







Problematic concepts in 1st year Mathematics

Assessment for Learning: Resources for First Year Undergraduate Mathematics Modules Caitríona Ní Shé







How did the project come about

Mathematics Problem

- transition from rote learning to independent thinking
- students grapple with 1st year undergraduate mathematics



- National Forum for the Enhancement of Teaching and Learning
 - shape the delivery of an outstanding teaching and learning experience at third level in Ireland
 - Building digital capacity
 - Teaching for Transitions

Assessment for learning

- Improve the teaching and learning experience of first year undergraduate mathematics modules
 - identify mathematical topics and concepts that are problematic
 - develop online activities and tasks to promote understanding of these concepts
 - and evaluate the effectiveness of these resources
 - provide the resources to all Higher Education Institutes (HEI's) in Ireland

CETL-MSOR Conference 2015

Identifying topics and concepts that First Year students struggle with in Mathematics

Caitríona Ní Shé

Outline of presentation

- Survey & Outcome
- Problem Topics & Concepts
 - Likert item analysis
 - Open ended question coding
- Resources
 - What and why used

Next Steps

Surveys: Spring 2015 - end of 1st year

Identify problematics concepts AND useful resources

Questionnaire developed by team





Student Survey: Question Topics

23 different mathematical question types • Understand and Do

14) Finding limits of functions using rules of limits

	Strongly	Agree	Neutral	Disagree	Strongly
	Agree				Disagree
I understand the ideas in questions					
like this.					
I am able to do questions like this.					

Example of Question

14. Finding limits of functions using rules of limits

Example: Use the rules of limits to evaluate

$$\lim_{x \to 2} \frac{3x^2 - 4x + 9}{x + 5}$$

Open ended Questions

- Student survey had 7 questions
 - Topics most difficult and most easy
 - Resources they used and why
 - Gaps and how they should be filled
- Lecturer survey had 7 questions
 - Concepts, procedures and tasks difficult
 - Resources they recommend and why
 - Gaps and how they should be filled

Surveys: What did we find out?

Concepts and Topics

- Prior mathematics level as a predictor
- Student and Lecturers differing views
- Themes emerging

Resources

- Online videos and websites etc
- Prescribed books & Handouts
- Student reliance on examples and solutions

Student Background Data

Category	Gender	Mature	Leaving Cert Mathematics
Males	293 (65%)		
Females	160 (35%)		
Non Mature		368 (84%)	
Mature		69 (16%)	
Higher			282 (64%)
Ordinary			142 (32%)
Foundation			5 (1%)
Did not take			15 (3%)
Total Responses	453	437	444

Leaving Certificate Mathematics Level



Problem Topics and Concepts Students & Lecturers

Students have few problems!



Students have few problems!



Higher Level students only



Higher Level students only



Ordinary Level Students only



Ordinary Level Students only



Higher Level Versus Ordinary Level

- Chi-Squared test to compare Higher and Ordinary level responses to the Likert items
- Reduced to 3 point scale agreement, neutral, disagreement

p= 0.004

 There is a dependency between Leaving Certificate Mathematics Level taken by student and their rating of their ability to both Understand and Do the 23 questions types in the Likert items

What does Likert survey tell us?

Overall students report very few problems

- Students who had taken Ordinary Level mathematics perceive they have more difficulties than those who took Higher Level
- Problem areas are logs, exponents, limits of functions, graphing and advanced 1st year calculus

Open ended questions analysis

- Imported to Nvivo
- Students
 - Topics most difficult
 - and topics most easy
- Coded to select most frequent

Coding in Nvivo – difficult topics

No.of responses containing these codes (414)



Higher versus Ordinary

% of student who responded and mentioned these topics (414, 251 HL, 134 OL)



Open Ended: Easy Topics

% of student with mathematics level who responded and mentioned these topics (407)



Higher level completed

Ordinary Level completed

Why? Coding the comments

- A number of themes
 - Prior mathematical background
 - Method selection
 - Applications
 - Visible

Student Comment: Leaving Cert

Topics cause difficulty and why

"Optimization and graphing functions. It was one of the topics **that was least covered in secondary school,** therefore coming into university, studying maths at a higher level was a bit difficult to grasp. **The formulas and when to use the right ones was the difficulty**"

Student Comment: Leaving Cert

Topics most easy and why

"most easy were topics I covered in Leaving cert like : linear equations, graphs, algebra functions, quadratic equations"

Student Comment: Applications

Topics cause difficulty and why

"When we done concave up and concave down graphs, it was very hard to apply yourself to a **concept which seemed so useless**, it didn't seem to have any practical use so it was hard to apply yourself to it and the Planes section from linear algebra"

Student Comment: Visible

Topics most easy and why

Interpreting graphs and base functions because the **date is visible and relatable to application** and its easier to understand as a result

Lecturer viewpoint

Concepts most difficult



Lecturer versus student recoding



%students responses



Lecturer Further Breakdown

Lecturers Survey: 13 specifically reference logs, indices or exponents.

- 42% (13/32) of lecturers indicate that their students experienced problems with these
- Only 18% (74/414) of students mentioned these

Lecturer Comments: Logs

"Logarithms – general understanding and how to use rules to solve equations; application to experimental laws"

"In the case of Logs, once the student understood the concept of adding the indices of was the same as multiplication of two or more numbers, their engagement with the topic increased"

Some students agree re logs

"I found **logs** and limits the most difficult as the ideas are hard to understand. Also some integration towards the end of the year was challenging as the methods were hard to start off"

"mostly ideas of topic confuse me most. Most difficult was algebraic manipulation of rules of indices. Without knowing these it was hard to do a lot of the maths"

Resources

Students & Lecturers

Students Found Useful



Students Found Useful

- Recommended texts (DCU and MU)
- Lecture, class or tutorial handouts "the notes from the support centre were excellent, they summarised the course in an approachable but
 - concise manner, making it easier for looking over just before the exams "
- Videos and Websites
 - Khan Academy, Wolfram Alpha, YouTube, VLE
 "Khan academy is fantastic. The guy who does the video works everything out in simple steps and explains everything as he goes along "

Lecturer Found Useful



Lecturer Found Useful

 Mathstutor, mathcentre, khan academy, geogebra, VLE

"For weak students the Kahn academy has been good. – We use MathXL as an online assessment tool for homework, providing instant feedback and this has been somewhat useful"

Handouts

'Handouts in class seem to help hold attention"

Advise on Resources: Students

> 252 responses



Advise on Resources: Students themes

- Solutions, steps and examples
 - video tutorials of different styles of questions
 - Videos of someone going through past exams
 - Examples of different questions to be given on line with step by step solutions and methods that people of all levels could relate to.
 - Printed steps of class procedures

Conclusion Students & Lecturers

Next Steps: Topics Identified

Basic Algebra

- Transposition of formulae
- Logs & Exponentials
- Functions
- Limits
- Logs

Next Steps: Resource Development

- Currently developing resources:
 - An inventory of useful existing resources;
 - Moodle Courses and assessments using Khan Academy materials;
 - Online 'lessons' and quizzes designed in Moodle;
 - Student screencast continuous assessment projects;
 - Audience Response system
 - A suite of interactive tasks.

Next Steps: Evaluation

- Autumn and Spring 2015/2016 Academic year
 - Survey
 - Focus group interviews
 - Task based interviews

Other relevant projects

 UCD – mathematical difficulties as experienced by students in a Mathematics Support Centre

UCC and CIT – Transitioning to e-assessment in Mathematics education

The End

Thank you