Paper code: 1837

Igniting and Sustaining Mathematical *Proficiency*: a Poststructuralist Analysis of the Pitfalls and Essentials of Classroom Practice

Mary Klein
James Cook University
mary.klein@jcu.edu.au

Abstract:
Nationally we face a serious problem in that over the last twenty years the quality of Australian students' mathematical knowledge and abilities has "deteriorated to a dangerous level" (Brown, 2009, p. 3). Too few students want to study further mathematics (Willoughby, 2000) 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 interrupt proficiency in participation and (c) nominate three (3) key indicators of instructional practice necessary for students to achieve and maintain a state of being 'proficient' as defined in the Australian curriculum: mathematics (ACARA, 2010). An alternative, poststructuralist reading of how the learning process impacts engagement and ultimately proficiency may interrupt taken-for-granted humanist assumptions that currently inform the teaching and learning of mathematics.

Lauren 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). For Resnick, and indeed 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 [with/in mathematics] (Luke, 2010). 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, 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 investigations in, and after, schooling. It may be useful to try to think again about what sorts of interactional strategies might have some effect in enabling students to creatively use and apply constructed knowledge.

However, great care is needed; as Foucault said "everything is dangerous" (1982, p31). 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 transfers 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 psychological understandings of learning with poststructuralist concepts that talk to how it is that learners are constituted as 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 strive to establish themselves as proficient but are not always 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 and Rabinow, 1982); I make this point because it is the field of operation that should be deepened and broadened. 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 imagined it in the past. 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 the psychological. 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. In other discipline areas learners are encouraged, at least some of the time, to speak, initiate ideas and show what they can do; they might put on a play, write a letter, create a health plan or organise a march to save the dolphins or another endangered species. Learning mathematics, however, too often ends up being experienced as one continual *close* 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; they might throw back the ball, but if ever they are to get in on the 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; that is, they must 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 it is commonly assumed 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) state: "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".

I think back to my own classroom teaching days, and the types of engagement I managed to make available to my students. I sought to have them understand the mathematics while enjoying the learning experience. I did the usual things with them, shopping activities, cutting up fruit to demonstrate fractional parts, measuring with arbitrary and standard units; at the time I imagined that my students would construct complex mathematical ideas that they would willingly and competently use in civic life. Too often this turned out not to be the case, and I now realise that while in interaction with the students we were consistently constituting me as a competent teacher, the students were constituted as dependent, denied the thinking and reasoning capacities that might enliven their participation and sense of themselves as competent and valued participants in the discourse. In those days I trusted that each small piece of knowledge constructed would be stockpiled and later used to solve important and serious problems in the wider world; 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:

	HUMANIST	POSTSTRUCTURALIST
LEARNER	Rational, coherent, autonomous. Proficiency is a personal attribute.	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 establishing oneself as proficient.
PROFICIENCY	An individual attribute	Constituted in the operation of the discourse

Table 1: Humanist and Poststructuralist notions of the individual

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*; 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 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*.

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. These are interspersed with classroom scenes where the teacher moves around the room asking short calculation questions of the whole class. Her questions and instructions are presented to the whole class, whether she is referring to the children as a whole group or as individuals. 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. 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 the learner she makes dangerous assumptions that render invisible the possibility that:

- The students are not engaged in doing mathematics (from a psychological perspective), 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).

Comment from the teacher:

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.

In classroom scene:

Teacher: 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.

Comment from the teacher:

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.

In classroom scene:

Teacher: Have a quick check of that one, Misha. You should be showing me twelve.

Comment from the teacher:

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

Looking closely at this snapshot of learning, it becomes clear that mathematics education is played out to position learners in relation to a community that makes some practices possible, and others patently unthinkable (Britzman, 2003). In this classroom, on this day, there seems to be little opportunity for students to actively engage in logical reasoning, develop analytical thought processes or problem solve (ACARA, 2010). It 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. Although there is some reference to some direct teaching that precluded this lesson, the teacher says "they have got a method or strategy that we have talked through together", an opportunity to help Michael and the rest of the class investigate multiples is missed. Learning is more or less taken for granted and the emphasis is on the military precision of the teaching. Although the teaching is meant to be a two-way process where "pupils are expected to play an active part" their role is restricted to answering questions (Dfee, 1999, p. 14). Here the culture of the classroom is one of control, of indomitable regulation that leaves no physical, social or emotional spaces for learners to imagine themselves as competent and confident numerate citizens of a global world. Some of them may eventually answer the many questions and even pass the exams, but because they are constituted to respond and obey rather than investigate and innovate, their flirtation with mathematics is likely to be short lived.

Poststructuralism is a useful lens to add here because it looks past structural linguistics to interrogate meaning; it makes visible specific discourses at meanings origin, and the truth effects of what is claimed to be the case. Here 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*. How can this be?

Teachers worldwide continue with these sorts of interactional patterns because they subscribe to (have been constituted through) humanist views of the learner; unlike poststructuralism, they do not recognise that the learning process can either support or suppress levels of meaningful engagement in mathematics. The humanist teacher essentialises students as uncomplicated, either “motivated” or unmotivated, 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 student centred and 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 students’ construction 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. Students should be able to recognise themselves as legitimate participants of the learning mathematics discourse; they need to be acknowledged and valued as persons who have had experiences that can be used to enliven and enrich the learning of mathematics, and ideas and suggestions that can take the production of knowledge forward as a collaborative effort. 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 depends on it.

Key conditions of a practice supporting proficiency

From a poststructuralist 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 and Wenger, 1991) ‘situating’ learning in socially supportive contexts are premised on the rational, autonomous learner of mathematics. While each of these has contributed a great deal to 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 'make' mathematics relevant or real world; only the learner can sense relevance and speak his/her 'real world' as an emotional resonance and mathematical energy released in interaction in the teaching-learning community. 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, are delineated below:

Rigorous mathematical knowledge. Students 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 (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 level).

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 (which are constitutive).

Conclusion

Devlin (2000, p. 254) states: "The key to be able to do mathematics is wanting to". Unfortunately, as recognised two decades ago, although children come to school enthusiastic and eager to learn mathematics, they "leave school with quite negative attitudes" (*A National Statement on Mathematics for Australian Schools,* 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 practices are not able to demonstrate what proficiency demands: competence *with* the mathematics and *in* participation in its contemporary discursive forms (ACARA, 2010).

These practices, 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, unmotivated or anxious. Another reading of the situation suggests that students unfortunately find themselves in an untenable situation; the tasks they are given to complete 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. Too often students find participation in these tasks not at all compelling, because they are never in a position to control the learning experience and make sense of what they are doing; any mathematical muscle they do have becomes flabby and flaccid as engagement is superficial to engagement in mathematics as a social practice.

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. 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.

References

Australian Curriculum, Assessment and Reporting Authority. (2010). *Australian Curriculum: Mathematics.* Canberra, ACT: ACARA

Australian Education Council. (1990). A national statement on mathematics for Australian schools. Carlton, Victoria: Curriculum Council.

Ball, D. (2003). *Mathematical proficiency for all students: Towards a strategic research and development program in mathematics education*. Santa Monica, CA: RAND.

Bernauer, J. & Rasmussen, D. (1987). The final Foucault. Cambridge: MIT Press.

Britzman, D. (2003). Practice makes practice: A critical study of learning to teach. Albany, NY: State University of New York Press.

Brown, G. (2009) Review of education in mathematics, data science and quantitative disciplines. Report to the Group of Eight Universities. Canberra: The Group of Eight.

Department for Education and Employment. (DfEE) (1999). National numeracy strategy: Framework for teaching mathematics from reception to year 6. Sudbury: DfEE Publications.

Dreyfus, H. & Rabinow, P. (1982). Michel Foucault: Beyond structuralism and hermeneutics. New York: Harvester Wheatsheaf.

Devlin, K. (2000). The maths gene: Why everyone has it but most people don't use it. London: Phoenix.

Foucault, M. (1982). On the genealogy of ethics: An overview of work in progress. In H. Dreyfus & P. Rabinow (Eds.), Michel Foucault: Beyond structuralism and hermeneutics (pp. 229-252). Chicago: University of Chicago Press.

Hardy, T. (2004). "There's no hiding place. Foucault's notion of normalisation at work in a mathematics lesson". In M. Walshaw (Ed.), Mathematics education within the postmodern (pp. 103-120). USA: Information Age Publishing.

Killen, Roy. (2007). Effective teaching strategies: Lessons from research and practice. Sydney: Social Science Press.

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2006). *Adding it up: Helping children learn mathematics.* Washington, D.C.: National Academy Press.

Luke, A. (2010). Will the Australian curriculum up the intellectual ante in primary classrooms? Curriculum Perspectives, 5, 10. *(In press*)

Lave, J. & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge: Cambridge University Press.

Masters, G. N. (2009). *A shared challenge: Improving literacy, numeracy and science learning in Queensland primary schools*. Camberwell, Vic: Australian Council of Educational Research.

Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) (2008). Melbourne declaration on educational goals for young Australians. Canberra, ACT: MCEETYA.

Resnick, L. (2010). Nested learning: Systems for the thinking curriculum. *Educational Researcher*, 39, 183-197.

Vygotsky, L. (1978). Mind in society. The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Willoughby, S. (2000). Perspectives on mathematics education. In M. J. Burke & F. Curcio, Learning mathematics for a new century (pp. 1-15). Reston, VA: National Council of Teachers of Mathematics

Walshaw, M. & Anthony, G. (2008). The teacher's role in classroom discourse. *Review of Educational Research*, 78, 516-551.