UNIVERSITY OF CAMBRIDGE
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CSMC
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Mathematics Curriculum Development, Delivery, and Enactment in a Digital World

The re-sourcing movement in mathematics teaching: some European initiatives

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The idea of re-sourcing

- The term "re-source" was first used in discussing the role of resources in teaching and teacher development:
  - *"It is possible to think about resource as the verb* re-source*, to source again or differently. This turn is provocative. The purpose is to draw attention to resources and their use, to question taken-for-granted meanings."* (Adler, 2000)
- In this spirit, "re-sourcing" teaching includes drawing on new sources as well as using conventional resources in new ways.
- The term has become associated with the process through which teachers acquire, transform and organise material in many forms and from many sources to support their teaching:
  - *"Re-sourcing teachers' work and interactions: a collective perspective on resources, their use and transformation".*

(Pépin, Gueudet & Trouche, 2013)

A re-sourcing movement

- Within the teaching profession, there has long been a related current of thought which is critical of teaching that is reliant on externally developed schemes of curriculum materials.
- This current has given rise to approaches in which teachers devise their own curriculum scheme through assembling, adapting and structuring materials from multiple sources.
- Major lines of argument for such an approach are that:
  - By drawing on varied sources to design new materials or adapt existing ones, mathematics teachers can create a tailored curriculum scheme that both satisfies systemic requirements and takes account of the local context in which they teach.
  - Through engaging with the development, evaluation, selection customisation and organisation of resources, teachers can deepen their understanding of how to use them effectively.

Digital technologies and re-sourcing

- This type of active and eclectic re-sourcing has become increasingly feasible as advances in digital technology have:
  - broadened the range of accessible sources and available media
  - facilitated the preparation and modification of materials
  - transformed the diffusion and evaluation of open resources
  - fostered the creation of interactive user communities

Motive for, and outline of, this talk

- There has been considerable research on the design, diffusion and use of conventional resources, particularly textbook-based curriculum schemes.
- In this talk, I will draw on the much smaller and more recent body of European research on re-sourcing in practice to examine this new phenomenon and issues that it raises.
- More specifically, reflecting the foci of the range of research studies available, I will examine two aspects of re-sourcing:
  - The functioning of online networks for the creation and exchange of mathematics teaching resources;
  - The implementation of a re-sourcing approach by individual teachers, and across an educational system.

Typifying online resource networks

- Research has examined French online teacher networks concerned with resource development and exchange in several subject areas, including one mathematics network.
  (Quentin, 2012; Quentin & Bruillard, 2013)
- This research identified two main prototypes for such networks:
  - The *hive*, in which systems of resources are produced by groups of teachers working collectively in an organised manner towards common aims within a carefully regulated framework;
  - The *sandbox*, in which discrete resources are produced independently by individual teachers working autonomously with relatively limited regulation.

Sésamath (http://www.sesamath.net/)

- Sésamath is a not-for-profit association in which teachers contribute to the development of systems of open and re-usable resources to support lower-secondary mathematics teaching and learning in French schools, including:
  - Series of Sésamath textbooks and workbooks, available in downloadable digital or conventional printed form;
  - Mathenpoche, an online study-support site for pupils, providing exercises with supporting lessons and animations;
  - LaboMEP, an online site which enables teachers to produce customised sequences of resources for their pupils;
  - Sésaprof, an online site for discussion and exchange of resources between teachers.
- In late 2012 nearly 20 thousand teachers and over 1 million pupils were registered users of the Sésamath portal.
- Sésamath's printed textbooks have won 15% of the market.

Sésamath: the hive exemplified

- Development of resources takes place through a system of projects guided by the core members of the association.
- Serving teachers contribute to the association by working together in teams on such projects, according to expertise.
- Resources are evaluated and refined through a structured process of peer review and trialling.
- The resulting resources are attributed to the association rather than to the individuals who created them.
- The commercialisation of printed versions of its textbooks generates income to support the operation of the association.
- This enables the association to employ staff who provide specialised technical and administrative support.

(Quentin, 2012; Quentin & Bruillard, 2013)

Intergeo (http://i2geo.net/)

- Intergeo, an EU-funded project, created an online repository for interactive geometry resources developed by individual members of the wider project community.
- The project sought to enhance the usability of such resources:
  - by enabling users to employ their software of choice through specifying a common file format based on open standards;
  - by helping users to identify resources that would meet their needs through associating metadata with each resource;
  - by providing prospective users with reviews of each resource through a quality questionnaire completed by previous users.

(Kortenkamp & Laborde, 2011)

- In late 2014, the repository:
  - had nearly 3000 members, and over 30 subgroups;
  - held nearly 4000 resources, and nearly 900 reviews.

Intergeo: more sandbox than hive

- One focus of project evaluation was on the quality process.
- Data available from the repository showed that:
  - Only a small proportion of resources (around 13 %) had been reviewed, and most of these had received only one review;
  - Few of the resources that had been reviewed had subsequently been modified.
- Further evidence gathered from relatively active contributors identified reasons why they did not modify a resource:
  - They did not find sufficient guidance in a review on how to improve the resource;
  - They disagreed with, or were discouraged by, a review;
  - They did not feel sufficiently strong membership of the community to want to commit time and effort to revision.

(Trgalova, Soury-Lavergne & Jahn, 2011; Trgalova & Jahn, 2013)

Online networks from a user perspective

- In both types of network, teachers emphasised how the sharing of resources between peers inspired and enabled them to develop and diversify their classroom practice.

  (Quentin, 2012; Quentin & Bruillard, 2013)
- However, major differences of approach are apparent.
- Intergeo:
  - provides an extensive reservoir of resources and supports users in searching for those that satisfy their own particular criteria;
  - but leaves users to integrate them into a coherent program.
- Sésamath:
  - creates a single complete program, and trials and refines the associated resources to warrant a certain quality;
  - but provides these resources in a form that still allows users to select from and adapt them.

Re-sourcing the practice of teaching

- To turn, now, from the production and exchange of teaching resources through online networks to the implementation of a re-sourcing approach in the immediate practice of teaching.
- First, to examine the implementation of re-sourcing at the teacher level I will draw on a case study of individual teachers in Norway and France. (Gueudet, Pepin & Trouche, 2013)
- Then, to examine the institutionalisation of re-sourcing at a systemic level, I will draw on a case study of the English school system. (Ruthven 2012; 2013)

Inga's resources for lesson preparation

- Inga usually worked on her own to prepare her lessons; there were few opportunities for collaboration with colleagues.
- She reported drawing on a range of types of resource:
  - the textbook used by the class;
  - other textbooks in the school library, "to search for ideas";
  - her "own literature" and Web resources, collected over the years, including:
    - Ideas.
    - Activities and games,
    - Videoclips and applets.
- By adding these to the school's "teaching scheme", Inga could make them known to colleagues who taught similar classes.

(Gueudet, Pepin & Trouche, 2013)

Vera's resources for lesson preparation

- Vera regretted the absence of teacher collaboration on lesson planning and preparation of teaching materials that she found in her present school (unlike her previous one).
- Her "crucial resource" was her teaching folder for each class, in digital and paper form, containing her own plans and copies of exercises/activities from textbooks or other sources.
- Amongst personal and school resources that Vera reported drawing on, two textbooks played an important role:
  - Hélice, chosen some years ago by colleagues at her school because of its original approach to teaching and learning;
  - the Sésamath textbook chosen with her colleagues the previous year, because of its digital format and special facilities for use with an interactive white board.

(Gueudet, Pepin & Trouche, 2013)

An evolving personal “mashup”

- Teachers make a strong investment in building up a personal repertoire of resources for lesson planning, drawing on ideas and materials from a range of sources.
- At the core of these resources lie the teacher’s course and lesson plans (linked, in turn, to the teacher’s mental “curriculum script” for teaching each topic).
- Nevertheless, textbooks continue to play an important role, providing a default curriculum scheme and a reservoir of relevant teaching resources.
- There is often little collaboration between teachers in the same school on lesson planning, but adopted textbooks act as a common resource, and a school programme of work can provide a vehicle for sharing other resources.

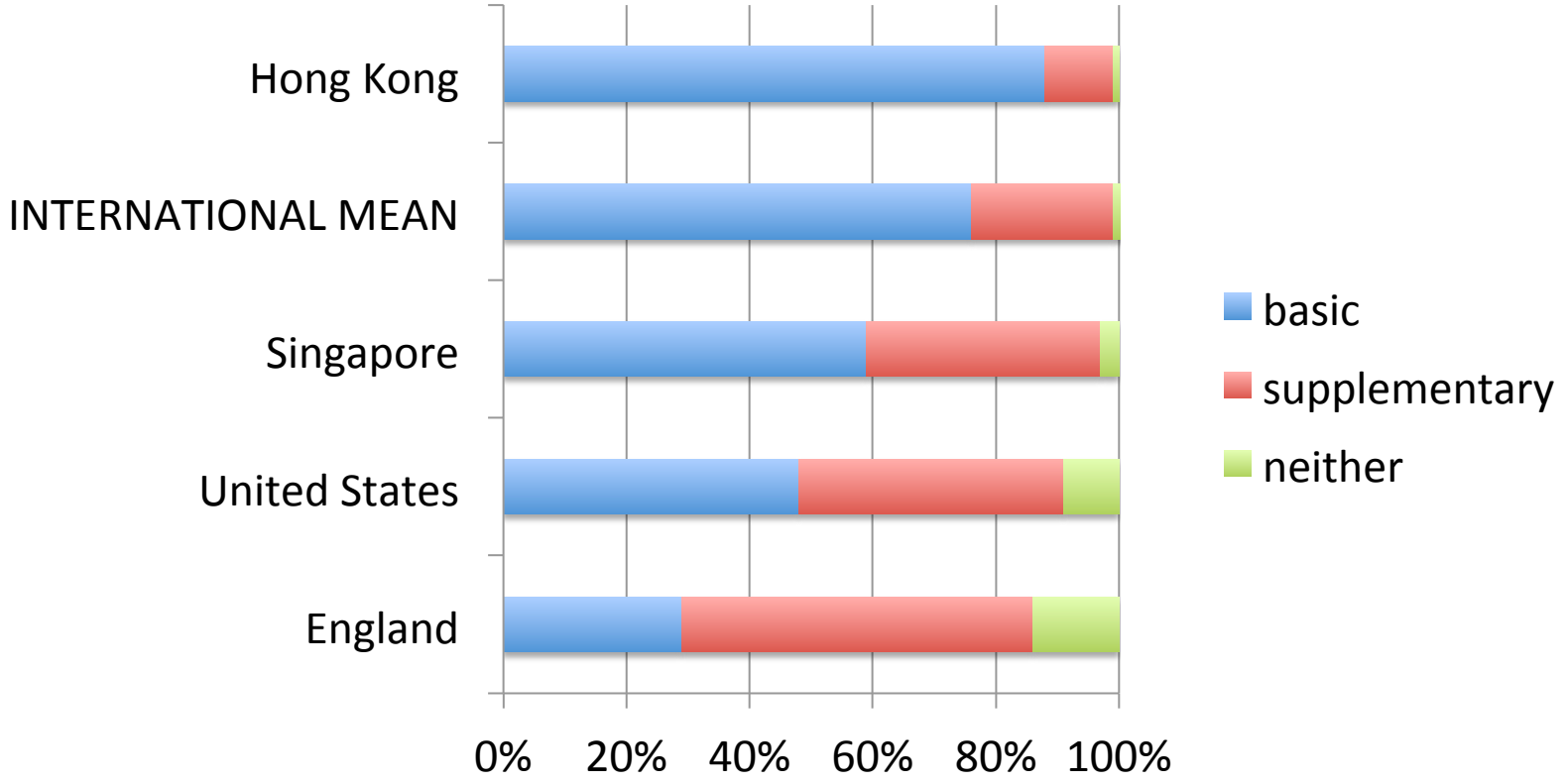
Institutionalising a re-sourcing approach

- In England, schools have been encouraged (from 1989), then mandated (from 2001), to develop their own detailed "scheme of work" for mathematics teaching at each level.
- As well as providing pedagogical guidance internally, this "scheme of work" contributes to external accountability through government inspection of the school.
- While a "scheme of work" may draw on a commercial curriculum program, the expectation is that it will demonstrate how use of such a program has been locally customised and complemented by a more diverse range of resources.
- Another key factor in the evolution of school "schemes of work" has been a drive to equip all classrooms with interactive whiteboard or projection facilities.

(Ruthven 2012; 2013)

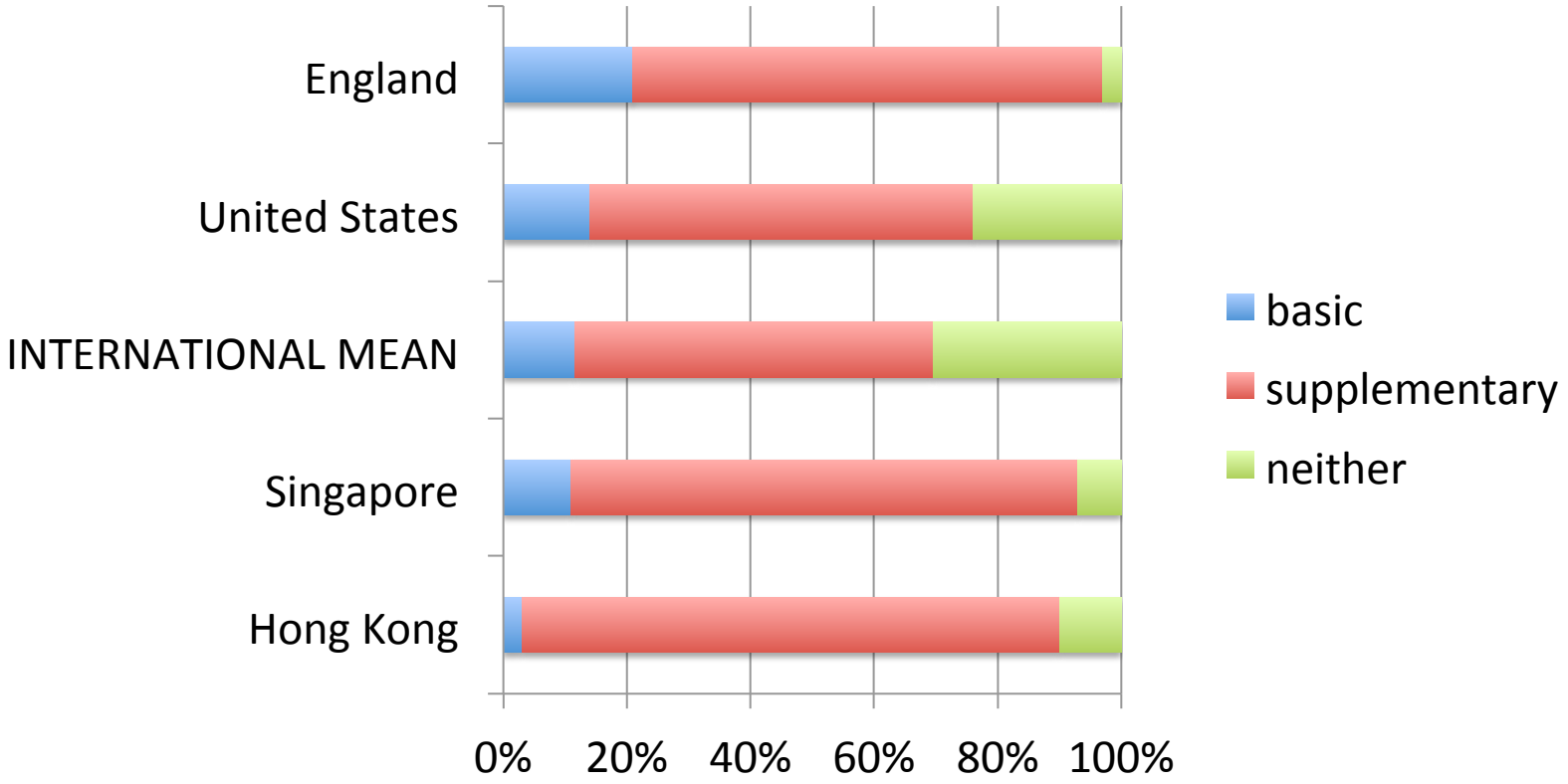
International comparison of textbook use

- Percentage of Grade 8 students whose mathematics teachers use textbooks as a basic or supplementary teaching resource, or neither, as reported in TIMSS 2011 (Mullis et al., 2012)



International comparison of software use

- Percentage of Grade 8 students whose mathematics teachers use software as a basic or supplementary teaching resource, or neither, as reported in TIMSS 2011 (Mullis et al., 2012)



Extract from scheme of work in professionally highly regarded department:
Framework for lesson planning which guides compliance with official curriculum and assessment specifications and identifies appropriate textbook resources

YEAR 7 MODULE 7b 2 weeks	**PROBABILITY** *Students explore chance and probability through experimentation and analysis. They give and justify probabilities in a range of events.*	*Cross Curricular Dimension: STAY SAFE (ECM)* *Probability has obvious applications in games and horseracing but more fundamentally it is a key skill for staying safe and making balanced risk decisions.*

Tier	Programme of Study **2008 Framework Learning Objectives in bold**	Tier 4 EM7	Tier 3 EM7i	Tiers 1 & 2
1 2 3 4	**Learn about and through the key processes: represent, analyse, interpret, communicate**	See 'Key Processes' below		
	The Language Of Probability NF p 276 - 278			
1 2	**Use vocabulary and ideas of probability, drawing on experience.** Place events in the order of likelihood. Understand and use the idea of evens and say whether events are more or less likely than this. Distinguish between "fair" and "unfair." Recognise that when a fair coin is tossed the probability of heads is ½.	p199-200	p 201-202	MW3 ch15 p83 - 85 IMP 1G p 58 - 63
1 2 3 4	Give and justify subjective estimates of probabilities in a range of events,			
1 2 3 4	**Understand and use the probability scale from 0 to 1 find and justify probabilities** (as fractions) **based on equally likely outcomes in simple contexts**	p200	p202	IMP 1G p 63 – 67 IMP 2B p 103 - 105
	Experimental Probability NF p 282			
1 2 3 4	**Estimate probabilities by collecting data from a simple experiment and recording it in a frequency table.** Find probabilities by experimentation and know that when repeating the same experiment different outcomes may result.	p201	p203	IMP 2B p 111 - 114
	Theoretical Probability NF p 280 - 284			
1 2	Use Venn and Carroll diagrams to record sorting and classifying of information			
2 3 4	**Identify** and list **all the possible mutually exclusive outcomes of a single event .**			
2 3 4	Know that if each of n events is assumed to be equally likely the probability of one occurring is 1/n.	p202-208	p204-209	IMP 2B p 106 - 109
3 4	Know that the total sum of the probabilities of mutually exclusive events is 1 and that the probability of something happening is 1 minus the probability of it not happening.			IMP 2B p 109 - 110
3 4	**compare experimental and theoretical probabilities in simple contexts**			
	Combined Events			
3 4	Identify all the outcomes when dealing with 2 combined events which are independent using diagrammatic, tabular or other forms.			
1	How Much Do You Know			MW3 ch4 p13-16

Prior Learning: Year 6 Key Objectives

Assessment Criteria (APP)	Level
• use Venn and Carroll diagrams to record their sorting and classifying of information	3
• continue to use Venn and Carroll diagrams to record their sorting and classifying of information	4
• in probability, select methods based on equally likely outcomes and experimental evidence, as appropriate understand and use the probability scale from 0 to 1 • understand that different outcomes may result from repeating an experiment	5
• find and record all possible mutually exclusive outcomes for single events and two successive events in a systematic way • know that the sum of probabilities of all mutually exclusive outcomes is 1 and use this when solving problems	6

Key Vocabulary
likely, unlikely, outcome, possible, impossible, probability, probability scale, probable, random, risk, spin, spinner, certain, uncertain, chance, evens, dice, equally likely, fair, unfair, event, experiment, likelihood

Extract from scheme of work in professionally highly regarded department: Framework for lesson planning which establishes key components of local pedagogical approach and identifies further appropriate resources available

Keep Basic Skills fresh!

Oral/Mental Starters:

Oral mental starters provide opportunities to rehearse mental strategies, rapid recall, estimating, visual imagery, problem solving, explaining methods…

1. Calculate simple **fractions and percentages of** whole numbers *NF p 98*
2. Find quarters and eighths by repeated halving
   3 /5 of 20 = 12 (e.g. find one fifth, then multiply by 3) 40% of 400 kg (e.g. find 10% then multiply by 4)
3. Calculate VAT at 17½ % by finding 10%, then 5%, then 2½ %

In a successful 'Thinking Skills' classroom, students are confident to take

Rich Tasks and Resources

*Rich tasks are **at the heart** of each module. They provide opportunities to focus on **key processes** and to develop **personal learning** and **thinking skills (PLTS)** through **investigation, applications** and **problem solving**. They promote **group work** and **discussion** and facilitate **AFL** and **assessment of pupil progress (APP).***

Compulsory Rich Tasks

1. Higher / Lower (SMART activity)
2. Card Sort

Other Rich Resources

3. TL4 Consolidation 5
4. Springboard 7 Unit 7
5. TTIC Starter TTIC Plenary
6. NRICH Odds and Evens
7. DIME probability kits
8. Fourbidden Playing Cards

ICT (Teacher led Activities)

Probability at Lesson Starters M2

Spinners at NLVM

Probability at MicroSMILE

WhiteboardMaths Data Handling

ICT (Student Activities)

MyMaths -> Data -> Probability

Probability at Bounceback Unit 7

LINK TO OTHER AVAILABLE RESOURCES

If homework is interesting students are more likely to do it!

Home Learning

List two things that are certain, likely, even chance, unlikely, impossible
Devise a probability game (where the outcomes do not always give even chances)

A 'dual focus' lesson has both a maths and a key process or L2L objective!

Key Processes

*Key processes are about how to **'be mathematical'**: ie **process not content**.*
In the scheme of work, key processes are addressed mainly through rich tasks.
However most lessons should make explicit at least one of the following key process objectives and key processes should be referred to frequently.

Representing

- simplify the situation or problem in order to represent it mathematically, using appropriate variables, symbols, diagrams and models (1c)

Analysing – mathematical reasoning

- make and begin to justify conjectures and generalisations, considering special cases and counter-examples (2e)

Analysing – mathematical procedures

- make accurate mathematical diagrams, graphs and constructions on paper and on screen (2k)

Interpreting and evaluating

- form convincing arguments based on findings and make general statements (3a)

Communicating and Reflecting

- engage in mathematical discussion of results (4b)

Some students think we ask questions because we want to know the answer! Allow students time to think!

Probing Questions

- *Make up examples of equally likely outcomes with given probabilities, e.g. 0.5, 1/6, 0.2, etc: justify your answers*
- *What does the probability of 3/5 mean?*
- *What would you expect to happen if the event were repeated 20 times? Can you be sure?*

Assessment For Learning

AFL Target and self assessment sheet
Levelled revision questions
Oral and written feedback
Module test
Mini whiteboards
Opportunities for peer assessment
Highlighting misconceptions
Student Reviews

Cross Curricular Links

Quality of school schemes of work

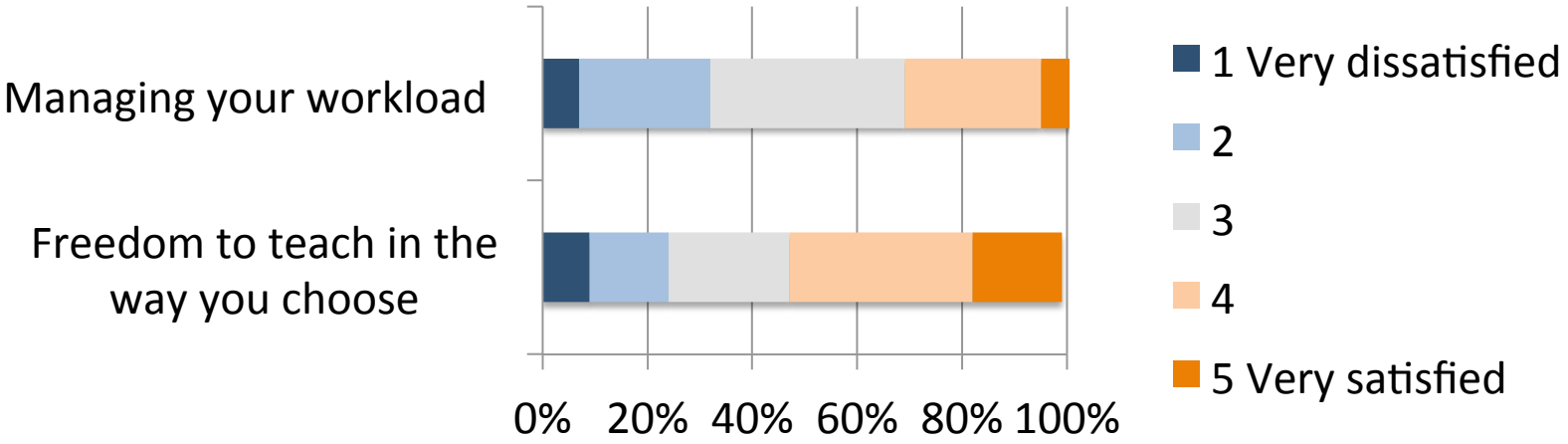
- Some schools display many of the qualities attributed to re-sourcing through localised schemes of work:
  - *"The best schemes of work included guidance on approaches, interesting activities and resources that help nurture pupils' understanding. They were seen as living documents, subject to regular discussion and review, which helped staff to develop their expertise".* (OfStEd, 2008)
- However, such schools are the exception rather than the rule:
  - *"Good schemes of work were rare... It was not uncommon for teachers to use only examination specifications and textbooks to guide their lesson planning, focusing on content rather than pedagogy"'* (OfStEd, 2008)
  - *"Schemes of work were rarely adapted to the particular circumstances of the school and its pupils. They were often simply the schemes provided by [examining] bodies or [by] textbooks".* (OfStEd, 2012)

Factors impeding quality of schemes

- Need not perceived
  - *"When the schools had a stable and experienced staff, they frequently did not see the need to formalise guidance."*
- Lack of capacity
  - *"Schools with many inexperienced, non-specialist and/or temporary teachers, which would most benefit from guidance, lacked the capacity to prepare it."* (OfStEd, 2012)
- Intensification of workload
  - *"[Creating] schemes of work continued to be problematic… for mathematics departments, with high degrees of resentment apparent in teachers' statements on the time spent in finding appropriate resources to match objectives."* (Barnes et al., 2003)
- Absence of consensus
  - Respect for professional autonomy leads teachers to "agree to disagree" on pedagogy, setting only a skeleton scheme of work that ensures little more than common pace and coverage.

Satisfaction, workload and freedom

Results from a national survey of secondary mathematics teachers in England (NFER, 2006)



Overall satisfaction associated with:

- Managing workload (r=.50)
- Freedom to teach (r=.46)

Likelihood of remaining in teaching associated with:

- Managing workload (r=.24)
- Freedom to teach (r=.22)

The ecology of collective re-sourcing

- Institutionalising a re-sourcing approach risks transforming a voluntary intensification of workload undertaken for personal satisfaction into an unwelcome external imposition.
- Productive collaboration between teachers within a school on a re-sourcing approach depends on favourable circumstances, notably internal capacity and shared pedagogical orientation.
- Concepts of *sandbox* and *hive* may be equally applicable to the functioning of collective schemes of work within a school.

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