Chapter 3
Analysis of materials

The materials provided as part of the JUMP programme, including teacher manuals and pupil workbooks, are analysed in this chapter. First, an overview of JUMP materials is provided. Second, their content is analysed to see how fully they address the objectives of the Irish PSMC. Third, JUMP materials are compared with three sets of commercially available Irish mathematics materials for Third class pupils. The materials are broadly compared in terms of their relative weighting of the curriculum strands, and emphasis on computational practice. Following this, the treatment of a single topic is analysed in detail, in JUMP and in the set of Irish materials most commonly used by participating teachers.

The analysis of materials takes place in a contextual vacuum, examining what might be learned *if* teachers were to follow the manuals with no deviations, and *if* pupils were to solve every exercise in their workbooks (Mesa, 2004). Thus, while the present chapter considers the JUMP *intended* curriculum, later chapters consider factors mediating the creation of an *enacted* curriculum (Remillard, 2005). As such, analyses here should be read in conjunction with findings on teachers' adherence, and attitudes, to programme materials (Chapters 4 and 6).

Overview of JUMP materials

As indicated in Chapter 1, the materials provided to participating JUMP teachers consisted of:

- teacher manuals, levels 3.1 and 3.2.
- pupil workbooks, levels 3.1 and 3.2 (and, from January 2014, 4.1 and 4.2).
- teacher and pupil versions of the supplementary "Confidence Building Unit", level C.

These are described in more detail in the sections that follow.

Teacher manuals

The JUMP teacher manuals are extensive, containing:

- an introduction to the principles and methods of JUMP Math (15 pages).
- a detailed sample template of a "problem-solving lesson" on perimeter (five pages).
- a section on mental mathematics skills, exercises, and assessment (19 pages).
- lesson plans, organised in five strands: Patterns and Algebra; Number Sense; Measurement; Probability and Data Management; and Geometry. All strands are represented in both manuals, in the above order. (471 pages).
- Blackline Masters materials, including charts and games that could be photocopied or used as templates from which to create materials. Suggested uses are given in the lesson plans. (98 pages).
- answer keys for pupil workbooks 3.1 and 3.2 (42 pages).
- tests (with answer keys) for each of the five strands (55 pages).
- tables summarising the correspondence between JUMP materials and the Grade 3 objectives of two Canadian curricula (26 pages).

Thus, lesson plans comprise the bulk (64%) of the teacher manuals. A typical lesson plan begins with a summary of goals, prior knowledge required, and useful vocabulary. Next, it provides specific instructions as to what the teacher should ask, tell, draw, etc. Plans usually end with Activities and/or Extensions (often including "bonus questions"), through which a topic can be further developed.

Appendix G shows some sample JUMP lesson plans, addressing the topics of Place Value, Writing and Reading Number Words, Writing Numbers, and Representation with Base Ten Materials, with accompanying Blackline Masters and pupil materials.

Pupil workbooks

Pupil workbooks are called Assessment and Practice workbooks. For Grade 3, the workbooks comprise:

- a brief note for teachers and parents on how to use JUMP Math (one identical page in each volume).
- worksheets, organised in the same strands used by the teacher manuals (349 pages).

The pupil workbooks for Grade 4 are similarly arranged (349 pages of worksheets).

All workbooks are printed in black and white, although the covers feature brightly-coloured images. The exercises are rarely accompanied by graphical displays other than representations. Sample extracts are included in Appendix G, addressing the same topics (Place Value, Writing Numbers, and Base Ten) as the sample teacher lesson plans in that appendix.

Confidence-Building Unit (CBU)

The CBU (Level C) is intended for use at the start of the school year, for a maximum of two weeks. As outlined in Chapter 1, it deals with the addition, subtraction, and reduction of fractions, but does not aim to teach the topic in *conceptual* depth. Rather, it aims to promote pupils' confidence by assuring them that they can master *procedures* usually tackled by pupils at more advanced grade levels. The CBU comprises:

- a teacher manual (for Levels C and D combined, but with the recommendation that only Level C be used with Grade 3 pupils). The manual explains the purpose of the CBU, and provides lesson plans, sample homework, tests, answer keys, and an appendix on teaching basic operations. (62 pages in total, of which 42 are relevant to Level C).
- a pupil workbook ("Fractions Challenge: Level C"). This comprises worksheets on basic operations, adding and subtracting fractions, reducing fractions, and naming mixed and improper fractions. (30 pages).

While the JUMP programme generally aims to balance procedural and conceptual learning, guided practice and guided discovery, the CBU represents procedural learning and guided practice in distilled form. The lesson plans in the CBU teacher manual feature even more "steps" than those in the main teacher manuals, but rarely suggest explaining the rationale behind steps. (The teachers' introduction to the CBU observes that fractions can be taught in depth using the main JUMP teacher manual and pupil workbook, but that the purpose of this unit is "more to build confidence, harness attention and motivate children to learn their number facts than to teach fractions completely" [Mighton, 2013a, p. 10]).

Of course, many commercial textbooks and teacher manuals also do not include the rationale behind activities. However, with a typical textbook series, teachers use the core

material to develop their own lesson plans (presumably including reference to rationale). In contrast, JUMP presents an apparently fully-formed lesson plan, so the exclusion of conceptual explanation in the CBU becomes more important.

Two other relatively unusual features of the CBU are that teachers and pupils are presented with only one concrete model (the circle/pie) and one algorithmic approach to any problem, and in the pupil workbook, there are *no* graphical displays other than representations (with the exception of one page featuring drawings of hands, intended to aid pupils in skip counting). Thus, of all the JUMP Math materials, the CBU seemed likely to be perceived by participating teachers as least similar to typical Irish materials. As shall be seen in Chapter 6, teachers in just under half the JUMP classes indicated that they did not use the CBU, while those who did use it had varied views on its usefulness.

JUMP Structure

JUMP has been developed to support the Ontario Curriculum Unit Planner (OCUP), and consequently shares some of its structural characteristics. JUMP and OCUP – like the PSMC – are grouped around five strands. OCUP contains 65 specific objectives, and either two or three "Overall Expectations" for each strand unit (these are not counted in the 65 objectives as they summarise the more specific aims). Each specific OCUP objective is the target of at least one JUMP lesson unit. However, 10 objectives (15%) are addressed fully in the teacher's lesson plan, but not in the pupil workbooks. Examples include objectives relating to temperature, the comparison of objects by units of mass or capacity, and the comparison of angles using concrete materials and pictorial representations. In other cases, multiple lesson plans and workbook activities are directed towards a single OCUP objective – e.g., nine lesson plan units address the objective to "represent, compare, and order whole numbers to 100, using a variety of tools".

Thus, while JUMP is designed to cover the Ontario curriculum in full, not all content is in the pupil workbooks, meaning coverage is contingent on teachers adhering to the content of their manual. Also, some objectives receive considerably more attention than others. However, this may reflect the complexity of some objectives relative to others. For example, the single objective related to representing, comparing, and ordering whole numbers requires that teachers explain a number of concepts and demonstrate operations in a variety of ways. Other objectives, such as the objective to "use a reference tool to identify right angles and to describe angles as greater than, equal to, or less than a right angle", may be taught within a single lesson unit.

The five strands in JUMP (Number Sense, Measurement, Geometry, Patterns and Algebra, and Probability and Data Management) not only closely mirror those of the OCUP, but also broadly correspond to the five strands of the Irish PSMC (Number, Measures, Shape and Space, Algebra, and Data) (Table 3.1).

Table 3.1: Strands in the Ontario curriculum (OCUP), JUMP materials, and the Irish primary curriculum (PSMC)

OCUP	JUMP	Irish PSMC
Number Sense and Numeration	Number Sense	Number
Measurement	Measurement	Measures
Geometry and Spatial Sense	Geometry	Shape and Space
Patterning and Algebra	Patterns and Algebra	Algebra
Data Management and Probability	Probability and Data Management	Data

JUMP materials and the PSMC

As noted in the preceding section, although JUMP was originally based on the strands and objectives of the OCUP, there is broad similarity between the five strands underpinning both JUMP and the PSMC. This section looks in more detail at the relative importance accorded to each strand in JUMP and the PSMC, and examines JUMP materials to see how well, if at all, each of the PSMC content objectives for Third class is addressed. Where we indicate that an objective is "addressed", this simply means that most or all content relevant to an objective is dealt with by JUMP materials. As with any set of materials, coverage of key content is a necessary prerequisite for a learner successfully meeting an objective, but does not, by itself, ensure that the learner will *meet* the objective. While the PSMC also lists overarching skills that a learner should master, these are not included in the present analysis as it is not possible to quantify the extent to which they are addressed in any set of materials.

Strand emphasis in JUMP and PSMC

To measure how emphasis is divided between strands in JUMP and the PSMC, the percentages of JUMP lesson units and PSMC objectives per strand were quantified. However, as this is a slightly crude indicator of the importance accorded to strands, this was followed by a more detailed review of *how* JUMP and the PSMC deal with each strand. JUMP for Grade 3 contains 230 lesson units, while the PSMC has 70 specific curriculum objectives relating to Third class. As shown in Table 3.2, a little less than half (42%) of the JUMP lesson units fall under Number Sense. This is more than double the number of lesson units allocated to Geometry (19%), and considerably more than allocated to Patterns and Algebra (16%) and Measurement (14%). Only one in ten JUMP lesson units addresses topics related to Probability and Data Management.

In contrast, 36% of PSMC objectives relate to the Number strand and 24% to each of Measures and Shape and Space. Although coverage of Data is broadly in line with JUMP's coverage of Probability and Data Management, only 7% percent of PSMC objectives relate to Algebra. At first glance, therefore, JUMP places more emphasis than the PSMC on two strands (Number and Algebra), less emphasis on Shape and Space, and considerably less emphasis on Measures.[1]

Table 3.2: Percentage of JUMP lesson units and PSMC objectives per strand (using their own classification systems)

JUMP (N=230)		PSMC (N=70)	
Strand	% lesson units	Strand	% objectives
Number Sense	41.7	Number	35.7
Measurement	13.9	Measures	24.3
Geometry	19.1	Shape & Space	24.3
Patterns & Algebra	15.7	Algebra	7.1
Probability & Data Management	9.6	Data	8.6

However, a single objective may be addressed over several lessons, or a single lesson may address several objectives. Further, while the general content of the JUMP and PSMC strands match quite well, there are differences in classification. Therefore, a more detailed

[1] For simplicity, the names of the PSMC strands are also used to refer to their JUMP equivalents.

analysis is needed to understand if and how strands are treated differently in JUMP and the PSMC.

Number

The strand Number Sense composes a larger percentage of JUMP lesson units than the percentage of PSMC objectives falling under the Number strand. However, JUMP's Number strand includes the treatment of money, which falls under the Measures strand in the PSMC. Excluding lesson units related to money brings a slightly closer alignment between the emphasis on Number in JUMP and in the PSMC.

Also, certain Number objectives require multiple lessons due to the mental mathematics and operational skills involved. For example, the two PSMC objectives "explore and identify place value in whole numbers, 0-999" and "read, write and order three-digit numbers" are addressed across *nine* JUMP lesson units. That JUMP also goes well beyond 999 and addresses numbers in the thousands and ten thousands may account for part of the greater emphasis in JUMP lesson plans on Number. However, it is likely the greater emphasis largely reflects the fact that while it is possible to summarise the two PSMC objectives relatively succinctly, the actual content, the skills and procedures involved, requires a considerable amount of class time. Put simply, some objectives take longer to teach than others. This, coupled with the "extra" money strand units, suggests that JUMP and the PSMC match quite closely in terms of the relative emphasis placed on the Number strand.

Measures

The Measurement strand does not feature very prominently in JUMP lesson units. However, as noted in the preceding section, this is partially attributable to money being classified under Number Sense, and two units on time being classified under Patterns and Algebra. Within the Measurement strand, JUMP allocates only one lesson unit to weight and one to capacity, whereas two curriculum objectives are related to each in the PSMC. In contrast, JUMP covers temperature and perimeter, neither of which feature in the PSMC for Third class. In sum, JUMP appears to place relatively less emphasis than the PSMC on Measures, but this is mainly attributable to money appearing under the Number strand.

Shape and Space

JUMP units address all Shape and Space topics dealt with by the PSMC, and some additional material not contained in the PSMC (congruency, as in Euclidean geometry; use of grids, as in coordinate geometry; and in-depth study of flips, slides and turns, as in transformational geometry). While the PSMC requires pupils to recognise an angle in terms of a rotation, the Ontario curriculum requires pupils to identify flips, slides, and turns, through investigation using concrete materials and physical motion, and to name flips, slides, and turns as reflections, translations, and rotations. Reflecting the heavy emphasis in OCUP, JUMP dedicates 12 lesson units to flips, slides, and turns.

Despite this, the percentage of JUMP lesson units addressing Shape and Space is slightly low with respect to PSMC objectives, partly because the PSMC seeks a more in-depth study of 2-D and 3-D shapes than JUMP provides. In JUMP, 2-D shapes that are polygons and 3-D shapes that are prisms and pyramids are considered, but the associated activities promoted by the PSMC are not all included. For example, JUMP does not require pupils to tessellate 2-D shapes. Also, the PSMC objective on parallel, horizontal and vertical lines is not fully reflected in JUMP lesson units (although prior knowledge of horizontal and vertical lines is assumed in some units). Thus, it seems that JUMP and the PSMC emphasise different aspects *within* the

strand of Shape and Space. Also, while JUMP covers a large number of topics, it does not cover all of them in great depth.

Algebra

The Patterns and Algebra strand in JUMP receives proportionally more attention (16% versus 7%) than the broadly equivalent Algebra strand in the PSMC, largely reflecting the greater emphasis on the strand found in the Ontario curriculum. The main topics covered are similar (i.e., number sequences and number sentences/equations). However, JUMP also includes a wide variety of *types* of sequences – e.g., pupils are challenged to identify, describe and extend number patterns involving addition, subtraction, and multiplication, represented on a number line, a calendar, or a hundreds chart. JUMP also includes four units dealing with patterns in the times tables (as an aid to mental mathematics). In contrast, the PSMC requires pupils to explore, extend and describe sequences, but does not specify what *kinds* of sequences.

Classification by two criteria is included in the Patterns and Algebra strand of JUMP for Third grade, but is covered at Second class in the PSMC. More generally, JUMP has five Patterns and Algebra lesson units related to classification that the PSMC would categorise under Shape and Space. It also has two units on time patterns that would be more likely to fall under Measures on the PSMC. If classification- and time-related content is excluded, the difference in emphasis between the PSMC and JUMP reduces, but only to 7% of objectives versus 13% of lesson units. Thus, in the case of Algebra, it seems likely that JUMP materials provide a little more depth and breadth of coverage than indicated by the PSMC.

Data

Data was the strand least emphasised in both JUMP and the PSMC, although some JUMP content related to data went beyond the aims of the PSMC. For example, JUMP devotes a lesson unit to the understanding of fairness in games and its relationship to probability, something not addressed at Third class in the PSMC. Also, JUMP includes varieties of data representation – such as Venn diagrams – not mentioned explicitly in the PSMC (or, indeed, in the OCUP). Those caveats aside, JUMP and the PSMC seemed generally well matched on the Data strand.

Overall balance

The five strands of the JUMP materials correspond closely with those of the Irish PSMC. Although some topics appeared under different strands in JUMP and the PSMC, there was a high level of correspondence in content. Table 3.2 showed the percent of JUMP and PSMC content under each of their respective strands. However, this did not take into account situations where there is a close match on content covered in both, but where the strand classification differs (as in the case of money).

Applying the PSMC strand structure to JUMP lesson units, units related to money or time would move from Number Sense, and Patterns and Algebra (respectively), to Measurement/Measures. Units related to classification would move from Patterns and Algebra to Geometry/Shape and Space. Doing this reveals that JUMP and PSMC content is very similar (Table 3.3). JUMP's apparent heavier emphasis on Number disappears, as does the apparent lesser emphasis on Measures. It is only in the treatment of content in the Algebra strand that notable differences remain between the emphases found in JUMP and in the PSMC.

Table 3.3: Percentage of JUMP lesson plans and PSMC objectives that fall under the PSMC strands (using PSMC definition of strand content)

	JUMP (N=230)	PSMC (N=70)
Number	34.8	35.7
Algebra	12.6	7.1
Shape & Space	21.3	24.3
Measures	21.7	24.3
Data	9.6	8.6

PSMC objectives not addressed

The JUMP materials were analysed by two researchers to assess the extent to which they addressed each of the 70 objectives of the PSMC for Third class. An objective was deemed fully addressed if the JUMP teacher manual and/or pupil workbook could be used without major adaptations to facilitate the targeted outcome. For instance, the objective that pupils should be able to "read, write and order three-digit numbers" was deemed fully addressed, as at least six JUMP lesson units dealt with it in detail. While some of the terminology was slightly different ("three hundred [and] one"), this was not perceived to interfere with the objective being fully and clearly addressed.

An objective was deemed partly addressed if the JUMP teacher manual and/or pupil workbook could be used to achieve some elements of the targeted outcome, but would need significant adaptation to achieve the outcome in full. For instance, the objective to "multiply a one-digit or two-digit number by 0-10" was rated as only partly addressed. This was because JUMP dealt with multiplication of one-digit numbers, but had limited coverage of multiplication of two-digit numbers (the few exceptions involved doubling, and multiplying larger numbers by 10).

An objective was deemed not addressed if the JUMP teacher manual and/or pupil workbook did not provide any obvious starting point from which to proceed towards the targeted outcome.

Although the review process was somewhat subjective, both reviewers independently agreed that of the 70 PSMC objectives, 63 were fully addressed by JUMP materials, six were partly addressed, and only one not addressed at all. Full details of the review are contained in Appendix H, which maps each of the 70 objectives onto JUMP lesson unit(s), and identifies differences in approach, if any, between JUMP and the PSMC. Table 3.4 draws on Appendix H to present information about the relatively few objectives that JUMP did not fully address.

As can be seen, the only objective not even partly addressed was the aim that pupils develop an understanding of the relationship between fractions and division. However, this objective is in practice rarely addressed by Irish-produced materials either. Other strand units in which objectives were only partly addressed included Number: Operations (two objectives), Algebra: Number sentences, and Shape and Space: Lines and angles. Also, as might reasonably be expected, two objectives from the Measures strand relating to money were considered to be only partly addressed, due to JUMP's use of Canadian currency rather than euro.

Of course, the fact that, theoretically, JUMP and PSMC content are broadly aligned does not necessarily mean that teachers found they aligned well in practice. Therefore, the preceding analyses should be read in conjunction with data from teachers' interviews (Chapter 6). In particular, while we rated JUMP money sections as "partially addressing" the relevant PSMC objectives, some JUMP teachers felt the pupil materials related to money were unusable.

Thus, in the case of money and perhaps a small number of other objectives, while the theoretical alignment was good, the practical implementation (i.e., unmodified use of JUMP pupil materials to teach the topic) was difficult.

It is also notable that a significant minority of JUMP teachers in the first set of interviews considered the "pitch" of the materials wrong for Third class (i.e., either too high, too low, or a mixture of too high and too low). A few – inaccurately – believed that Canadian Grade 3 was equivalent to Irish Fourth class and that, therefore, the materials were not grade-appropriate. However, by the second set of interviews, only one JUMP teacher raised pitch as an issue.

Table 3.4: PSMC objectives which were partly addressed or not addressed by the JUMP materials

Strand: *strand unit*	PSMC Objective	Relevant JUMP unit(s)	Gaps in JUMP
Number: *Operations*	Multiply a one-digit or two-digit number by 0-10	NS3-36- 39.	Limited instances of multiplying two-digit numbers (e.g., doubling, multiplying larger numbers by 10).
Number: *Operations*	Divide a one-digit or two-digit number by a one-digit number with and without remainders	NS3-62- 63; NS3-66.	Does not require that work be recorded using the division algorithm (as PSMC does).
Number: *Fractions*	Develop an understanding of the relationship between fractions and division	n/a **Not addressed**	Only one unit (NS3-85) deals with fractions greater than one. No explicit link with division was made.
Algebra: *Number sentences*	Translate an addition or subtraction number sentence with a frame into a word problem (frame not in initial position)	PA3-33 and 35; NS3-88-91.	Focus on translating word problems to number sentences, rather than vice versa.
Shape & Space: *Lines & angles*	Identify, describe and classify vertical, horizontal and parallel lines	G3-11 – 14, especially G-12.	Deals with horizontal and vertical lines in the context of symmetry, but does not deal with parallel lines.
Measures: *Money – euro*	Rename amounts of euro or cents and record using symbols and decimal point	NS3-42-47; NS3-70-74.	Money section referenced Canadian currency, not euro.
Measures: *Money - euro*	Solve and complete one-step problems and tasks involving the addition and subtraction of money	NS3-48; NS3-75-76.	Money section referenced Canadian currency, not euro.

JUMP materials and Irish textbooks

The preceding sections outlined the structure of JUMP materials and their relationship to the PSMC. However, daily mathematics instruction in Irish primary classrooms is usually based around a textbook, not the curriculum (Eivers et al., 2010). As the textbook is the medium through which the primary mathematics curriculum is experienced, a brief comparison of JUMP materials and three commercially available Irish textbooks was carried out. These three were chosen as they were the only ones that teachers in the study mentioned using.

The JUMP pupil workbooks and the Irish materials were analysed in their entirety, to see what proportions of each set of materials focused on the various strands. In addition, a more detailed "vertical" analysis (similar to Charalambous et al., 2010) examined how a single mathematical concept was dealt with in different materials. The concept selected for review was that of *equal parts in relation to fractions.* One of the three sets of Irish materials was chosen for

the more detailed comparison with JUMP, on the basis that it was the textbook series most widely found in participating classrooms prior to the evaluation, and it was from one of the two Irish textbook series analysed in the Charalambous et al. study.

Overview: JUMP pupil workbooks and three Irish textbooks

JUMP pupil workbooks were compared with three commercially available pupil textbooks for Third class. These materials are hereafter referred to as Textbooks A, B and C, where Textbook A was the book used in a large majority of classrooms prior to the evaluation.

Earlier in this chapter, number of JUMP lesson units was used as a measure of relative strand emphasis. As lesson units do not have direct equivalents in pupil materials in Irish textbook series, page counts were used as an indicator of relative coverage. All three Irish textbooks include revision sections for pupils, which were included in page counts. Revision in JUMP materials tends to be covered in teacher materials, and could not therefore be included in the analysis of pupil materials. However, as the relative topic emphasis in revision sections largely mirrored the relative topic emphasis in the main parts of pupil materials, the exclusion of JUMP revision sections does not substantively alter the balance between strands. In a related vein, supplementary pupil materials for some of the Irish textbooks were not included in the analyses, as not all pupils use them. However, content of supplementary materials largely mirrored the relative emphases found in the "parent" textbook.

In the JUMP pupil workbooks, 50% of pages related to the PSMC Number and Algebra strands (Table 3.5).[2] This is slightly higher than the 43% of PSMC objectives related to Number and Algebra but nonetheless lower than the percentages in all three sets of Irish textbooks – 53% in Textbook C, 61% in Textbook B, and 65% in the widely used Textbook A.

At 21%, level of coverage of Measures in JUMP was very similar to levels in Irish materials (23% in Textbook C, and 20% in both Textbook B and Textbook A). Generally, the amount of cover given to Measures in both JUMP and Irish textbooks is quite close to the 24% of PSMC objectives devoted to Measures.

In contrast, Shape and Space, which accounts for 24% of PSMC objectives, received proportionally more coverage in the JUMP workbooks (20% of pages) than in any of the Irish materials (17% in Textbook C, 14% in Textbook B, and only 8% in the most widely used textbook, Textbook A). JUMP pupil materials were also similar to the PSMC in terms of coverage given to Data (9% in both). However, Data received relatively little coverage in the three Irish textbooks (7% in Textbook C, 6% in Textbook A, and 5% in Textbook B).

Table 3.5: Percentages of pages in JUMP pupil workbooks and three Irish pupil textbooks that cover each PSMC strand

% of PSMC objectives (N=70)		% of pages			
		JUMP (N=349)	Textbook A (N=174)	Textbook B (N=172)	Textbook C (N=156)
Number & Algebra	42.8	49.6	65.2	61.2	52.9
Shape & Space	24.3	20.1	8.3	13.5	16.5
Measures	24.3	21.2	20.1	20.5	23.4
Data	8.6	9.2	6.3	4.8	7.2

[2] The comparison takes account of strand classification differences discussed earlier in this chapter – e.g., Money was counted under Measures rather than Number and Algebra in JUMP.

Comparing the JUMP workbooks with the textbooks normally used in Irish classrooms, it appears that JUMP gives less emphasis to Number and Algebra, and more emphasis to Shape and Space. It would not be reasonable to expect a perfect match between the percentage of PSMC objectives per strand and the percentages of pages dealing with content in that strand. As noted earlier, for example, certain Number objectives are quite complex, and require multiple lessons. A slight "overemphasis" on Number in all pupil materials might be expected, while still anticipating a broad alignment between percentage of objectives and percentages of pages. However, the focus on Number in some Irish textbooks (particularly the widely used Textbook A) is more than a slight overemphasis, and contributes to relatively limited coverage of the Shape and Space and/or Data strands. In contrast, strand emphasis in JUMP materials is more closely aligned with PSMC objectives than in any of the Irish textbooks considered.

Aside from strand coverage, the percentage of pages containing purely computational questions – i.e., questions involving varied and repetitive practice of counting, addition, subtraction, multiplication, and division skills, in isolation from any practical context or verbal representation – was examined. Despite JUMP's emphasis on repeated procedures, only 16% of pages in the JUMP workbooks dealt solely with computation – a lower percentage than was found in *any* of the Irish materials. Coverage in Textbook C and Textbook B was reasonably similar to JUMP, with 19% and 18% of their pages relating to computation, respectively. In contrast, the very popular Textbook A devoted 29% of its pages to computation.

A closer look: "equal parts" in JUMP and Textbook A

For the more detailed "vertical analysis", Charalambous et al.'s framework was considered a useful starting point for developing the review method, as it had previously been used for cross-cultural comparison of textbook series, including comparing Irish mathematics textbooks with those from other countries. However, their target concept for vertical analysis (*addition and subtraction of fractions*) did not feature at Third class. Therefore, the analysis was performed on another element of the Fractions strand unit to retain as much similarity in method as possible. "Equal parts" was chosen as a specific focus because the Fractions sections of both JUMP and Textbook A materials began by considering this concept. As JUMP teacher manuals contain materials that do not appear in the pupil workbooks, the textbook analysis was extended to include teacher manuals as well as pupil workbooks, and the coding system modified to include teacher prompts as well as pupil tasks.

JUMP materials for analysis included units NS3-78 ("Equal Parts"), NS3-79 ("Models of Fractions"), and NS3-81 ("Equal Parts of a Set"), in both the pupil workbook and teacher manual (3.2). Textbook A materials for analysis included two pages from the first section on fractions in the pupil textbook, and two pages from a supplementary pupil workbook,[3] as well as associated instructions from the teacher manual. The comparability of the mathematical content of these sections in JUMP and Textbook A was confirmed by an SME prior to the development of a coding scheme.

Pupil materials

The tasks presented in pupil materials were analysed on two dimensions: the **potential cognitive demands** they made of pupils, and the **type of response** they required. Following

[3] While the supplementary pupil workbook was excluded from the previous analysis of strand and computational content, it was included here as the focus was on specific *items*. It was thought that the items in the supplementary workbook might differ somewhat from those in the main textbook, as the two books are intended to complement one another (even if in practice they are not always used together).

Charalambous et al. (2010), a task was defined as any question asked within the exercises/problems, even if it was not individually numbered. The selected extract from the JUMP pupil workbook contained 73 tasks, while the extracts from Textbook A's pupil textbook and supplementary workbook contained a total of 82 tasks.

Potential cognitive demands of tasks were categorised by Charalambous et al. using four codes, based on the Task Analysis Guide (Stein, Smith, Henningson, & Silver, 2000). These were: memorisation; procedures without connections; procedures with connections; and doing mathematics. However, Charalambous et al. reported particular difficulties in distinguishing between the categories of procedures *without* connections and procedures *with* connections. Therefore, the coding system was adapted so that procedures requiring connections were grouped with other tasks that involved higher-order cognitive demands.

The three types of demands were therefore:

- **recall of facts, terms, or concepts** (corresponding roughly with Charalambous et al.'s memorisation code).
- **implementation of procedures** (procedures without connections).
- **reasoning, connecting, or problem-solving** (broadly similar to Charalambous et al.'s "doing mathematics" code, but also including procedures with connections).

As an added advantage, the revised task structure aligned reasonably well with the classifications used in assessment instruments used as part of the National Assessments (Eivers et al., 2010).

Most of the tasks in JUMP (74%), but even more in Textbook A (85%), were coded as demanding recall (Table 3.6). However, the remaining 26% of JUMP tasks were all coded as requiring the higher-order skills of reasoning, connecting, or problem-solving. In contrast, the remaining 15% of Textbook A tasks all required implementation of procedures.

Table 3.6: Percentages of tasks in JUMP and Textbook A pupil materials coded under three categories of potential cognitive demands

	JUMP (N=73)	Textbook A (N=82)
Recall of facts, terms, or concepts	74.0	85.4
Implementation of procedures	0.0	14.6
Reasoning, connecting, or problem-solving	26.0	0.0

Tasks were also categorised by the type of response they required. As described in Chapter 2, Charalambous et al.'s codes were reduced to two for the present evaluation:

- **closed response** (corresponding with "answer only" code)
- **extended/open response** (which could include an explanation and/or a justification).

Most of the JUMP tasks (79%) and *all* the Textbook A tasks were coded as requiring a closed response[4] (Table 3.7). The 21% of JUMP tasks requiring an open or extended response were largely composed of tasks demanding reasoning, connecting, or problem-solving.

[4] This mirrors Charalambous et al.'s (2010) finding that Textbook A's (Fifth class level) treatment of addition and subtraction of fractions included only closed response options.

Table 3.7: Percentages of tasks in JUMP and Textbook A coded under two categories of response required

	JUMP (N=73)	Textbook A (N=82)
Closed response	79.5	100.0
Extended/open response	20.5	0.0

Teacher materials

Teacher materials were not included in the framework developed by Charalambous et al. However, it was essential to include them in this analysis since the JUMP programme relies heavily on its teacher manuals both to cover content and to direct teaching strategies. Therefore, a coding system was developed to account for the instructions given in the sample extracts of the JUMP and Textbook A teacher manuals.

At a structural level, differences between the two sets of teacher manuals appeared significantly more pronounced than differences between the pupil materials. As described earlier, the JUMP teacher manual contains very detailed lesson plan units, including instructions to teachers to ask specific questions, draw specific representations, etc. (Three such lesson plans were included in the extract sampled). The Textbook A manual, however, offers a much more general guide to teaching the topic. For the "Fractions" strand unit, it includes the PSMC objectives, a summary of useful terminology, and a list of things to keep in mind (e.g., that it is important to develop a solid understanding of tenths before decimals can be introduced). After this preamble to the strand unit as a whole, there are notes to guide the teacher through each page of the pupil textbook. Notes to the relevant two pages of the pupil textbook were included. The teacher manual for Textbook A includes appendices which can be photocopied and used as pupils' work pages. One of these is relevant to the topic of equal parts and fractions. Therefore, the guide to using this appendix was also included in the sampled extract.

To compare the contrasting approaches of the JUMP and Textbook A teacher manuals, a system was developed to code "teacher prompts". A "teacher prompt" was defined as an instruction or piece of advice given to a teacher. It could be brief or lengthy, specific or vague, provided that it dealt with a single element of the teacher's expected activity. Thus, examples include:

- "Explain that a fraction has a top and a bottom number." – JUMP teacher manual
- "Finding half and quarters of sets is presented in a manner which will support the pupils in the transition from hands-on materials to symbolic representation. These concepts have already been covered in previous lessons." – Textbook A teacher manual.

There were 98 such prompts in the sample JUMP extract, but only 12 in the sample Textbook A extract. This discrepancy underlines the different *functions* of the two manuals: JUMP intends to provide very specific instruction to teachers, while Textbook A intends to offer a more generalised guide, and expects teachers to draw more upon their own resources.

Teacher prompts were coded on two dimensions. First, a "Yes/No" code captured whether the information in a prompt (e.g., a script, a representation, or an instruction) **could be directly copied** by the teacher without further adaptation or preparation. For JUMP, 94 of the 98 prompts (95.9%) contained information that could be directly copied, compared to nine of the 12 Textbook A prompts. Second, prompts were coded based on what the teacher was being prompted to do (Table 3.8).

Categories included:

- verbally **eliciting** information: an answer only, *or* an explanation of an answer/process).
- **explaining** something: a fact, procedure, or step, *or* a deep conceptual reason or mathematical generalisation.
- **drawing or writing** a mathematical representation.
- **initiating** activity: use of structured manipulatives, *or* use of everyday materials, *or* pupil discussion, *or* pupils drawing or writing.
- explicitly **making links**: with other mathematical concepts/procedures, *or* with other school subjects/everyday life.
- mentally **anticipating**: probable pupil error/confusion, *or* connections between present and past/future work, *or* an opportunity for differentiation among pupils.

Table 3.8: Percentages of teacher prompts in JUMP and Textbook A manuals coded under six broad categories of suggested activity, and 14 subcategories

		JUMP (N=98)	Textbook A (N=12)
Verbally elicit	Answer only	33.7	8.3
	Explanation of answer/process	4.1	0.0
Explain	Fact, procedure, or step in procedure	13.3	0.0
	Deep conceptual reason/generalisation	1.0	0.0
Draw or write	Representation	19.4	25.0
Initiate activity	Use of structured manipulatives	2.0	8.3
	Use of everyday materials	2.0	8.3
	Pupil discussion	2.0	8.3
	Pupils drawing or writing	14.3	25.0
Make link	With other maths concepts/procedures	1.0	0.0
	With other subjects/everyday situations	2.0	0.0
Anticipate	Probable pupil error/confusion	3.1	0.0
	Connections with past/future maths learning	1.0	16.7
	Opportunity for differentiation among pupils	1.0	0.0

Unsurprisingly, given the large disparity in total number of prompts, JUMP prompts fell into considerably more categories than did Textbook A prompts. That aside, there were some similarities between the two sets of materials in terms of relative emphasis. Both JUMP and Textbook A frequently prompted teachers to draw or write a representation, or to initiate pupil activity around drawing or writing. However, JUMP placed a heavy emphasis (34% of prompts) on teachers verbally eliciting simple answers from pupils, whereas only one (8%) Textbook A teacher prompt did so. More generally, 50% of JUMP prompts fell into the categories of verbally eliciting and explaining information, while 50% of the Textbook A prompts involved the teacher either drawing or writing themselves, or initiating pupils to draw or write. However, given that there were only 12 Textbook A prompts versus 98 for JUMP, the conclusions that can be drawn from analysis of teacher materials are limited.

Summary

Generally, the *mathematical content* of the JUMP materials is a good match for that of the PSMC. Of the 70 PSMC content objectives, 63 were fully addressed by JUMP materials, six were partly addressed, and only one not addressed at all. While some topics would require cultural adaptation for use in an Irish context (e.g., money), overall JUMP and PSMC content is very similar and it is only on the Algebra strand that notable differences in emphasis can be found.

Differences between JUMP materials and pupil materials normally used in Irish classrooms were more pronounced. The JUMP pupil workbooks were *more* closely aligned with the PSMC, in terms of relative emphasis placed on Number and Algebra, Shape and Space, and Data, than any of the three Irish textbooks considered. The JUMP workbooks also placed less emphasis on isolated computation than did any of the Irish books.

Textbook A differed most from both the PSMC and JUMP, yet was the textbook most commonly used by teachers participating in the evaluation. Comparing it with JUMP materials revealed superficial differences in the use of colour and illustrations, but broad similarities in the demands made of pupils. In the more detailed analysis of how "Equal Parts" was dealt with, most JUMP questions sought recall of facts and concepts, and closed responses, while a small percentage required pupils to engage in higher-order cognitive activities, or to provide extended or open responses. In contrast, *all* Textbook A questions were based on recall and in closed format, while none required higher-order cognitive activities.

However, there were marked differences between the *format and purpose* of JUMP materials and Textbook A. The JUMP teacher manual contains very detailed lesson plans almost entirely composed of scripts, representations, and injunctions that teachers could reproduce directly. In contrast, the Textbook A teacher manual provides a broad, general guide to teaching each topic and to the exercises in the accompanying pupil workbooks. Given the differences in functions of the materials, and the fact that only one topic treatment was examined in detail, considerable caution should be exercised in interpreting differences between the materials.

Finally, as already noted, pupils' experiences in class are not determined by intended curriculum alone, but by a complex interaction of the curriculum materials and the learning environment (Tarr, Reys, Reys, Chávez, Shih & Osterlind, 2008). Eivers et al. (2010) reported a heavy emphasis on the textbook as the basis of mathematical instruction in Irish classrooms, while Charalambous et al. (2010) noted that "the role of textbooks in instruction depends on how students and teachers interact with them in instruction" (p.118). JUMP materials and the PSMC are reasonably well aligned, in theory, but how this manifests in practice must also be considered. Thus, findings in this chapter should be considered alongside Chapters 4 and 6, dealing with programme implementation.