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CURRICULUM ALIGNMENT: PERFORMANCE TYPES IN THE INTENDED, ENACTED, AND ASSESSED CURRICULUM IN PRIMARY MATHEMATICS AND SCIENCE CLASSROOMS

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Abstract

This study examined the process of curricular alignment in primary school mathematics and science. Six performance type categories were used to define the cognitive-demand levels evident in the mandated curriculum and elicited through classroom practice. The purpose of this comparative case study is to understand how the intended goals of the mandated curriculum are interpreted for planning, instruction, and assessment purposes. The data includes video-recorded lessons, interviews, planning documents, and work samples from units of work. The results revealed that interpreting the intended goals of the mandated curriculum at the classroom level is a complex and dynamic process. The process is one of iterative interpretation at various levels of curriculum planning. The alignment of performance type expectations are influenced by the "sources of authority" that are accessed, such as standardized testing programs, textbooks, and curriculum consultants. The types of performances that were privileged in assessment practices were reflected in planning and instruction at the school level, indicating that, among other factors, assessment has a critical role in determining how the curriculum is enacted.

Keywords

alignment, assessment, curriculum, planning, science, mathematics

Introduction

Curriculum alignment researchers assert that in a coherent education system, the intended, enacted, and assessed curriculum must be well-aligned (Porter, 2002; Webb, 1997). It is difficult to argue with the basic principles of alignment resulting in an education system where the various elements are in harmony with one another. This would be a system of education where what students should know (standards) is consistent with what they are taught (instruction) and corresponds with how they are assessed to determine their levels of achievement (assessment). However, the reality is that curricular alignment is a dynamic and complex process.

Alignment research typically uses categorization schemes that have been developed for examining the alignment between curriculum, instruction, and assessment. There have been various alignment studies that have captured a snapshot of practice and assessed it for degrees of alignment. Rather than assess degrees of alignment, in this study we endeavored to develop an understanding of the process of alignment and the factors that influence this dynamic system. Within this complex process, a series of curriculum interpretation acts are performed by various stakeholders, including the relevant curriculum and assessment authorities and classroom teachers. We investigated the sources of influence and authority impacting curriculum construction in the form of standardized testing, planning documents, and resources that are both internal and external to schools that are accessed by teachers and others involved in the planning process.

The following three key research questions will be addressed in this paper:

1) To what extent are performance types aligned in the intended curriculum, the enacted curriculum, and the assessed curriculum?
2) Who has *curriculum authorship* responsibilities and what *sources of authority* are accessed during curriculum planning?
3) To what extent do the sources of authority accessed for planning the curriculum influence and shape the enacted and assessed curriculum?

The Victorian context

At the time this research project was implemented, significant curriculum reform was occurring across Australia. The Melbourne Declaration on Educational Goals for Young Australians (2008) is a federal policy document developed by the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA). The two educational goals identified in this policy are:

> Goal 1: Australian schooling promotes equity and excellence
> Goal 2: All young Australians become:
> – successful learners
> – confident and creative individuals
> – active and informed citizens (MCEETYA, 2008, p. 6)

Australian Curriculum, Assessment and Reporting Authority (ACARA) Outcome Strategy 1 (ACARA, 2013) is: "Improved quality and consistency of school education in Australia through national curriculum, national assessment, data collection and performance reporting system". In particular, Program Objective 1.3 highlights the importance of aligning the assessment with the Australian curriculum as a priority:

> Program 1.3 objectives:
> To align national assessments with the Australian Curriculum and ensure that they validly, reliably and fairly capture achievement across a wide range of learning areas and valued outcomes, particularly those capabilities of special importance in the 21st century. (ACARA, 2013, p. 170)

It is widely believed that alignment of curricular goals with instruction and assessment is crucial for meeting the goals of the curriculum and for the effective functioning of the educational system as a whole. Curriculum alignment studies can serve to inform the implementation and evaluation of national standardized testing programs and also of other published diagnostic testing programs used by schools. Alignment studies can provide useful information about the interpretation and implementation of curriculum standards, which can lead to appropriately targeted professional development programs for educators.

Models of alignment

Curriculum alignment models have been implemented extensively in the United States of America as a result of the 2001 No Child Left Behind legislation. Curriculum alignment has been proposed as a powerful tool for raising student achievement and a range of models have been developed for determining the level of curriculum alignment (Squires, 2009).

In order to determine whether a system is aligned or not, various models have been developed to measure the degree of alignment between the relevant aspects. The models used to measure alignment range from basic models to highly complex ones that contain multifaceted approaches to determining degrees of alignment. The models themselves are defined by the criteria they use. As different models place emphasis on particular aspects of alignment, the associated research should be read within the boundary set by the alignment criteria used. Two key issues arise from the literature on alignment. The first has to do with the difference in opinion regarding what criteria should be used to determine alignment. The second is the degree to which a system needs to be aligned for it to be deemed coherent, for example "completely aligned" or "adequately aligned".

The theory underpinning standards-based reform emphasizes alignment as a critical factor in the success of the strategy (Rothman, 2003). In an effort to make the state systems accountable, methods for measuring alignment have been produced. Even though the alignment methods are specific to measuring alignment between standards and large-scale testing, particular methods are useful and adaptable in their application for determining alignment in different contexts.

Bhola, Impara, and Buckendahl (2003) categorised the various methodologies into three major groups; low, moderate, and high complexity, with each subsequent model adding another layer or dimension to the previous one.

Low-level complexity models: This category defines the most basic alignment methods. In its simplest form, alignment between the content of standards and assessment are investigated to determine a match – simply a correspondence of content. An expert in the particular content area typically uses a Likert scale to indicate the degree of alignment between a test item and a corresponding standard. The range is generally "no match at all" to "matches exactly" (Bhola et al., 2003). This rudimentary measure of alignment underpins all other methods of increasing complexity.

High-level complexity models: An example of a higher-level complexity model is Webb's alignment method. Webb (1997) identified twelve criteria classified into five categories that examine both the breadth and depth of alignment between standards and assessments. The five categories are:

1. Content focus
2. Articulation across grades and ages
3. Equity and fairness
4. Pedagogical implications
5. System applicability

The degree of alignment for each criterion is measured by one of three levels: full, acceptable, or insufficient. A recurring problem that is not addressed in Webb's (1997) criteria is the underlying assumption that instruction is, or will be, aligned with standards and assessment. In the present study, the inclusion of instruction in the process of determining alignment aims to provide the missing link between what should be learnt and what is assessed. Standards–assessment alignment may satisfy accountability at the state or national level, but if alignment is to have any effect on student learning, it must be linked to instruction. In the field of alignment, instruction seems to be a collateral issue as standards–assessment alignment takes the spotlight.

Another example is the Surveys of Enacted Curriculum (SEC) method, which has been used to determine the alignment of standards, instruction, and assessment (Porter, 2002). This model adds another dimension to the measurement of alignment using content matching by including cognitive complexity as an alignment criterion. The method is employed by approximately four reviewers using a two-dimensional matrix to code standards, instruction, and assessment in any arrangement. The degree of alignment is analyzed for two dimensions: content topic and category of cognitive demand. The information contained within the content matrix may be converted into tables, graphical displays, and content maps to portray similarities and differences.

In a study of alignment, it is easier to find a match between standards and assessment items in low-complexity models (Bhola et al., 2003). The more complex models with specific criteria may be more likely to result in judgments of a lesser degree of alignment between the standard and the test item. Moreover, Bhola et al. (2003) found that the degree of alignment as determined by the models can vary greatly due to differences in the way that the criteria have been defined. This is an important detail that requires careful consideration because on the surface the criteria do seem similar. In general, criteria that are broadly defined result in a more likely match than those with a higher degree of specificity. Furthermore, the definition of alignment itself changes depending on the criteria within each particular model. Bhola et al. (2003) recommends that the conclusions of alignment studies are read within the boundaries that are defined by the criteria used.

One of the limitations of Webb's (1997) model of alignment is that the focus is only on matching standards and assessments. The assumption is that if the standards and assessments are aligned, the instruction must also be aligned; to determine whether a system is indeed aligned, however, instruction must be included in a study of alignment. Porter, Smithson, Blank, and Zeider's (2007) research on alignment is the exception in this case as the SEC takes into account classroom instruction. Porter (2004) stated that there are four aspects to the curriculum: the intended, enacted, assessed, and learned curriculum. The following definition was provided by Porter (2004):

> The intended curriculum is captured most explicitly in state content standards—statements of what every student must know and be able to do by some specified point in time. The enacted curriculum refers to instruction (e.g. what happens in classrooms). The assessed curriculum refers to student achievement tests. (p. 1)

It is considerably more difficult to conduct an alignment study of the "enacted curriculum" by doing classroom observations or recording lessons than it is to do a document analysis of the "intended curriculum" (Porter, 2004). One of the benefits of participating in a study of alignment is that the process itself increases the degree of alignment between curriculum, instruction, and assessment. La Marca, Redfield, Winter, Bailey, and Despriet (2000) found that teachers who had participated in alignment studies had increased their understanding of the assessment process resulting in an increase in curriculum alignment.

There are three significant factors that contribute to the understanding of alignment between the intended and enacted curriculum. First, research indicates that the curriculum design, or the procedure for planning and implementing the curriculum, affects alignment (Herman, 1997; Webb, 1997). Second, the degree of alignment between the intended curriculum and the actual enacted curriculum identifies whether students have been provided with the appropriate content that enables them to meet the standards that have been set. Last, regardless of whether the purpose of assessment is to inform teaching, to obtain an end result, or a combination of the two, Cohen (1987), Field (1991), and Posner (1994) concluded that the processes involved in assessment are representative of fundamental values. If this is so, educators need to be aware of the intended and actual messages that students are receiving through the curriculum in relation to what is valued.

La Marca et al. (2000) and Rothman (2003) pointed out that even though there are a variety of strategies that can be used to measure alignment, an overwhelming majority of studies have concluded that alignment between standards and assessment is poor. Conversely, the information gained from such studies identifies areas that need to be strengthened, which can only serve to improve practice. Absolute alignment is unrealistic, but there is no consensus on either the criteria that should be used or the degree of alignment that is required (Rothman, 2003). In addition, alignment studies are only of benefit when the standards and assessments they are measuring are of good quality (Beck, 2007; Porter et al., 2007). This caveat highlights the purpose and limitations of alignment studies that are designed only to measure the degree of alignment between standards and assessments, not their quality.

Challenges in defining the curriculum and describing the processes of planning, enacting, and assessing the curriculum include the complex organizational structures and many factors that impact decision-making in school contexts. It is widely believed that alignment of curricular goals with instruction and assessment is crucial for meeting the curricular goals and for the effective functioning of the educational system as a whole. Ultimately, the classroom implementation of the curriculum is the responsibility of the teacher, so it can be argued that those performance types valued in the classroom are determined by the teacher. However, the teacher will inevitably be influenced by factors beyond the classroom, such as the state-mandated curriculum, standardized testing programs, and school-level curricular processes and requirements.

Developing performance type categories for analyzing alignment

Alignment is a multi-dimensional state and the literature contains a variety of alignment methods, each with its own purpose and focus. Alignment studies use categories as a way of explaining the types of performances that are evident in planning, those seen during instruction, and those that are elicited through assessment activities. In order to devise categories for this research project, the categories that are used in key alignment research were compared and contrasted and then appraised for their utility with respect to the emerging categories evident in the data set for this research project. The categories used in the Alignment Project are: knowing, performing, communicating, reasoning, non-routine problem solving, and making connections.

Table 1
Alignment model categories

The Alignment Project	Blooms Taxonomy (Krathwohl, 2002)	Porter (SEC) (Porter et al., 2007)	Webb (2005)
Knowing	Remember	Memorize facts, definitions, formulas	Level 1 Recall & reproduction
Performing	Apply	Perform procedures	Level 2 Skills & concepts
Communicating	Understand	Demonstrate understanding	
Reasoning	Analyze & evaluate	Conjecture, analyze, prove	Level 3 Strategic thinking
Non-routine problem solving	Create	Solve non-routine problems	Level 4 Extended thinking
Making connections		Make connections	

The category definitions for this study were initially developed based on Porter's cognitive demand categories (Porter et al., 2007). An earlier analysis using a preliminary version of the categories was reported by Xu, Kang, and Clarke (2011). The following performance type category definitions were developed using classroom data to determine key themes in addition to a comprehensive review of categories used for Porter's cognitive categories (Porter et al., 2007), Webb's criteria for alignment (Webb, 1997), TIMSS performance categories (Garden, 1997), and the PISA key competencies (OECD, 2009).

The performance types identified for this study are not in hierarchical order of least valued to most valued, that is, no more value is placed on one category over another. It is also important to note that the categories are not necessarily mutually exclusive. Different types of performances can and do occur simultaneously during an activity. Certain performance types are an essential prerequisite in order to address performances in other categories.

Performance type definitions

The following working definitions, synthesized from existing frameworks, were used to determine descriptors for each category when classifying classroom practices.

Knowing

The knowing category is based on declarative knowledge, which is generally static. The performance of knowing specifically pertains to the recall and recognition of content knowledge. The emphasis in this performance type is on the reproduction of content taught previously in verbal or non-verbal forms.

The performance of knowing specifically pertains to recall of content knowledge. Knowing is not necessarily understanding. A student might be able to recall scientific facts without understanding the concept involved. Stiggins (2005, p. 56) stated that "at any point in the instructional process, a teacher concerned about student attainment of the building blocks of competence might legitimately hold as the valued target that students master some important knowledge. At such a time, assessment of student mastery of that knowledge might very well make sense". In Bloom's revised taxonomy, factual knowledge is defined as "the basic elements that students must know to be acquainted with a discipline or solve problems in it" (Krathwohl, 2002). Therefore, the knowing domain is the basis for all other performances in the classroom.

Performing procedures

Performing relates to procedural knowledge. Similar to knowing, this performance type is also about reproduction, but that of methods or procedures taught previously. "Students demonstrate fluency with basic skills by using these skills accurately and automatically, and demonstrate practical competence with other skills by using them effectively to accomplish a task" (Porter & Smithson, 2001, p. 37).

Krathwohl (2002) stated that there are three elements of procedural knowledge: knowledge of subject-specific skills and algorithms, knowledge of subject-specific techniques and methods, and knowledge of criteria for determining when to use appropriate procedures. In science, procedural knowledge can pertain to the procedures involved in conducting an experiment. In other cases, it can involve solving routine problems. Woodward, Beckmann, Driscoll, Franke, Herzig, Jitendra, Koedinger, and Ogbuehi (2012) defined routine problems as follows:

> Routine problems can be solved using methods familiar to students by replicating previously learned methods in a step-by-step fashion. … Routine problems are not only the one- and two-step problems students have solved many times, but they can also be cognitively demanding multistep problems that require methods familiar to students. (p. 11)

Communicating

Communicating refers to activities where the performance expectation requires students to describe, discuss, and represent concepts. This includes the use of models and diagrams to represent mathematical concepts.

In the mathematics domain, Porter (2002) described the category of "Communicate Understanding of Concepts" as a performance whereby "students share their mathematical understandings in both oral and written forms with their teacher and classmates. Students actively participate in conversations about mathematics. They talk to other students about mathematics (e.g. critique, question). … Students:

– Communicate mathematical ideas.
– Use representations to model mathematical ideas.
– Explain findings and results from analysis of data (p. 36).

Reasoning

Reasoning is a performance that involves forming inferences, making judgments, framing generalizations, or drawing conclusions.

Stiggins and Chappuis (2012) asserted that reasoning strategies "have a place among our valued achievement targets. We need to be ready to teach and assess student mastery of each, not only that it is evident, but the quality of the responses. But more important, we must prepare our students to be lifelong assessors of the quality of their own reasoning" (p. 48). Just as different types of performances may be required for a particular task, types of reasoning may also overlap as they do not necessarily occur independently of one another. Types of reasoning include analytical reasoning, synthesizing, classifying, comparative reasoning, classifying, inductive and deductive reasoning, and evaluative reasoning (critical thinking, judgmental reasoning; Stiggins & Chappuis, 2012).

Non-routine problem solving, designing, investigating

Non-routine problem solving involves making decisions and developing logical strategies for solving unfamiliar problems.

Porter (2002) combined the categories of non-routine problem solving and making connections, but they have been treated as individual categories for the purposes of this study. Porter (2002) defined non-routine problems as "open-ended problems with more than one right answer or problems where the answer is not obvious if the student follows a standard step-by-step routine. Non-routine problems may be solved in more than one way" (p. 38). Stein and Lane (1996) defined non-routine problems as "problems for which there is not a predictable, well-rehearsed approach or pathway explicitly suggested by the task, task instructions or a worked-out example" (p. 58).

Making connections

The performance of making connections requires students to connect and integrate knowledge from different areas or sources. This includes the ability to apply knowledge to contexts outside the subject area or classroom.

Porter (2002) described "making connections" as when a "student sees relationships between different topics and draws on these relationships in future mathematical activity" (p. 38). The following three productive pedagogies have been modified to suit the purposes of this project:

> *Knowledge integration* is identifiable when either: a) explicit attempts are made to connect two or more sets of subject area knowledge, or b) when no subject area boundaries are readily seen.
>
> *Background knowledge* provides students with opportunities to make connections between their world knowledge and experience and the topics, skills and competencies at hand.
>
> *Connectedness* describes the extent to which the lesson has value and meaning beyond the instructional context, making a connection to the larger contexts within which students live. (Education Queensland, 2000)

The types of performances defined above provided the structure for analysing the scope of practice and alignment of the intended, enacted, and assessed curriculum. The utility of the performance type categories were tested and refined by applying them to the curriculum, various school-based documents, standardised tests, teacher-designed tests, and video-based data.

Curriculum authorship and the planning process

Barnes, Clarke, and Stephens (2000) asserted that "all elements of a school system should work together to give consistent messages to teachers, parents, students and the wider community about what is being valued" (p. 625). When considering the alignment of performance types and the factors impacting the correspondence between the intended, enacted, and assessed curriculum, consideration must be given to the processes that result in a system of alignment at the school level. Curriculum authorship is first and foremost concerned with the intended curriculum, that is, the documents and resources that are consulted as part of the decision-making and planning processes. Curriculum authorship or authority is at the core of curricular alignment and the associated actions, such as the interpretation of the state-mandated curriculum, use of standardized testing, and the development of plans for instructional and assessment purposes. Acknowledging this chain of interpretation and reconstruction and its impact on the enacted and assessed curriculum results in the "curriculum" being defined by much more than what is mandated at the national or state levels (Ziebell, Ong, & Clarke, 2017). The idea of "authorship" and "curricular authority" was first reported in a study focusing on teachers' planning in mathematics (Sullivan, Clarke, Clarke, Farrell, & Garrard, 2013). That study sought to determine the processes undertaken when planning a mathematics curriculum. The findings presented the range of documents identified as sources of authority that were accessed by teachers in order to make decisions about teaching and learning.

Clements (2006) reported on research about the significant influence that authors and editors of textbooks have and their impact on determining teaching practices. This research project extends the notion of influence or "curricular authority" to include the authors of a range of curricular documents and resources that are accessed by teachers, including testing programs, yearly and term-based planners, teacher planning documents, and textbooks. All the documents that were used to inform the planning of the curriculum were considered as "sources of authority". The responsibility of authorship and the dynamic planning processes that are adopted by schools and teachers have significant implications for curriculum alignment.

Data sources and analysis

The data for this comparative case study was generated across three schools in two mathematics and two science classrooms at the grade 5 level in Victoria, Australia. Students in grade 5 are typically between the ages of 10 and 11. There are seven years of primary school commencing with prep, followed by grades 1 to 6. Secondary school is from grade 7 to grade 12.

In the mathematics classrooms, it was possible to gather data on the common unit of fractions, but for science, one unit focused on micro-organisms while the other focused on space. The duration of the mathematics units was one week, whereas the science units spanned a whole term. The data collected from each classroom focused on one unit of work from the planning stage through to the implementation and assessment of the unit.

Table 2
Data collection

	Grade 5 Mathematics	*Grade 5 Science*
Classroom 1 *Unit*	Acacia Primary *Fractions*	Crowea Primary *Micro-organisms*
Classroom 2 *Unit*	Banksia Primary *Fractions*	Banksia Primary *Space*

Lessons were recorded on video every day in the mathematics classroom for the duration of the unit, which was implemented over one week. Due to the length of the science units, particular lessons were selected for recording at various stages of the unit resulting in approximately one lesson per week being recorded.

Two levels of analysis were required in order to examine curricular alignment. The *vertical* analysis determined the types of performances that were valued at the national, state, school, and classroom levels. The *horizontal* analysis was used to compare the alignment of performance types between classrooms at the same grade level and across the two domains of mathematics and science. This horizontal comparison was significant because of the different processes that directed curriculum implementation at each site. It was decided to include mathematics at the grade 5 level because this is the year in which all Australian students need to take the nationally mandated National Assessment Program – Literacy and Numeracy (NAPLAN) standardised test. Science provided a point of comparison because it is a learning area that is not monitored nationally to the same degree as mathematics is.

The range of methods that were used in this study included interviews, questionnaires, document analysis (curriculum documents, planning documents, student work samples, and assessments), classroom observations, video recordings of lessons throughout the unit, and recordings of teacher planning meetings. Figure 1 provides a summary of the methods and documents that were used in order to determine the alignment of performance types for the vertical and horizontal analyzes.

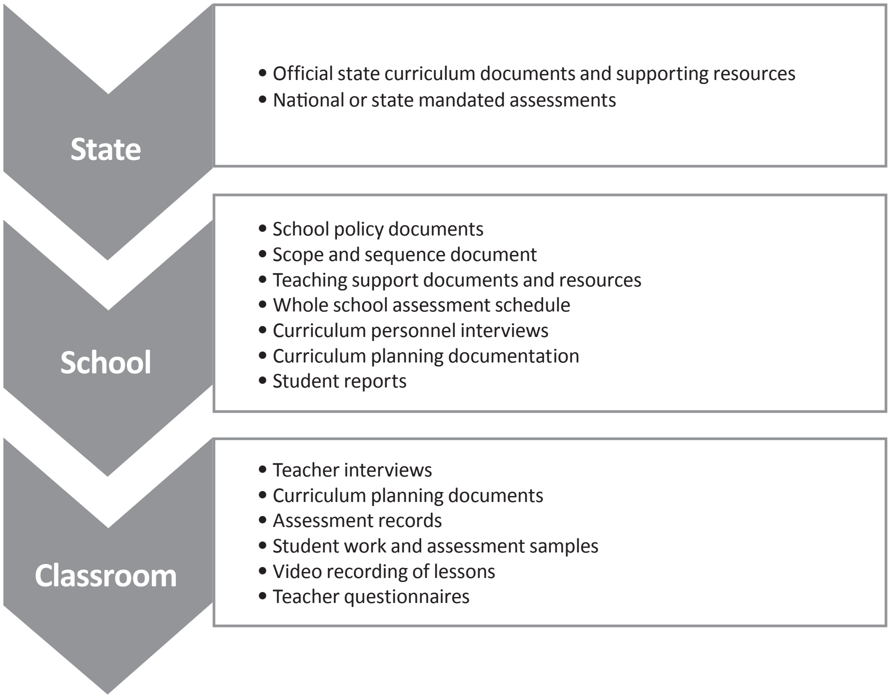


Figure 1. Data summary

The data from each site was analyzed for the performance types evident in the intended, enacted, and assessed curriculum. As the analysis progressed, the performance type categories that had been defined for this project were revised and modified based on the examples that emerged from the data.

School structure and curriculum responsibilities

School structures were important in determining the sequence of planning and to identify potential people to be interviewed for their role in interpreting and developing curricula and assessments. The distribution of responsibilities varied greatly among schools depending on the school structure. At one site, for example, the Assistant Principal was responsible for overseeing planning the curriculum and the development of yearly and term-based overviews and planners. In Victorian schools, the school year consists of four terms and each term is approximately ten weeks. The Leading Teachers were responsible for designing these overviews and planners, which would then be passed on to the grade-level teachers to be refined and eventually implemented. This information was necessary in determining who had authorship responsibilities for curriculum documents and thereby the authority to make decisions at the school level. The key personnel at each school were interviewed in order to understand each context and how the decision-making processes functioned. In addition, an interview with a key stakeholder at the curriculum and assessment authority was conducted in order to obtain information about the broader context in which these schools operate.

Ethical considerations

Ethics approval was sought and obtained from the University of Melbourne and the Department of Education and Early Childhood Development in Victoria. Informed consent was obtained from the school principals, teachers, parents, and students. Protocols regarding video filming and other data sources were developed for the project and strictly adhered to. While every effort was made to reduce the impact of filming lessons, it is reasonable to assume that there was some impact on the way that the participants behaved and responded. Recording two familiarization lessons prior to filming the units involved minimized this impact. The classroom documents and video data were password protected and only accessible to the members of the research team. During the data analysis phase of the project, all identifiable information was removed and aliases were assigned to participants and schools.

Limitations

The use of case study methodology can limit the generalizability of the findings (Stake, 1995). The classrooms from which the data were collected are not assumed to be representative of the school system in Victoria or Australia. However, by purposefully selecting contrasting school sites, it was hoped that some indication of the diversity of practice possible within the school system would be provided. The research project did not attempt to draw conclusions about typical assessment practices in a schooling system. The scope of this project comprised identification of the different types of assessment practices and types of performances evident in a small number of classrooms and examination of practices that might be similar or different. In a larger project, increasing the number of cases being analyzed would increase the generalizability of the findings (Miles & Huberman, 1994).

Results

The initial analysis focused on determining the scope of practice evident in four Victorian classrooms in science and mathematics. First, assessment documents for each domain were analyzed in order to determine the performance types elicited through assessment practices. When classroom formative-assessment practices were coded for use of the performance type categories, it was quickly determined that judgments about the performance types could not be made by isolating formative-assessment "events" and excluding instructional practices. The nature of formative assessment was a challenge in that it was difficult to document the minute-by-minute assessment judgments and decisions that were made by teachers in response to what was happening in the classroom. The results of such an analysis would be highly subjective. Therefore, all instructional materials and video footage were analyzed in order to determine those performance types that were evident in the enacted curriculum and, as a result, available to the teacher for formative-assessment purposes.

Alignment of the mathematics curriculum

The first analysis that was conducted focused on the performance type expectations in the national testing program (NAPLAN), the Victorian curriculum (Victorian Essential Learning Standards; VELS; Victorian Curriculum and Assessment Authority, 2007), and a diagnostic test used by the schools involved in the project (Progressive Achievement Tests; PAT). Figure 2 shows the results of the analysis of the performance types evident in the standards identified in the VELS curriculum at the grade 5 level based on the work of Xu et al. (2011). This is compared with the performance type expectations in the NAPLAN and PAT test items at the grade 5 level.

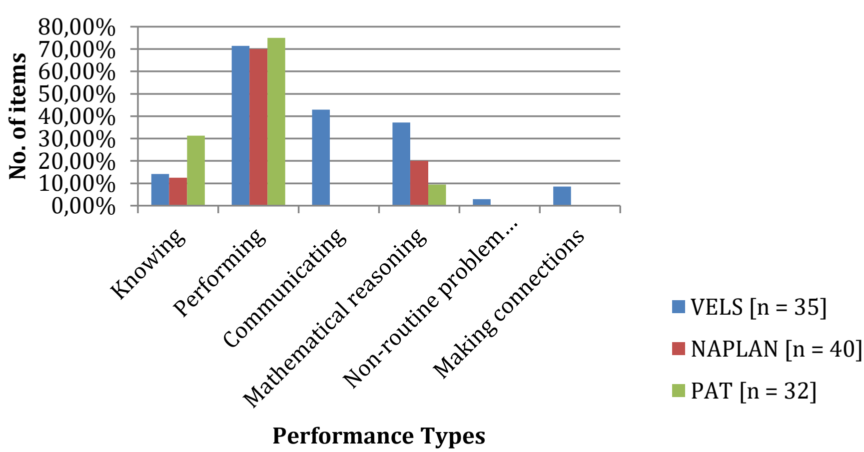


Figure 2. Performance types

The intentions and goals of the VELS (state), NAPLAN (national), and PAT (local) are very different, but they all had a significant influence on the enacted curriculum. The VELS curriculum contained all of the performance types identified for this study. The NAPLAN and PAT tests predominantly elicited the performance types of knowing, performing, and, to a lesser extent, mathematical reasoning. The performance types of communicating, non-routine program solving, and making connections were not evident in these tests. This has significant implications for classroom practice, particularly if the results of these tests are being used formatively for curriculum planning at the school level.

The following graphs show the results of an analysis of the teacher-designed tests that were completed by students at the beginning and end of the fractions units. The results of the pre-tests were used to target instruction at the students' point of need. At both schools, the pre-test and the post-test were exactly the same, presumably so that teachers could easily quantify student progress throughout the unit.

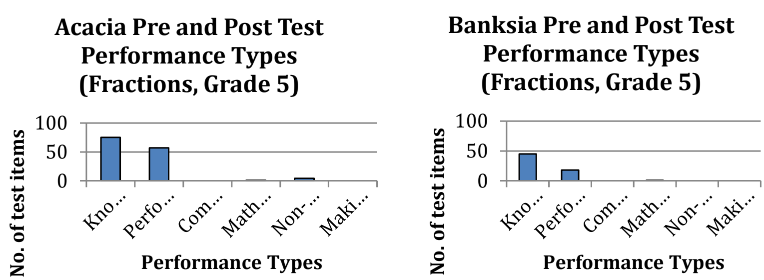
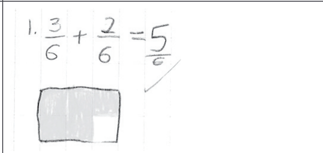
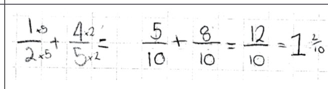
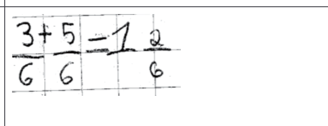
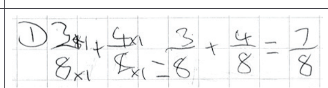
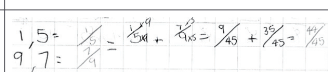


Figure 3. Pre- and post-unit testing

The diagrams of the performance types evident in the pre- and post-tests shows that the focus is entirely on knowing and performing procedures. The proportion of test items that focus on recall of facts (knowing) is significant because this is not reflected to the same extent in the VELS, NAPLAN, and PAT testing.

If the assessed curriculum is not aligned with the intended curriculum (VELS), the focus on the range of performance types that are valued can have an impact on the enacted curriculum. This was evident in the analysis of the video-recorded lessons, student work samples, and classroom observations. The enacted curriculum at Acacia Primary addressed the performance types of knowing, performing procedures, and communicating. Table 3 presents examples of the activities that were completed by students as well as the respective performance types that were elicited through each task.

Table 3
Performance types – student work (Acacia Primary)

Lesson	Activity	Example	Performance
1	Addition of fractions with common denominators.		Performing procedures Communicating
2	Addition and subtraction of fractions with unlike denominators.		Performing procedures
3	Dice game. Students roll two dice to create a fraction. Repeat. Students use the two fractions to create an equation.		Performing procedures
4	Quick fractions. Addition of fractions. Students complete as many problems on the whiteboard as possible in 5 minutes.		Performing procedures
	Fraction lotto. The same as the dice game in lesson 3, but this time students earn a point for each correct answer.		Performing procedures

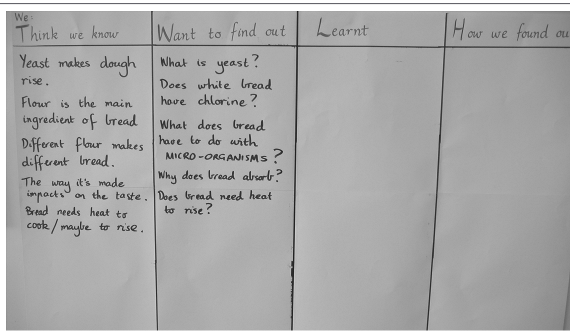
In the enacted curriculum at Banksia Primary, the performance types were predominantly knowing, performing procedures, and communicating. One of the activities that was completed by the students during the unit focused on reasoning, non-routine problem solving, and making connections, but these performance types were not evident in the teacher's instructional practice and had a weak link to these performance types. In the mandated curriculum, the performance types of mathematical reasoning and non--routine problem solving are found predominantly in the standards within the Working Mathematically dimension. In the planning documents at Banksia Primary, the Working Mathematically dimension from the curriculum was treated as a distinct content area, so such performance types as reasoning and non-routine problem solving were addressed during one unit at the end of the term. This ensured that these performance types were addressed at some stage. The planning documents at Acacia Primary stated the expectation that the Working Mathematically dimension would be embedded across all other content areas in mathematics, so it was up to the teachers to recognize or create opportunities within the content units to promote such performance types as making connections and non-routine problem solving.

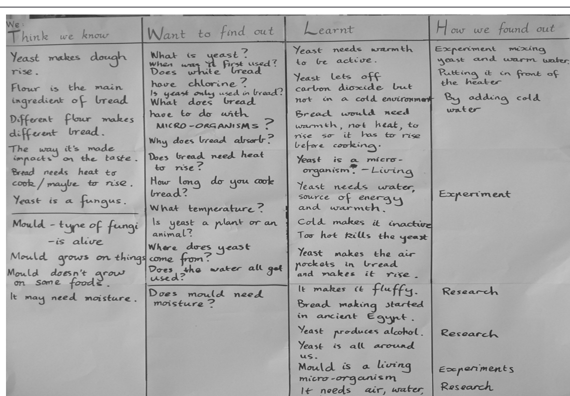
The enacted curriculum at Acacia Primary included the performance types of knowing, performing procedures, and communicating. The other types of performance were not evident in the intended, enacted, or assessed curriculum.

Alignment of the science curriculum

Currently, there is no national mandated standardized testing program for science. It is interesting to note that the process for planning and implementing the science curriculum is significantly different to that for the mathematics curriculum. In both grade 5 science classrooms, teachers implemented long-term inquiry-based units. Rather than opting for pen and paper pre- and post-testing, the teachers asked students to record what they knew and what they wanted to learn about the topic. KWLH charts were used in both classrooms in order to gauge students' current knowledge.

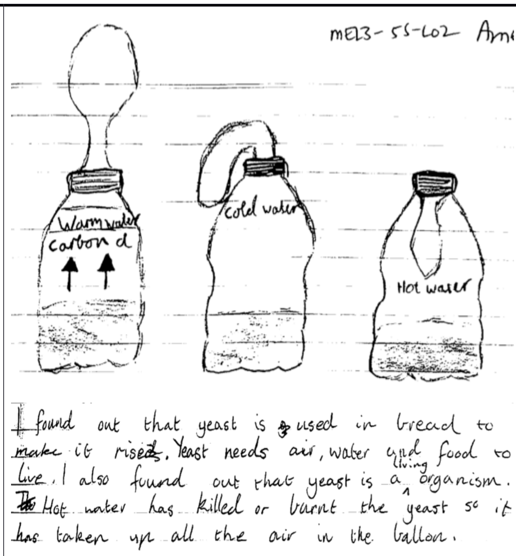
Table 4
Performance types evident in a science classroom

<table>
<tr><th>Lesson</th><th>KWLH chart</th><th>Performance Types</th></tr>
<tr><td>End of lesson 1.</td><td>
</td><td rowspan="2">Things we Know
Knowing
Communicating

Want to find out
Non-routine problem solving
Communicating
Learnt
Knowing
Reasoning
Making connections
Communicating
How we found out
Knowing
Making connections
Communicating</td></tr>
<tr><td>End of lesson 5.</td><td>
</td></tr>
</table>

The tasks chosen in the science classrooms had the potential to elicit a broad range of performance types. For example, a scientific experiment has the opportunity to elicit all performance types, particularly if students formulate their own problems to investigate. Table 5 shows how one activity in science targeted a range of performance types.

Table 5
Sample of performance types evident in classroom tasks

Students to determine how heat affects yeast. Students make predictions about the effect of heat. A report was written in their journals.		Knowing Performing Communicating Reasoning Non-routine problem solving Making connections

A significant finding is that the pedagogical approaches utilized by the teachers in both settings resulted in individual activities that elicited a range of performance types. The investigative nature by which scientific concepts were explored resulted in the heightened accessibility of content and the development of inquiry skills for all students, regardless of prior knowledge. Summative assessments were based on oral presentations and students were provided with the opportunity to design their own presentations by selecting the content that they felt was relevant. Teachers used a range of informal and formal assessments such as anecdotal records, checklists, and rubrics to record information about student progress.

Authorship

The results of the initial alignment study of performance types in mathematics and science curricula provided the impetus for investigating why the performance types that were valued in the mandated curriculum were not evident in the mathematics classrooms.

A key curriculum and assessment stakeholder that worked for the organization responsible for the design of the state-mandated curriculum was interviewed. The VELS curriculum was explained as follows:

> [From] prep to ten there is a documented curriculum framework that defines the learning areas that all schools are required to provide. It sits somewhere between the detailed syllabus and a very pared back framework… That's the space, the distinct space in Victoria I think, because we do have this framework that sits in the grey space between the syllabus and very loose guidelines. *But there is some substantial gap between that and what the classroom program looks like.* [emphasis added]

As described in the interview, "the gap" between the goals of the curriculum and what is actually taught and assessed in classrooms is an essential consideration for this study. One of the goals of this study was to determine the process that was undertaken to interpret the state-mandated curriculum, the plan for curriculum implementation, and the instruction and assessment practices that were enacted in the classroom.

The planning process for the mathematics curriculum at Banksia Primary School was complex and Figure 6 presents the various influences, beginning with the state-mandated curriculum and including key assessments that are completed by students at the school level.

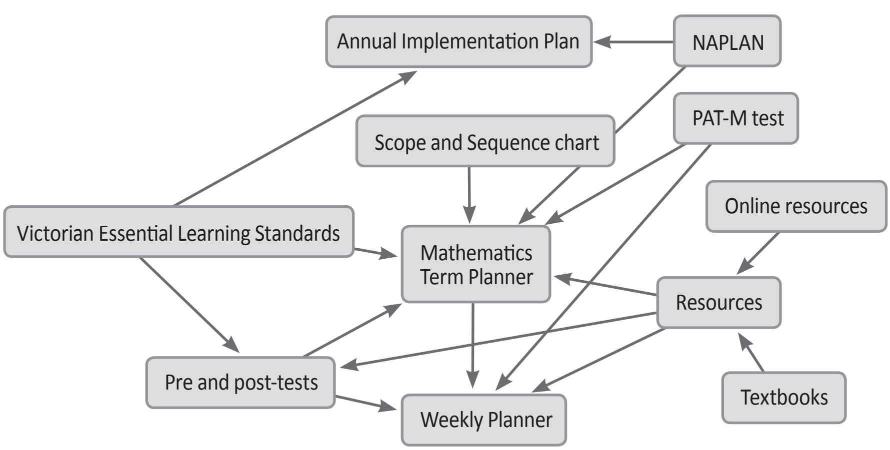


Figure 4. Banksia mathematics documents and authorship for mathematics

At Banksia Primary, there was a significant contrast in the planning processes for the domains of the mathematics and science curricula. A school-level decision was made to use a commercial science-curriculum resource containing plans, support materials, assessment tasks, and rubrics. It is evident from the diagram above, and in practice, that constructing curriculum plans at the school level takes a considerable amount of time and resources. Figure 5 shows that for science the mandated curriculum was interpreted by an external organization and aligned with the VELS curriculum. This program was implemented by the classroom teachers in its entirety.

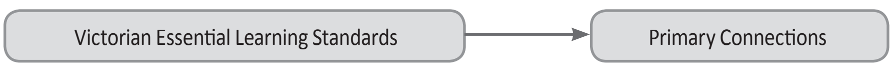


Figure 5. Banksia science documents and authorship

The first key distinction between planning for mathematics and for science is that for mathematics the topics were generally shorter, approximately one week in duration, whereas the science topics spanned the entire semester. Overall, students were given more opportunity to negotiate topics or content within the scope of the unit for science, but this was not an option afforded to students in mathematics.

Standardised tests as a curriculum influence in mathematics

The analysis of performance types raised the question of why some performance types were consistently privileged in mathematics over others at the national, school, and classroom levels when they are a requirement of the state-mandated curriculum. Determining the influences on the enacted and assessed curriculum required exploring the process of curriculum authorship and the influences that promoted particular performance types while leading to others not being addressed in the classroom setting. The comments in Table 6 show that the testing programs did indeed have a significant impact on classroom practice and were considered as sources of authority from the perspective of teachers and people in leadership roles.

Table 6
Impact of the standardized testing program on school planning

Assistant Principal *Acacia PS*	*We spend some time looking at the curriculum demands…in each of those NAPLAN tests. … We've analyzed that data, talked about what we see in it and then we've talked about and documented what is it that next year's teachers need to do to improve on this and then that information then gets put into our literacy numeracy plan.* [emphasis added]
Leading Teacher: *Acacia PS*	*Particularly with NAPLAN, there is a middle step. The middle step is when the team will sit down and plan the term week by week as well. … We do that for NAPLAN to make sure that we have everything covered in the time that we have.* [emphasis added]
Assistant Principal *Banksia PS*	*This year we've moved to the PAT reading test which is much more up to date and it is very similar to the NAPLAN format as well so we feel that that's just giving our children extra practice in that way of doing a test. But it does give very good information.* [emphasis added]
Teacher: *Banksia PS*	*The other tests that we do, the PAT tests they also give you a more diagnostic report of the skills. The questions are grouped according to the skills so you can look at which skills they're falling down in again and tailor your teaching explicitly to those areas, so we use it for assessment but also for planning.* [emphasis added]

It is evident that there are a range of influences impacting classroom curriculum and assessment practices. Firstly, the state-mandated VELS curriculum is a primary influence on classroom practice. This document is interpreted at the school level by various people (including curriculum consultants, Leading Teachers, and classroom teachers), and the responsibility of curriculum interpretation is subject to the planning processes in place at each school. The planning process itself can enable or be a constraining factor for the types of performances that are privileged in classroom practice. A consequence of attributing authority to a document or resource based on someone's interpretation of the mandated curriculum results in the possible omission of performance types valued in the mandated curriculum. Finally, the national standardized testing program (NAPLAN) and the school-based assessment practices are significant influences on the mathematics curriculum. If the tests are not adequately aligned with the goals of the curriculum, the result is a limited focus on a few types of performances.

Discussion

The findings outlined above suggest that there were a range of influences that impacted curriculum and alignment. Teachers drew upon various documents to inform their teaching, including some that were produced by authors that are external to the school: the state curriculum, the national standardized test, and a commercially available diagnostic test. At the school level, the planning processes used to interpret and construct curricula for implementation is another factor that can have an impact on curriculum alignment. In addition to these curricular influences, it is evident that further assessment documentation in the form of teacher-designed pre- and post-tests had a direct impact on teacher decision-making and curriculum enactment. These elements are significant when considering the dynamic process of curriculum alignment and the curriculum documents that are afforded authority in the design process. One of the aims of this study was to determine who had authorship of key documents and how these documents were used within the planning process. It is important to note that that the planning processes differed significantly among the three schools involved in this study, and in one case there were planning variations between the two domains of mathematics and science at one school.

A major finding in this study is that in the mathematics curriculum a restricted set of performance types for the unit on fractions was evident in both classrooms. There are a number of possible explanations for the differences among the curriculum, instruction, and assessment documents:

1. *The performance types were not included in the school planning documents through which the state curriculum was interpreted, such as the yearly, term-based, and teacher planners.*

It is possible that the sources of authority that are accessed by teachers for planning purposes have eliminated particular performance types through the act of selecting and interpreting curriculum standards. In its most simplified form, the planning process is a causal sequence, with each document informing the next. For example, the yearly planner is used to construct the term-based planner, which is then consulted when creating the weekly plans. However, the results reveal that this is not a linear chain, but a dynamic process with the construction of each new document impacted by the experience and intentions of the author and other influences that are both internal and external to the school. It is possible that when the mandated curriculum is interpreted in the yearly plan, at some point the mandated curriculum is no longer accessed as a primary source of information further along in the planning sequence. In both mathematics classrooms, the weekly planner contained a summary of activities, materials, and classroom organization information. In the classrooms studied, the lesson focus and activities in the weekly teaching plans were enacted exactly as planned. While the teachers responded to students' questions and addressed any challenges experienced by students immediately during the lesson, the content and performance expectations as planned prior to the unit commencing were not modified or adapted in any way during the teaching of the units.

2. *The teacher might consider teaching only those performance types that are evident in assessment documents: teaching to the test.*

The key consideration when determining what performance types might be valued by the teacher is: To what or to whom does the teacher accord authority? If the teacher accords authority to assessment documents, then the teacher is likely to "teach to the test" and construct a plan for instruction that promotes the performance types found in the assessment. In the past, teaching to the test has had negative connotations in education, but teaching to the test is considered almost inevitable and potentially beneficial provided that the valued performance types in assessments are well-aligned with those specified in the published curriculum.

If students are to be successful in assessments, the learning experiences given to them must provide every opportunity to develop their knowledge and skills in precisely those areas being assessed. However, if the test to which the teacher accords authority is not aligned with the performance types valued in the curriculum, it presents a problem. The teacher's instruction will be aligned to the performance types found in the test but not to the curriculum. Schoenfeld (1999) is critical of standardized tests and what can be achieved from them:

> Since "teaching to the test" these days typically means teaching to a set of skills that have little to do with deep competence, the current incarnations of most assessments serve disruptive rather than productive functions. We should question the degree to which we rely on frequent standardized tests. To the degree that we use them, we should have assessments that are actually meaningful and informative. (p. 12).

If important assessment instruments such as PAT and NAPLAN do not contain performance types aligned with the curriculum, why would the teacher value them? This is an example of alignment that has been shaped by one aspect of the education system, an effect that is amplified by the fact that the results of the NAPLAN tests are published and comparisons are made with other schools. If our goal is to assess what we value, alignment of national standardized tests and other forms of testing should be reviewed to ensure the alignment of performance types to the curriculum.

The influence of state-mandated assessment documents was not a factor in the science classrooms. As there are no standardized science tests or published formative or summative tests in widespread use, these could not impact the curriculum at either the school or classroom level in this domain. Furthermore, the balance of all performance types evident in both primary science classrooms indicates that in this domain teachers approached the instruction and assessment aspects of these classrooms in a very different way than with the teaching of mathematics. This was highlighted at Banksia

Primary, where both teachers participating in this research project implemented the same mathematics and science units. Therefore, it can be concluded that similar performance types were addressed by both teachers for the domains of mathematics and science. In the case of Banksia Primary, the key factor influencing the performance types evident in the enacted curriculum was that the performance types were domain specific and not a result of an individual teacher's practices.

3. *The teacher does value the performance types but is unsure of how to implement some of them in the classroom.*

The analysis in this study has demonstrated that performance types such as making connections, problem solving, and reasoning are valued aspects of the published curriculum. It is possible that teachers recognise the importance of these performance types but do not have the necessary training, experience, or skills to be able to incorporate these performance types in their teaching. Furthermore, school and classroom constraints such as time and resources can impede a teacher's ability to implement these performance types in the classroom. That is, there are two types of constraints: context and the teacher's capability or inclination.

Another contributing factor could be whether students are assisted to develop a sufficient toolkit to engage in problem solving tasks. Schoenfeld (1999) stated that "current reforms of instruction have been shaped by growing understandings of what it means to 'think mathematically' …. Instruction no longer focuses almost exclusively on the mastery of facts and procedures, but also on strategies, metacognition, beliefs, and engaging in intellectual practices central to the discipline" (p. 6). The VELS curriculum has dedicated a dimension in mathematics to Working Mathematically, and the recently implemented Australian Curriculum (ACARA, 2013) also contains "problem solving" and "reasoning" as two key proficiency strands in the mathematics curriculum. The "communicating" performance type is also subsumed within the "problem solving" proficiency strand. Through curriculum reform in Australia, these performance types have been mandated and advocated in policy, such as the Melbourne Declaration (2008) and the initiatives that followed, including the Australian Curriculum.

The Australian Numeracy Review Report (Council of Australian Governments, 2008) was a key document in the development of the Australian mathematics curriculum. Recommendation 3 is as follows:

> That from the earliest years, greater emphasis be given to providing students with frequent exposure to higher-level mathematical problems rather than routine procedural tasks, in contexts of relevance to them, with increased opportunities for students to discuss alternative solutions and explain their thinking. (p. 31)

In order for students to develop this toolkit, the performance types of non-routine problem solving, reasoning, and making connections should form part of the instruction and assessment practices at the classroom level. It is important that teachers have the content, knowledge, pedagogical repertoire, and relevant resources in order to do this effectively.

Conclusion

Inevitably, schools are going to be held accountable for student achievement levels in the domain of mathematics. The goals outlined in the Annual Implementation Plans for the schools participating in this project set targets for improvement in NAPLAN results for mathematics and English. If teachers perceive core curriculum subjects, such as mathematics, as being directed by a set of particular performance types evident in the national testing program and diagnostic tests, this could potentially have a significant impact on the flexibility of curriculum design and the enacted curriculum.

Mathematics is perceived as core curriculum and the subsequent planning at the school level is highly structured and less adaptable than other areas, such as science. One of the challenges when selecting participants for this study was whether science was being taught at the school. In many schools, science units are not taught every term and, in some cases, are heavily integrated with other curriculum areas, such as geography and English. The organization of the integrated curriculum is at the discretion of individual schools, but this does result in a higher degree of flexibility for teachers with regards to planning in science. This study shows that the flexibility afforded to teachers has resulted in good outcomes in terms of the diversity of performance types evident in the enacted curriculum.

If curriculum areas are high stakes, selective interpretation of curriculum goals and standards can be influenced by external assessment obligations and can impact the planning of curricula from the school level to the classroom level. Diagnostic tests that are used to track student progress over long periods of time, such as PAT, can also narrow the focus of the planned and enacted curriculum. It is expected that teachers will prepare students well in order to complete tests, but teaching to the test will result in an impoverished set of goals for the enacted curriculum if the tests are not adequately aligned to the state-mandated curriculum.

The results show that the alignment of some performance types in the enacted and assessed curriculum is stronger in some areas, such knowing and performing in mathematics, and weak or non-existent in other areas. The major assertion as a result of this study is that if performance type expectations in documents that are used by teachers as sources of authority, such as standardized tests, are not aligned with curriculum standards, this will inevitably impact on the alignment of instructional practice. If performance types are not evident in classroom practice, they cannot be formatively assessed and should not be summatively assessed.

The issue of curricular authority characterized by the authorship of the intended curriculum (planning documents and programs) at the school level has a significant impact on how the state-mandated curriculum is interpreted and subsequently enacted in the classroom. Further research could greatly inform curricular alignment research, highlighting the factors that impact the degree of consistency within the intended curriculum (as this is documented at all levels of the school system), the enacted curriculum, and the assessed curriculum.

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