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Lifeworlds and the 'w/ri(gh)ting' of classroom research

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This paper is about re-representing the lifeworlds experienced by different participants in the 'same' physics classrooms; dissatisfied with the monolithic accounts that dominate the educational literature, we offer here an attempt to w/ri(gh)te classroom research. This paper, therefore, has a dual purpose: We exemplify how authors might want to represent different perspectives on the 'same' classroom and we build on this example to argue for w/ri(gh)ting research by drawing on literary forms that differ from traditional master narratives. W/ri(gh)ting requires reading in new ways; by skipping text, readers risk missing out on the reflexivity of our argument.

Interviewer: Rona, do you think students feel free to speak out in your classroom?

Rona: Mr Sparks will joke around with me, you know he'll tape my shoes together or something like that, and everyone will laugh at me and that, you know, gets frustrating.

Interviewer: Mr Sparks, do you think that students feel free to speak out in your classroom?

Sparks: I'd be very surprised if anyone felt a bit timid about speaking out. We've got too good a personal relationship going, and [given] the type of class, I would be surprised if they felt hesitancy or timidity out of fear or out of inferiority.

Interviewer: Rona, I wonder if you could elaborate on your view of the nature of the relationship between Mr Sparks and students in your class?

Rona: He sort of tends to be—you know—'You're the little people and I'm really good and I am teaching you so you just have to sit there and listen when I want you to'. He doesn't sort of let us get the chance to speak up or anything like that. I think most people are scared of him, 'cause most people get really scared of their teachers' reactions if you question anything about the teachers themselves.

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In these interview excerpts, a student and her physics teacher (all names are pseudonyms) talk about their experiences in the same suburban classroom of a large Australian school. The two experiences are quite different, and, as we found out in the course of our 6-week stay, many students' experiences interfered with understanding what they were supposed to learn. At the end of a unit on rotational motion, written tests and interviews with students showed that only three of the 24 students in the class could talk about rotational motion, the topic of the unit, competently and in scientifically correct ways.

> *Fieldnote*: Mr. Sparks is a well-regarded teacher in this school, very well educated, kind, concerned, full of enthusiasm for creating new demonstrations and laboratory hardware which he willingly shares with his science teacher colleagues. He offers students to call him at home whenever they have problems in learning physics. He willingly answers questions students may have after class is over and does his best to help students with their problems. However, while he lectures (which includes many demonstrations), he does not encourage questions from the students and deals with those that do come in an almost abrupt manner.

As physics is a key subject for university access in Australia, this situation implies success (high grades) for some students but also a shaking out of career options for others (e.g. Roth and McGinn 1998). We re-represent a learning environment through a 'bricolage' (Denzin and Lincoln 1994) of texts from interviews with the students and the teacher, our research notes, quotes from the writings of Derrida and Bourdieu, and our own professional discourse. This bricolage disrupts attempts to produce one master narrative. But this form of w/ri(gh)ting also requires new ways of reading, for 'quotes' are no longer supportive adjuncts of the main narrative, but co-constitute the main text through their intertextual relations to other parts of the text.

> *Interviewer*: Mr Sparks, do you think students feel free to speak up and voice their needs?
>
> *Sparks*: They're certainly free to complain about anything that prevents them from learning. I have few complaints, I would think they would feel free to complain. But I would also think that from their view they don't really have a lot that they would want to complain about. If they wanted to complain I think that most of them would be happy to express themselves.

Mr Sparks and Rona's descriptions of student–teacher relations are a testimony of differences. For example, we hear differences that arise from the knowledge Rona ascribes to Mr Sparks. However, she not only ascribes a greater degree of knowledge to her teacher, but she also experiences him as belittling students because of his knowledge and role as a teacher. Furthermore, she experiences strictness in this difference in knowledge/power, so that in the end she sees students as scared and intimidated. Mr Sparks on the other hand perceives, and therefore lives in, a different world.

> *Interviewer*: Rona, do you think students feel free to speak up and voice their needs?

> *Rona*: I don't know, but Mr Sparks really seems to intimidate people. He tends to be a very strict sort of teacher as in, 'You know I have got the book, I know what I am talking about, you are going to get it wrong anyway'. I don't think he likes to accept the fact that he has made a mistake at anything.

The Self that emerges from Mr Sparks' narrative is open and has good relationships to students so that they really should not experience timidity, hesitancy, fear and inferiority. As he repeatedly suggested during interviews (supported by his fellow teachers and school administrator), in his lifeworld (table 1), he has done everything to prepare students for university access and for future tertiary-level physics studies.

Researchers have often blamed either teachers or students for what were perceived as the problems in classrooms. On the one hand, there are reports that students do not learn science because the teacher had not provided the 'appropriate' (e.g. constructivist) learning environment (e.g. Tobin *et al.* 1988). On the other hand, the media are full of reports blaming teenagers for violence in schools and classrooms. Our intent here is not to lay blame on the teacher because he should have taught better or should have had different teaching referents; neither is it our intent to blame students for failing to learn, for exhibiting low motivation, or for having cognitive deficits. Our intention is to provide readers with an opportunity to create, through engaged reading, their own representations of the different lifeworlds, the different experiences in what might be understood as the same (physical and

> [*Voice over*:] The morsels, which I cut [*coupe*] and sew [*couds*] in the text designated by the one named Genet, must neither destroy its form or quash its (prompting) breath (do not say its unity, the question posed here being one of knowing whether *a* text could be *one* and if such a thing exists any more than a unicorn), nor recompose or recapture [*ressaisir*] its integrity in one of those nets [*filets*]—formal or semantic—that we have feigned to throw and rethrow without counting (Derrida 1986: 169).

Table 1. Features of lifeworld analysis.

For learning-environment researchers interested in lifeworld analysis, it is useful to distinguish two aspects of human beings' relationships with their familiar environments: *embodiment* and *embedding* (Agre and Horswill 1997). Embodiment is concerned with individuals' physical body, the finiteness of their resources, the limited perspectives on the world, the indexicality of their perceptions, the particularities of the physical setting, and so on. Embedding pertains to individuals' structural relationship to their social and material worlds, including habitual practices, connections to other people, and their perceived position in sets of roles and hierarchies. Curriculum research from a lifeworld analytic perspective, therefore, has a crucial role in helping to understand the (physical, social, perceptual) conditions which afford or interfere with learning (Roth 1999). Only if we know what an individual's perceived environment is like can we determine if given patterns of behaviour are adaptive. The same physical environment, e.g. a kitchen or a physics laboratory, affords different kind of activities to a chef or a physics teacher, though the lifeworlds of these two may overlap. We feel that lifeworld analysis and the conceptual dimensions of embeddedness and embodiment provide a useful and fruitful framework for conducting research on different aspects of learning environments.

Table 2. Relationship between language and reality.

In our analyses, we understand language not as an expression or representation of reality, but as a means of producing reality in public discourse, including 'beliefs', 'desires', 'attitudes', 'Self', 'reality' and 'world' (Roth and Alexander 1997). We, therefore, analytically examine the ways that conduct, belief, and judgement are organized, produced and made intelligible in members' own accounts and descriptions, and how these are embedded in various other practices (Jayyusi 1991). We take our participants' talk as ways of bringing about and accounting publicly (in the interviews) for *their* lifeworlds, that is, the physical and social worlds *they* experience and, therefore, the learning environments that afford or interfere with their learning. World-making always happens in a current conversational context, is situationally coherent, and in a way is taken as legitimate for the purposes at hand.

social) setting. Through the narratives of the participants in this learning environment (Mr Sparks, Rona, researcher's fieldnotes), we re-represent the different lifeworlds affording and constraining different actions and social practices for each of the participants. (For the relation between the different narratives and 'reality' see table 2.) We find that behind this heterogeneity lie textualizations that are too different, permitting only minimal interactions and, therefore, minimally-commensurable lifeworlds. Rather than completing this story in despair and drawing on the authors' experiences as physics teachers, we show what could happen if students and teacher engaged in conversation to construct convergent interpretive horizons and more commensurable lifeworlds.

Methodologically, we use a form of representation that interferes with the construction of dominant narratives by one or the other participant (e.g. Derrida 1986). Of course, as 'authors' of this text, we cannot but take ultimate responsibility for text selections. This is, therefore, *our* way,

> [*Voice over*:] The way to solve the problem of realist inquiry is by a concentration on textuality and by the articulation of a practice of wrighting [*sic*]. This will include the use of new literary forms; though the problem of developing an adequate reflexive practice is unlikely thereby to be automatically solved (Ashmore 1989: 110).

to construct, with hindsight, a particular world. We do not pretend that we can write *the* authoritative story of events (for an analysis of 'wrighting' research see Ashmore 1989); but we attempt to produce a text that provides the grit to the readers' work of reading. Participants' textualizations (including our fieldnotes) parallel, complement, intersect and disrupt each other; this allows us to escape, at least to some extent, the linearity of traditional research accounts which tended to marginalize and delete feelings, emotions and ideas of those whose ways of knowing are different from mainstream science (Barton 1998). We invite readers to submerge themselves in the multiple experiences in a physics classroom through our kaleidoscopic bricolage of texts.

> *Critic*: In your preoccupation with wrighting and w/ri(gh)ting research, you seem to forget reading and the reader?

Author: I w/ri(gh)te because I try to eschew those realist discourses which (attempt to) influence one single reading; that is, I w/ri(gh)t in the attempt to avoid those coercive discourses which desire the chimera of the guaranteed reading.

Critic: To me, your w/ri(gh)ting is profoundly problematic. I find myself skipping the marginally-placed data and wondered how and where they fit in with your argument.

Author: In skipping what heretofore have been marginal texts, you miss out on the experience I was trying to prepare for you. My bricolage of different texts asks readers to engage in reading *as work*, constructing intertextual relationships, rather than consuming the text in unproblematic ways. By skipping, you miss out on the experience of this reflexive text.

More images from the lifeworlds in a physics classroom

Demonstrations and hands-on discovery activities have been a stable feature of science education for decades (Tobin 1990). These activities are thought to assist students in learning canonical science in part because, from a realist perspective, they allow students to *see* scientific laws in operation. However, philosophers of science suggested that all observation is theory-laden (e.g. Feyerabend 1975). If so, rather than discovering a world full of, and built by, scientific laws, students' perceptions and interpretations will disclose worlds that are consistent with the common sense they bring as fundamental cultural fall-back theory to class (Roth *et al.* 1997a). Thus, rather than viewing a demonstration in the same way, teachers and students are more likely to see different events with the result that subsequent developments of a theoretical framework on the basis of the presumed shared experience will likely not make sense to students.

Sparks: [picks up a bicycle wheel and sits down on his turning stool. Watch me now.] So alright now, there are a few other ideas we can put together with this, I got the bicycle wheel; some kind child donated it. Now just watch very carefully; at least you can see the part you need to see, that is the top of my body and the wheel. Right, watch carefully.

Rona: I think he should spin in the opposite direction as the wheel. Like if he spins it clockwise or something, I think he should spin it in the opposite direction. Because of what he did the other day. I think he should slow down, I think he should slow down, maybe stop or something.

Fieldnote: We asked students to predict, observe, and explain what would happen if a person on a rotating stool were to spin a bicycle wheel and later interviewed them about their written answers. We found that a majority of students (19 of 24) did not see the events in the same way as Sparks. We should, therefore, not be surprised that students' explanations were incompatible with the scientific canon. In fact, students' explanation of the demonstration appeared to be a bricolage of common sense, vaguely remembered images from other demonstrations with surface similarities, scientific words from different contexts.

From a classical perspective, students' failure to see and understand events in a scientific way is often conceived in terms of cognitive deficits (e.g. Heller and Reif 1984) or in a reverse attribution of blame, ascribed to teachers' failure to enact curricula that engage students in ways which allow them to construct meaningful knowledge (e.g. Tobin *et al.* 1988). However, a social practice perspective is more likely to focus on the extent that opportunities existed for individuals of heterogeneous competencies to co-participate in democratic practice. Here, then, failures of learning science are conceived as lack of opportunities (1) to co-participate in the practice; (2) to see practice-related principles in action, including false starts, waverings, impasses and renunciations, without necessarily having to thematize any one of these behaviours; and (3) to receive assurance, reassurance and corrections.

> *Sparks*: [The chair wobbles a bit.] This chair isn't very good, I'll try that again. [The chair makes about an one-eighth of a turn.] Did you just see it? Look again, look at my body mainly. What was my angular momentum just now? Zero, I'm isolated sitting in this awkward-looking position. When I spin it what do you notice?
>
> *Rona*: He turns, but just slightly, very slightly. Oh no! I was thinking the wrong thing. I hope he won't ask me. It would really help me a lot more to understand a lot more about what I am looking at if we were to talk about it. But not in front of the class. I am just going to believe him. I just sit there and say 'OK, he is saying it, it must be true, we wouldn't have a clue if it is or not'. I just listen to him and hope that he is right.
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> *Interviewer*: What did you want students to learn from this demonstration?
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> *Sparks*: One of the facts provided was how to measure angular momentum as a vector. How we find its direction, and using the right hand rule, so they should have come out of it knowing how they could find that axial vector. They should have come out of that with some appreciation of the knowledge that angular momentum is conserved in a closed system. I kept apologizing for the friction in the wheel which interfered with my... Well, once I started moving in one direction, I didn't continue it. I did slow down. So that was the limit of the experiment and I hope that I just illustrated the problem of the friction slowing me down as a side issue.
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> *Interviewer*: Rona, I noticed that you and others saw different things in Mr Sparks' demonstration? Can you explain how this is possible?
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> *Rona*: I don't think Mr Sparks should be surprised if we found something new or different. Now that I've done physics and chemistry for the last couple of years, you tend to pull something new out of it every time so that you might find something and someone in the class might see something new that you've never seen before.

Seeing the physical and social world in different ways is not inherently problematic. However, students are also evaluated regarding the extent to which their own representation of the world maps onto those of the teacher. The extent of overlap (often expressed as a percentage) is expressed in another form of representation: grades. Grades, as all representations, are inherently political in that they embody the ideologies and agendas of their authors. This does not seem to be the case when school science is presented

in decontextualized ways. However, school science knowledge, especially as assessed by teachers and converted into grades, become representations of students that are clearly political (Roth and McGinn 1998). Grades, as teacher-authored representations of students' knowledge and abilities, are no different. In a less obvious, but more insidious and pervasive sense, representations (of achievement and work) are active elements that shape the relationships of people to each other and with settings (Suchman 1995).

> *Rona*: Some of the boys stick their nose up at us. They think they're really good at physics because they get really good marks. Like Sean gets really annoying sometimes because he is like, 'You know I get really good marks and I understand it'. When he and Jon take over all the lab activity, you just sort of feel like saying, 'Oh, don't worry about it because I'll manage'.
>
> *Fieldnote*: The top five students, all with very high achievement (A, A+), are male. Grades in this class are a considerable resource for constructing Self in relation to science, here physics. Some boys use grades to construct themselves, discursively, as interested, strongly motivated students who have decided to get down to business and do the hard work. They construct female students as the polar opposites.
>
> *Sparks*: I have never felt that they either the boys or girls have felt that they've been left behind or treated secondly, or getting a second go at using equipment. In other words, as far as gender, I mean gender has always been a non-issue.

Because of the identification of individuals with the representations, science-related Selfs may be shaped along gender lines even if teachers were to treat all students equitably. Representations such as grades consistently delete individuals' contributions to collective achievements in the service of 'grading' (i.e. sorting) individuals into standard curricular trajectories (Roth and McGinn 1998).

> *Fieldnote*: Male students associate their female peers, like others who do not achieve high marks, with low learning motivations or as incapable of coping with the required work. They define themselves and their relation to physics in stereotypically different ways. As a consequence, these male students take things into their hands and complete the tasks to be done, relegating the female students to mere bystanders.
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> *Sparks*: All of the girls take as many science-oriented subjects at tertiary level as the boys, never any less. They are just as frequently in engineering [and] pure science. The ones who don't go into science, go into a set of arts-law-journalism, which is perhaps with about the same frequency as boys might. Sometimes a girl has been very conscientious, you can see them [sic] struggling more, asking for help more. I try to get the message across, even if you're not succeeding now, stick with it, because 3 or 4 years down the track it might all come together. I'm sure there are some who are a bit embarrassed and quiet because it shows up their ignorance. They're not keeping up with their home study, so they keep quiet.
>
> *Rona*: But when you actually sit down and think about it you think, hang on, it's affecting my marks. He always takes over, it drives me mad. Like you say, 'I'll do this', and he says, 'No, this is how you do it'. And then he puts it on

> the table when he's finished, and it drives me mad. That's what Sean is like with females, you know 'Oh, but you're girls'. He always does it, he's really sexist basically; it drives you insane.
>
> [*Voice over*:] Assessments such as the Third International Mathematics and Science Study (TIMSS) (e.g. Robitaille *et al.* 1996) afford social scientists the opportunity to construct phenomena, but the phenomena only exist because of the assessments and the numerical representations that are said to stand for each student, or some category including nation, state (province), gender and race. Grades are frequently used to construct gender differences in achievement. Thus, 'the phenomenon of gender differences in science education exists because grades are accumulated and operated on by a statistical apparatus and the results mapped onto the category of gender. Researchers use grades as transparent tools to make judgements about gender or employ grades in mathematical equations (derived from statistics) to predict the success either student is expected to achieve in a particular post-secondary programme' (Roth and McGinn 1998: 415).
>
> *Rona*: And I just find that Mr Sparks only really takes the opinions of the really intelligent people who listen a lot. I mean workwise, he works with anyone, but when it comes to someone's opinion, it is only really the intelligent people like Sean who know what they're talking about. The opinions of the others don't count. But I am not that intelligent.

Mr Sparks, as is the case with his fellow teachers, is responsible for assigning grades. Grades are treated as a symbolic capital of which students require as much as possible should they seek university entrance. They are in crucial positions, obligatory passage points for those who need the capital that grants them access to university and, thus, a translation of symbolic capital into real financial capital. In schools, as in many other institutions, relationships between participants have been stabilized for long enough to generate the effects and so the conditions of power.

> *Sparks*: Despite how well-meaning we like to think we are, we engender fear in the kids. Especially if you give the impression that you know most of the answers and children become fearful of that and I could very much accept the point that not in a wrong way I engender fear, like nobody would think that Mr Sparks is about to shout them down or abuse them or slap them, but you may get children in awe of a teacher.

However, power is not something that can be conferred, or is associated with a particular position. Rather, uses of power should be treated as relational products; thus, to store power or to have discretion in its development means to enjoy (or suffer from) the effects of a stable network of relations (Law 1991). In schools, the power/knowledge divide accrues from the different positioning in terms of scientific knowledge and assessment discourses: scientific knowledge is viewed as a commodity dispersed by teachers, who are also the auditors who assess the degree to which students have acquired and stored this commodity. School science learning-environments can be viewed as places of transition, with their specific rites of passage (Costa 1993), where students accumulate cultural and symbolic capital that permits them to reach their ultimate goals beyond schooling. Those who control the dispensation of knowledge (i.e. cultural capital) and grades (i.e. symbolic capital) are in positions where they may

construct differential power relations and enforce conformity (Roth and McGinn 1998).

> *Rona*: He doesn't sort of let you say anything about your rights as a student, you know you have the right to do this. It is more like, 'I am the teacher I have got more rights'. It's like, you know—we might turn up late for class or something but have a really good excuse like we've been to see another teacher and he says 'You should do that in your lunch time'.
>
> *Fieldnote*: I struggle with the notion of power for, in this classroom, I cannot see it. Ethnomethodologists insist that notions such as power only have descriptive value for *a posteriori* accounts rather than prescriptive value that would allow us to predict the particular form of an interaction between two differently positioned individuals, such as a student and her teacher. But, in this class, it is clear that events, transitions, activities are planned, prepared, started, and terminated by Mr Sparks. In contrast, there are other classrooms where students do science even in the absence of the designated teacher, where students control the sequence and nature of activities, co-participate in assigning term grades (60%of the total), and where teachers and students not registered for the present class are also present in the same room and shape the learning environment (Roth 1995).

Power is a technique that achieves its strategic effects through disciplinary character that, in many cases, is used to create and regiment obedient bodies through assessment mechanisms (Foucault 1975). Resistance to regimentation, Foucault maintains, only demonstrates the necessity of the discipline that provokes the resistance in the first place. Assessment is part of a disciplinary practice that constitutes power and is a form of knowledge in and of discursive practice (Clegg and Wilson 1991). This knowledge disciplines the body, regulates the mind and orders the emotions in such a way that ranking and the resulting hierarchy produces a basis for the productive worth of individuals as they are defined by these new disciplinary practices of power.

> *Interviewer*: Rona, you suggested earlier that there are differences between what Mr Sparks and students can do in this classroom. Can you elaborate on this point?
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> *Rona*: Well, if *he* turns up late it is just, 'Well I am the teacher'. So he sort of doesn't accept the fact that students are the same as teachers but teachers are just older. He sort of tends to be, 'You know, you're the little people and I'm really good and I am teaching you, so you just have to sit there and listen when I want you to'. He doesn't sort of let us get the chance to speak up or anything like that. Obviously we want to pass the course so we're pretty much going to do anything he wants us to do.
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> *Interviewer*: Mr Sparks, some students in your class suggested that they have little input into this class.
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> *Sparks*: Effectively I'm conducting the course, I'm taking the lead. I'm not one of those teachers who has a subject like English, where you can ask, 'What interests you? Shakespeare? Shakespeare—right, Shakespeare'. I don't have that liberty, so students don't have any input. And neither do I have the liberty of saying that we've got 6 weeks for a project, now how do you think we should handle that. Class, whole-class, small groups, individuals—what should we look at; we don't have that time and that perhaps also reflects the

> way, that's not the way I teach. We've never had that opportunity in physics to say 'Well now, let's all sit down and plan and give me your suggestions [about] how you think I should run the course'.

Learning is inhibited when individuals merely cope with their situation rather than actively forming and transforming their learning environments. Gaining legitimacy in a practice is a problem when teachers act as pedagogical authoritarians who view learners as novices who should be instructed by direct teaching (Brown and Duguid 1992); but the daily practices of out-of-school communities can also be disenfranchizing and interfere with learning (Lave and Wenger 1991).

> *Sparks*: I can't find out individually from everyone, simply because of lack of time—I simply don't have the time to get to them. Time precludes doing this course another way; nothing is ideal and I just reconcile myself to that. I just don't think the circumstances are practical—and it's not the best—but then reality means that when they finish this we've got atomic physics, nuclear physics, and time disappears. I'm aware that there are some, no matter how much detail you go into, no matter how much time you spend, who never get the point. When I give a test on that nowhere near 100% will ever get that sort of stuff right. So I have to reconcile myself to that, as hard as that is.
>
> *Rona*: When it actually comes to explain stuff, I can never relate to what we have done and how to give an explanation to anything. Because I don't know, I just write anything that I think relates to the question. Like you might get five marks for just one question or something, and mark it like you have got the equation written down then you get one mark, and if you have got a bit of work then you get two. So what I try to do is just rewrite the question in numbers and that like you know, just say the velocity is this and you just write V equals. So just do that and you might get one or two marks. If I can't do the question, I just write down formulas and anything I can read from the question, and hope that it will get me some marks.

In this process, both teachers and students engage in activities that have little to do with the culture into which students are to be inducted. Students and teachers appropriate and enact interstitial practices, practices characteristic of the formal institution of learning and compliance to its requirements, which pre-empt participation in ongoing practice as a legitimate source of learning opportunities. Compliance with the current structures of schooling, as perceived by different individuals, engenders coping and reconciling behaviour. But these practices have little to do with the kind of democratic educational practices which we envision and practice. Students and teachers in many institutions therefore simply live with the conditions and in compliance with their situations as they perceive them.

> *Fieldnote*: With so little interaction between Mr Sparks and his students (e.g. concerning the subject matter, learning and teaching, and changes to the learning environment), it is no wonder that they all appeared to have made a silent agreement to settle for the lowest common denominator: the teacher asked for minimal comprehension and gave predictable tests which asked for plugging numbers into formulas. Students prepared for these tests but did not engage with physics as a way of knowing and making sense of the material world. They did not pay attention in class, or attempt to understand.

In this case, this means living with the fact that teachers take most responsibilities and students relegate themselves to passing tests, no matter where they fall on the scale of participation, because they live in landscapes (of their lifeworlds) shaped and being shaped by the personal histories of each and every participant. Yet, there are ways out. The power of an emancipatory (postmodern?) analysis is to move from the experience of being an outcast or castaway to an understanding that given learning environments are not inevitable, however entrenched or stabilized. We can always bring the eyes of a strangers to such experiences and think about how it could be made otherwise.

Transformations ... in theory ...

Much of school science teaching uses metaphors rooted in information-processing: 'Providing students with information', 'getting the material across', and 'providing students with (drill and) practice' are characteristic of the talk in school staffrooms. Teaching is, therefore, frequently concerned with providing culturally-sanctioned knowledge as information to the learner.

> *Sparks*: I would not like to see the physics just be watered down from content just to discuss the sociological impacts and know no physics, no academic physics as such. There's too much of this in the junior school, watering down of the content of science, that does disturb me—and pressures to give it less and less time in the timetable.

More so, staying with the information metaphor (including storage and processing), science teaching is frequently concerned with the transfer of information. (The computer revolution and internet have changed little; for example, teachers and media speak about information as being at the students' fingers as long as they have access to the internet.) Despite much classroom research on science learning, and despite teachers' realization that students 'just don't get it', there has been little change in most science teaching (McRobbie and Tobin 1995, Tobin and McRobbie 1996). Failure to learn, however, is an inevitable consequence of current classroom learning environments, when we describe them in terms of an epistemology of practice. Epistemologies of practice focus on what people *say* and *do* rather than on what we *might find* between students' ears and underneath their skulls. Thus, when students do *sit still*, do *take notes*, and do *listen*, we expect them, from an epistemology of practice perspective, to learn to sit still, take notes, and listen. We do not expect them to learn to conjecture, hypothesize, experiment and so forth.

In recent years, many researchers have begun to realize the tremendous efficacy of learning and teaching in communities of practice (Lave and Wenger 1991): by co-participating in the everyday activities of some practice, newcomers complete learning trajectories that lead to increasing co-participation and competence. This participation, depending on the particular community, can range from quiet observation to active participation in the ongoing activity. The actual level of participation depends on

the current position of the individual along a trajectory of participation in the community and on the nature of the community itself.

> *Bourdieu*: [Well, I have changed my teaching as I evolved my theoretical position.] Instead of giving a formal exposition of the notion of structure in modern mathematics and physics and on the conditions of applicability of the structural mode of thinking to sociology, as I used to do twenty years ago (this was undoubtedly more 'impressive'), I will say much the same thing but in a practical form, that is, by means of very trivial remarks and elemental questions—so elemental indeed that we too often forget entirely to raise them (Bourdieu 1992: 222; paraphrase in brackets added).
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> *Rona*: I think this would also be a valid approach for our physics course. For example, it would really help if we had the time to talk more through actual practical things. Like if Mr Sparks did it the same time as the students. Instead of him saying, 'This is what you do go and do it', I reckon if he said, 'Put this here' and 'Why you did that?' or if he said, 'Push the ball' and why you did that. Then we could say, 'Oh, yeah'.
>
> *Derrida*: [I am with the two of you on this one. Without exchange,] education could be a loss without return, a gift without countergift ... But in truth exchange takes place. The other consciousness, the child's, in which the parents lose theirs, is their own proper consciousness. The other and one's own proper(ty) do not oppose each other, or rather yes, they oppose each other, but the opposition is what permits, not what interrupts, the specular, imaginal, or speculative circulation of the proper, of one's own proper(ty) (Derrida 1986: 134; paraphrase added).
>
> *Author*: Both of you, Bourdieu and Derrida, had influenced me long before I had spend the six weeks in Rona's classroom. Thus, cognitive apprenticeship appeared to me consistent with your position. For example, in Mayan society, becoming a midwife initially involves quietly listening to stories of birthing through bearing one's own child, to more intensive apprenticeship with an older midwife, and finally to becoming midwives themselves; in physics, newcomers learn by co-participating, as graduate students, in increasing ways in doing (talking, building, measuring) physics (Traweek 1988, Jordan 1989).
>
> *Critic 1*: I don't think that Mayan midwives are a particular good model for schools.
>
> *Author*: But, in my own experience, co-participating in physics as a set of heterogeneous, research-related practices (including design of experiments, statistical analysis of data, presentation of research reports) was a powerful learning environment in high school science (Roth 1995).
>
> *Critic 1*: I have a problem with the notion that co-participation is the hallmark of learning regardless of the culture that not only the author of this text, but that all of the previous speakers just advanced. I have taught many Asian students over the years, and they typically become puzzled by the modern Western tendency to diminish the importance of quiet observation and keen attention to the wisdom of others, particularly elders. If co-participation is essential to learning, you need to explain how some cultures eschew it entirely and seem to function just fine.
>
> *Author*: My phenomenologically-inspired response is grounded in the experience of always and already finding ourselves *in* material and social worlds, already populated with individuals and institutions, and with their

historically evolved (power) relations. Thus, co-participation in material and social worlds is the beginning of our (phenomenological) theorizing which begins with this experience. According to phenomenologists, there is no Self, Other, world, or any experience possible unless we co-participate.

Critic 2: Hold on before you get too far! I, too, have a problem with the notion of co-participation, especially 'when teachers act as pedagogical authoritarians who view learners as novices' or when 'learners are seen as in a community engaged in its cultural production and reproduction'. For me, both forms of co-participation are pretty much equally distasteful.

Author: In my own use and that of other colleagues, cultural production is a positive aspect of co-participation, because it involves the individual's productions which may enact or transgress habitual practices. As I think about it, I notice that I have shifted the referents for teaching science from 'preparing scientists' to (environmental) activism and stewardship. Rather than trying to make all students think and talk like a scientist (which sounds like indoctrination anyway), I now want students to become competent participants (along the lines of their own aspirations, inclinations) in everyday science-related activities. At the same time, I already enact and recommend to others science classrooms in which students co-participate in the setting of curricular goals and assessment of learning outcomes (Roth and McGinn 1997, McGinn and Roth, 1999).

Rona: In my classroom, it doesn't work like that. I don't know, Mr Sparks is just one of those people that are very intelligent, and that sort of puts you off a bit sometimes because he'll sit there and explain a question or something and you'll say you don't understand it and he'll sit there and explain it again but in exactly the same way, and you sort of say 'I don't understand' but you can't sort of say, 'Teach it a different way. I don't know what you are talking about', 'cause he gets really annoyed and says, 'This is the way I'm supposed to teach'.

A phenomenological argument begins with the fundamental presupposition that the world comprehends (in the sense of comprises) the individual subject as one material thing among others. But, for a world and its things to be, the individual has to comprehend (in the sense of understand) this world through its own object–object, subject–object, and ultimately subject–subject relations. Through the material inclusion in the world and what follows from it—the incorporation of social structures in the form of dispositional structures (i.e. Bourdieu's (1997) *habitus*), hopes, and anticipations—the individual acquires knowledge and a practical mastery of the enveloping (material and social) space. But, practical understanding has to be understood through its opposition with scientific explanation and the conditions of these two forms of understanding. Learning is, therefore, an adaptation of the individual body (physically, mentally) to the social and material regularities of which only a small number are explicit and embodied in semiotic (linguistic, mathematical, iconic) systems.

Fieldnote: In this demonstration, the teacher is already aware of what students are to see. He sees the world, or has the competence to see the world in a canonical way. The students do not have this competence, and thus have difficulties assessing whether what they see, their world, is what

they are supposed to; or whether the action they are taking based on the plan (i.e. instruction) is the one that will reveal the phenomenon the teacher wants them to construct.

Bourdieu (1992) insists that there is no other way of mastering the fundamental principles of a practice (which in the present situation would include planning physics experiments, representing nature and writing applications) than by practising it alongside a more experienced other who applies precepts, provides assurance, reassurance and corrective feedback, and who sets examples, *in situation*, directly to the *particular* case at hand. Bourdieu further insists that there is no other way to acquire modes of perception than through co-participation—with a more experienced member—in practice-relevant situations and in the face of practical choices, without necessarily explicating (or being able to explicate) these choices in the form of formal precepts. Co-participation in worlds of practice 'causes us to do what we do at the right moment without needing to thematize what had to be done and still less the knowledge of the explicit rules that allows us to generate this conformable practice' (Bourdieu 1992: 224). The central aspect for the design of learning environments then is *not* how to get the explicit across in a better way, but in designing learning environments such that the implicit is engaged and developed in such a way that it usefully constrains the understanding of the explicit.

Transformations ... and in practice

For curriculum praxis, we need to know what kind of experiences students and their teachers need in order to come to this shared sense of a learning environment which affords, rather than interferes with, learning: students coming to participate in the teachers' worlds, and teachers coming to understand students' struggles of the learning journeys into the unknown that each and every student has to traverse. From a phenomenological, democratic perspective, if students and teacher are to get to know each other's worlds, they have to engage each other (Roth 1999). Rona can be understood as voicing a participant's desire for more conversations, not only about the subject matter but also about the conditions of learning. To achieve this, participants have to enter each other's lifeworlds by co-participating in parallel discourses that deal with the products and processes of learning, and that do so in democratic ways. Our personal observations in this and other physics classrooms around the world suggest that interacting with others, discussing experimental results, explaining each other's ideas and constructing phenomena in small-group and whole-class sessions are listed by students as their greatest need. Rona and many of her peers suggested that they needed more sense-making conversations among each other and with the teacher. In a transformed classroom, there will be conversations about teaching and learning.[1]

[Scene 1:] Rona and her group-mates are sitting around a table where they had just completed an experiment in which they heated ice which melted and became water which was heated in turn to the boiling point and evaporated.

Mr Sparks has joined the group and asked the students whether they could bring together, in one explanation both the macroscopic description (ice, water, vapour, melting, evaporation, melting point, boiling point) and the molecular model.

Rona: During a change of state, the molecules don't gain any kinetic energy.

Jon: Because, during a change of state, they don't change the temperature. They are, they're gaining or loosing energy—depending.

Sean: Oh, during the change of state, energy is taken so that molecules can escape.

Rona: During the change of state, how does the potential energy—doesn't exactly the motion of the molecules increase the volume?

Jon: It's the potential energy, it depends on how far they're spaced apart.

Sparks: That's right, how far they're spaced, that's their potential energy and the kinetic energy, how much they move and how much they vibrate. Water molecules can also vibrate and turn around their own axis, this also is kinetic energy.

Rona: What I don't understand is, when you added the heat it uses up some energy. The molecules are going faster and faster then because of the energy they're going farther apart. Because you have more space between the molecules.

[Scene 2:] Later, Mr Sparks and Rona sit together in the physics preparatory room to talk about the learning during the lab on the changing states of water.

Rona: I learned many things from this experiment. I learned about the relationships between distance and force, kinetic energy, potential energy and motion that I had previously been oblivious to. Also, concepts and theories that I had only read about and been forced to believe now began to make some sense.

Sparks: What were some of the difficulties you experienced during this activity?

Rona: I still have some difficult times with the unstructured nature of the experiments we are doing. I mean, there is very little supervision and direct teaching. We are mainly teaching ourselves. But, on the other hand, when we had questions or problems, we turned to you.

Sparks: Do you think that it helps you to talk in your group? Or do we need to set up something different.

Rona: No, no, I find that the disagreements are probably the most important aspect in our activities. They are sort of mini-debates that can quite often become rather complex. New ideas are constantly being proposed, justified and then rejected during these debates, yet I always learn something in the process.

Sparks: We should not forget to sit down and think about assessment.

Rona: You know, it is not so much important for me that I determine my grade than to go over what we have done with you. Then I could see where I didn't understand, whether I was reading it differently, or reading it right and explaining it differently. Then I could try studying a little more.

In these two scenes, students and their teacher engage in conversations, providing opportunities for developing shared discourses about science and

Table 3. Designing democratic workplaces in democratic ways: a Scandinavian experience.

The conception of knowing and learning as co-participation in common practices has led a group of Scandinavian software designers to the 'participatory design' of computer-based work places (Greenbaum and Kyng 1991). The Scandinavian experience—developing democratic workplaces in a democratic learning situation—shows that troubles related to new technologies can be mediated if software designers and future users spent a lot of time together to develop a common ground, that is, common ways of seeing and talking about the things which the computer environment is to accomplish. In this endeavour, the users and engineers did not need to understand each other fully from the outset: co-participation in collective activities around shared artifacts created the emergence of common understandings (Ehn 1992). Together, the engineers and users created focal artifacts that were sites for engaging each other's conversations. They produced mock-ups, prototypes, and scenarios that were modified as the common ground between them increased. By co-participating in design, the software engineers and future users develop shared ways, tacit assumptions, and common sense. In other words, before the Scandinavian software engineers created new, democratic work-places, they created opportunities to develop, with the future users, a common and democratic discourse suitable for communicating their respective interests and concerns.

learning. For the science conversations, artifacts such as equipment, data-tables, statistical analyses on computers, and reports provide a material basis for conceptual talk to develop, co-evolve, and converge. For the conversation about learning, student and teacher take as basis their lived experiences in order to bring about change and better adaptations of each individual and her or his learning environment.

If we take the phenomenological perspective serious, shared views of the world and interpretive horizons can only be obtained when teachers and their students are not just physically co-present (which is a necessary but not sufficient condition) but actually co-participate in learning activities, establish *dia*-logues about the subject matter and learning (involving changes from magisterial 'we discuss [i.e. lecture] heat' to an inclusive '*we* talk about heat'), and co-construct shared experiences and, therefore, learning environments. *Dia*-logues are important prerequisites of the kind of democratic classroom environment that we envision, and have already enacted (e.g. Roth 1999, in press). (Table 3 presents another case of a democratic out-of-school learning environment that might serve as a viable model for teachers and curriculum planners.)

Refle-ct/x-ive w/ri(gh)ting

From a phenomenological perspective, individuals' perceptions constitute a horizon within which they understand themselves. When individuals co-participate in practices over longer periods of time, their respective horizons begin to overlap; individuals become members of communities in which ways of seeing, knowing and representing are common. That is, it makes little sense to

> [*Voice over*:] That is how the thing is written. To write means to graft. It's the same word. The saying of the thing is restored to its being-grafted. The graft is not something that happens to the properness of the thing. There is no more any thing than there is any original text (Derrida 1981: 355).

speak of a world independent of one's experience and perceptions, for the world we perceive is the one in which we experience our settings, live in our familiar environments, act in and upon the objects of our intentions. As long as our actions do not conflict with the other(s) engaged in a collective activity, it does not matter whether there is a coherence in a person's perspectives.[2] Because we normally do not experience ourselves as thinking and acting irrationally, a suitable point of departure for research is the assumption that if the (material, discursive) actions of participants seem irrational and contradictory, this is not due to the irrational and contradictory character of the people involved but the researchers' own inappropriate understanding of the participants' worlds.

> [*Voice over*:] Methodology is like spelling of which we say in French: *c'est la science des aînes*, 'it is the science of the jack-asses'. It consists of a compendium of errors of which one can say that you must be dumb to commit most of them (Bourdieu 1992: 244).

This study breaks with a number of cherished research and reporting traditions. (See the appendix for a contradiction to this claim.) In traditional qualitative research, multiple data sources were used to triangulate the data and to get at *the* (one) way participants construct their world (Lincoln and Guba 1985). At best, negative case analyses provided examples that triangulation was the

> [*Voice over*:] And we we would need also to analyse the rhetoric of data presentation which, when it turns into an ostentatious display of data, often serves to mask elementary mistakes in the construction of the object, while at the opposite end, a rigorous and economical exposition of the *pertinent* results will, measured by the yardstick of such an exhibitionism of the *datum brutum*, oftentimes incur the *a priori* suspicion of the fetishizers of the *protocol* (in the twofold sense of the term) of a form of 'evidence'. (Bourdieu 1992: 226–227).

qualitative researcher's tool to get at coherence and commonalities which wash out difference and variation. Many qualitative studies (at least in science education) are no different in their authoritative voice and claims to particular perspectives than the formal (mathematical, statistical) representations the discipline has inherited from the natural sciences.

We pursued a different route to research and representation. Thus, we began with the assumption that we are never members of just one community but, in fact, participate in multiple communities, speaking multiple dialects, and with multiple voices; the unity of Self is but a fiction in the face of multiplicity (but not in the sense of pathological multiple personalities) which is obliterated by the invisible work of silencing whose objective is reductionist and purificational (Star 1991). Star suggests that to understand and gain access to the different Selves, we must acknowledge the primacy of simultaneous multiple memberships in multiple worlds of each human being. Multiple membership,

> [*Voice over*:] It would no longer be possible to enclose [the multiplicity of voices] in a 'book' and the text, as a weave of voices, would be sustained by different rhythms, tones, breaths which ebb and flow. These voices would not be enclosed in a system or logic, nor in a theory, yet they would modify the discourse you chose, the discourse of philosophy, the most strongly marked as masculine (Verena Andermatt Conley in Derrida 1995: 158).

which is also multiple marginality, is not a source of epistemic impurity and monstrosity, but is a source of power which allows us to resist epistemic violence of traditional master narratives by encompassing heterogeneity (see also Barton 1998). The multiply-intersecting voices in the present study represent the structural equivalent of our epistemological and methodological commitments. Multiplicity is to be read as the point of departure for our analysis rather than the addition of perspectives to an essentially monolithic model. This way of (a) writing implies refusing translations of authentic voices in the support of master narratives and talking *on behalf of* others (teachers, students); and (b) reading implies listening rather than resting comfortably and content with the strange and unfamiliar around us.

However, our narrative cannot achieve a levelling of all voices. This is *our* narrative (authorship) which we constructed for a particular end and audience, and we do not speak on behalf of Mr Sparks, Rona, or her classmates. We therefore chose *these* excerpts and *this* format. We do not

> [*Voice over*:] Writing of the singular voice. Type, since there is inscription, *typtein*, timbre and tympanum, but without a type, that is to say, without a model, without a prescriptive form, type without 'type' and without a stereotype (Derrida 1995: 165).

claim to do better justice than the (potential) narratives other participants can provide. But we think that readers can learn something new by simply listening. As a matter of w/ri(gh)ting research, we have taken a departure from the usual forms of texts which, in their linearity and argumentative development, become grand narratives on local and global scales of the text. We struggled with our own tendencies, historically and culturally embodied through our participating-in-the-world-of-research, to construct master narratives, and to provide informed research-oriented commentaries to all of our participants' texts. Yet, research does not have to be written in the form of

> [*Voice over*:] By objectivizing the pretension to the regal position that turns sociology into a weapon *in* the struggles internal to the field instead of an instrument of knowledge *of* these struggles, and this of the knowing subject himself who, no matter what he does, never ceases to wage them, I gave myself the means of reintroducing into the analysis the consciousness of the presuppositions and prejudices associated with the local and localized point of view of someone who constructs the space of points of view (Bourdieu 1992: 254).

master narratives, and new forms of w/ri(gh)ting research may be much more interesting to read than traditional forms. Latour's (1992) account of the failure of the French ARAMIS (an individualized urban transit system) project, presents but one possibility,

which blurs any notion of boundary between fact and fiction in its textual assembly of original engineering drawings and texts, government publications, interview transcripts, excerpts from Mary Shelley's novel *Frankenstein*, and the story (à la Sherlock Holmes) of a sociologist and his side-kick, a recent engineering graduate doing an internship. Our own research of the lifeworlds in a physics classroom constitutes a different form of w/ri(gh)ting research and, thereby, accounting for what might be constructed as the failure to learn canonical physics on the part of Rona and many of her peers.

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Notes

1. For our argument, it should make no difference that the following transcripts are from conversations Roth (1995) had with his students and the reflections they wrote about their learning experience. We use them to project what could happen between Mr Sparks and his students. Fictional dialogues could have been used with the same effect.
2. We have observed groups of students work on tasks for more than 40 minutes, only to realize at that point that their definitions of the 'same' task had been considerably different (Roth and Bowen 1993).

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Appendix

The nature of this study, as conceived, planned, and executed, was similar to that of many others that draw on mixed, qualitative and quantitative methods to understand learning and learning environments—though larger than most in its scope, including students' and teacher's perceptions of the learning environments, epistemologies, understandings of the nature of science, views of laboratory activities, and understanding (and change thereof) of science subject-matter content. However, over time, we faced many misunderstandings that our research reports generated among readers of our earlier reports (e.g. McRobbie *et al.* 1997, Roth *et al.* 1997a, b, 1998, 1999). For example, after reading one phenomenological account of student learning in laboratories (Roth *et al.* 1997a), some of our graduate students were upset with what they perceived as the 'teacher-bashing' we had done. Others, reading the same account, condemned Mr Sparks and wondered how any caring teacher could interfere with students' learning in the way he had done. The present report about individuals' lived experience attempts to eschew such readings through its different approach of

writing research. Thus, while acknowledging traditional forms of accounting for research practices in the first section, we provide in the second a rationale for writing this research in the format we have done.

This study was conducted in a suburban Australian Year 12 physics class comprised of 24 students (17 male, seven female) and their teacher Mr Sparks, who, because he was acquainted with one person on the research team, willingly invited us to conduct a study of learning in his class. A research team of four spent six weeks in the class, observing all lessons and conducting a minimum of five interviews with each of 10 students (about 50 minutes each) and six interviews with Mr Sparks (each 2+ hours), and 15–30 minute debriefings after each lesson. We also administered a variety of instruments including a constructivist learning environment scale (CLES; Taylor *et al.* 1995), a nature of science survey (selected items from VOSS; Aikenhead *et al.* 1989), a science laboratory environment inventory (SLEI; Fraser *et al.* 1995), an instrument assessing students' pre-unit understanding based on items used in previous research (Gunstone 1984), and an instrument assessing students' post-unit understandings.

As a research team, we met daily to talk about our understandings of the classroom events and of how students and the teacher constructed and managed the learning environment. The research team members debriefed each other after each site visit, communicated observations, talked about directions for subsequent data collection, constructed tentative hypotheses, and prepared initial analyses. Our ongoing personal fieldnotes sensitized us to what later became an important aspect in our own understanding, namely that students and the teacher looked at both the world in general and the events in the classroom more specifically in different, often incompatible ways. Our fieldnotes also directed our data collection in that we decided to use specific video clips with our participants to find out more about their assessment of what was happening in the classroom.

In this study, we took a phenomenological stance (Ricoeur 1991, Bourdieu 1997) to curriculum research in which neither different perspectives (student, teacher, and researcher) were taken as unwanted variation of one truly existing environment, nor one of the perspectives as an *a priori* privileged one. We understand the differences to lie in the different cognitive histories of participants which, in turn, lead to differences in the social and material worlds people perceive and therefore inhabit—although they appear to co-participate in the same physical and social setting. Lifeworld analysis, as we conducted it here, treats the different worlds as individual objective (i.e. personally-experienced) realities that constrain and afford people's actions; furthermore, these worlds are constructed in a public interview space for us and, therefore, are the results of people's discursive actions to account rationally for their experience. If a student perceives her teacher as powerful and threatening, she will act accordingly, i.e. she may not speak up or protest when she experiences problems or injustice. Likewise, when a teacher perceives that there are no gender inequities in his classroom, he or she will not perceive any need to precipitate changes in the enacted curriculum.