

# Mastery-Based Grading in Intro to Proofs, or Innovation at the Last Minute

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# Background

## MAT 2224 – Fundamentals of Mathematics

- Prerequisite for most upper-level Math courses
- 12–20 students, mostly 1st and 2nd year math majors
- Topics up to instructor; traditionally Logic and Set Theory

Essentially unchanged over the last 15 years.

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Last year (first time teaching):

- Proof revisions
- Presentations of homework problems
- Light amount of group/IBL work

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Didn't really work.

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How to fix it?

- Full IBL?
- Re-emphasize homework/presentations?

Kept coming back to “skills necessary for upper-level courses”. So – the night before the course started:

**Grading:** Your grade in the course will be calculated as follows:

Homework/Class Participation/Attendance	15 %
Proficiencies	50 %
Quizzes (beyond Proficiencies)	10 %
Final	25 %
<b>Total</b>	<b>100 %</b>

## Proficiencies

Proficiencies are the core ideas of the class (for example: truth tables, how to show two sets are equal, induction; see the reverse for the tentative full set of proficiencies.) Each quiz (until the last few weeks of the semester) will contain problems from 2 new proficiencies. Problems on proficiencies will be graded on the following scale:

3. Problem is correct.
2. Problem is mostly correct, with at most a few minor errors.
1. A major error, but progress toward a solution.
0. No significant progress toward a solution.

The 50 points for the proficiencies will be assigned as follows:

**50 points:** A score of '3' on at least 16 proficiencies; no score below a '2'.

**40 points:** A score of '2' or higher on at least 15 proficiencies; no score below a '1'.

**30 points:** A score of '2' or higher on at least 12 proficiencies; at most 2 scores of '0'.

**0 points:** A score of '0' on at least 3 proficiencies or a score of '2' or higher on at most 11 proficiencies.

## List of Proficiencies (subject to change)

1. Truth tables
2. Propositional Logic (AND, OR, implies)
3. Predicate Logic (for all, there exists)
4. Interpreting Propositional and Predicate Logic in terms of English sentences.
5. Rules of Inference and methods of proof
6. Induction
7. Counterexamples
8. Definitions on sets (unions, intersections, complements)
9. Showing sets are subsets/equal to each other
10. Set builder notation
11. Arbitrary unions and intersections
12. Product sets
13. The definition and use of functions
14. Properties of functions
15. One-to-one and onto functions
16. Images and inverse images
17. Equivalence relations
18. Posets – maximal/minimal elements and upper/lower bounds
19. Cardinality
20. The Pigeonhole Principle



## Additional Details:

- Homework due Tuesday, Quiz on the following Monday
- 1 additional problem on Quiz – combining ideas, more complex topics (10 total points)
- Google Survey each weekend asking about old proficiencies/review topics
  - 3 or 4 old proficiencies on each quiz
- No written comments on Proficiency problems – only the grade.
- All proficiency grades on Blackboard

Universally positive. Hooray!

- Complete student buy-in
- Much better view of students' difficulties
- Several students dramatically improved over the semester
- Average score on final higher than last year

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Some caveats, but nothing to dissuade me from doing it again this Spring.

# Caveats

- Class may have just been stronger than last year
- Initially made quiz problems too difficult
- Some necessary “make-up” quizzes later in the semester

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## Big Question

How do I get student connect ideas and integrate them into a larger mathematical framework?