A HIATUS IN VET RESEARCH: THE CASE OF MATHEMATICS

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ABSTRACT

To support industries to be at the cutting edge, the VET system must prepare workers appropriately through recognition of the critical importance of mathematics which operates in a dialectical relationship with technology. A healthy research base in vocational mathematics education is needed to inform policy decisions on curriculum and teaching.

A View from the Margins

I establish my positionality as a TAFE teacher, specialising in mathematics and statistics subjects, and a Ph. D. research student. Some four years into my studies, I have come to the realisation that my research is at the margins of both mathematics education and vocational education. At the institutional level, it is becoming apparent that teachers do not feel valued *qua* teachers, even less as researchers.

A FOCUS ON MATHEMATICS EDUCATION

Focusing on the *discipline* of mathematics, a small number of graduates will find employment in the academy, a larger number will find work in industrial research and development, and an ever-diminishing number (Thomas, 1997) will find work as teachers of mathematics. Currently in Victoria many people teaching school mathematics have few or no university qualifications in mathematics (Swedosh, 1998). A small number will undertake research in mathematics education; some will be employed as researchers and/or teacher educators. Current work in the academy and industry has minimal effect on both teaching and mathematics education research segments which focus on a small subsection of teachable material, generally located in mathematical developments made well before the twentieth century — from Ancient Greece which dealt with number as magnitude, and the latter from Modern Europe (from around the seventeenth century) which dealt with number as an object of pure thought, focusing on the concept of function (Spengler, 1926).

The institution of mathematics *teaching* — taken as the work of teachers together with related texts and teaching materials (electronic and concrete), subject associations, conferences, journals, and so on — is virtually entirely concerned with the needs of children from early learning to the end of formal schooling; with a tiny effort made on behalf of university teaching, particularly in the bridging area. In Australia, and to a lesser extent internationally, the needs of teachers of mathematics subjects in VET are all but ignored (with the exception of further education courses coming under the literacy umbrella).

The situation for mathematics education research is very similar. For example, Paul Ernest (1998) identified some of the objects of mathematics education research — with a distinct focus on school mathematics. He included as primary objects the nature of mathematics and school mathematical knowledge, its learning, aims and goals, teaching, resources, the human and social contexts of mathematics learning/teaching — and the interaction and relationships between all of the above factors. At another level, the objects might be taken to include: the nature of mathematics education knowledge, research, teacher education, and the social institutions of mathematics education.

There is no reason to exclude post-compulsory education from research perspectives such as this. However, the teaching of university mathematics has been formally addressed in Australia through a discipline review (NBEET, 1995) and internationally (e.g., Niss, 1997). FitzSimons (1996) and in a timely research publication on adult learners FitzSimons and Godden (in press) document examples concerning the teaching and learning of mathematics at university. But in Australia, apart from the work of the author, there is little equivalent published research pertaining to the VET sector.

A FOCUS ON VOCATIONAL EDUCATION

Industry is, not surprisingly, central to vocational education. However, it is only in the last decade that, as part of a sustained effort of deprofessionalisation on the part of governments adopting neo-liberal policies, deliberate efforts have made teachers peripheral in terms of decision-making. Clearly industrial experience is important for teachers of vocational subjects, but it has not always been mandatory for teachers of generic studies such as mathematics and communication skills. Funded industrial experience has been available to teachers but the task itself may be subverted into other work on behalf of the college.

Teachers' work in the VET sector has been transformed and intensified by the marketisation of education together with erosion of working conditions, so that there is little time and energy left for preparation (and innovation) for classroom teaching. There appears to be little status attached to the work done in and for the classroom, where the quality of teaching appears to count for little. Generic studies such as mathematics and communication skills appear to have fewer restrictions on increasing class sizes or location of teaching rooms. In fact teachers with no pedagogical preparation in these areas, nor even any relevant tertiary qualification, are known to be assigned to these classes in order to fill up a teaching load.

From NREC's (1997) six key priority areas for the VET sector it would appear that issues of teaching and learning, covered by the phrase *quality provision*, are of recognised but limited importance, and in any case, taken to be generic. My contention is that these are central issues on which all others depend. If teaching skills are generic how could one account for the establishment over the last three decades of the field of mathematics education research (Niss, 1998)? The strategy's planned investigations are all contextually situated and cannot be generalised for all students (even groups of students), teachers, and sites of learning.

Thus, as a TAFE teacher of mathematics subjects and a VET researcher, I am positioned on the margins of both the mathematics education community and the vocational education community. Yet I am both insider and outsider: working within both realms yet looking in on each from the perspective of the other. Fortunate, perhaps, that I have voice in each as practitioner, producer of peer reviewed publications, and leader of working groups, nationally and internationally. But still, always on the margins.

This paper, then, is looking at VET practices from the perspective of an insider (i.e., a practising teacher) who is also engaged in mathematics education research. Following the work of Anna Yeatman (1994), having begun to consider the epistemological positioning of myself as a subaltern intellectual and the different and conflicting lines of intellectual and political accountability, I wish to defend the values of professionalised (mathematics and vocational education) knowledge, to offer critical and reflective perspectives.

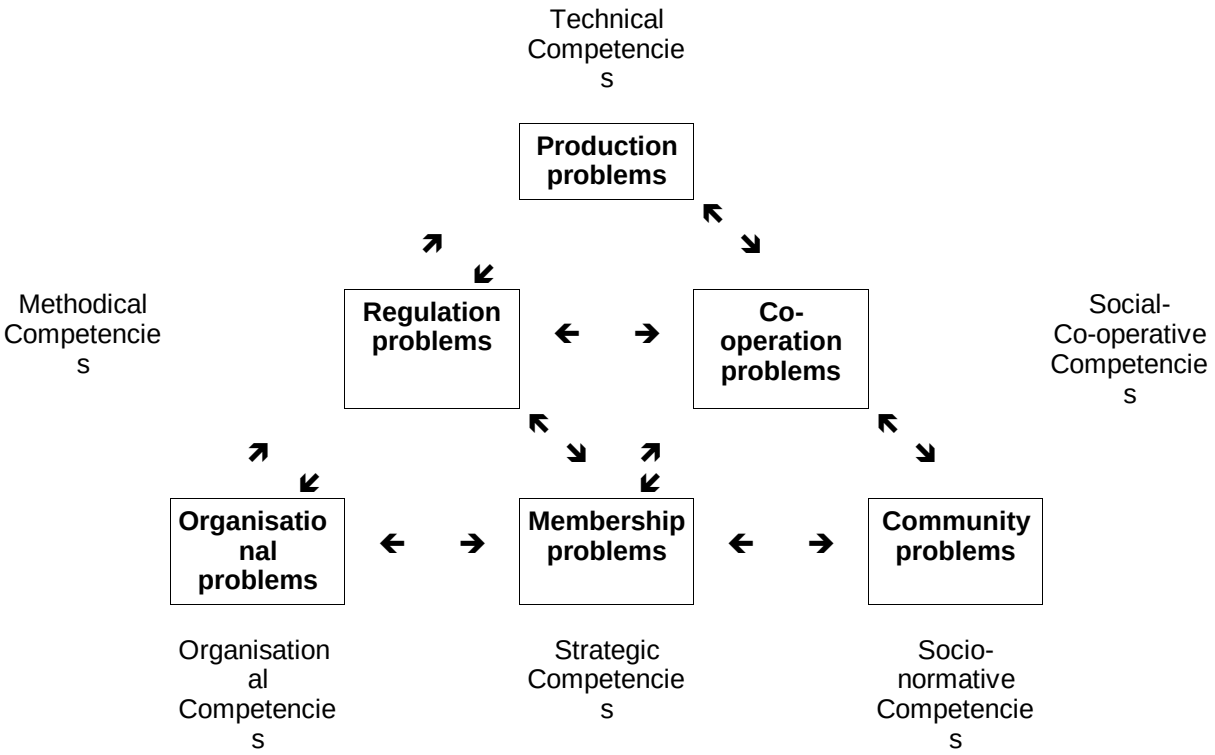
Mathematics Education in the VET Sector

Mathematics has a very high public profile. Niss (1994) noted the subjective irrelevance paradox where mathematics was regarded as generally important but not at the personal, subjective level. Media reports about proposed changes to school mathematics are usually greeted with major public interest. Somewhat surprisingly, mathematics in the VET sector is never mentioned, apart from recent publicity given numeracy and literacy tests for the unemployed. In an increasingly technological world mathematics is held to underpin a nation's industrial competitiveness and generally support the quality of life (NBEET, 1995). However, Niss's paradox can be related to the dilemma posed by Chevallard (1989), that while more and more mathematics is implicitly built into all aspects of social life the amount actually made explicit becomes less and less. For example, the mechanisation and computerisation of almost every facet of our lives. One result is the tendency among members of the public, including some industry spokespersons, to believe that there is a diminishing need for formal mathematics education in the VET sector. However, this is a superficial view. Industry-based research suggests that when workplace decisions become problematic or contested, mathematical skills far broader than basic numeracy are required (see FitzSimons, in press-b, for a review of the literature).

Onstenk (1998) has elaborated a broad range of workplace competencies: in addition to technical competencies for production are a range of methodical and communicative skills for working within an organisation, interacting within and between various communities of practice (see Figure 1).FitzSimons (in preparation) and Wedege (in press) elaborate on these and how they are inextricably related to the mathematics education of the worker. Democratic competence is needed not only in the workplace, but also in the wider community, where mathematics and its models (e.g.,

percentages, graphs and charts) can be used as means of encouragement or discipline and control. In fact it can be argued that the Key Competency *Using Mathematical Ideas and Techniques* is interlinked with each of the other Mayer Key Competencies, problematic as they might be. Figure 1 shows Onstenk's (1998, 100) conception of competence, which he built on the activity theory approach of Engeström.

Figure 1. Core problems and broad professional competence (Onstenk, 1998).



MATHEMATICS CURRICULUM AND TEACHING

The curriculum and teaching of mathematics in the VET system is basically in an educational (epistemic and pedagogical) time-warp, when it could and should be at the cutting edge, unhindered by restrictions of massive public examinations and access to positional goods in education and (most) industry. Little is known, and much is assumed by curriculum decision-makers about the actual uses of mathematics in industry (not to mention society at large). Yet there is a burgeoning of research reports (FitzSimons, in press-b) in this area.

There have been two disturbing tendencies concerning mathematics curriculum and teaching in the VET sector. The first is that most formal accredited curricula concentrate on a narrow range of technical mathematics competencies, albeit in CBT format. There is an essentialism in content and process, not dissimilar from the content of much school mathematics, with the inclusion of spurious *vocational* contextualisations which are by-passed by the students as they seek to find the closed solutions. School mathematics in recent years has attempted to incorporate more realistic mathematical processes of problem solving and modelling, with limited success and much opposition: the very thought processes used by mathematicians and which should be valued by industry have not been seriously addressed in VET mathematics. Teaching is generally based on a, transmission paradigm, adopting a simplistic tool-box mentality, where students learn a set of disconnected de-(re-)contextualised skills in the classroom and are expected to identify applications in a work situation — shown by Billett (1998) to be highly problematic. The sector has also been slow in adopting new technologies (e.g., calculators, graphic calculators, and computer packages) as a teaching medium or tool-of-trade — let alone as on object of critical study. In FitzSimons (1997) I discuss the impact of this narrow curriculum with particular reference to gender, and in FitzSimons (in press-a) I discuss my attempt to work around the difficulties in workplace education. The situation is exacerbated for students who are enrolled for flexible delivery through distance education methods, since this mode is recognised to be extremely challenging for even well motivated students who have good time-management skills, to say nothing of literacy levels (Misko, 1994).

The second trend is towards reduction in amount of mathematical content. As courses become reaccredited or transformed into training packages, reductions have become apparent. On one hand it might be argued that mathematics, as described above, is not seen as relevant by students (and possibly industry spokespersons). On the other hand it is frequently argued that the educational backgrounds of vocational students are becoming weaker — due to the combined effects of higher participation rates in post-compulsory education and the push by undergraduate courses to increase their student numbers to the detriment of the lower status TAFE courses. Although the trend in both TAFE and university sectors is towards making students responsible for their own educational outcomes, the university sector in Australia and overseas is addressing the problem by attempting to improve its own teaching (NBEET, 1995; Niss, 1997, 1998), supported here by well publicised grants. Arguably TAFE students are in need of better mathematics teaching than their university peers, yet the issue has been treated unproblematically. Yet, at the technician level there is likely to be close professional interaction between TAFE graduate and university educated researcher, and they must be able to communicate mathematically. In fact the content of some courses overlaps, especially in statistics and mathematics for high technology areas. The NBEET report argues for university mathematics (and statistics) to be taught as an active, laboratory subject, and there is evidence that this is occurring. How many VET mathematics/statistics courses are taught in this manner? This situation in VET is not helped by the disappearance of discipline studies: In Victoria there are no longer any mathematics departments and therefore no career structures for discipline experts; not even to encourage multi-disciplinary strategies among the various subject experts.

Another important silence in the VET sector is the issue of student attitudes and beliefs towards mathematics — not to mention their teachers'. I wonder how many teachers in the VET sector hold and impart philosophical views of mathematics as an infallible, absolutist discipline?

In summary, the sector has paid little attention to the results of research in the international mathematics education community and has, to my knowledge, failed to carry out its own programs for the improvement of mathematics teaching and learning.

PROFESSIONAL DEVELOPMENT

Professional development for VET teachers of mathematics remains an important issue. In Victoria there has been no systemic professional development for mathematics teachers. With changes to TAFE structures in other states, even those more fortunate are likely to experience a deterioration with the devolution of responsibility for professional development to individual providers. What happens for mathematics teachers working for small private providers? At the same time there is now no educational qualification requirement for new teachers, in Victoria at least. What other industry would survive under such unfavourable conditions for self-renewal and development of innovation?

GOALS OF VET MATHEMATICS

In addressing content it may appear that I have overlooked discussion of the goals of VET mathematics. Internationally this is a major issue for school children (Niss, 1996), and more recently, perhaps, for university students (Niss, 1998). Where is the debate about the descriptive/analytic positions on content and pedagogy (or andragogy)? Could we ever have a debate on the normative positions? This seems unlikely in the current climate.

Arguing that the curriculum is *neither* free from *nor* determined by the economic and political space in which it operates, Noss (1994) suggests asking how mathematical ideas fit with society, and encourage particular ways of seeing, particular ideologies. In FitzSimons (1998) I interrogate some of the reasons in support of the continued low-level provision of mathematics for VET students. There may well be certain interests served in producing graduates who are obedient, docile, dualistically-oriented, rule followers rather than creative questioners.

Research

Internationally there are governments actively encouraging research into mathematical and technological needs of their vocational and further education adult learners. Whereas mathematics-discipline research is generally sponsored by large business and industry interests, as well as by government for areas such as defence, education research has been more geared to answer questions of political relevance. This apparently does not include mathematics in VET, and so there are silences about curriculum and teaching.

In the devolution of responsibility for curriculum and professional development to institutions one consequence is that mathematics tends to become invisible (e.g., courses in two- and three-dimensional art and design do not address mathematics directly) or not problematic (e.g., existing mathematics courses are simply transferred on-line). Hence it is an unlikely candidate for research.

Another consequence is that, because of the emphasis on user-choice, it is courses or institutions which are evaluated, not the teaching of mathematics and communication skills subjects per se, critical as these may be to completion and workplace communication. Thus there is little incentive for these to improve, or even be problematised. Related to this issue is the decline in large-scale government employment of TAFE educated apprentices and technicians (e.g., Gas & Fuel Corporation, State Electricity Commission, Telecom). Such large groups were, in the past, able to influence providers who had reputations to defend in terms of quality of teaching.

The VET system prides itself on being responsive to industry needs (even if not clearly articulated, especially in the case of mathematics), which presumably includes proactive as well as reactive strategies. The continual reproduction of an epistemologically flawed curriculum framework founded on school mathematics, and the failure to recognise the genesis and use of mathematics in the workplace or to seriously address the issue of transfer indicate the hiatus in VET research. To provide adequate curriculum and teaching in times of rapid economic change, the system needs to adopt innovative strategies, supported by sound educational research, to monitor and evaluate theoretically well-founded approaches in discipline areas such as mathematics for vocational education and training. These are currently lacking in focus where research funding is concerned.

A RESEARCH AGENDA

The VET sector needs to pursue ongoing critical, research-based, analysis and evaluation of teaching and learning mathematics. For example:

What is known about:

1. Students' mathematical backgrounds?
2. Teaching and learning practices in classroom, workplace, and on-line?
3. Teachers' (of mathematics subjects) mathematical and educational backgrounds; professional development records?
4. Industry's real mathematical needs (not lists of school mathematics topics)?
5. The mathematical needs of society at large for democratic citizenship?

Further research questions, including theorisations of the above, include:

1. Is mathematics important in Australian vocational education and training?
2. Can we continue with a simplistic 'tool-box' mentality to teaching mathematics?
3. How can we engender higher order thinking in mathematics classes and mathematical situations at work and in general?
4. What are the links between mathematics education and productivity?
5. Who is responsible for the conditions of mathematics teaching (i.e., institutional constraints faced daily by teachers).

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