Structure in the Professional Vocabulary of Middle School Mathematics Teachers in Australia

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Members of the Australian mathematics education research community and experienced teachers of mathematics participated in the process of documenting the professional vocabulary of middle school mathematics teachers. This vocabulary, the Australian Lexicon, captures the language in use by Australian mathematics teachers when describing the phenomena of the middle school mathematics classroom. In this paper, we examine the structure of the Australian Lexicon with particular attention given to content, connection, and characteristics of the professional vocabulary available to middle school mathematics teachers in Australia.

A technical or professional language to describe and analyse practice in teaching has been previously reported as lacking or underdeveloped (Grossman 2009; Lampert, 2000; Lortie, 1975). Lampert (2000) has concluded that the lack of opportunities to work collaboratively with peers on the problems of practice result in "a language of practice [that] remains flat or nonexistent" (p. 90). Connell (2009) has similarly observed that the teaching profession's organisational culture does not always support the "the informal processes by which practical know-how is passed to new teachers in on-the-job learning" (p. 223) and that a culture that might do so needs to be purposefully fostered.

Bhatia (2006) argues for studies of professional practice in order to:

- gain a more informed and comprehensive view of the language employed by professionals to describe, represent, interpret and theorise; and
- gain significant understanding of the coherent and social reality of members of the profession.

This research engages in the first of Bhatia's goals. However, with regard to the second, the social reality is inferred through the activities that are named. The Sapir-Whorf hypothesis suggests that our lived experience is shaped by our capacity to name and categorise our world: "We see and hear...very largely as we do because the language habits of our community predispose certain choices of interpretation" (Sapir, 1949, p. 162). If the Australian teachers' conceptions of the mathematics classroom are constructed around activities that they can name, then it may follow that they are unlikely to engage in activities that they cannot name.

Research Methodology

This research has put into practice a methodology that can be legitimately described as "negotiative". It relied, to a significant extent, on the collaborative involvement of members of the mathematics education community. Members of the research community and a select group of practitioners have participated in the process of negotiating the lexicon employed by practitioners (middle school mathematics teachers), whilst the community at large has assisted in the validation of that lexicon.

This research project shares attributes with the discipline of anthropology as its goal is the construction of a cultural artefact. As such, it has some commonality with the aims of the applied ethnographer, as insights – the lexicon employed by middle school

mathematics teachers – are generated through the perspective of the 'insider' (Hammersley & Atkinson, 1995; Hoey, 2014). In this case, however, the key insiders are drawn from two distinct communities:

- our teacher partners, whose professional expertise both informs and shapes the study; and
- the broad practitioner community, whose input is sought in the process of refining and ratifying the national lexicon.

The emphasis in this methodological approach is thus on allowing critical categories and meanings to emerge from the ethnographic interaction (in our case the encounter involving ourselves with our partners) rather than imposing these from existing models.

Research Questions. The research outlined in this paper has been driven by the following research questions:

1. What are the terms that teachers use to describe the phenomena of the Australian middle school mathematics classroom?
2. What is the significance of the things that are named by Australian middle school mathematics teachers in relation to the phenomena of their classrooms?

One of the immediate and significant products of this work is the documentation of a collection of elements (terms, descriptions, examples, and non-examples) that together make up the Australian Lexicon, that is, the vocabulary used by teachers to describe the phenomena of the middle school mathematics classroom.

Research Design

Research Context. The research outlined in this paper is undertaken as part of a larger project *The Lexicon Project*, being undertaken simultaneously in Australia, Chile, China, the Czech Republic, Finland, France, Germany, Japan, and the U.S.A. Research teams in each country are documenting their teaching community's lexicon: "the vocabulary of a person, language, or branch of knowledge" (Stevenson, 2015), in order to use these as analytical tools to categorise, interrogate and enrich classroom practice, classroom research, and educational theorising. This paper relates only to the Australian Lexicon.

Stimulus Package. A video package of nine mathematics lessons (one from each participating country) was a key catalyst for the initial generation of the key terms in the lexicon. These lessons were selected by each country team to maximise the diversity of activities displayed. Each team contributed video material, time-stamped transcripts and classroom supporting material for one lesson of mathematics at Year 8. The video data files were configured into one viewing window (see Figure 1) – a synchronised display of three videos, arranged as teacher camera, whole class camera, and student camera, with all public utterances shown as English subtitles, and a time counter, to allow for the recording of starting and finishing times of each video excerpt illustrative of a particular term.

Figure 1. The video "three-up" (three camera angles with time-code and subtitles).

Generating Data. The Australian research team is composed of two mathematics teachers of more than 20 years of experience, a recently graduated teacher, and four academic researchers. All research team members viewed the Australian lesson, whilst the remaining eight lessons were assigned to team members using a matrix structure ensuring at least one experienced teacher viewed each lesson and each lesson was viewed by a minimum of four team members. The prompt used for stimulating thought whilst watching the video was, "What do you see that you can name?" A standardised template was used to record any term that came to mind. It was not necessary to identify a video example of each of the terms generated as the primary purpose of the video was to stimulate thinking about classroom events, actions, and interactions and the recollection of associated terms.
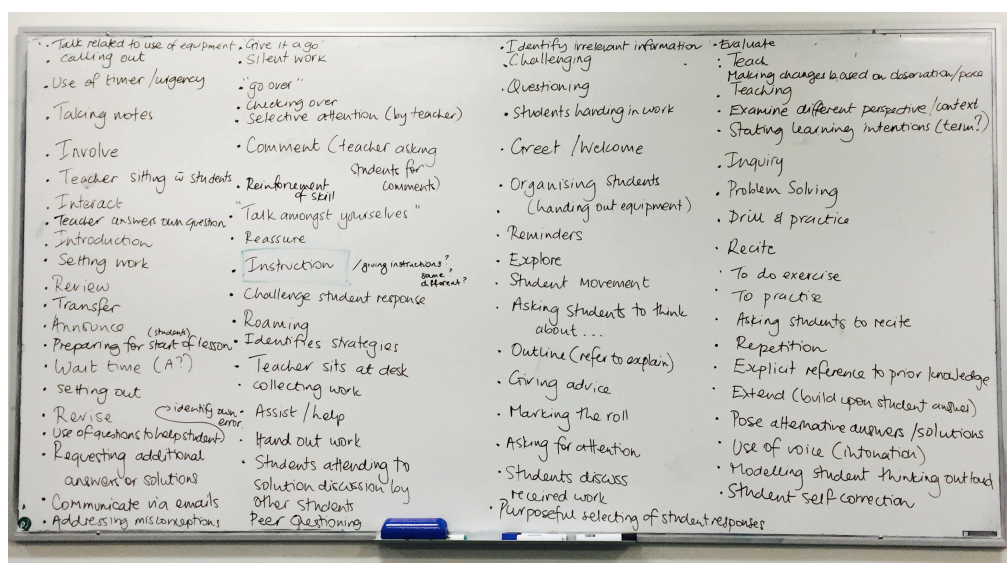

Figure 2. Image of candidate terms or short phrases for inclusion in the lexicon (August, 2015).

Generating the Lexicon. At regular meetings, the research team shared terms, phrases, and short descriptions of familiar activities that were felt to be possible candidates for inclusion in the lexicon (see Figure 2). In order for a term or short phrase to be included in the lexicon, team consensus was required, and if agreement was not reached, authority was accorded to classroom experience. In other words, the teachers on the team were given final say about whether a term was indeed likely to be familiar to teachers. We also found it useful to include two additional categories for the classroom events that did not seem to meet the criteria for inclusion:

- Phrases that are recognizable and readily understood, describing familiar classroom phenomena for which there did not appear to be a single, institutionalized name (e.g., setting a time limit).
- Familiar Activities, those pedagogical activities that are seldom described or referred to, but have a familiar quality to them (e.g., arranging the seating).

We felt it useful to record items falling into these two categories, in part, to anticipate the possibility that these practices might be named by other communities.

The Australian Lexicon

The Australian (middle school mathematics classroom) Lexicon consists of 63 terms that are familiar and in use by teachers in the mathematics education community. Because video played an important role in stimulating recognition of terms, it is possible to illustrate many of these terms with video exemplars.

Assessment	Any activity undertaken by the teacher or a student(s) with the primary purpose of generating information about student learning or achievement.	For example: • The teacher administers a test. • The teacher observes students while they work, making notes on each student's progress. Non-example: • Assigning homework, unless the teacher explicitly indicates that the purpose is assessment.
Practising	The activity of repeating a procedure for the purpose of improving efficiency or accuracy in its use.	For example: • A student solves ten consecutive tasks all involving the addition of fractions. • A student works through the problems on past exam papers. Non-example: • A student attempts to make use of the property of similar triangles in a real-world context for the first time.
Scaffolding	A form of (typically verbal) guidance intended to influence a student's thinking in order to assist them in the achievement of some cognitive task (e.g. solving a problem or learning a new skill).	For example: • The teacher (while walking around the room) asks a student whether the student's current approach is effective (stimulating the student to reflect on their approach). • The teacher asks, "Is there a diagram you could draw?" Non-example: • The teacher suggests that the student use the method just taught.
Worked Example	The teacher (or student) writes out the steps involved in order to illustrate the type of solution expected to a problem or task (a model answer) with or without student involvement.	For example: • Teacher writes out the solution to a problem on the whiteboard, providing oral explanations and clarifications along the way. Non-example: • Students recording their solutions at the board.

Figure 3. A sample of the operational definitions developed of the terms in the lexicon.

For each term, composite operational definitions were generated including the following essential elements: (a) the agreed name of the term; (b) a description, (c) examples, and (d) non-examples. These operational definitions were subjected to a validation process to investigate the extent to which the community of mathematics education researchers would endorse the constituent terms of the Australian Lexicon. A selection of terms together with their operational definitions is provided in Figure 3.

Local Validation. Two groups of people were invited to participate in a local validation of the lexicon: mathematics education researchers (specialists) and education researchers. The intention for recruiting the first group was to investigate the extent to which the local community of mathematics education researchers would endorse the purpose, the structure, and the constituent terms of the Australian Lexicon. The second group was recruited to provide a check on the possible cross-disciplinary nature of the mathematics lexicon. The first group (eight participants) was, strictly speaking, the group that was "validating" the terms, descriptions, examples, and non-examples from the perspective of the discipline of mathematics education, but not from the perspective of mathematics teachers, which is being undertaken separately. The second group (11 participants) provided an understanding of how widely used and understood the terms are outside of mathematics education.

This supplementary data collection to validate our reflections confirmed that the 63 terms in the Australian lexicon all identify general pedagogical practices. Not one of the terms is unique to the classroom of mathematics. Although a practice like practising might "appear" quite different in the mathematics classroom from, say, a music classroom, the intent and description of the term might be understood by both teaching communities albeit illustrated with different examples and video material.

National Validation. 120 teachers across Australia participated in an online survey in which they indicated their familiarity with each of the terms in the Australian Lexicon, as well as commenting on the clarity and appropriateness of the descriptions and examples and non-examples provided for each term. The 63 terms, descriptions, examples, and non-examples in the Australian Lexicon were validated locally and nationally in this fashion. Whilst the online survey has fulfilled the purpose of national validation, its function as a data collection device continues, and, in a later phase of the project, teacher responses across Australia will contribute to the profiling of term familiarity and use for different sectors of the Australian mathematics education community, including differentiation by level of experience.

Structure of the Lexicon. Whilst identifying terms for inclusion in the lexicon, thought was given to the possible structure or format that would best communicate the content of the lexicon. A university class of practising teachers was invited to group the items in the lexicon. Three categories were identified across almost all the item clusters generated: Administration, Assessment, and Classroom Management. However, the categories suggested in addition to these illuminated a very interesting aspect of classroom practice (see Figure 4 for these additional categories).

Team 1	Team 2	Team 3	Team 4	Team 5
Building Self-Confidence (Intrinsic)	Differentiation Strategies	Group work	Discussion	Cognition and Metacognition
Metacognitive Skills (Learning Strategies)	Direct Instruction	Positions in the Room	Questioning	Directing
Peer Learning and Teaching	Teaching Strategies	Student Output	Showing Understanding	Feedback
Setting the Scene/ Structuring the Learning Environment	Relationships	Tone of Environment	Student Activity	Grouping
Teacher Directed throughout Lesson	Responses	Strategies of Teaching and Learning	Teacher Movement	Representation
	Student Directed		Teaching Strategies	Speech
	Students Working Together			Student Mechanics
				Support
				Teacher Mechanics

Figure 4. Additional teacher-suggested categories for the lexicon terms.

The diversity of groupings employed across five teams of teachers was initially quite surprising. However, on reflection, it is quite reasonable to suppose that individuals' associations with the mathematics classroom would reflect the diversity of their personal histories and, in addition, that teachers practise their art differently. This tolerance of idiosyncrasy within education may indeed be one of the defining characteristics of the Australian teaching community. In other words, teachers have the freedom to develop a highly personal pedagogical style, with an associated personal vocabulary, and a sense of the context in which such a term might apply that reflects the teacher's personal educational history. The research team decided on two additional categories that captured the spirit of the teachers' suggestions: Learning Strategies and Teaching Strategies.

Communicating the Lexicon. The 63 terms of the lexicon were organised into the five categories consistent with the groupings suggested by teacher practitioners: Administration (eight terms), Assessment (11 terms), Classroom Management (six terms), Learning Strategies (27 terms), and Teaching Strategies (50 terms). An illustrative selection of terms, organised by category, is given in Figure 5.

Administration	Assessment	Classroom Management	Learning Strategies	Teaching Strategies
Collecting Work	Giving Feedback	Disciplining	Answering Questions	Prompting
Handing Back Work	Monitoring	Giving praise	On Task	Wait Time
Marking the Roll	Test/Testing	Raising Hands	Practising	Whole Class Discussion

Figure 5. A sample of terms present in each of the organisational categories.

A number of terms appeared in more than one category when members of the research team agreed there was a strong association of the term with each of the categories. Indeed, 24 terms were found in both the Learning Strategies and Teaching Strategies categories, whilst three terms were associated with three categories (see Figure 6 for a selection).

Learning Strategies	Teaching Strategies
Board Work	
Group Discussion	
Questioning	
Summarising	

Assessment	Learning Strategies
Correcting	
Note-taking	

Assessment	Learning Strategies	Teaching Strategies
Reviewing		

Figure 6. A sample of terms present in more than one category.

Another interesting feature of the lexicon is that very few terms reveal a singular pedagogical intention or purpose in engaging in the particular instructional practice or activity. For example, the Worked Example might be used to introduce a new skill, review a homework task, or model an approach to a worded problem. This attribute of many of the terms of the Australian Lexicon might be seen either as inclusiveness or as lack of precision. Other lexicons employed by other communities may employ terms that are far more specific as to the purpose of a named activity. By way of contrast, some terms within the Australian Lexicon are specific either as to purpose or as to location in the instructional sequence. For example, one could argue that Reviewing and Summarising suggest that the named activity assumes the occurrence of some prior event or activity, providing a partial specification of both purpose and location in the instructional sequence. The majority of terms in the Australian Lexicon lacked even this level of specificity.

Another form of imprecision or ambiguity within the Australian Lexicon arose from the prevalence of gerunds (noun/verbs). As can be seen from the examples in Figures 5 and 6, participles were widely employed in this way (marking, questioning, monitoring). Such terms give a sort of dynamism to the Australian Lexicon that may or may not be evident in the lexicons employed by other communities.

Conclusion

A sophisticated professional language of practice would greatly advance discussion about classroom practice. Our entry point in the development of this professional lexicon has been the empirical identification of the lexicon in current use by middle school mathematics teachers. A robust and coherent lexicon, defined and illustrated, would provide a common point of reference for teachers and teacher educators alike. Then, the adequacy of this lexicon to encompass and distinguish the variety of practices and pedagogical and didactical phenomena prioritized by contemporary mathematics education could be evaluated. We could also determine if differences exist between the language that the researcher community of practice (CoP) uses to identify classroom events and actions, and the language used by the educator CoP (Lave & Wenger, 1991). Any differences might have significant implications for the translation of research findings for practitioner use.

If the general aim of an education research community is to better equip pre-service and in-service teachers, an essential starting point is engaging both groups in a study of the "terms" that feature in teachers' professional speech when conceptualising the practice of the classroom. Equipped with such a lexicon, teachers will be better able to reflect on and improve their practice. The primary intention of this research was to provide insight into the naming system employed by middle school mathematics teachers in Australia in relation to their classroom practice, by documenting and interpreting the constructs that are well-known, understood, and used in discussions with others. From this foundation, we hope to inform national and international efforts to better equip contemporary mathematics teachers with a sophisticated lexicon to shape their professional practice.

Acknowledgements

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