Mathematics Textbook Analysis; Supporting the implementation of a new Mathematics Curriculum

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Introduction

Mathematics Textbooks

- have a major influence on classroom practice (Valverde et al., 2002).
- is one of the key factors in implementing mathematics curricula. (Schmidt et al., 1997)
- organised in a purposeful way, and consequently their content and structure are important for the promotion of a specific vision of mathematics curriculum, which in turn impact directly on students' learning (Robitaille & Travers, 1992).
- TIMSS (2005) conceives and develops a powerful link between curriculum and textbooks, suggesting the textbook can be considered as a 'surrogate curriculum'.

Irish Context

- Historically influenced by commercially produced school textbooks
  - a view of mathematics concerned mainly with skills and instrumental learning
  - over reliance on mathematics textbooks
  - contributor factor to the low uptake of higher level mathematics in state examinations

(NCCA, 2005).

- discontinuity between the senior primary school curriculum and the lower secondary school textbooks.

(Cosgrove, Oldham, & Close, 2005)

- Which is affecting the students' transition from primary to secondary education.

(Smyth, McCoy, & Darmody, 2004)

Irish Context

- **Irish Junior Cycle Mathematics Curriculum**
- The 2005 NCCA curriculum review and consultation discussion paper
  - create and implement a new second level mathematics curriculum - P*roject Maths*
  - piloted in twenty four schools in Ireland during the period 2008-2010.
  - implemented nationally in September 2010.

- Project Maths is a five strand curriculum;
  - Statistics and Probability,
  - Geometry and Trigonometry,
  - Number,
  - Algebra
  - Functions

Irish Context

- cooperating teachers were required to evaluate the resource materials and provide feedback,
  - No new mathematics textbooks were introduced by the Project Maths team with the new curriculum.

- However, as each strand was rolled out into schools nationwide some textbook materials emerged,
  - supplement material to be used in conjunction with previous textbooks

- The Project Maths development team urged teachers to be flexible in their approach to selecting and using textbooks highlighting that
  - '*no single textbook*' can meet the needs
  - somewhat limited by the 'linear presentation of ideas'

(Project Maths b).

Background to the Study

- **Background to the report**
- NCCA commissioned the National Centre for Excellence in Mathematics and Science Teaching and Learning (NCE-MSTL) to conduct a review of school mathematics textbooks published commercially for Project Maths.

- The report (O'Keeffe & O'Donoghue, 2011) was published in 2011 at a time when a significant number of new textbooks were made available for Project Maths

- The intention of the report was to offer an objective evaluation of a selection of new textbooks available for Project Maths.

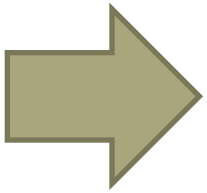
Theoretical Framework

TIMSS

- TIMSS focuses on curriculum as a means of comparing education systems.

- TIMSS model of curriculum:
  - Intended curriculum
  - Implemented curriculum
  - Attained curriculum

- Curriculum framework:
  - Subject matter content
  - Performance expectations
  - Perspectives



  - Structure
  - Expectation
  - Perspectives

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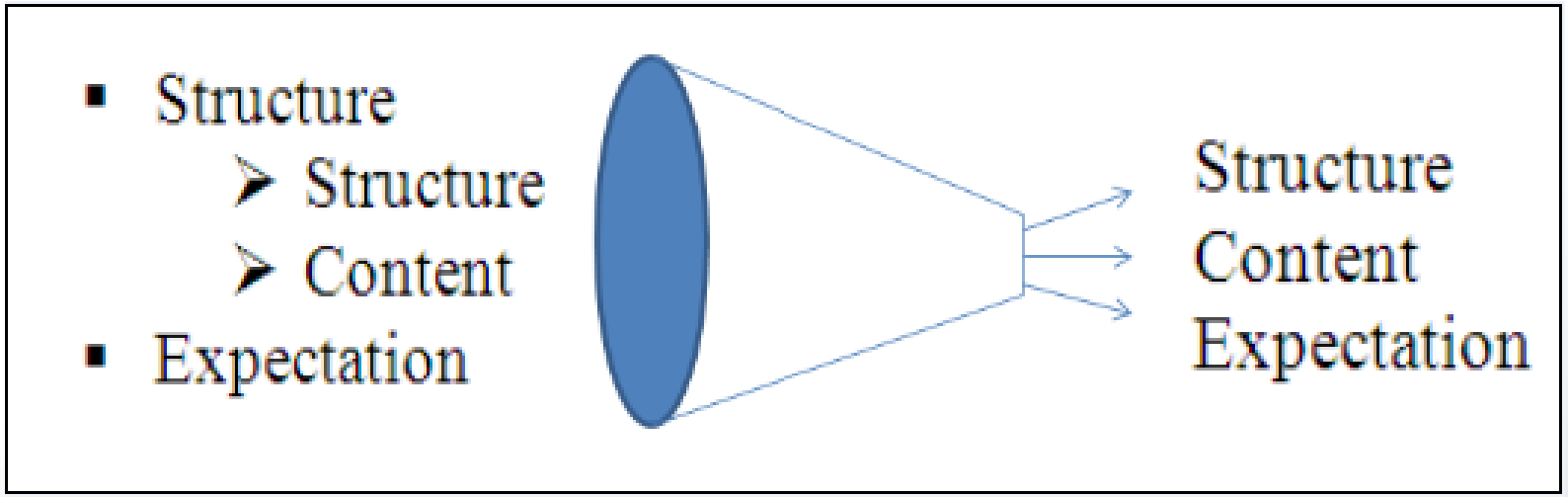
Methodology

Theoretical Framework

- Structure
  - Structure
  - Content
- Expectation
- Perspectives

TIMSS+ Instrument



Specially Constructed Curricula (SCC) Subcategories of PM

- 6 SCC
  - Junior Cycle Curricula
    - Common Introductory Course (CIC)
    - Strands 1-5 O
    - Strands 1&2 O
  - Senior Cycle Curricula
    - Strands 1&2 O
    - Strands 1&2 H
    - Strand 2 H
- 10 Textbooks
  - 14 disaggregated "textbooks"

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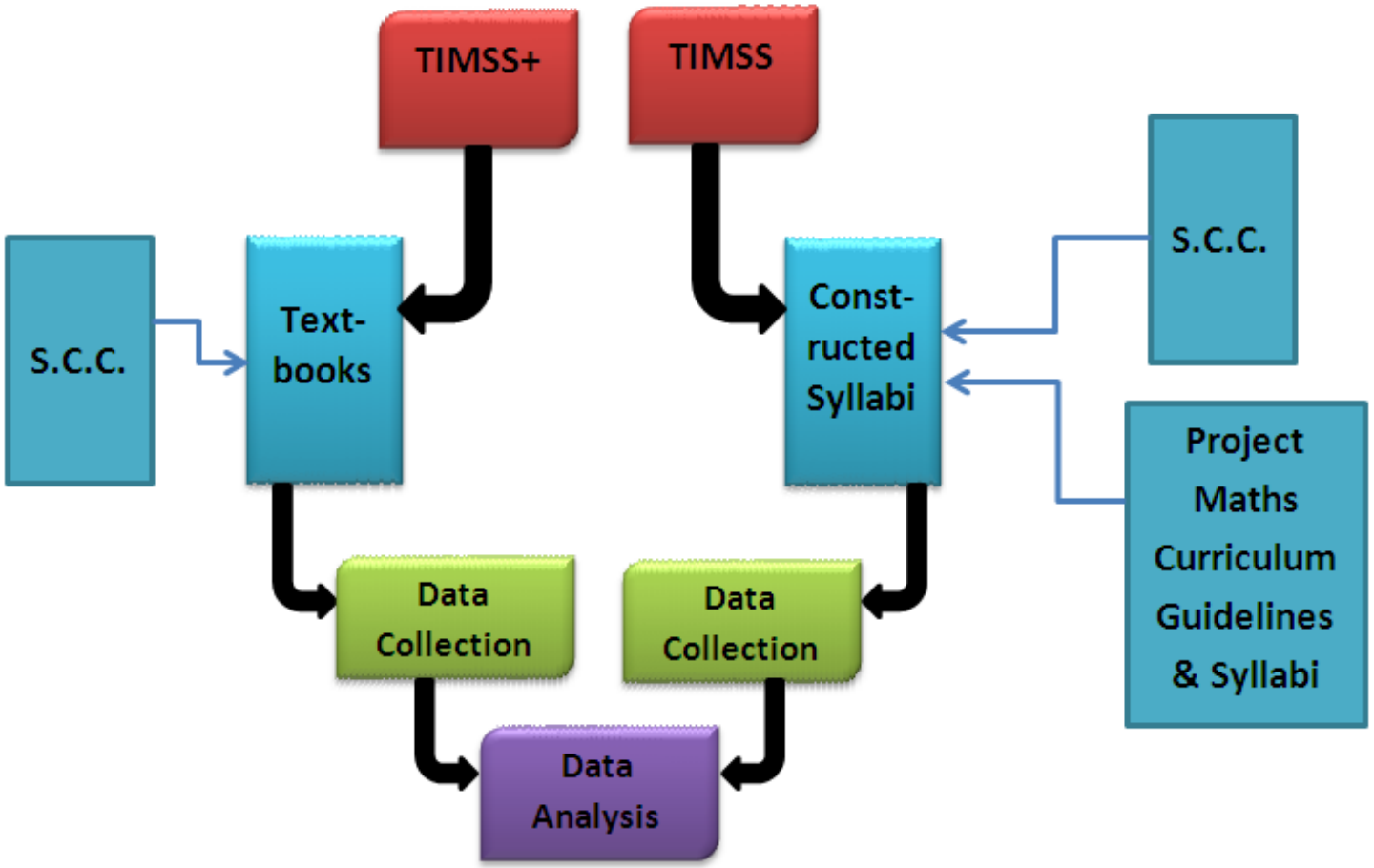
Methodology

Overview



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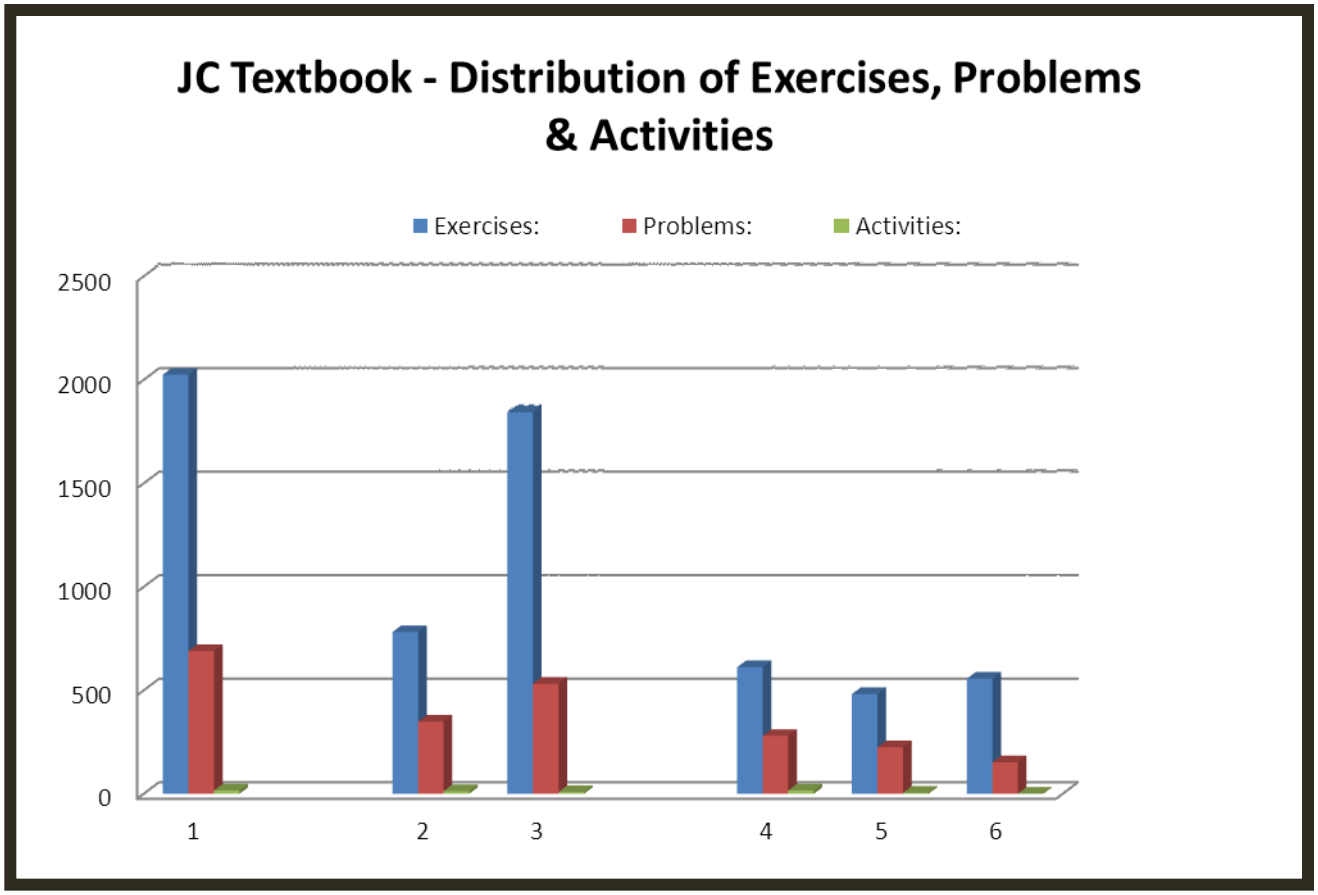
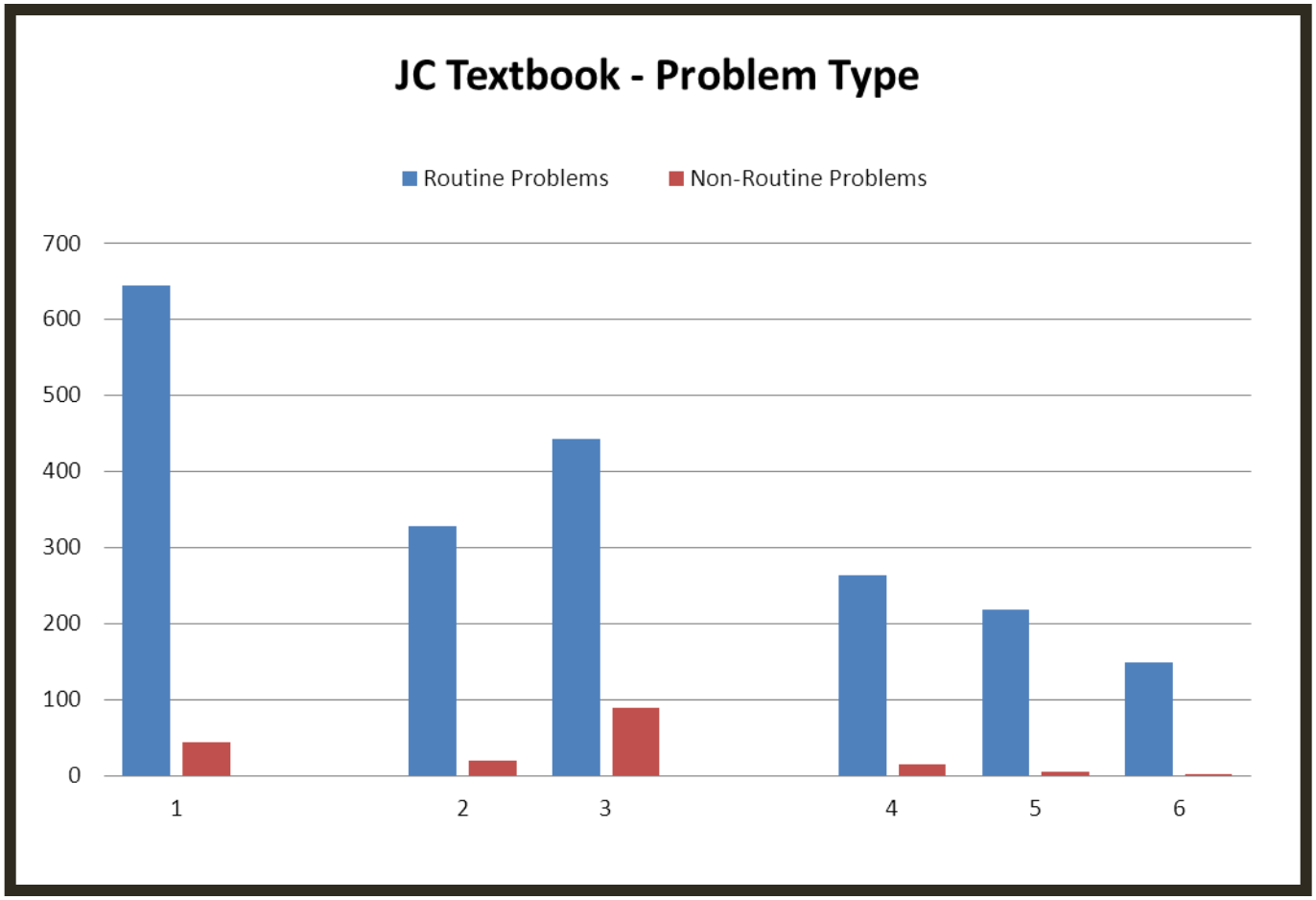
Example of Main Findings

- Structure
- Content
- Expectation

Content Analysis:



Content Analysis:



Expectation Analysis: Main Findings

SCC 2	Textbook 1	Textbook 2
Omissions when compared with PM syllabus:	• Generalising (S3&4) • Performing more complex procedures (S2&4) • Formulating & Clarifying Problems (S2&4) • Developing Strategies (S2&4) • Predicting (S4) • Developing Algorithms (S3)	• Generalising (S3&4) • Recognising Equivalents (S2) • Developing Strategies (S2,3&4) • Predicting (S1&4)
Absent from Strand 4	• Conjecturing • Justifying & Proving • Use of Vocabulary & notations • Describing & Discussing	• Conjecturing • Justifying & Proving • Use of Vocabulary & notations • Describing & Discussing
Syllabus key expectations: (under-represented)	• Inquiry based Learning • Problem Solving in Context • Using Graphics to assist Problem Solving	• Inquiry based Learning • Problem Solving in Context • Using Graphics to assist Problem Solving

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Report Conclusion:

Text-book	Structure	Content	Expectation
1	• High narration • Low instructional narration • Key terms accentuated by printing devices • V. Large number graphics • Ex:Pr is 3:1 • 2% of total are non-routine • Strand 4 – problems not integrated	• Gaps: ICT • Good consideration to motivational factors	• Lack of focus on mathematical thinking • Underrepresentation of Problem Solving in context
2		• Reasonably well aligned with PM	• Key Expectations Omitted in Strand 4 • Problem Solving (S2 & 4)

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Key findings

- The summary of the key findings suggests that no one textbook met the needs of the new mathematics curriculum but there were some genuine attempts.

- While there were structural differences, as expected, across the disaggregated textbooks the mismatches with regard content and expectation are of primary concern.

- Content omissions such as
  - 'Domain and Range', 'Linear Functions' and 'Proportionality Problems'
- Similarly key expectation omissions such as:
  - a focus on 'Developing Algorithms', 'Performing more Complex Procedures', 'Formulating & Clarifying Problems' and 'Across and Inter Subject Connections'.

- Further to this a note in the expectations data indicates that a greater emphasis could be placed on 'inquiry based learning', 'problem solving in context' and the 'use of graphics to assist with problem solving'.

- A further key finding was the noteworthy omissions of the integration of ICT throughout all textbooks and disparities between approaches to teaching for understanding and problem solving.

Implications…

- The above findings indicate a mismatch between curriculum and textbook expectations.

- Ball & Cohen (1996) mismatch could obstruct a complete ‘change’ in approaches to teaching and learning

- The previous mathematics curriculum
  - providing predictable exams,
  - large chunks of the curriculum could be omitted entirely
  - students could rote learn some key information

(Oldham, 2001).

Implications…

- Project Maths identifies itself as a **new mathematics curriculum** with a **new focus** aimed at improving the teaching and learning of mathematics and hence improving students' comprehension and understanding (Jeffes et al., 2012)

- Project Maths intends to counteract this with a change in teaching methodologies and a focus on teaching for understanding and application (Lynch, 2011).

  - fully informed on expectations and good practices
  - Textbook must echo the expectations of the curriculum (Ball & Cohen, 1996, Remillard, 2005)

Implications for Teachers…

- NCCA identify that Irish mathematics teachers
  - focus entirely on routine procedures
  - place little or no value on the concepts of understanding, communicating, validating and justifying mathematics.

- This is reflected in the previous Irish textbooks (O'Keeffe, 2011) by the dominance of:
  - the expectation to perform routine procedures
  - minimised or omitted focus on predicting, verifying, justifying, critiquing and discussing mathematics.

- Ball & Cohen (1996) discuss the difficulties teachers face when asked to change practices, strategies and approaches to teaching
  - Such difficulties are increased in light of the findings of Ní Ríordáin & Hannigan (2009).

Conclusion:

- Textbook analysis
  - provided an insight into how the focus and expectations of the new mathematics curriculum was developed in the supporting mathematics textbooks.
  - raised awareness among teachers about the differences between textbooks, the options available to them
  - the key features and expectations of Project Maths were discussed from a different perspective.

- This report reinforces a method of textbook analysis than enables direct comparison between mathematics curricula and textbooks
  - while explicitly identifying the impact that such can have on ensuring greater cohesion between the message of the curriculum and the message of the textbook.

Thank You Very Much.

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