An Evaluation of the *Count Me Into Measurement* Program: Teachers' Perspectives

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This paper describes the evaluation of a program for teaching measurement in the early years of school. The Program, Count Me Into Measurement (CMIM) is based on recent research findings that indicate the importance of students' knowledge of the unit iteration structure. The CMIM Program was implemented in thirty-nine schools across NSW in the second half of 2000. The results of the evaluation were extremely positive, with teachers reporting that they liked the contents, structure and practicality of the Program. Many of them also commented that the Program had changed their approach to teaching measurement.

Measurement is one of the four strands of the NSW Mathematics K-6 Syllabus, together with Space, Number, and Working Mathematically. Although measurement is a fundamental aspect of everyday mathematics, there is some evidence that measurement concepts are not well understood by students (Schwartz, 1988; Hart, 1993; Lokan, Ford & Greenwood, 1996).

Measurement concepts have been found to develop later than number concepts because of the difficulty of dividing a continuous whole into equal sub-units as opposed to counting a set of discrete objects (Piaget, Inhelder, & Szeminska, 1960). Students need to be made aware of key differences between measurement and number concepts, in particular, the notions of continuous quantities and variability. Otherwise students may consider that measurement is essentially a process of counting units, and may not realise how the actions, of exhaustively aligning, covering or packing, are related to subdivision of quantity. The spatial structure of the iteration of length, area, and volume units does not seem to be emphasised in textbooks and curriculum documents, yet it would seem to be central to understanding and linking these two processes of unit enumeration and subdivision of quantity. Emphasising the spatial structure of the unit iteration may assist students to link concrete, pictorial and symbolic representations of measurement concepts. For example, moving one length unit and marking the end of each move (without gaps or overlap) creates a linear scale analogous to that of a ruler. Although many students can use rulers, few of them understand what they are doing when they use one (Bragg & Outhred, 2000). Studies by Outhred and Mitchelmore (2000) and Battista, Clements, Arnoff, Battista, and Borrow (1998) have found that the structure of a unit covering of squares is not well understood by students. The structure of unit packing of a rectangular container has also found to be difficult for students, especially linking the structure of packed cubic units to the dimensions of the container (Hart, 1989).

The Count Me Into Measurement Program (CMIM)

The *Count Me Into Measurement* Program (CMIM) was developed for the Curriculum Support Directorate, NSW Department of Education and Training by Outhred and McPhail (2000). It comprises a conceptual framework, activities, and example lesson plans. The conceptual framework is designed to provide a sequence of similar conceptual levels for length, area, and volume, prior to the introduction of formal units. The three levels are (1)

identification of the attribute, (2) informal measurement, and (3) the structure of the iterated unit. The third level does not seem to have been included previously in measurement teaching programs. The three levels provide a conceptual sequence for teaching each strand—students are not expected to be at the same level in each strand.

The activities and sample lesson plans are designed to help teachers to link their teaching of measurement concepts across length, area, and volume. Several different but related activities, involving practical applications of estimation and measurement, are provided at each Level. Each Level includes a list of key strategies, linked to Syllabus outcomes, describing skills and understandings which students may demonstrate at that level. Lesson notes illustrate modelled mathematical language and teacher questioning within a structured lesson. The lessons also exemplify introduction of the attribute, key aspects of the measurement process, and recording and reporting back to the whole class.

This paper presents the results of an evaluation of the introduction of the CMIM Program in forty NSW Department of Education and Training (DET) schools in Terms 3 and 4 of the year 2000.

Aims of the Evaluation

The aims for the evaluation of the implementation of the CMIM Program into selected NSW schools were:

- to assess whether the CMIM Program affected students' learning of measurement and whether the conceptual framework of CMIM Program was well sequenced in terms of difficulty levels;
- to obtain feedback from the facilitators and teachers about the model of professional development and the CMIM Program itself; and
- to determine if the CMIM Program affected the way teachers planned and taught measurement.

Suggestions were sought from both facilitators and teachers for changes to the method of implementation and the CMIM Program. Such suggestions would inform future revisions of the model of professional development and the CMIM Program. The information about the planning and teaching of measurement would be invaluable to plan follow-up support for teachers. The assessment information would enable the effect of the CMIM Program on student achievement to be evaluated and the conceptual framework to be modified if necessary. This paper will report on facilitators' and teachers' reactions to the CMIM Program and their perceptions of its impact on the way they taught measurement.

Methodology

Participants and Procedures

One school from each district in NSW was included in the evaluation. A teacher-facilitator model of professional development was adopted compared to the "mathematics consultant as facilitator" model of *Count Me In Too* (CMIT) Numeracy Program. The CMIM project and conditions were explained to the mathematics consultants who were asked to identify suitable schools in their districts. Preference was given to schools who had already participated in CMIT training. Once the school and facilitator agreed to participate, letters were sent to facilitators inviting them to a training day early in Term 3.

Facilitators from the schools attended an inservice day, held in Sydney. The aim of the training day was to present the CMIM Program to them, to explain the data collection procedures and to suggest an approach they could use to introduce teachers in their schools to CMIM. The facilitators were asked to work with a minimum of three teachers in Grades K to 3 when they returned to their schools. Their role included introducing the teachers to the CMIM document, assisting them to implement it in their classrooms, as well as assisting teachers with student assessments. Facilitators were responsible for the different approaches they took to teacher professional development in their own schools.

Altogether, 39 facilitators attended the training day and they were representative of all NSW school districts, except one; one district did not nominate a school to take part in the project. Later, another school withdrew from the project and returned the funding. Two other schools did not return the questionnaires and assessments by the end of December, when the questionnaires were coded. Thus, the final sample comprised 36 facilitators and 118 teachers (29 Kindergarten, 4 composite Year K/1, 33 Year 1, 11 composite Year 1/2, 26 Year 2, 4 composite Year 2/3, 9 Year 3 and 2 composite Year 3/4).

The teachers were asked to teach ten CMIM lessons, five from each of two substrands. Teachers could select the substrand and level they felt would be most suitable for their classes. They were asked to select five students and record assessments made as a result of observation and questioning, both before and after, each set of five lessons. The assessments could be done as part of a small group lesson and a component of the facilitator's role was to assist teachers with student assessment. Both facilitators and teachers were asked to complete an open-ended questionnaire to provide feedback about:

- the CMIM document - its strengths and changes to improve it; and
- the facilitators' and teachers' approach to teaching measurement.

Both groups were also invited to comment on any aspect of the project.

Analysis of the Questionnaire Data

The facilitators' and teachers' questionnaire responses were scanned for commonly occurring themes, issues and concerns. These responses were then formulated into categories and an appropriate coding system was devised for each question. These categories in all returned questionnaires were then coded. These quantitative results give a measure of the extent to which specific responses were common to teachers and facilitators. A qualitative analysis of the written responses was also undertaken to identify insights, issues, or suggestions that may not have been evident in the quantitative analysis.

Results and Discussion

Strengths of the CMIM Document

The responses in Table 1 clearly indicate that both facilitators and teachers were satisfied with the CMIM document. The majority of responses (78% of facilitators and 54% of teachers) commented positively on the organisation (clearly set out, well-organised, sequential) of the document and many responses (61% of facilitators and 36% of teachers) mentioned the document's ease of use (easy to follow, user friendly). The percentages of facilitators' responses that included these aspects were higher than for teachers, perhaps a reflection of the release time given to facilitators to complete and organise responses.

Table 1
Percentage of Facilitators and Teachers Who Listed Each Strength of the CMIM Document

What did you think were the strengths of this document?	Facilitators (N=36)	Teachers (N=118)
Clearly set out/well organised/sequential	78	54
Easy to follow/user friendly	61	36
Lesson notes/plans to use as models	28	26
Knowledge & strategies listed and explained	25	8
Language/terminology given	11	17
Colour-coded sections	11	5
Resources listed		14

The most common strengths listed, apart from the CMIM Program's structure and ease of use, were the lesson notes—about a quarter of both facilitators and teachers commented on the helpfulness of these, particularly including questions that teachers might ask to probe students' knowledge.

> Within the expanded lesson notes, the section entitled "Questioning, Comments and Discussion" is important as it is through this and teacher knowledge that the children can potentially think on a deeper level and in addition become more aware of, and able to use and understand specific mathematical terminology. (School 17)

A similar percentage of facilitators noted that having the knowledge and strategies for each level listed and explained was helpful. Facilitators (25%) made the latter comment more than three times as often as teachers (8%). A possible explanation for this difference may be that the knowledge and strategies helped the facilitators explain the activities and assessment to the teachers, so the facilitators became more familiar with this section of the document. However, most facilitators also taught the CMIM Program and one of them commented that she "found the knowledge and strategies section excellent as a lesson prompt" (School 28). A Year 2 teacher saw the strengths of the document as "The specific way it shows strategies and knowledge for each level, and the learning activities are matched to these strategies and knowledge. The expanded lesson notes for each level were great too - very helpful" (School 26).

Many teachers (17%) also commented that the emphasis on the correct terminology assisted the students to understand the concepts. For example, "... children were taught the correct vocab for measurement and they became used to using it because they really understood what it meant" (School 30); and "the constant use of explicit mathematical language/vocabulary for each strand made for explicit teaching" (School 1).

Some teachers had not realised that the students did not know the mathematical language associated with measurement, for example, "The language or lack of it was an eye opener and emphasised the necessity of doing these lessons" (School 10). Many measurement terms are commonly used in everyday life, such as, length, area, row, column, and teachers may assume that students understand the mathematical meaning of the words. Often misunderstandings of the terms will only become apparent when teachers ask students to explain or report back on what they have done. The CMIM Program emphasises that students explain, in oral or written form, what they have done, and these explanations may have drawn attention to students' inadequate knowledge of the

mathematical terms. The emphasis on oral and written explanations of what students had done was included as a means of having students reflect on the activities and consider what they had found and how or why this situation had occurred. Such reflection was considered particularly important as the activities were predominantly of a practical nature.

The Effect of the CMIM Program on the Way Measurement Was Taught

All the facilitators and 95% of the teachers agreed that the document had helped them to teach measurement (see Table 2).

Table 2
Percentage of Facilitators and Teachers Making Each Comment About the Assistance of the CMIM Document to Teach Measurement

Did the document assist you/your team in teaching measurement and if so, how?	Facilitators (N=36)	Teachers (N=118)
Provided structure/sequence	61	36
Provided information (language, knowledge & strategies etc.)	42	25
Developed concepts in hands-on, practical way	36	36
Provided enjoyable/motivating activities	36	18
Provided lesson plans & outcomes	28	22
Provided assessment guidelines	14	28
Assisted learning/concept development, etc.	17	19
Emphasised students having to respond/explain	3	14
Provided a variety of ideas		25
Assisted teacher to reflect on teaching of measurement		21

Of the six teachers who did not agree, three omitted the question, while one felt that the "syllabus document is an excellent document as it is" (School 1). Another facilitator (School 11) liked the document; however, in her class, measurement was taught by a support (RFF) teacher. The third felt that the activities did not achieve the desired learning outcomes for Year 3 (School 36), a reasonable comment as the document was not designed for Stage 2 (Years 3 and 4).

Table 2 illustrates that facilitators' and teachers' responses varied slightly; quite understandably, teachers focussed more than facilitators did on the provision of assessment guidelines, the variety of ideas and the reflection on their own learning. The majority of responses reinforced comments that facilitators and teachers had made about the strengths of the document—they approved of structured, sequenced material, that provided information about what students were expected to learn and was linked to syllabus outcomes. For example, "The clear progression of activities, the activities themselves, the framework seems so logical although I'd never really thought out those divisions of learning" (School 34); "Oh yes - it made me aware of the concepts that students need to achieve in one area before moving on to the next. I actually look forward to teaching measurement!!!" (School 22).

> Yes, it made me realise that I take some things for granted. For example, I may have assumed that a particular child knew something that they didn't yet, or I may have underestimated some children's abilities and been surprised with their response or interpretation (School 23).

Student engagement would seem to be fundamental to learning and many facilitators (36%) and teachers (17%) mentioned student interest in the activities, often associated with the use of concrete materials. About a third of all respondents mentioned the "hands-on" activities — "the practicality of it, the 'hands-on' sequential development of each strand" (School 15). Although some teachers said they had taught measurement using such an approach, others obviously had not and the document appeared to assist several of them to reconsider their methods of teaching, while others mentioned that it increased their confidence in teaching measurement:

> It made the class teacher reflect on the present style of teaching concepts and gave them practical examples of how to achieve new concepts in a motivational way. (School 27)
>
> Yes, it gave us a different view of teaching measurement, more learning by doing with concrete materials and students were accountable for learning records. (School 21)
>
> It assisted greatly. The teachers involved were talking measurement and it 'opened up a whole new can of worms!!' about working mathematically. (School 8)
>
> Definitely! Many felt threatened by the measurement area, this document gave them more confidence in their abilities to teach it. (School 9)
>
> Definitely. The activities were not just worksheets but tasks which required thinking and recording. We could follow it easily. (School 3)

The emphasis on explaining and recording was mainly evident in the teachers' responses (14%). The idea of asking students to write and/or draw explanations of their mathematical thinking appeared new to many teachers. They seemed to find this feature of the document informative: "I especially liked the idea of students recording what they had learnt so (1) they thought about it and (2) I was aware of their strengths and needs" (School 21).

One teacher found "that the lower ability children were always focussing on irrelevant factors when writing about their experience! eg It was fun, I used pink counters, Pink is my favourite colour. This was a hard habit to break" (School 15). Teachers need to realise that low-ability students often focus on irrelevant information or such students are unlikely to learn any mathematics. This last comment also illustrates that students may need to be taught about the structure and features of a mathematical explanation—how is an explanation written and what information is relevant.

Many teachers (19%) also stressed concept development and consolidation: "Good gradual progression of skills and concepts. Clear links to knowledge and strategies. Focussing on one strand for 4/5 lessons provided children with time to build on earlier lessons and make links to those lessons" (School 12).

Reflection may be perceived as a means of promoting independent learning and 14% mentioned that using the document had encouraged reflection about teaching measurement. A further 7% of teachers noted that their own concepts of measurement were clarified: "Yes, it gave measurement a sequence. Something that I didn't understand" (School 38); "Yes, taught concepts I'm not confident in teaching. Made me use the correct vocabulary" (School 20). Although she liked aspects of the program, one Kindergarten teacher felt that the activities simply replicated those found in the syllabus.

> Yes, I liked the idea of allowing children to write their recordings of each lesson as I feel this consolidated learning. I do however feel the activities were the same as already given in the syllabus and do not differ much from what is already practiced in the classroom (School 3).

The first level of the CMIM Program, the most applicable to Kindergarten, does not differ markedly from the syllabus. However, the conceptual framework does show

processes common to length, area and volume; these links that are not included in the syllabus. For example, one facilitator commented "We have been most happily surprised with the outstanding learning of our students. They really have made excellent leaps with maths. We showed them the links between multiplication and area and even our kinder students developed understandings about rows and columns" (School 28). In addition, the CMIM document differs substantially from the syllabus at Level 3, where the structures for repeated units of length, area, and volume are emphasised.

As part of the data collected about the method of professional development, the facilitators were asked what they had learnt from their professional development role and many commented on pedagogy. For example, that they learnt what is happening in classrooms, the importance of recording and assessing student ability and about the document and teaching measurement. Some had re-assessed the role of textbooks and realised the importance of understanding the mathematical language. Their responses illustrate their reflection on what they have learnt by participating in CMIM.

> I have really enjoyed running this project in my school and learnt a lot about measurement I did not know and was therefore not covering in my ordinary teaching. At our school we have been using a textbook and working from that. Now I can see the gaps in our textbook and how it just covers an area without teaching the strategies and skills involved in a strand to achieve an outcome. I have found it vital to use a variety of materials in "hands-on" experiences with the students. I have valued the recording process which is more often than not left out of the textbook situation. (School 21)

> We have all learnt some valuable lessons from this project eg the value of hands-on teaching, the value of recording to organise and consolidate learning and the need for concise use of language in measurement. (School 10)

> By participating in this project our teachers and myself learnt the following:
> Students were not used to estimating - must develop this skill
> Students were not able to articulate why/how orally or in written form; probably used to circling answers. (School 7)

> Many new and wonderful things! I learnt how to team teach as well as being a support to students and the classroom teacher. As a facilitator I also learnt how to organise and prepare resources for lesson activities. Most importantly, I gained confidence in teaching measurement across K-2. (School 32)

Reflection on learning is crucial for further learning and these responses are a good indication that the facilitators have reflected about how to teach measurement. The development of both teachers' and facilitators' knowledge of teaching measurement as well as ongoing support would seem to be key factors in the continued growth of CMIM

Conclusion

The comments indicated that many teachers relied on textbooks for teaching measurement. A number of them also reported that they did not feel confident about the measurement concepts they were expected to teach, nor the sequence in which these concepts should be taught. Anecdotal comments indicated that some facilitators thought volume concepts were easier than length or area ones. These comments suggest that these teachers did not teach volume as the packing of an interior space, or as displacement.

In summary, both facilitators and teachers approved of the document and found it assisted their teaching of measurement. They particularly liked its format, organisation and sequencing. The provision of a variety of activities was found to be practical and motivating and the expanded lesson notes were considered extremely worthwhile as they provided guidance and minimised planning time. The major changes that were

recommended were clearer guidelines for the assessment and provision of more activities and expanded lesson notes. Overall, the first implementation of the CMIM Program appears to have been extremely successful in terms of both facilitators' and teachers' responses.

References

Battista, M. T. Clements, D. H., Arnoff, J., Battista, K., & Borrow, C. V. (1998). Students' spatial structuring of 2D arrays of squares. *Journal for Research in Mathematics Education, 29*, 503-532.

Bragg, P., & L. Outhred (2000). *Students' knowledge of length units: Do they know more than rules about rulers?* Twenty-fourth annual conference of the International Group for the Psychology of Mathematics.

Hart, K. (1989). Volume of a cuboid. In K. Hart, D. Johnson, M. Brown, L. Dickson, & R. Clarkson (Eds.), *Children's Mathematical Frameworks 8-13: A study of classroom teaching* (pp. 126-150). London: NFER-Nelson.

Hart, K. (1993). Confidence in success. In I. Hirabayashi, N. Nohda, K. Shigematsu, & F. Lin (Ed.), *Proceedings of the seventeenth annual conference of the International Group for the Psychology of Mathematics Education* (Vol. 1, pp. 17-31). Tsukuba, Japan: Program Committee.

Lokan, J., Ford, P., & Greenwood, L. (1996) *Maths and science on the line. Australian junior secondary students' performance in the Third International Mathematics and Science Study*. Melbourne: Australian Council for Educational Research.

Outhred, L., & D. McPhail (2000). A framework for teaching early measurement. In J. Bana & A. Chapman (Eds.), *Mathematics Education Beyond 2000*. Fremantle, WA: MERGA.

Outhred, L., & M. Mitchelmore (2000). Young children's intuitive understanding of area measurement. *Journal for Research in Mathematical Education 31***,** 144-167.

Piaget, J., Inhelder, B., & Szeminska, A. (1960). *The child's conception of geometry* (E. Lunzer, Trans.). London: Routledge & Kegan Paul.

Schwartz, J. (1988). Intensive quantity and referent-transforming operations. In J. Hiebert and M. Behr (Eds.)., *Number concepts and operations in the middle grades* (pp. 41-52). Reston, VA: National Council of Teachers of Mathematics**.**