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ORIGINAL PAPER

Reflections on themes in professional contributions by David Clarke

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Abstract
In this article, three of David Clarke's long time collaborators offer perspectives on how David shaped and continued to influence projects in which they were involved, over a 30 year period. The three sections of the article focus on David's contributions to original research on high stakes assessment, research on the development and use of assessment alternatives to traditional pen and paper assessments, and research in three smaller projects involving the use of open-ended questions, the implementation of the *Australian Curriculum: Mathematics*, and the complexity of the mathematics classroom, respectively. Through discussion of these various national and international projects, the authors provide examples of David's capacity to synthesise theoretical ideas, to appreciate the implications for classroom practice, and to communicate both perspectives to researchers, teacher educators and teachers. The authors argue that David's capacity to distil crucially important ideas into brief, highly insightful statements, was fundamental to the enactment and effectiveness of both research studies and projects for the teaching profession.

1 Introduction

This article presents reflections of three long term colleagues of David Clarke and various projects and initiatives they shared. An underlying theme in all of this work is the intention to communicate the complexity of classroom action. In the first section, David's contribution to original research on assessment and particularly high stakes assessment and ways that such assessments influence teaching throughout school years is outlined. The second section describes processes and outcomes of a major initiative by David to document alternatives to conventional pen and paper assessments. The third section summarises David's contribution to three smaller projects. In each of the sections, the breadth of David's intellectual energy, his capacity to connect the theoretical and the practical, his active collaborations and his generosity with his ideas are clearly evident.

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2 Researching approaches to high stakes assessments

One of the consistent themes in the professional contribution of David Clarke was his emphasis on the importance of informed and broadly based assessment. As D.J. Clarke et al. (2000) argued, "It is our contention that assessment should be recognized, not as a neutral element in the curriculum, but as a powerful mechanism for the social construction of competence" (p. 625).

In what follows, we adopt a perspective on David's work connecting advice to teachers on assessment strategies with studies exploring ways that curriculum and assessment are intertwined and particularly that systemic curriculum reform not only needs to accommodate assessment reform but also to drive improvement in teaching. A significant aspect of this work was the international collaborations developed in Germany, the United Kingdom and the United States exploring further the role of assessment. The conceptual insights that David brought to this work were part of a thread that extended through much of his subsequent research.

A closely related research focus was on high stakes assessments. Clarke and Stephens together with other colleagues explored in several publications the impact of changed curriculum and assessment practices in the new mathematics curriculum for senior students in the Australian state of Victoria (D. J. Clarke & Stephens, 1996; Stephens,

D. J. Clarke, & Pavlou, 1994). The study by D. J. Clarke, Barnes and Stephens (2000) built upon this previous work in several respects. First, it was an analytical comparative study between two Australian states, Victoria and New South Wales. Second, it was intended to be published in a major international journal (Journal of Curriculum Studies, JCS), setting out to show that public high stakes assessment, involving end-of-high school examinations and including school-based problem solving and investigative tasks, could have what David termed a "Ripple effect" on the complexity of mathematics teaching, not only in the final years of secondary school but in the preceding years as well. Third, to investigate this question several innovative methodologies were required.

David saw that this research needed to go beyond aspirational goals embedded in curriculum documents. Many worthy goals for teaching mathematics are embodied in official curriculum documents. Yet we often hear from curriculum writers and those in authority words like, "we don't assess that but, of course, all good teachers teach it." New methodologies were therefore needed to gather evidence based on changed practices of classroom teaching. These innovative methodologies are discussed below. A fourth feature of this 2000 collaborative research—and especially relevant to this tribute to David as a researcher and colleague—was the emergence of critical assumptions and seminal perspectives that were to guide and flourish in David's subsequent contributions to educational research.

In Clarke et al. (2000), we can see an early recognition by David that researchers needed to recognize the complexity of the educational processes and events with which they are working. This is true whether the research focuses on events in the classroom or in a school system or on the perspectives of students and teachers. The phenomena are never simple and unproblematic. They are given meaning not only by the participants but also by the surrounding environment, including the particular words that teachers employ or choose not to employ.

These careful delineations were features of David's ongoing research and were further developed in his subsequent and important international research collaborations such as the *Learners' Perspective Study* (Clarke et al., 2006a, b) and more recently the *Lexicon Study* (Clarke & Mesiti, 2010). These studies are also alluded to in other contributions to the special issue. The titles of the various studies may have changed but underneath remain several common features: David's respect for complexity; a recognition that terms we use are socially constructed; and that our analytical frameworks have embedded values.

David was fond of reminding collaborators that his Master's degree was in theoretical physics. We believe that this provided a strong basis for his comfort with complexity. True, one of the tasks of educational research is to explain complexity, to interpret evidence, and to enable us to see connections and commonalities. But for David this goal was never the same as simplifying. Sometimes terms that researchers use can serve unwittingly as a source of simplification and diminish complexity. Educational systems and classrooms are inherently complex and that needs to be respected.

The article, *Assessment: The engine of systemic curricular reform?* (Clarke et al., 2000), illustrated David's orientation. Although Barnes and Stephens were contributing authors, they both acknowledged places where David's words made their position clear. For example:

> The inclusion of particular performance types in external mandated assessment supports an emergent consensus as to the nature of these valued performances. Where performance types lack this form of instructional institutionalized endorsement their enactment is consequently varied not just in occurrence but in character. (p. 627)

In the case of externally mandated high stakes assessment which was the focus of the 2000 study, the aim was "to examine the messages that the school system sends to teachers through the means by which success is measured in public terms for teachers and students, and by which teachers are held accountable" (p. 627).

Another key idea that David brought to this research was to distinguish clearly between beliefs held by teachers and the enactment of those beliefs in the classroom. Teachers' beliefs and values are important, but do they really carry weight in what teachers do? Beliefs can be articulated but fail to find full expression or become diverted in the busyness of teaching. Hence the need to develop a robust methodology that would enable a researcher to distinguish those beliefs which are held from those which are enacted and how.

For David, describing and evaluating the impact of mandated assessment on teaching practice is best guided by evidence. Investigating complex phenomena required evidence from different sources and perspectives. The 2000 study employed a combination of actual classroom documents, teacher questionnaires and interviews to examine what teachers did in the classroom, that is, their instructional and assessment practices, as distinct from their espoused beliefs about these things.

The scientific evidence for the 2000 paper was derived from two component studies carried out in two Australian states: Victoria and New South Wales. Both States assessed students' performance in mathematics at the end of Year 12 (the end of secondary schooling), using the results of school-based assessments during the school year and a final end-of-year external examination. In Victoria, however, the curriculum in Year 12 had shifted to include investigative

and problem-solving tasks undertaken by students during the school year. Performances on these tasks constituted what was assessed in the school-based component of the final grade. On the other hand, although teachers in NSW were free to, or even encouraged by curriculum documents to include these kinds of tasks in their teaching program, there was little evidence that they were accorded weight like that given by Victorian teachers. Supporting evidence for these findings was drawn from analysis of classroom documents, teacher questionnaire and interviews.

David's thinking at this time already embodied a deep concern with the words or terms that teachers used, and how they were defined in practice. The same word need not necessarily describe the same classroom phenomenon or accompanying practices. When teachers in Victoria and New South Wales, adjoining Australian States, similar in their economic and general educational provisions, use a term such as "problem solving" in Mathematics, it might have been assumed that they were using that term to mean the same thing. For those Victorian teachers who participated in the 2000 study, problem solving took on consistent meanings about how tasks were presented to students, how students were expected to write up their solutions, and the importance of justifying their solution processes, as opposed to merely giving a solution. Victorian teachers shared commonly understood criteria that were to be used in the assessment of problem-solving tasks.

However, among New South Wales teachers, our study showed that there were diverse interpretations of the nature of problem solving and investigations. There was little agreement about what these terms meant, how important the activities were, how to incorporate them into teaching programs, and how to assess them. In many schools, problem solving was assessed either informally or not at all, thereby sending a message to students that it was not as important as those activities that were assessed by means of conventional tests and examinations.

Words become meaningful in educational cultural contexts. Particular words as used by teachers can be different from how they are used more generally, and sometimes less precisely, by the general community. For teachers in Victoria, the terms "mathematical problem solving" and "mathematical investigations" took on meanings that were different from their counterparts in New South Wales. As later studies such as the *Lexicon Study* (see Clarke et al., 2016) showed, David's research remained attentive to and adopted a sharper focus on those educational words or terms that may be peculiar to a particular country: words or terms that appear to have no exact translation outside that country; descriptors that may be peculiar to a particular country or region.

The *Lexicon Study* investigated more systematically than the 2000 study the complexity of the pedagogical naming systems used by educators in nine countries (eight languages). Some terms may be used interchangeably such as "teacher." But as Sullivan points out below, the term "curriculum" comes with different assumptions about the degree of agency that teachers should or be expected to exercise and how a curriculum should be constituted.

David's involvement in the Lexicon Study was a feature of the last phase of his research activity and is discussed separately in this special issue. There are clear connections to our 2000 study: words are used to embody and give importance to practices or activities that are valued by the teachers who use them and whose meanings are readily shared among those who use them.

Recognising and respecting complexity and abstaining from simplification might seem an easy goal for researchers. But, as David pointed out, simplification can be unwitting and its effects unintended. Learning environments are never identical. Research findings from the *Learner's Perspective Study* (LPS), with its focus on the voices of students, affirm just how "culturally-situated are the practices of classrooms around the world and the extent to which students are collaborators with the teacher, complicit in the development and enactment of patterns of participation that reflect individual, societal and cultural priorities and associated value systems" (Clarke et al., 2006a, b, p. 1).

Through our nearly thirty years of professional collaboration, several intertwined themes emerged from and were continually refined and reframed in David's research: a respect for the complexity of educational systems at all levels and a consequent avoidance of simplification; a recognition that meaning and value are constructed and conferred on educational events and practices; and that naming these events and practices is mediated by linguistic forms that may sometimes be locally specific. In the studies referred to above, and in those discussed further below, David consistently saw the need to design and execute innovative and effective research methodologies.

3 Communicating alternative approaches to assessment to teachers

As well as communicating with researchers and teacher educators, David also sought to communicate with teachers. One of his often quoted epigrams was "It is through our assessment that we communicate to our students those things which we most value" (D. J. Clarke, 1989a, p. 1).

From 1985 to 1989, Charles Lovitt and Doug Clarke jointly coordinated the *Mathematics Curriculum and Teaching Program* (MCTP, Lovitt & D. M. Clarke, 1988; 1989), an Australian professional learning program focused on teaching and learning in Years K to 10. Lovitt and Clarke "collected" images of innovative classroom practice from

around the country, alongside a range of models of professional learning into which these images could be embedded (Lovitt, Stephens, D. M. Clarke, & Romberg, 1990). The aim was to capture and share the *wisdom of practice* (Shulman, 1987).

As part of MCTP ("the project" hereafter), interested teachers were encouraged to examine their current practice and to consider ways in which aspects of pedagogy which were "new educational territory" (Lovitt & D. M. Clarke, 1988, p. 5) for them might be incorporated into their practice. Teachers of students in all compulsory years (aged 5–15) were encouraged to take one or more of these innovative MCTP lessons, adapt them for their own contexts, and explore what for them might be new approaches, such as mathematical modelling, social issues, new technologies, visual imagery, and the use of story shell frameworks.

In the early days of the project, insights of teachers around the country on strengths and current challenges in the teaching of mathematics were sought. Concerns of teachers included perceptions of many students that school mathematics is boring and irrelevant, and students were reluctant to be independent learners and had a general fear of failure.

During this consultation, it was clear that many teachers saw a need for a range of assessment alternatives to complement pen and paper tests (Lovitt & D. M. Clarke, 1988). The argument was that if assessment was not aligned with proposed teaching and learning approaches, there was little chance of sustained change in new practices. This was not an area of particular strength of Lovitt and Clarke, and so they sought the involvement of David Clarke in the project.

The following sample of quotes from David (D. J. Clarke, 1992, 1997), including the one which introduced this section, provide a flavor of his rationale in approaching this work:

- Frequently, we assess to no purpose; collecting information we already possess, do not need, or information on which we will never act. (1992, p. 1).
- The demands [on students] of accurate, systematic planning and implementation of a strategy have replaced the neat replication of a learned procedure applied to a routine task in a familiar context. (1992, pp. 1–2).
- Within a mathematics curriculum which emphasises applications and problem solving, we need assessment tools which are sensitive to process as well as product. (1992, p. 1)
- Assessment should model sophisticated mathematical activity. (1997, p. 12).
- Assessments should give a complete picture of students' performances and recognise a wider range of learning and achievement than can be done with any single approach. (1992, p. 3).
- Assessment should anticipate action. (1997, p. 19).
- Assessment should be designed to give students realistic feedback while allowing them to show what they can do. (1992, p. 5).

Drawing upon his extensive rationale, the insights of other researchers and teacher educators and his own years of experience as a secondary mathematics teacher, David proposed the piloting of a range of assessment alternatives to conventional written tests (D. J. Clarke, 1992, p. 17) in project schools. A number of these are now discussed.

- *Individual or group reports on problem solving and investigative work, including models and displays.* David noted the considerable potential for assessment possibilities of problem solving, arguing that "because a good problem does not simply cue a well-rehearsed response, the mathematics that a learner chooses to draw on is a real indication of the mathematics which that person is likely to access in a real-world situation" (D. J. Clarke, 1989a, p. 35). He believed that problem solving offered the chance to identify the mathematics that learners *choose* to use, rather than simply the mathematics they could recall when prompted with a familiar cue like, 'Solve for x' or 'Find the average.'

  Further, he argued that problem solving provided chances to assess goals which transcended narrow confines of mathematical skills, facts, principles and procedures. These new goals included planning, information collection and organisation, distinguishing between fact and opinion, framing of conjectures, and verification. Fermi problems (Lovitt & D.M. Clarke, 1989, pp. 499–503) proved to be an excellent vehicle for teachers in incorporating problem solving into their practice during the project.
- *Annotated class lists, where teachers note emerging insights as they observed individuals and groups at work*. The argument was that the greatest potential source of information for teachers on what students knew and could do occurred during day to day classroom activities. David's argument was that it was what teachers *saw* and what teachers *heard* during their interactions with individuals, small groups or the whole class which had rich assessment potential, but this was rarely documented (see also D. M. Clarke & Wilson, 1994).

  The two main approaches to documenting these observations which were trialled during the MCTP were brief written comments on class lists, or sticky notes with comments which were pasted into large exercise books, in which each student was allocated a page. The latter approach was preferred by primary teachers, the former by secondary teachers. Typical comments were "confused 18 and 81," "no concept of odd and even," "strong

spatial solution," and "persisted for 40 minutes on challenging task."

Some teachers anticipated that this process would involve too much work for them during busy classroom activity. However, those who found it successful argued that even if they only wrote two or three comments in a given lesson, this was more than they had done previously, and that over time, a large amount of information accumulated. This could be acted on during subsequent lessons, or in conversations with parents, for example. An important additional benefit was that from this process 'invisible' students emerged, those who rarely interacted with the teacher or their peers. Teachers noticed that in some cases weeks passed without a single comment being made about these particular students. This alerted them to give greater attention during their observations to those students in coming lessons (D. J. Clarke, 1992).

- *Expanding questioning techniques to extend wait time (*Rowe, 1978*) and use Newman's five point error analysis (*Clements, 1980*).* David's thorough knowledge of research findings in education generally and mathematics education in particular was evident in this aspect of the project. Wait time refers to the amount of time allowed between the asking of a question and the naming of a particular student to respond; between the naming of the student and the student's reply; and between the student's reply and the next teacher utterance. Rowe's work had shown that teachers typically provided a wait time of between one and two seconds, and that wait time allowed for a student who was perceived as 'slower' was typically less. By increasing wait time by as little as three or four seconds, it was noted that children gave longer responses, gave more explanations, and demonstrated speculative thinking. Also, teachers' questions decreased in number but showed greater variety and quality. Project teachers were encouraged to extend their wait times. This was not easy for teachers to do, but the effort appeared to have considerable impact (D. J. Clarke, 1992).

  Anne Newman's research (see Clements, 1980) had resulted in five questions which teachers could use with individuals to pinpoint areas of difficulty in solving story problems. The five questions were:

  1. Read me the question (to identify *reading* errors).
  2. Tell me what the question is asking you to do (to identify errors in *comprehension*).
  3. Tell me how you are going to find the answer (to identify *transformation* errors).
  4. Show me what to do to get the answer; tell me what you are doing as you work. (To identify *process* errors)
  5. Now write down the answer to the question (to identify *encoding* errors)

  A key finding of this research was that at least 40% of students' errors on written mathematical problems occurred before they even got to use the process skills that teachers had so laboriously emphasised in their teaching. David suggested that project teachers give more attention to the transformation of a written task into a mathematical procedure. He noted that the five questions above could "usefully equip teachers (and students) to evaluate understanding and identify the point at which difficulties occur" (D. J. Clarke, 1989a, p. 33).

- *Student self-assessment* David's recently completed PhD research (D. J. Clarke, 1989b) had involved following a class of students through the transition from Year 6 to Year 7, from primary to secondary school. As part of this research, students were encouraged to complete regular short surveys in response to questions like "write down the two most important things you have learned in mathematics during the past month; Write down at least one sort of problem which you continue to find difficult; What would you most like more help with? What is the biggest worry affecting your work in mathematics at the moment? and How could we improve maths classes?" David called this the IMPACT procedure. The questions were deliberately varied over a school term, to maintain student commitment. As David noted, "These questions provide children with the opportunity to regularly share their successes and concerns with their teacher" (D. J. Clarke, 1989a, p. 46). David emphasised some key teacher actions which maximized the value of IMPACT: the response sheet was a confidential (but not anonymous) communication from the student to the teacher; the use of the response sheets should be regular (every 2–4 weeks); and teachers must value and act on the responses. A sample of student responses (with their related prompt) follow, and give a sense of the usefulness of this project in informing teacher actions (D. J. Clarke, 1989a, p. 51):

  - What is the biggest worry affecting your work in maths at the moment? ("Homework, because at home hardly anyone knows what to do because it is just as new to them as it is to me")
  - Write down one particular problem which you found difficult? ("Algebra a bit, because I don't understand why we don't just use numbers. It would be simpler")
  - How do you feel in maths classes at the moment? ("I don't know what is wrong, but I think it is going in one ear and out the other. How can I improve when I don't understand? I want to improve and pass Year 7 so much. Can you help me?")

- How could we improve maths classes? ("Have less work and more learning")

This last assessment alternative reflected an interest that David would maintain throughout his teaching and research career: the importance of giving students a voice.

The assessment alternatives discussed above and several more were piloted extensively during the MCTP, with generally positive feedback (D. J. Clarke, 1997; Clarke, Clarke, & Lovitt, 1990).

After a very promising start, the use of these assessment alternatives appeared to wane somewhat over subsequent years, particularly with the introduction of the National Assessment Program—Literacy and Numeracy (NAPLAN), a national pen and paper assessment in Years 3, 5, 7 and 9 (Australian Curriculum & Assessment Reporting Authority, 2008). David had earlier shared his concerns with these kinds of assessments, using the words of Blum (1978):

> So often tests measure how quickly people can solve relatively unimportant problems making as few errors as possible, rather than measuring how people grapple with relatively important problems, making as many productive errors as necessary with no time factor. (p. 83)

On a more encouraging note, with the major emphasis in the *Australian Curriculum: Mathematics* (Australian Curriculum, Assessment and Reporting Authority, ACARA, 2014) on the Proficiencies of *understanding*, *fluency*, *problem solving* and *reasoning*, the authors have noted anecdotally a greater openness to David's innovative work in assessment. As throughout his career, David was ahead of his time.

4 Connecting theoretical perspectives and classroom practice

A further perspective on David's interest in assessment is the ways that perspectives on assessment can inform design of lessons and teaching resources and also teacher planning.

David was an initial collaborator with Peter Sullivan on research on open-ended questions in mathematics, in particular exploring ways that such questions change the nature of the learning experience and what students' responses tell us about their thinking. The following anecdote illustrates David's intellectual generosity and vitality. The interactions started from discussions on ways of gathering information on student learning to better inform teaching which was a theme underpinning much of David's thinking and contribution. At the time, there was much consideration of the limitations of pen and paper tests. David related an incident from his time teaching an upper secondary class. Students had done well on a written assessment of their interpretation of the graphs of linear functions, both drawing lines of given functions and writing the equations of lines drawn on Cartesian axes. David then posed this task to the class:

> Give the equations of five lines that go through the point (3, -2).

All the students were confused by the question and were reluctant to proceed.

Peter had experienced a similar incident. His daughter had scored 100% on a test requiring students to calculate perimeter and area of rectangles. Peter then posed the following task:

> A shape that looks like an "L" has an area of 100 cm^2. What might be the perimeter?

His daughter was unable to even make a start. For both examples, students had earlier demonstrated that, in response to conventional items, they had access to all of the mathematical knowledge they needed to respond correctly. Clarke and Sullivan's hypothesis was that, in both cases, the important concepts had been learned by following rules (even if the teacher did not so intend) that did not result in flexible or robust learning. Their thinking was that tasks such as the two above, which were termed "good" questions, not only had potential to reveal important information about what students know but also may offer the type of resources that can stimulate more robust, flexible and adaptable learning. These questions and others like them are often termed open-ended in that there is, intentionally, more than one possible correct response and there is no expectation that students will apply a taught method. The implied intent is that students are not shown a particular method for solving such problems but are encouraged to apply what they know in the process of finding a solution. Another feature of both of these questions, and others like them, is that it is possible to give one or two responses with quite basic knowledge, but it is also possible to respond in more sophisticated and even generalised ways.

After various discussions (academics had more time in the Eighties to develop ideas together), Sullivan and Clarke (1991) argued that such questions offered ways of stimulating better quality communication between teachers and students. They defined these questions as follows:

> "Good" questions have three features: the students are required to do more than simply remember a strategy to answer them; the students can learn in the process of answering the question; and the questions have several acceptable answers. (p. 14)

That article, written for a teacher audience, presents a range of examples of such questions and some samples of student responses to illustrate the richness of assessment information that can be gathered from such responses.

Sullivan and Clarke (1991) also argued that such questions are suitable for mixed achievement classes in that while some students can find one of the possible solutions, other students can be challenged to find other answers. This characteristic has come to be known as "low floor, high ceiling." The questions have all of the characteristics exemplified by the PISA 2012 items termed "cognitive activation" (see Caro, Lenkeit, & Kyriakides, 2015) which are connected with higher achievement. Subsequent research has emphasised the importance for student engagement of positive dispositions, ways of differentiating learning to engage all, and the value of further experiences appropriately varied to consolidate learning.

David and Peter continued to discuss over subsequent years the power of such questions, their characteristics and other incidental benefits. It can be argued that such questions are accessible for most students yet still challenging for those who are ready. The intention is to enhance students' sense of control. These characteristics address the E2030 (Organisation for Economic Co-operation & Development, 2019) goals of developing student agency and fostering equity.

Partly stimulated by the insights into students' learning from these discussions and the importance of coming to quantify and understand classroom process, Clarke and Sullivan contemporaneously explored tools that can capture the complexity of mathematics classrooms. This initial work and the tools developed informed a substantial stream in David's later research (e.g., Clarke et al., 2006a, 2006b). Sullivan, with colleague Judy Mousley, also worked on the development of an interactive multimedia resource (Mousley & Sullivan, 1996), and although this was intended to be used as a tool for professional learning of teachers rather than an instrument for data collection as was the case for David's work. In both themes we found that classroom action is multidimensional, there are many ways of teaching mathematics well and there is no one recipe, simplistic approaches should be viewed with caution, and teachers and students are resilient and adaptable.

Later, David was part of a team, along with Peter and Doug, researching the implementation of the Australian Curriculum in English and Mathematics (see Sullivan, D. J. Clarke, D. M. Clarke, Farrell, & Gerrard, 2013). The first aspect of this work was a study of the preliminary deliberations associated with the development of curriculum documentation and many of the key decisions taken that had potential to influence ways that teachers planned, taught and assessed learning in mathematics. One of the characteristics of the Curriculum was that it assumed a role previously performed by various jurisdictions in order to unify overall documentation across Australia. This transfer of authority was one of the objects of the study. David had a long-term interest in the relationship between the documented curriculum and its connection to the intended and enacted curriculum. He challenged writers of resources to make the "important interesting—not the interesting important."

One key influence, evident in early data collection, was that different jurisdictions take particular perspectives on whether teachers are seen as learners and professionally agentic partners in the implementation of curriculum or whether they need to be given explicit direction to "teacher proof" the purpose of documents. For example, the curriculum was written to be presented parsimoniously with the intention that teachers would build the enacted curriculum from such documentation. A further advantage identified for such simplified documentation is that teachers could easily read expectations for a full year so formulating priorities and interpreting connections between sub domains. We found that some jurisdictions sought to subvert this recognition of teachers as professionals. For example, one of the content descriptions in the Australian Curriculum (ACARA, 2018) is:

> Choose appropriate units of measurement for length, area, volume and mass.

In at least one jurisdiction, this was disaggregated to separate statements creating the impression that the focus of the statement is the learning of the individual attributes (length, area, volume, mass) rather than "choose appropriate units". The argument is the more the overall and generalisable purpose of learning can be made accessible to teachers the better. This does, though, have implications for teacher professional learning during which the more generalised focus (choose appropriate units) can be emphasised rather than presenting activities for teaching a single attribute (such as length).

In terms of ways that teachers interpret the curriculum, and particularly use the curriculum for planning, the focus question was whether the simplified statement was sufficient to communicate the original intention to, in the case of these examples, generalist teachers or whether separated statements were easier for teachers to interpret and implement. This emphasis in David's contribution related to building the connection between the philosophical or general principles underpinning teaching and learning and the ways that teachers convert the curriculum to classroom action.

Another focus of this curriculum research was the nature of the mathematics to be studied and who should study that mathematics. The documentation argued for a balance between practical applications of mathematics on one hand and those topics that are more specialised on the other hand. The documentation also emphasised that the learning of mathematics was essential for all citizens and not just for an elite who might ultimately study mathematics at university. This stance has implications for the enacted curriculum in that the choice of learning experiences and the pedagogies

to support such learning are ideally inclusive of all students. Connected to this was the intention to describe the content not only in terms of building understanding and developing fluency but also fostering problem solving and mathematical reasoning.

Among other actions, a wide sample of teachers was surveyed on their planning processes and a model of those processes was developed. The model represents key elements of planning processes that can inform teaching and assessment (see Sullivan, D. M. Clarke, Albright, D. J. Clarke, Farrell, Freebody, & Gerrard, 2012). Once the overall focus of the learning has been determined, key initial decisions for teachers are, on one hand, examining available resources and the relevant aspects of the curriculum, and on the other hand, drawing on the experiences of themselves and colleagues and assessments of student existing knowledge. The next step is to articulate the specific learning intentions and prepare assessments. Teachers then select and sequence learning experiences after which they plan respective lessons including planning to differentiate that learning. This intention was that schematising processes in this way would facilitate collaborative planning.

In all three of these projects—on open-ended questions; on documenting classroom practice; and coming to understand the connection between curriculum documentation and classroom action—David's appreciation of both theoretical perspectives on teaching and the practical realities of classrooms was paramount.

5 Conclusion

The three authors of this article enjoyed professional associations with David Clarke over many years. The various projects and publications to which David contributed over this time are evidence of his capacity to synthesise theoretical ideas, to appreciate the implications for classroom practice and to communicate both perspectives not only to other researchers and teacher educators, but also to preservice and in-service teachers. In particular, David's capacity to distil crucially important ideas into brief, highly insightful statements, was so often the key to the planning, enactment and effectiveness of research studies and professional projects. The studies discussed in this article cover a period of nearly thirty years during which David's ideas and areas of focus continued to develop largely because of his own intellectual energy but also as a result of the people with whom he collaborated. One of the tensions experienced by all researchers is between capturing the complexity, nuance and subtlety of research objects on one hand and communicating results effectively to practitioners and educators on the other. In this article, we described how David engaged with issues associated with high stakes assessment, classroom-based teacher judgments using specific tools and purpose designed tasks, and challenges of converting curriculum statement to action. In this, David not only embraced the diversity of salient factors but also communicated effectively the implications for teachers. All researchers could productively incorporate such a model into their design and publications. As a researcher, David was constantly striving to extend his own and others' vision of where researchers could extend their investigations and how that research can be communicated to the wider profession.

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