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Values, Vocational Education and Mathematics: Linking Research with Practice

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Stevenson, in his 1998 keynote address to this conference, called for conversations across practice as an attempt to overcome the institutionalised polarisations of knowledge. Underpinning his paper is the notion of values in relation to self, work, and society generally. VET practitioners work within an imposed value system of the institution of VET in terms of its policies and mandated practices. They must also reconcile their personal value systems with the values inherent to the subject matter they are teaching. In the particular case of mathematics there are powerful implicit values as well as a range of explicitly transmitted values. Yet this area of teachers' values is under-theorised and under-researched. However mathematics teaching, in the context of VET sector trends away from disciplinarity and formalised curriculum documentation, takes on a different dimension from school or university practice. This paper will address the issue of values in vocational mathematics education from a theoretical perspective which is both informed by and intended to inform practice.

Introduction

I will begin by briefly outlining some perspectives on values: societal, general educational, mathematical, and mathematics educational. I will then consider various influences on values in the teaching of vocational mathematics. Finally I will address briefly the need to overcome polarities between VET mathematics and other academic mathematics and mathematics used in the workplace. These polarities are the result of educational policy decisions underpinned by value judgements.

Values

According to McConatha and Schnell (1995, p.80), "values are primary constructs which affect an individual's interpretive schema and his or her sense of self, thereby exerting a direct or indirect influence on attitudes, beliefs, feelings, and the perception of the social and political world." They continue that values are not innate, immutable given qualities as has often been perceived, but are endogenous properties, shaped by cultural factors. Although values are transmitted from individual to individual, group to group, and generation to generation, educators remain one of the primary agents of values transmission. They argue that the study of values is consequently central to understanding the current philosophical debate regarding educational policy.

Societal.

At the societal level Stevenson (1996) outlined Campbell, McMeniman and Baikaloff's goal value system for a desirable future Australia. It placed social valuing and ecological responsibilities at the local, national, and global levels ahead of the fifth-ranked 'robust economy.' However, within the workplace Stevenson claimed that economic goals were the only ones regarded as legitimate, with a stark absence of

knowledge valued for its concern with social and ecological goals. This is reflected in attitudes of employers with respect to task/organisation, community of practice, quality standards and so on (e.g., NBEET 1995a; Stasz 1996; Stevenson 1997). These goals go beyond the Key Competencies (Mayer 1992) to demand dispositions suited to the needs of employers and the economic good of the nation as a whole (Butler 1998b) — including lifelong learning.

Educational.

According to Le Métais (1997, p.5) basic values, where the primary focus is on the individual, include: “democracy, participative governance, differentiated provision, professional autonomy or discretion.” These may be supported by, or in tension or conflict with, operational values where the focus is on the system or society — where a balance is sought “between universal and residual provision, between the public cost and meeting individual needs, between effectiveness and economy and so forth” (p.5). Marginson (1997) observed such conflicts in the commodification of education, using the concept of ‘positional goods’ to explain phenomena associated with this neo-liberal transformation of education in Australia. Le Métais (1997) further observed that

there may be a dissonance between the aims of education expressed by legislation or reforms, and those pursued by students, teachers, parents, education administrators and others. It may be difficult for a single educational structure to reflect the diversity of values and aims. . . . As a result, criticisms may be levelled at the system for failing to: instil basic values; teach basic skills; develop higher order thinking and problem solving skills; develop creativity, flexibility and cooperative working; prepare young people for today’s jobs; prepare them for tomorrow’s unemployment and lifelong learning and so forth. These criticisms reflect different expectations or different value positions. (p.6)

Vocational education in Australia has a long history of such criticisms. Yet, in spite of this it has survived because of its perceived ability to continue to meet the needs of its key clients (Anderson 1998). Yet, as Stevenson (1997) claimed, the industrial relevance of vocational curricula — based on industry standards — supplants personal and societal needs; misreading current and future industrial as well as general social needs. This is particularly serious in view of the fact that economic theory is just that — in its predictions of economic futures, local or global. It is also now recognised that there will not be continuous paid work for all, full-time, part-time, or casual, and that the limited (e.g., gendered) nature of the construct of skill fails to recognise the multifarious kinds of unpaid work performed daily (Butler 1998a).

Mathematical.

Values associated with the institution of mathematics were discussed in FitzSimons (1998). In particular, I discussed aspects of the discipline of mathematics from a social perspective, making reference to the increasing volume of implicit mathematics and corresponding decrease in explicit mathematics in our society (Chevallard 1989) — leading to its invisibility in the gaze of many non-mathematicians, not least in industry. This trend has been accompanied by an imbalance for many individuals between the objective, controlling and explanatory side of mathematics and the subjective, systemic side of which most people are unaware (Fischer 1993).

In a seminal work, Bishop (1988, p.59) noted that “mathematics, as well as being a certain kind of symbolic technology, is also the bearer of, and the product of, certain values.” He outlined three pairs of values commonly associated with mathematics; each

have been valorised by those within the mathematical community and yet have tended to further the alienation of those external to it.

1. The *ideological* values of rationalism and objectism, which separate objects from ideas and allow abstractions to be treated as objects, have vested mathematics with power and authority.

2. The *sentimental* values of control and progress underpinned by technology have resulted in improvements in many aspects of society. Many writers have observed that this has not been unproblematic: Although mathematics has provided a tool for gaining control over physical and social environments, these have not always been for the good of humanity, and humans are now entrapped in a technological society

3. The *sociological* values of openness and mystery in mathematics have in first case been linked, albeit tenuously, to democracy and in the second to widespread feelings of ignorance and confusion among many non-mathematicians.

The negative impact of each of these values on many adults, especially VET students, has been well documented (e.g., Buxton 1981; FitzSimons & Godden in press), and should be cause for concern in the VET sector.

Mathematics education.

According to Niss (1996), at an international level, fundamental reasons for teaching (school) mathematics include: contributing to the technological and socio-economic development of a society; contributing to its political, ideological and cultural maintenance and development; and providing individuals with prerequisites which may help them to cope with life in the various spheres of education or occupation, private life, social life, life as a citizen. For the individual learner, aims include, *inter alia*: (a) the development of *personalities* “by engendering or enriching self-respect and self-confidence, independent and autonomous thinking (including logical thinking), the development of explorative and research attitudes, linguistic capacities, aesthetic experience and pleasure etc.” (p.32); (b) an emphasis on “*mathematical processes* (such as exploration, investigation, conjecturing, problem posing/formulation/solving, representing, proving, modelling) and not only products (concepts, results, methods, skills)”; (c) the fostering of “*mathematical thinking and creativity*, while emphasising that mathematics is a living subject resulting from human activity and from the continuing efforts of humankind over five millennia”; (d) the enabling of pupils “to critically *analyse and judge uses of mathematics* (their own as well as others’) in extra-mathematical contexts”; and (e) “to provide students with an impression of and insight into the role of *mathematics in society and culture*” (p.33). The mathematical values embedded within these aims have largely been transmitted implicitly; the last two, in particular, demand that mathematical values be addressed explicitly — as they are in many other areas of the curriculum. Mathematics itself must be an object of critique. To what extent does vocational mathematics education address each of these aims? What is the ultimate benefit to industry and the broader society within which it is located? Education mediates between the individual and their culture, and research has shown that differing views of mathematics held by the teacher will influence the presentation of content (Thompson, 1992), forming the meta-knowledge of students. Nickson (1992) stated:

Where mathematics as a discipline has been perceived in formalist terms, it has on the whole remained inaccessible to teachers and hence to students. The traditional detachment of mathematical content from shared activity and experience, so that it remains at an abstract and formal level, erects a barrier around the subject that removes it from other spheres of social behaviour.

(p.104)

According to Skovsmose and Nielsen (1996), values and meanings which are not explicitly expressed by teachers and students can nevertheless be inferred from their actions and interactions in the classroom. Thus inferences drawn by students of their teacher's mathematical expectations can deter them from engaging with mathematics in a critical way.

I now turn to Billett's (1998) five levels of social genesis of vocational practice as a framework to explore the factors which might influence mathematics teaching and learning. Mulcahy's (1998) distinction between curriculum 'by design' and 'as critique' also offers a window onto two different approaches to the realisation of curricular protocols in VET workplace education.

Influences on Values in Vocational Mathematics Education

In any classroom interaction there are a variety of influences emanating from society at large, and its institutions, teachers, and students. As a result of these, often conflicting, influences, some values of curriculum and pedagogy are openly admitted and actively pursued; others remain covert (maybe recognised and consciously underplayed or not recognised at all) but otherwise real. Whether they are critically evaluated at any level is another question (Bishop & Clarkson 1998; McConatha & Schnell 1995).

In order to tease out the various levels of forces acting on the values assumed and portrayed by VET mathematics teachers I re-orient Billett's (1998) framework:

1. At the societal level are *socio-historic knowledge* factors affecting the values of VET management and its mathematics teachers in particular. For example, (a) the prior history of the TAFE and its values framework (e.g. Kell 1995; Rushbrook 1994); (b) the prior history of mathematics curricula in Australian school and TAFE sectors (e.g. FitzSimons 1997a; Horwood 1997); and (c) the historic, ideological, purposes of schooling — both officially recognised (e.g. the Mayer Key Competencies 1992), and hidden (Apple 1979; Popkewitz 1997).

2. *Socio-cultural practice* is guided by (a) current political goals for vocational education (Marginson 1997; Stevenson 1996, 1997, 1998a, 1998b); impacting on (b) current VET management strategies (national and local) with respect to educational and social values (in *loco parentis* for industry; constrained by budgetary considerations, etc.); instantiated in, for example, (c) national curriculum and assessment frameworks such as the National Vocational Mathematics Curriculum Project (ACTRAC 1993) and individual Training Packages.

3. *Community of practice in the classroom* is dialectically related to (a) teachers' goals with respect to, and portrayal of generic educational, mathematical, mathematics educational values (Bishop & Clarkson 1998); and (b) the influence of the reciprocal expectations of the didactical contract (Brousseau 1990), students' goals and portrayal of learning values, instrumental values (e.g., mathematics as a positional good), and personal behavioural values (e.g., acquiescence with or disruption of teacher's intentions).

4. *Microgenetic development*: individuals' (teachers' and students') moment-by-moment construction of socially derived knowledge, derived through routine and non-routine problem solving.

5. *Ontogenetic development*: (a) teachers' prior experiences of learning mathematics, researching mathematics education, classroom teaching, and using mathematics in other life/workplace experiences; (b) students' prior experiences of learning and using mathematics (formal, informal, non-formal) (e.g., FitzSimons 1994a, 1994b; Klein 1998).

Each of these developments will impact uniquely on any teacher's activities, depending on their prior knowledge and experiences, within and outside the VET sector. I now discuss each in more detail.

Socio-historic knowledge and socio-cultural practice.

In FitzSimons (1998) I discussed socio-historic factors in terms of ideologies of vocational education and mathematics education — What are the hidden curricula of current VET courses, especially mathematics? Is their intention to produce compliant workers who will unquestioningly follow instructions? I will now focus on the socio-cultural practices which control, albeit from a distance, teachers' day-to-day work. The combined influences of economic rationalism and powerful industrial interests have been effective in producing curriculum documents where the teacher's role is apparently reduced to achievement of a narrow range of predetermined learning outcomes. At the same time there has been a denial of the needs of teachers in general, including mathematics teachers in particular, for specialised discipline-based professional development (FitzSimons 1995). McBeath (1994) has argued cogently for the need for curriculum innovation to be accompanied by professional development, but this claim has not been seriously heeded by policy makers. The dearth of substantial discipline-related professional development is but one effect of policy decisions in VET associated with the declining conditions of teachers' work.

According to Chappell (1998) and other writers, dominant economic discourses are used to construct new pedagogical realities for teachers in an overly instrumental manner, while failing to appreciate the implications for their professional identity. Among other things, teachers are concerned about shifts toward utilitarianism and the perceived pressures to have students complete courses as quickly as possible. As Mulcahy (1998) observed, in order to minimise the need for direct political intervention national policies have deliberately avoided targeting teaching and learning practice. Instead, control over teachers' work has been largely achieved through the imposition of competency-based education and training (CBT) (Jackson 1995). Bagnall (1994 p.18) identified a list of tendencies associated with CBT: "towards orthodoxy, rationality, simplicity, centralisation, knowledge technicisation, pragmatism, learner dependence, reactivity, commodification, privatisation, conformatism, internal differentiation, and instrumentalism." Each of these is clearly value-laden and tends to oppose any notion of critical education.

The CBT mathematics curricula published since 1993 perpetuate the historical portrayal of mathematics as absolute and infallible; a series of abstract rules and processes which must be followed and applied on cue. They reinforce the ideological values of rationalism and objectism which have already alienated almost all VET students before their entry to post-compulsory education. They assume the goals of progress and control in a technological society without problematising these — as I have argued in the past (FitzSimons, 1996), these are unlikely to be successful in producing creative technicians, tradespersons, or operators. The sociological value of openness remains highly implicit, and that of mystery is likely to reign supreme for many students — even after they have been certified 'competent.' The new Training Packages do not appear to improve the situation. One might wonder what is being valued in the conflicting statements of policy which aim to improve the nation's economic viability yet downplay underpinning mathematical knowledge of current and future workers other than basic numeracy.

Community of practice in the classroom.

Somewhat paradoxically, practitioners who are confident in their own professionalism are able to work in the interstices (e.g., Clemans 1997; FitzSimons 1997b), provided that they are aware of the possibilities afforded by policy gaps. They must have the available pedagogical content knowledge and reasoning in mathematics (Brown & Borko 1992) and workplace education (O'Connor 1994). Mulcahy's (1998) example of curriculum 'by design,' where the teacher's work is circumscribed by the curriculum documentation, is contrasted with the example of curriculum 'as critique.' In the latter the curriculum is constructed around the needs of the students in the workplace, valuing communities and practices rather than protocols. Documentation on learning outcomes is used as a means of recognising, a posteriori, workers' knowledges and skills for qualification purposes. In this way, according to Mulcahy, a singular mode of policy making — the rationalistic mode, prescribing a singular mode of teaching practice — is challenged.

Microgenetic and ontogenetic developments.

There is a dearth of research into microgenetic development of VET students learning mathematics — in contrast to the school and, more recently, higher education sectors. But questions may be asked as to what mathematics education values VET students are learning. With reference to the aims listed by Niss (1996): (a) How does VET mathematics foster the full range of mathematical processes and mathematical thinking and creativity? (b) How does VET mathematics develop students' personalities (even older students)? (c) If foreground is a subjectively mediated and socially determined set of opportunities (Skovsmose 1996), how does VET mathematics contribute to the students' opportunity to act on their learning? More broadly, (d) How does VET mathematics give students an insight into the role of mathematics in society and culture? (e) How does VET mathematics contribute to the roles of citizenship? It is widely recognised that perceptions of mathematics among the general public are, in the cognitive domain, limited predominantly to school mathematics (mainly arithmetic) and tend to be associated with negative connotations in the affective domain. VET students, generally less well qualified in mathematics than their university counterparts, are more likely to hold, ontologically, negative attitudes and beliefs about mathematics. The school (and university) mathematics education of most VET teachers was almost certainly absolutist, with pedagogical practice based on the traditional transmission mode. The lack of professional development or support for post-graduate studies in mathematics education suggests that much of the VET teaching population would have had little reason to (re-)consider the values implicit in the discipline of mathematics or transmitted through their own mathematics education — to say nothing of their own teaching in the VET sector. What might be done to address the dual issues of quality mathematics education in VET and the lacuna which exists in relation to its values?

Overcoming Polarities

Gibbons et al. (1994) have suggested the shift to interdisciplinarity in the business world. However, this does not signal the abandonment of disciplinary studies in the post-compulsory sector. Rather, there is a need which is increasingly recognised by universities to adapt their mathematics education to the world of today and tomorrow (e.g., NBEET 1995b; Niss 1998). It seems to me that VET Training Packages are on a dangerous path, both socially and economically, in rendering mathematics almost invisible. Onstenk (1998) has graphically illustrated the complex interrelationships within the communities of practice of the workplace; Wedege (in press), among others,

has highlighted these with respect to the utility of mathematics in processes of democratic participation in technological (and other) workplaces. The polarities between the mathematics taught to university undergraduates as a service subject and that 'delivered' to VET students must be overcome. Otherwise how can effective communication in the workplace be achieved? VET students have the same rights as university students to a mathematics education appropriate to their calling — and by this I do not mean the impoverished curricula of the present — and to open and honest consideration of the values of mathematics in relation to society in and beyond the workplace and the home. Knijnik (1998) provides an excellent example of mathematics education which respects the ethnomathematics of peasant farmers in Brazil, which respects their traditional methods without valorising them, and which provides the opportunities to interrogate academic mathematics and to choose meaningfully between the two. Here the polarisations have been sensitively yet powerfully overcome. Australian workers, as all VET students, are entitled to the same respect and empowerment to link their workplace mathematics with academic mathematics, yet from a critical standpoint in full appreciation of the values entailed.

Conclusion

In this paper I have attempted to place the values inherent in mathematics and mathematics education in the VET sector within a five-fold framework established by Billett (1998). I have interrogated some of the many value-laden influences affecting the work of VET teachers and their impact on VET students. Finally I have argued that VET students are entitled to opportunities for personal development in mathematics; yet a mathematics education which respects them as people within the broader society and their ontogenetic development, both as workers and as more or less successful learners of mathematics. To accomplish these goals, practice needs to be informed by research on curriculum and professional development, focusing on teaching *and* learning mathematics in the VET sector, building iteratively yet heeding the messages from other disciplines and sectors.

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