that success (in passing) a subject is mostly dependent on the time a student needs to learn.
 - Instead of summative exams being once-off (particularly at the end of a unit), some exam(s) are earlier in a unit of study and assess a required level of “mastery” of the material.
 - Typically, these have a high hurdle of a mark of around 80%.
 - Should a student not achieve the level of mastery required, they are given second (and potentially further) attempts to meet the mastery hurdle.
 - Between attempts, students are given additional support in learning and reviewing the material.
- In principle, the design suggests that students should not move on to later material until they have met the required level on a mastery exam; in practice (in the context of university semesters) this is not easily achieved.

Mastery Learning

Our slice of this history is:

1960s: Idea of Mastery Learning originated by Benjamin S. Bloom

1971: Mastery Learning: Theory and Practice, James H. Block (ed).

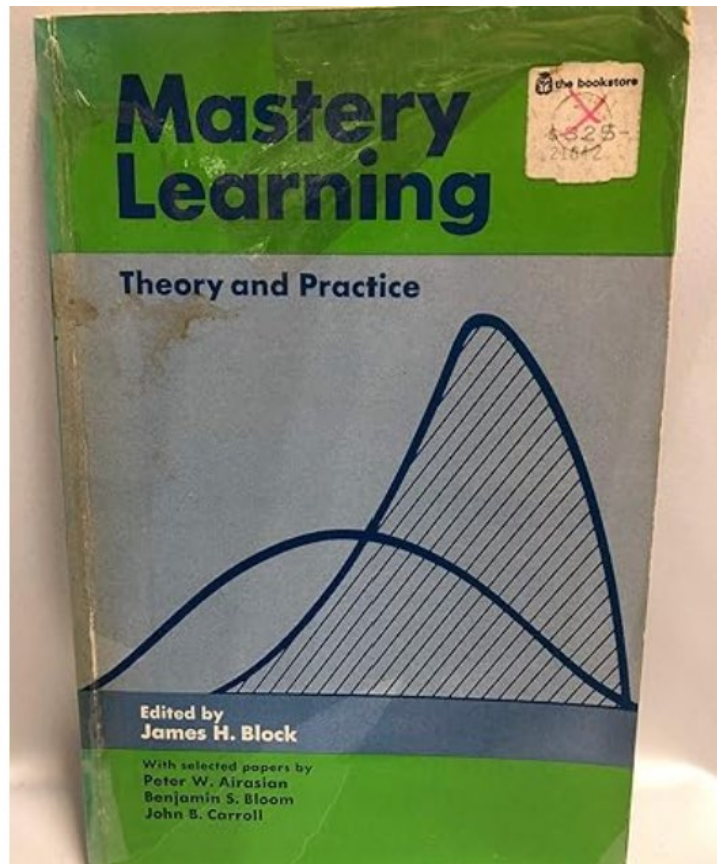
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2010s: Mary Coupland and colleagues applying principles in maths at UTS

2014: AP tries it in a second-year service course at Bucknell University

2018: Sam Kault and AP (UQ)

2024-2025: GW and AP (ANU)



A problem at one end of the grading scale ...

- Students at the minimum-passing level seemed underprepared for subsequent courses.

...and at the other end

- Students were earning high grades without necessarily demonstrating higher-order critical analysis skills and the ability to explain concepts. There was perceived difficulty in asking enough depth questions in an exam that also needed to determine pass/fail.

↑ Problems/Solutions ↓

Should this student pass?

- 20% two “Mastery Hurdle Exams” to establish baseline skills.
- 32% from online quizzes, tutorial activities, and assignments.

With what grade?

- 48% final exam with: question parts stratified to test learning outcomes at pass, credit, distinction, and high-distinction levels; marked on the assumption that a student at a bare-passing standard had already earned 40 – 42 of the 52 marks available earlier in the course



MATH1013 in 2024-2025:

Changes to assessment structure:

- 20% “Mastery Hurdle Exams”
 - Two separate exams, based on 1st and 2nd thirds of material, respectively.
 - Each has 20 questions marked correct/incorrect (no partial credit).
 - Questions are all intended to be at baseline minimum passing level.
 - Hurdle requirement to pass the course, is to get at least 16/20 on each of these exams. Once met, credited with the full 10% the exam is worth.
 - For each hurdle exam, students can have up to **four/three** attempts at similar exams during the regular semester, in order to meet the hurdles.
 - Opportunity to revise and get extra support before reattempts.
- 32% from online quizzes, tutorial activities, and assignments.
- 48% final exam (no hurdle on final exam).
 - Marked on the assumption that students at a bare-passing standard had already achieved 42/52 in marks available so far.
 - Question parts stratified to test learning outcomes at pass

2024/2025 Results

- Significant reduction in students withdrawing after census date.
- Significant reduction in fail grades for students who remain enrolled after census date.
- Reduction in the number of students requiring a supplementary assessment.
- Large drop in the proportion of HD grades.



WHAT'S OUR TAKE



Australian
National
University

Contact:

adam.piggott@anu.edu.au
griffith.ware@anu.edu.au



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