Mathematical Proficiency and the Sustainability of Participation: A New Ball Game through a Poststructuralist Lens

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In Australia we face a serious problem in that over the last twenty years the quality of students' mathematical knowledge and abilities has "deteriorated to a dangerous level" (Brown, 2009, p. 3). Too few students want to study further mathematics and are "unlikely to continue its study voluntarily" (Commonwealth of Australia, 2008) or pursue careers where high levels of mathematical proficiency are needed. In this paper I make use of the poststructuralist notion that 'proficiency' is a state of being daily constituted in classroom practice to (a) at a theoretical level, rethink how it might be ignited and sustained, (b) analyse contemporary interactional strategies that commonly though unknowingly obviate expressions of proficiency and (c) through a combined psychological/poststructuralist lens, nominate three (3) tentative indicators of instructional practice necessary for students to achieve and maintain a state of being 'proficient' as defined in the Australian curriculum: mathematics (Australian Curriculum Assessment and Reporting Auathority [ACARA], 2010). It is hoped that an additional, poststructuralist reading of the complexity and tenuous productivity of the learning process might interrupt commonly held assumptions that currently inform research on proficiency in mathematics.

For contemporary mathematics education in Australia proficiency is key in postmodern times (ACARA, 2010), as basic skills are necessary but not sufficient for sustainable engagement and achievement (Luke, 2010). Resnick (2010), in the Wallace Foundation Distinguished Lecture Series, made the chilling claim: "The evidence is now pretty clear. We seem to have figured out how to teach the 'basics' to just about everyone…but we are deeply unsuccessful at out 21st century agenda of moving beyond basic competencies to proficiencies" (p. 183). The emphasis on proficiency, a state of being proficient, introduces an ontological dimension to mathematics education, not yet carefully enough delineated and understood; it raises an urgent and pressing question about the nature of the pedagogic processes and strategies that might render each student proficient, that is, in having an appreciation of mathematics and the confidence to creatively use, investigate and communicate mathematical ideas (ACARA, 2010). Clearly, beyond the construction of content knowledge, qualitatively different instructional strategies are needed that *mobilise* students as active and engaged doers and users of mathematics, sustaining and extending interest and confident engagement in mathematical tasks and investigation in, and after, schooling. It may be useful to try to think again about the sorts of interactional strategies that might have some effect in enabling and enticing students to creatively use and apply constructed knowledge.

As always in contemplating pedagogic intervention great care is needed; as Foucault (1982) said "everything is dangerous" (p. 31). Foucault does not mean that everything is bad, but it could be that, despite our best intentions, despite recourse to inquiry based practice and active engagement, we have been careless in assuming too much about how learning happens and sustains itself across contexts. In the 21st century, and in the interests of having students build and sustain effective mathematical practices that enable "logical reasoning, analytical thought processes and problem solving skills" (ACARA, 2010, p. 126) our attention might turn to the learning *process*, and the extent to which it enables and imbues learner agency. It might be timely to value-add contemporary understandings of learning with poststructuralist concepts that talk to how it is that learners are constituted as

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proficient or not in discursive practices, and how it is that so many turn away from mathematics at an early age. That is, in the operation of the mathematics education discourse, learners may strive to establish themselves as proficient but may not be successful (or they might be 'successful', but only in terms of outdated notions of proficiency). How the teacher orchestrates the production of knowledge can restrict the field of operation of the students (Foucault, in Dreyfus & Rabinow, 1982); I make this point because it is our understanding and appreciation of the field of operation that requires research and investigation. The mobilisation of conceptual understanding, procedural fluency, strategic competence and adaptive reasoning (Kilpatrick et al., 2006, p. 5) depends on students' constituted sense of themselves as capable and valued in the construction and creative application of mathematical ideas. Throughout the schooling process and beyond, students must come to know themselves as valued constructors and users of mathematical ideas.

In this paper I want to argue that learners can only *be* as proficient as the operation of the mathematics education discourse allows; in not acknowledging this we compromise learning opportunity and give ourselves permission to ignore the urgency of further research on the necessary attributes of a learning process that mobilises the construction and application of mathematical knowledge. It is in the learning process that mathematical futures are made; but perhaps in somewhat more complex ways than we have previously imagined. Could it be that as teachers and researchers we have for too long found refuge in overly simplistic notions of learners that assume rational thought and autonomous action; we have allowed ourselves to be complacent with models of learning that imagine knowledge constructed has a more or less linear relationship to application. Through bringing both psychological and poststructuralist concepts to bear on one instance of classroom mathematics, I attempt to show how in this instance not only is the students' construction of powerful mathematical knowledge compromised, but so too their right to enlightened participation in a learning process (which is always constitutive, sometimes in ways we would not wish).

Reading Classroom Practice through an Additional Lens

One couldn't imagine an analysis of classroom practice in mathematics without an appeal to psychology; over the past 40 years or so, psychological and sociological understandings of how students learn mathematics have grown enormously. It is now considered important that students are engaged in a "learning process that involves making connections, identifying patterns, and organising previously unrelated bits of knowledge, behaviour and action into new patterned wholes" (Cambourne, cited in Killen, 2007, p. 3). The focus is on the learner *constructing* knowledge rather than absorbing it; the process of interaction with the content is most important, because the learning process includes opportunities for students to think and reason mathematically, leading to the construction of analytical thought processes and problem solving skills (ACARA, 2010). However, although the rhetoric surrounding mathematics education includes notions of sense making and active engagement, in practice many learners find themselves served up an emaciated form of mathematics in learning conditions that merely pretend to entice. Learning mathematics too often ends up being experienced as one continual exercise where learners are asked to slot in responses or follow procedures dictated by the teacher or test. Learners in mathematics are like the ball persons in a tennis match; if ever they are to get in on the real action, in a position where they can strategise and use an innovative game plan, they must first of all learn to recognise themselves as legitimate players. Having agency means they have a constituted sense that they can participate competently enough and even go beyond outmoded tactics to forge a new game plan. Such conditions are not yet regularly available to learners of mathematics, although recourse to humanist assumptions about rational, autonomous action affords educators the licence to assume that they are.

Methodologically, poststructuralism attends to power relationships in discourse and discursive practices (the learning process), and the constitutive effect of these power relations. Mathematics education is a discursive field in which the discourses of mathematics and education come together as discursive practices (group work, marking with ticks and crosses, the teacher asking questions) that structure learning experiences in mathematics. The way in which mathematics education is played out in any context affects the extent to which learners can establish and recognise themselves as mathematically proficient. The learner of mathematics, who manages to establish him/herself as proficient as recently defined (ACARA, 2010), owes this positioning partly at least to interactional practices that nourished his/her initiative and participation in constructing and creatively using mathematical ideas. That is, a state of being proficient (or not) is daily constituted, partly at least, in classroom interaction, and it affects participation post schooling. A poststructuralist analysis, then, is interested in *how* different enactments of the mathematics education discourse operate to support or suppress learners' engagement in the learning processes of mathematics. I suggest that educators and researchers may not fully appreciate the alienating effects on learners of instructional practices that deny them a genuine voice and the opportunity to make sense in personally meaningful ways. As Walshaw and Anthony (2008, p. 535) stated: "the development of thinking depends not so much on the frequency of exchange structures but on the extent to which students are regarded as active epistemic agents. Developing students' thinking also enhances the view that students hold of themselves as mathematics learners and doers".

In taking seriously this notion (Walshaw & Anthony, 2008) of the importance of positioning learners as "active epistemic agents" I think back to my own classroom teaching days when I saw knowledge and the learner as uncomplicated and absolute. Nowadays, through a poststructuralist lens, I appreciate that this is indeed not the case; I have come to see how a process of subjectification overwrites the construction and stockpiling of knowledge, influencing the students' present and future engagement in mathematics. I have come to appreciate how the view a teacher holds of learners and learning mathematics crucially affects interactional patterns and ultimately students' quality of engagement/ proficiency. In the table below humanist notions of the learner (from psychology and sociology), learning and proficiency are compared with poststructuralist theorisations.

In this paper I make the argument that contemporary humanist notions of rational, autonomous learners continue to frame discursive practices that can prejudice students' learning in mathematics. An analogy that may or may not be useful is to think of students constructing what I call *mathematical muscle*; from a psychological perspective these muscles (conceptual understanding) are nourished by the mathematics practices (Ball, 2003) and supported by skills at procedural fluency, strategic thinking and adaptive reasoning (the connecting tendons). However, for mobility it matters *how* these are nourished and exercised, their lifeblood is to be found in meaningful and valued participation in making mathematical and participatory sense; to the extent that this does not happen the mathematical lifeblood thickens and congeals, compromising present and future participation in mathematics. In summary, a student's appreciation of mathematics as a discipline and future place in mathematical activity is influenced by how the learning of mathematics is experienced in school; nothing new here, except that in this case I make special reference to relationships of power which constitute that experience. Proficiency, regardless of the student's level of mathematical understanding, is sensed (or not) in active participation rather than achieved as a *fait accompli*.

Table 1
Humanist and Poststructuralist Notions of the Individual

	HUMANIST	POSTSTRUCTURALIST
LEARNER	Rational, coherent, autonomous.	Constituted in discourses such as mathematics education through one's own and others' acts of speaking and writing.
LEARNING	Learning mathematics is about constructing & applying knowledge.	Learning is rhizomatic, rather than linear, a process of not only constructing mathematical ideas and practices, but also of gradually establishing oneself as proficient in the discursive practices.
PROFICIENCY	A personal attribute	Constituted in participation, a form of agency

Engagement Does Not Ensure Proficiency

Immediately below is an extract (Hardy, 2004, pp. 110-111) made up of interview scenes where the teacher comments on her classroom practices. The children's desks are arranged in blocks of six and each child has two sets of cards, both numbered from 0 to 9, in front of them. They hold up cards to show their answers to the questions asked of them" (p. 110). My intention in this section of the paper is to make visible how the teacher's best efforts can be read as compromising "the 21st century agenda of moving beyond basic competencies to proficiency" (Resnick, 2010). Specifically, in adhering to humanist notions of rational, autonomous learners the teacher makes dangerous assumptions that render invisible the possibility that:

- The students are not actually engaged in doing mathematics at all, and
- Learning is not necessarily liberating. In this case the students are learning (that is, *they come to know*) their place as optional extras in the articulation of mathematical knowledge (a poststructuralist reading). Proficiency is narrowly constructed as recall, giving the students no opportunity to establish themselves as proficient as defined, for example, in the Australian curriculum (ACARA, 2010).

Teacher (to researcher): A few children don't put their hands up. They try to hide, but that's the idea. There is no hiding place. You encourage them as long as you give them positive feedback. Even if they get it wrong, they are not scared to give an answer.

Teacher (in classroom): show me a multiple of five bigger than 75…Is that a multiple of 5 though, Michael? It's bigger than 75 but check it's a multiple of 5…

Well done, Sarah!

Teacher: Show me three threes…

Three threes? Check again please, Lauren.

Check please, Joe. You are looking at someone else's. Don't just look at someone else's. If you're not sure get your fingers and count in lots of three. Let's do it together (chanting) three, six, nine. You should be showing me nine there.

Teacher (to researcher): Some children don't have instant recall of three threes but I've given them a method to work it out. "Get your fingers and count in threes". So as long as they do regular counting in threes and they've got that pattern, they have got a method or strategy that we've talked through together to help them through that. They are not stood in queues waiting to get a book marked; they are getting instant feedback. They are not scared to get an answer wrong. They're having a go, they are risking things, and you don't gain anything unless you have a few risks and that's what they are doing.

Teacher (in classroom*)*: Have a quick check of that one, Misha. You should be showing me twelve.

Teacher (to researcher): It really works. We've seen it work. The children are motivated. The children want to learn. You never have to tell children "Are you messing around?" they're not. They are trying. They might not be succeeding but they are trying. They really love the pace. Children don't like sitting for 20, 30 minutes on one task especially if they are struggling on it. This doesn't allow that. The children have to find answers. They work together. They help each other but they are also pushing forward. The task is changing all the time. As long as you stay focused on target, most lessons you achieve eighty percent of children come out learning something that they didn't go in knowing and that's a wonderful experience and encourages you to go on further [End of classroom example, taken from Hardy, 2004, pp. 110-111].

A Two-pronged Analysis of the Learning Process

In casting a combined psychological and poststructuralist lens over this snapshot of learning it becomes clear that here mathematics education operates to render some learning practices possible while others are patently unthinkable (Britzman, 2003). In this classroom, on this day, there is an interlude where pre-established knowledge is tested; communication of what students know is transmitted through two sets of cards with numbers on them (Hardy, 2004). From a psychological perspective one is concerned that there seems to be little opportunity for students to actively engage in logical reasoning, develop analytical thought processes or problem solve (ACARA, 2010). Although the teaching is meant to be a two-way process where "pupils are expected to play an active part" (Department for Education and Employment [DfEE], 1999, p. 14) their role is restricted to answering questions. Problematic as this is from a cognitive, psychological perspective, a poststructuralist lens reveals even further complexity. Since classroom experience is constitutive of future experiences with mathematics, it is imperative that the 'active part' learners do play is not only furnished with rich and robust mathematical understandings, but also with the authority to participate in ways that are idiosyncratically reassuring and transformative. That is, 'how' the learners are able to actively participate can support or not the sustainability of participation in mathematics. While making sense of the mathematical content is a cognitive, intellectual affair, sensing competence in participation is an unconscious, embodied and constitutive 'sense' relative to identity which always influences the psychological. Although some of the children in this classroom may eventually answer the endless questions and even pass the exams, because they have no 'authorship' of the complex webs of understanding at the heart of mathematics nor of robust and rigorous demonstrations of proficiency (ACARA, 2010), their flirtation with mathematics is likely to be short lived. Students want to be legitimate participants, not sidelined, in the "game of truth" (Foucault, in Bernauer & Rasmussen, 1987, p. 1) that is school mathematics; their identity and future innovative participation in mathematics related tasks depend on it.

However, teachers worldwide persevere with the above interactional patterns because they subscribe to (have been constituted through) humanist views of the learner and absolutist notions of knowledge; they do not recognise the complexity of the productivity of the learning process, its production of conceptual knowledge and a constituted knowing about one's positioning as proficient, or not. The humanist teacher, as in the excerpt above, essentialises students as uncomplicated, either "motivated" or not, and "wanting to learn", or not wanting to learn. The "wanting to hide" is taken to be a personal failing, easily overcome through kindness and fellowship in teaching interaction. Within humanism, learning is a personal act where one fulfils one's inner potential, gradually leading to a state of self–actualisation. The teacher is a facilitator, making learning personalised. Note how the teacher addresses the students in demonstrations of fellowship: "Well done Sarah", "Check again please, Lauren", "Check please, Joe…You should be showing a nine there", "Have a quick check, Misha, you should be showing me 12". The teacher is very happy with the learning opportunity she has orchestrated for her students; "It really works", she says, "We've seen it work. The children are motivated. The children want to learn. They are trying. They might not be succeeding but they are trying. They really love the pace. As long as you stay focused on target, most lessons you achieve eighty percent of children come out learning something that they didn't go in knowing and that's a wonderful experience and encourages you to go on further". Herein, of course, lies the rub; students, because they are denied any form of meaningful participation learn (they are constituted to know) that mathematics is not for them, and just as worrying is the fact that this teacher is going to continue this sort of interactional pattern because it is considered to work. Yet the students' authorship or creation of mathematical ideas is sidelined as the teacher concentrates on orchestrating what is considered to be a co-operative, supportive environment; little mathematics is engaged in by students as the teacher provides the correct answers where they do not already know it. A combined psychological and poststructuralist framing of this practice sees as problematic the discursive construction of proficiency as recall, and the allied constitution of students as receivers, not generators, of knowledge.

Tentative Conditions of a Practice Supporting Proficiency

From a two-pronged perspective I have argued that students' competent and generative use of mathematics beyond school depends upon the operation of the mathematics education discourse; the operation of the discourse is influenced by the teacher's, and the wider socio-cultural context's, constituted beliefs about learning in mathematics. It is not that some students are essentially proficient and others not, but that humanist based instructional practices operate on and sustain this assumption. Piaget's child development through stages, Vygotsky's (1978) social interaction as a key force in the development of mind, and Lave's (Lave & Wenger, 1991) 'situating' learning in socially supportive contexts are premised on the rational, autonomous learner of mathematics. While each of these has contributed to research in mathematics education, they have not specifically recognised how learners themselves, as well as mathematical proficiency, are *produced* in teaching-learning interaction. Learners are produced in relationships of power, and should be able to recognise themselves as authoritative (in the sense of having author*ship* of ideas and practices) and competent in the intersecting and competing discourses of mathematics and education. It becomes a nonsense for teachers to imagine that they can 'gift' mathematics to their students; learner-centred means the learning process, where an energy for mathematics is experienced and released in interaction, is the hub of sustainability as it is constitutive. Teaching mathematics should not be about sugar-coating disparate bits of knowledge or the learning process, but providing those conditions for learning that gradually build (constitute) the mathematical energy and muscle for full participation in the 'game' of doing mathematics (Foucault, 1987). To build muscle (knowledge), energy (engagement in mathematical practices) and a desire to actually play the *game* (Foucault, 1987) three tentative, interdependent conditions, informed by psychology and poststructuralism, would seem to suggest themselves:

The provision of robust and related mathematical knowledge, where student learn

- to speak and write the language of mathematics

_ to communicate mathematically
_ to develop understanding and fluency through, and for, reasoning and problem solving
_ to appreciate the pattern and order of mathematics

Interactional relationships which centre the learner and the mathematics:
_ Students come to know mathematics as a method of reasoning, a way of figuring out a certain kind of system and structure in the world (Ministerial Council on Education, Employment, Training and Youth Affairs [MCEETYA], 2008), and
_ Students author, initiate, sense-making streams. They sense that they are respected and valued as participants in doing and using mathematical ideas.
_ The teacher provides the cognitive, social, cultural space for learners to establish themselves as proficient in participation (regardless of, but taking cognisance of, the level of the mathematics employed).

A classroom and broader social culture which recognises:
_ Mathematical knowledge and the learner as always *in process*, growing.
_ That students' appreciation of and participation in mathematics now and in the future is nascent in classroom patterns of interaction (because they are constitutive).

Conclusion

Devlin (2000, p. 254) states: "The key to be able to do mathematics is wanting to". I would add that the 'wanting' is constituted. Unfortunately, as recognised two decades ago, although children come to school enthusiastic and eager to learn mathematics, they "leave school with quite negative attitudes" (Australian National Council, 1990, p. 31) and do not want to have anything to do with mathematics once they get out of the school gate. The finger of course turns to the quality of classroom teaching (Masters, 2009) where observations of classroom practice (Luke, 2010) pick up on the pitfalls of having students struggle over too many worksheets, copying off the board, assessment based solely on recall and activity-based *busy work*. While, yes, these do inhibit the construction of robust knowledge and flexible thinking strategies, they also do nothing to nourish the students' recognition of themselves as idiosyncratically competent with/in mathematics. That is, students involved exclusively in these sorts of routines are not able to demonstrate what proficiency demands: competence *with* the mathematics and *in* participation in its contemporary discursive strategies and practices (ACARA, 2010).

Traditional forms of practice, like my previous teaching and the classroom example (Hardy, 2004) above, are held firmly in place by humanist assumptions of rational, autonomous students and absolute knowledge. Any bit of knowledge growth is thought to be worthwhile, and students who do not take up the offer are seen to be not able or unmotivated. Another reading of the situation suggests that students are in an untenable situation; the tasks they are given in the name of mathematics often incur no opportunity for mathematical reasoning at all. These tasks are not representative of the types of participation that build and sustain interest and enjoyment in doing and using mathematics; these tasks are not compelling because they do not author a learning process that follows idiosyncratic impulse. Igniting and sustaining proficiency is dependent on interactional patterns that deliver the very best knowledge, encourage learners to recognise themselves as proficient and mathematics as worth doing. Thus the mathematics, the learner and meaningful participation are equally important and at the centre of mathematics education; each is constitutive of the other, ideally in ways that mutually energise and mobilise for sustainability into the future.

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