

# **Mathematics analysis tools offer pedagogical opportunities: adapting lesson study to research appropriate lesson design principles**

**Lynda Ball and Robyn Pierce**

**University of Melbourne**

Mathematics Analysis Software' (MAS) encompass computer software or calculators capable of performing the algorithmic processes necessary to carry out routine mathematical procedures from any branch of mathematics, including any or all of arithmetic calculations, symbolic algebra manipulations, statistics calculations and data display, graph plotting, and construction of geometric figures. In a secondary school classroom these tools may be available as computer software (e.g. spreadsheets, function graphers and dynamic geometry packages) or hand held calculators (e.g. four-function, scientific, graphic, computer algebra system (CAS), with or without geometry). Pierce & Stacey have developed a 'map' to summarise the pedagogical opportunities afforded by MAS.

Taking advantage of such opportunities in the classroom requires appropriate lesson design based on principles grounded in research evidence. In this presentation we propose that 'lesson study' may be adapted from its primary use as a professional development strategy for use as a valuable research strategy, especially to identify principles of good lesson design. We report on a project undertaken in two Australian schools where lesson study research was used to investigate the design of a lesson which aimed to access some of the pedagogical affordances of MAS (TI-Nspire). An example of principles for use of multiple representations will be discussed. Using lesson study as a research strategy allowed the collection of rich data suitable for the thematic analysis of lesson design and also secondary analysis for other purposes, from all stake holders and under varying conditions. Professional development was a valuable outcome for participating teachers.

# **What value do handbooks serve?**

**Em. Prof. Alan J. Bishop**

**Monash University**

There have been five Handbooks on mathematics education produced in the last 20 years and more are in the pipe-line (Grouws, 1992, Bishop et al., 1996, English, 2002, Bishop et al., 2003, Lester, 2007). Clearly many people, including publishers, consider that they have great value. But what value do they actually have? What has happened since their publication that could be attributable to their publication? Have they influenced directions in research? Have they killed off any developments which may have been productive? Have they led to new areas of research being funded? Having been involved in four of the five Handbooks, and perhaps being yet further involved I would be interested in some frank and honest soul-searching as to their real value. I will present some of my experiences, and would like to hear those of others.

# Reviewing of an adaptation of complementary accounts methodology

Jill Cheeseman

Monash University

An adaptation of the complementary accounts methodology described by David Clarke (1998, 2001a, 2001b) was used for my PhD, *Challenging children to think: An investigation of the behaviours of highly effective teachers that stimulate children to probe their mathematical understandings*. In this presentation I will review the adapted features of the methodology.

Complementary accounts methodology, as described and used by David Clarke (2001), is distinguished from other methodologies by three features:

- The nature of the data collection procedures, leading to the construction of “integrated data sets” combining videotape and interview data,
- The inclusion of the reflective voice of participant students and teacher in the data set,
- An approach that utilises a research team with complementary but diverse areas of expertise to carry out a multi-faceted analysis of a common body of classroom data (p. 2).

While the methodology used for this study differed from that of Clarke (2001), similar fundamental techniques were used. These included videotaping the whole mathematics lesson, audio taping participants’ reconstructions of classroom events, and analysing the multiple data sets. Points of difference involved;

- technical matters including acclimatization to the camera crew and the composition of the video image,
- the focus of the study – the teacher’s interactions involving negotiations of mathematical meaning with children,
- the age of the student participants - children were in the first three years of primary schooling, and
- the use of video-stimulated recall to prompt children 5 to 7 years of age to reflect on their mathematical thinking.

In summary these adaptations to the original complementary accounts methodology proved useful in capturing the complexity of early primary mathematics classroom interactions.

## References

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# Helping Teachers To Make Effective Use of Real-World Examples in Statistics

Helen Chick and Robyn Pierce

University of Melbourne

The media (including newspapers, television, and the internet) provides a rich source of real-world situations and data that lend themselves to use in the classroom. Such examples can be used to stimulate the discussion and application of important statistical principles. To use examples effectively, teachers require two kinds of knowledge: content knowledge, sufficient to recognise the particular statistical principles that the example can be used to illustrate, and pedagogical content knowledge, sufficient to facilitate students<sup>1</sup> learning of those principles.

A recent study with pre-service primary/elementary teachers (Chick & Pierce, 2008) highlighted two areas that could cause difficulty for teachers in their use of examples. The study showed that even when teachers were supplied with a suitable statistically rich example, they may fail to identify its affordances, and, perhaps more significantly, struggle to bring out the significant ideas in their planned lessons, with a tendency to choose trivial or poorly related aspects. The former problem may well be a reflection of inadequate content knowledge (already a well-known issue when considering the connection between statistics education research and actual classroom practice) while the latter is influenced by levels of pedagogical content knowledge and occurred even in cases where content knowledge appeared adequate.

To investigate whether a simple intervention might help teachers make more effective use of examples, we conducted a repeat of the earlier study, but this time preceded by a short workshop on example use in mathematics. As part of this workshop, the pre-service teachers were supplied with a framework of questions designed to help them focus on the mathematical aspects of the example. The questions were also intended to have the teachers think carefully about how to keep their teaching activities closely aligned with the mathematical aspects that they had identified and with the content of the resource. Following the intervention the teachers were asked to plan a lesson based on the same statistically rich example used in the earlier study. We will discuss the preliminary findings from this study.

# Gender: The mathematical Phoenix has arisen!

**Helen Forgasz**

**Monash University**

Gender and other equity issues associated with the learning of mathematics have not been high on research, policy, or professional development agendas since the mid-1990s. Since then, there has been a general perception that girls' 'problems' with mathematics were 'solved' and the focus shifted to areas of boys' educational disadvantage. At the same time, while generally unsuccessful, efforts were expended on addressing the mathematical underperformance of Australia's Indigenous students, but little attention appears to have been paid to the relatively poor achievement levels of those from lower socio-economic circumstances.

In my session I will focus on gender. Recent data will be presented that clearly indicate the re-emergence of gender as an issue of concern with respect to the mathematics achievement outcomes of Australian students, particularly when compared to the directions in the UK and the US. I will draw on data from the following sources: NAPLAN 2008, PISA 2006, TIMSS 2007, and VCE Mathematical Methods and Mathematical Methods CAS results. I will postulate hypotheses to try to explain the findings, and will end the presentation with suggestions for potentially fruitful research directions. Policy implications will also be discussed.

The evidence that the clock has turned backwards with respect to the mathematics learning outcomes of Australian students, with males significantly outperforming females, is strong. The current federal government's social and human capital agenda holds promise for a re-focus on addressing societal and educational factors that can impact on learning opportunities and outcomes. On being the first woman in Australia to serve as acting Prime Minister, Julia Gillard is reported to have said:

But even I was surprised by the depth of community reaction... You know, women in the street... would come and talk to you about how good it was that a woman had done that job and get you to sign something for their daughter — a way of them not necessarily saying to their daughters that they should be in politics but reinforcing to their daughters that in Australia today there's no closed doors, that girls growing up should have the impression that every door is open to them. And not just have the impression, but the reality that every door is open to them.  
(Carney, 2008, p. 16)

The door to opportunities based in mathematical learning must be equally accessible to all members of the community; all artificial barriers must be dismantled!

## Reference

Carney, S. (2009, Jan. 3). At the helm. *The Age*, pp.15, 16.

# Null Curriculum

Abolfazi Gatabi

University of Melbourne (Visiting international student)

My lecture will focus on **Basic Mathematics literacy** as a **Null curriculum** in the Iranian school curriculum in mathematics. I will discuss some reasons for this claim, which include:

- Myth
- Iranian students performance in some special TIMSS question;
- Interview with students in grade 12 about a TIMSS advanced item (my study);
- Content analysis of the Iranian mathematical textbook in grade 9.

Three type of Curriculum by Eisner (1985, 1999, and 2001)

## 1. Explicit curriculum

Educational menu- the official and overt course of study, goals and objectives which appear in curriculum guideline and the course planning materials.

Educational theorist Elliot Eisner suggests the explicit curriculum, similar to Cuban's [official and taught](#) curricula, which is a small part of what schools actually teach.

## 2. Implicit (the hidden) curriculum

This curriculum is Covert and concealed process of learning.

"...The implicit curriculum of the school is what it teaches because of the kind of place it is." (Eisner)

## 3. The Null Curriculum

From Eisner point of view the null curriculum contains values and knowledge that school doesn't spent time on that. While probably the worth and importance of these things are more than things that taught by school. Null curriculum have two important dimensions:

- First: intellectual process that schools emphasize and neglect.
- Second: content or subject area that are present and absent in school curricula.

"It is my thesis that **what schools do not teach may be as important as what they do teach.**-A: I don't think so but it is a little bit tricky- Ignorance is not simply a neutral void; it has important effects on the kinds of options one is able to consider, the alternatives that one can examine, and the perspectives from which one can view a situation or problems. The absence of a set of considerations or perspectives or the inability to use certain processes for appraising a context biases the evidence one is able to take into account. A parochial perspective or simplistic analysis is the inevitable progeny of ignorance." ~ Elliot Eisner

# **Teacher's reactions to students' responses to two-tier tasks**

**Shajahan Haja and David Clarke**

**University of Melbourne**

This study aims to investigate assessment information generated by research-based two-tier tasks in 'proportion' and to document teachers' reactions to the assessment information. This paper discusses one Y7 teacher's reactions to her students' responses to the two-tier tasks. 12 Year 7 girls took four similar tests each having 8 two-tier tasks in 2008. 8 of the Y7 girls and their teacher were interviewed. Analysis of students' responses revealed that: i) high math ability students were more successful in solving the two-tier tasks, and ii) students' justifications gave some information about their correct and incorrect proportional reasoning. The teacher found that the two-tier tasks made the students think about why the answer was correct or wrong and made her think about why the students were thinking.

# **Using mathematical competencies to fight syllabusitis: A matrix structuring of teachers work and development**

**Tomas Højgaard (tomas@dpu.dk)**

**School of Education, Aarhus University, Denmark**

Syllabusitis is a name for a disease consisting of identifying the mastering of a subject with proficiency related to a syllabus. In this talk I shall be arguing that using a set of mathematical competencies as the hub of mathematics education can be a means to fight syllabusitis.

The introduction of this idea and a thoroughly exemplification of a suggested set of such competencies was the main outcome of the danish socalled “KOM” project. Furthermore, a matrix structuring of the relation between subject specific competencies and subject matter was suggested. As the analytic core of this talk I will argue and exemplify that such a matrix structure has proven to be a crucial element when attempting to put the competency idea into educational practice, not least because it makes it possible for teachers to take an active part in such a project and welcome it as a developmental tool.

# **Teachers' view on comprehensive classroom assessment and its practice**

**Rohani Mohamad**

**University of Melbourne**

Assessment alternatives have been advocated at global level as a better practice for today's classroom. Hence, teachers are expected to apply assessment alternatives, which include balancing between formal and informal feedback, serving formative and summative purposes, and implementing various assessment methods. Two major reasons for such assessment practice are to ensure meaningful learning is maximised and to provide fair opportunities among students.

However, a review of literature indicates that in many countries, classroom assessment practice has over utilised supervised-timed-examination-based assessments, which are mainly serving summative purposes. Hence, the focus of assessment has generally been on grading rather than learning. The review also indicates that implementing comprehensive assessment alternatives can be a challenge for teachers.

Nevertheless, this is not necessarily the case to all teachers. Those teachers who believe, implement, and in support of assessment alternatives are to be studied in this research. An ethnographic approach was proposed and the study will describe the teachers' view and their practice on classroom assessment alternatives.

In this presentation, I will share the journey to begin this research and in trying to locate potential research participants. At this research stage, I will also report on some of the responses from those whom I have been in contact with. Comments and suggestions from the audience are greatly welcome.

# **A Systems Approach to Large-Scale Testing**

**Patricia Morley**

**Monash University**

Addition of fractions is a topic known to be difficult for middle-school students around the world, and is a standard item in international mathematic assessments such as the Trends in International Mathematics and Science Study (TIMSS). On average, approximately half of year 8 students internationally correctly answer a multiple-choice addition of fractions item.

Accountability systems rely on motivation of those assessed to improve scores to obtain better results, but the widespread difficulty of this topic suggests that motivation alone may be insufficient to achieve significant gains. The systems approach is proactive, rather than reactive, and is found in the military and in high hazard environments.

The research literature has mainly developed in the context of preventing industrial accidents, and has influenced practices in industry and hospitals. Environmental factors are considered in order to identify and address not only obvious sources of errors, but also latent issues, which may not be causing problems immediately, but may cause issues later on, alone or in combination with other latent issues.

The addition of fractions is a complex topic, bringing several mathematical strands together. The synthesis of concepts and processes required of the student is may be allowing latent issues to cause difficulty where they had not before. The advent of large scale assessments provides an opportunity to extract diagnostic information from existing data, to identify what difficulties students are experiencing, and to consider how errors might be prevented, if possible.

This presentation outlines the use of systems approach to evaluate large-scale assessments to improve mathematics education, particularly the addition of fractions. In this presentation, the systems approach will be discussed and compared with accountability systems such as the US. No Child Left Behind (NCLB). The potential to extract diagnostic information will illustrated by a sample analysis.

# **Years 3 & 4: Vast differences in students' mathematical knowledge and strategies**

**Catherine Pearn**

**The University of Melbourne**

The Principal of a large metropolitan primary school in Melbourne expressed her concern about the mathematical standard of students at Year 3 and Year 4. The five Grade 4 classes were tested using Peter Westwood's One Minute Tests of Basic Number Facts (2000) and a paper and pencil Number Screening Test developed by the author and colleagues. As the author administered the Westwood tests several students from every class made the comment: "I can't do division!" Observation of the students during the assessment procedure revealed that students not only had difficulties with division but with all four processes. Many students completed the One Minute Tests using a 'counting by ones' strategy that was evidenced by the tapping of fingers, nodding of heads and the drawing of tally marks on the paper. As students completed the Number Screening Test they struggled with the word problems. They could read the problems but had difficulty deciding which process to use. This paper will look at the analysis of both sets of data.

# Physics Teachers' Use of Mathematics in Solving Motion Tasks

Zahra P. Shirazian

University of Melbourne

Motion with constant acceleration, as an important part of introductory mechanics, is a rich topic for the investigation of the links between mathematics and physics concepts. Many secondary school students are reported as having difficulty with understanding different physics concepts involved in motion. A critical issue appears to be how teachers teach students to employ meaningfully the mathematics involved in solving motion tasks.

This study explores aspects of teachers' content knowledge (CK) and pedagogical content knowledge (PCK) with respect to using and understanding physics formulae, teaching those formulae and their feedback to students' written response to introductory mechanics tasks.

In an in-depth '*instrumental case study*', a comprehensive questionnaire and a problem-centred interview (PCI) were used to obtain data from eleven physics teachers who taught Year 11 and 12 physics, subjected to a '*qualitative content analysis*'.

Findings showed that there was a considerable range of CK and, PCK among teachers. While the teachers attempted to teach the tasks in various ways, formulae seemed to be taken as a given, not something to be understood. Regarding teachers' feedback to students' responses, most of the teachers were giving many alternative explanations without considering which may be most helpful in meeting students' needs.

The findings of this study have implications of the focus and design of pre-service and in-service teachers' education programs, in terms of linking the mathematics and physics concepts.

# **SMART tests for personalised learning**

**Vicki Steinle and Kaye Stacey**

**University of Melbourne**

This session will describe the goals of our new 'smart-tests' ARC linkage grant with DEECD as industry partner. Beth Price, Eugene Gvozdenko and Helen Chick (co-Chief Investigator) also work on the project. We have created a bank of smart-tests (Specific Mathematics Assessments that Reveal Thinking) that can quickly give teachers a picture of their class's conceptions and misconceptions. Links to appropriate teaching will be provided with the diagnosis. We will show the progress in the first year in item creation, computer delivery and diagnosis. We will give an example of the automated tools that have been built to find the patterns in students' responses that reveal their thinking and to understand the functioning of the items. In 2009, this project begins to track teachers' MPCK as they use smart-tests on a regular basis.

# Exploring the relationship between tasks, teacher actions and student preferences

Peter Sullivan, Doug Clarke and Barbara Clarke

Monash University

We are investigating ways that particular types of mathematics classroom tasks create opportunities for students and challenges for teachers. Various authors have argued that classroom tasks are the medium through which teachers and students communicate, and that the type of task influences the nature of the learning (e.g., Christiansen & Walther, 1986; Hiebert & Wearne, 1997).

This presentation will include data from the *Task Type and Mathematics Learning*<sup>1</sup> (TTML) project which focuses on four types of mathematical tasks as follows:

- Type 1: Teacher uses a model, example, or explanation that elaborates or exemplifies the mathematics.
- Type 2: Teacher situates mathematics within a contextualised practical problem to engage the students, but the motive is explicitly mathematics.
- Type 3: Teacher poses open-ended tasks that allows students to investigate specific mathematical content.
- Type 4: Teacher poses interdisciplinary investigations in which it is possible to assess learning in both mathematical and non mathematical domains.

The focus of our overall research is to describe how such tasks respectively contribute to mathematics learning, the features of successful exemplars of each type, constraints which might be experienced by teachers, and teacher actions which can best support students' learning.

In this presentation, I describe a particular unit of work developed by some project teachers, and show the results of a survey of the students on their task preferences. The basic finding is that students have a diversity of preferences, suggesting that task variety is central to effective teaching and learning.

## REFERENCES

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- Hiebert, J., & Wearne, D. (1997). Instructional tasks, classroom discourse and student learning in second grade arithmetic. *American Educational Research Journal*, 30(2), 393-425.

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<sup>1</sup> TTML is an Australian Research Council funded research partnership between the Victorian Department of Education and Early Childhood Development, the Catholic Education Office (Melbourne), Monash University, and Australian Catholic University.

# **An electronic interview technique**

**Jill Vincent and Kaye Stacey**

The average Australian mathematics lesson was shown by the TIMSS 1999 Video Study to display a cluster of features that together appear to constitute a 'shallow teaching syndrome': low complexity of problems, which are undertaken with excessive repetition, and absence of mathematical reasoning in classroom discourse. In response to these findings, a study was designed to explore whether the 'shallow teaching syndrome' was indeed a reality of Australian eighth-grade mathematics classrooms. One phase of this study involved interviews with mathematics curriculum leaders from five Australian educational jurisdictions. A CD-based interview that included hyperlinks to resources provided on the CD was designed to enable us to engage deeply with the opinions and experiences of the participants relating to teaching mathematics, especially with respect to the elements of the shallow teaching syndrome. This session describes and illustrates the structure of the interview, and discusses the advantages and disadvantages compared with a direct person-person interview.

# **The Role of Optimism in Collaborative Problem Solving in Mathematics: Building Problem Solving Capacity**

**Gaye Williams**

**University of Melbourne**

Until Clarke (2002) developed the Learners' Perspective Study (LPS) methodology, collecting data on student thinking during problem solving activity in class was a challenge to researchers. Williams (2005) showed the LPS methodology could be used for this purpose and for examining the psychological orientations of students that affect their problem solving capacity. She showed that the students who creatively developed new mathematical ideas individually were optimistic (Seligman, 1995) and illustrated their optimistic activity during problem solving. That study raised questions about the role of optimism in collaborative problem solving. Williams adapted the LPS data collection techniques to enable study of this topic. A longitudinal study, funded through an ARC Discovery Project including a post-doctoral fellowship has resulted. The theoretical framework and research design of this video-stimulated post-lesson interview study are presented. Students' mathematical problem solving activity will be studied over three years as they move from Grade 4 to Grade 6. Engaged to Learn pedagogy that elicits frequent creative student thinking (Williams, 2007) will be employed as students undertake three complex tasks during six eighty-minute sessions each year (May, August, October). Associations between optimistic orientation and problem solving capacity will be explored. The pilot study highlight situations that theoretically should build optimism and this ARC Project provides opportunity to empirically support, and to elaborate this theory. In relation to group problem solving activity, ways that the relative optimism of group members can affect opportunities to engage in creative thinking are examined because the pilot study showed less optimistic students can inhibit the creative activity of others (Williams, 2008), and other research using alternative lenses suggests similar findings (Wood, Hjalmarson & Williams, 2008). The above ideas will be discussed in this session with opportunities for interaction, and for the audience to guide the areas of focus.

**(references available from Gaye)**