Chapter 6
Local Matters, EcoJustice, and Community

Opportunities of Village Life for Teaching Science

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It is often assumed and reported that students from rural schools do not achieve as well as students from urban areas; and research often appears to overlook the special needs and opportunities that arise for science teaching and learning, in particular, from a rural setting (Tippins and Mueller 2009). Having taught science in rural schools for more than a decade and in different areas of Canada, I have experienced firsthand how there are special opportunities for teaching science that come with a rural context. For example, science can be taught so that local people, local places, and local knowledge matter, allowing students who often do not do well in school, to find themselves and their local environment validated and to excel. This includes students who are treated differently because of a "learning disability" that they come to be stuck with despite the fact that they demonstrably make great contributions not only to their own learning but also to the learning of others. Rural settings provide particular opportunities for implementing the idea of "learning communities," where the term "community" goes beyond denoting classrooms or school and extends to the entire village or municipality. That is, because of the size of the rural setting, greater permeability between school and everyday life is a possibility and students, rather than producing tests and assignments actually contribute to village life and as a consequence, learn in the process of contributing to the social fabric of their setting. This includes coming to understand ecojustice, because natural environments perhaps more so than the manufactured urban environments allow us to understand the connection between the totality of life generally and human life more specifically. Thus, learning science in rural schools is special because students may not only draw on their local knowledge to make sense of more school-based (book) knowledge but also because their engagement is situated in village life and what they produce and learn enhances the amount of knowledge already available in and to the collective. In the process, the students' own local knowledge expands and their action possibilities increase, including those for pursuing academic studies that take them away from their rural setting. But for some – including myself, who, first as a teacher then as a professor – rural life remains so attractive and the preferred lifestyle

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that they return to it after studies and getting settled in a career. That is, teaching science in a place-based manner, in ways that make local people and places matter, and toward ecojustice, actually produces and reproduces a stronger social fabric in rural areas than exists in many urban environments. In fact, there is evidence from big cities that the introduction of urban gardens fundamentally changes life, including substantial decreases in crime and violence. Teaching so that the local matters and for ecojustice, therefore, may contribute to work against the current movement of people toward urban areas, which has become not only a "brain drain" but also a problem for maintaining the social fabric in rural areas. In this chapter, I provide an extended case study of science teaching and learning in one rural community, where I worked with teachers to draw on the opportunities that a rural area provides for teaching science.

Introduction

Rural education frequently is represented in the literature as a part of society facing difficulties and hard times (e.g., Hardré et al. 2007). Due to remoteness, rural communities and schools generally face serious economic and community resource constraints, a fact that places students in rural schools at risk both in terms of motivation and academic achievement. Rural schools often have available fewer support programs and extracurricular activities than are available to students in more suburban and more affluent regions of industrialized nations. It is not astonishing, therefore, that a considerable part of the scholarly literature uses a deficit discourse when it comes to the situation and the opportunities rural schools and communities offer to the education of their younger generations. But does this have to be?

Here I argue that there are opportunities in rural communities frequently not available to schools in urban areas, which, when entire communities – students, teachers, parents, administrators, and politicians – are encouraged to capitalize upon, may actually advantage rural students over those living in urban or suburban areas. It turns out that I not only grew up and live in (semi-) rural communities – I currently operate a garden in my backyard that produces, year-round, all vegetables that we need and also has a small five-count flock of by-law-permitted chicken – but also spent a large part of my middle- and high-school teaching career in rural communities and subsequently conducted research on teaching and learning science in what are termed "semirural" communities because of their dual, hybrid characteristics that arise when urban characteristics are infused into and mix with heretofore entirely rural communities. In this chapter, I articulate some of the advantages that come from teaching and learning in rural communities as exhibited in a design experiment that I conducted in the semirural community ("municipality") of Central Saanich, British Columbia, where I am also a resident. That project was explicitly grounded in an integrated program of social and environmental justice concerned with involving children and students in building a sense of place both in rural and urban environments (Roth and Barton 2004). I begin with an account of my early teaching, which allowed me to develop an appreciation for rural education and the opportunities it provides to *education* (in contrast to *schooling*) generally. This example also shows that it is not lack of resources that should impede high-quality science education, not only in the life sciences but in the physical sciences as well.

My early teaching career was characterized by a more naïve approach to teaching science, whereby I thought that through hands-on experiences students would get directly into contact with the patterns in the world that science captures in its conceptual knowledge and in its equations. I subsequently learned about cultural-historical activity theory, which provided me with a framework for designing curriculum with goals and intentions that really matter – to (rural) students, teachers, and their community. I sketch the theory to show how one might design a rural school curriculum to which students subscribe and with which they engage because what comes to be done does affect their community, their lives, and the lives of their families. I exemplify my work in rural schools with extensive examples of teaching and learning science in different communities where I taught before summarizing some of the main advantages that derive from rural education.

Teaching in Rural Communities

In 1980, during an economic downturn and as a recent immigrant to Canada, it was very difficult to find a job as a physicist, a subject in which I had obtained a masters degree. I had abandoned the idea of becoming a teacher after very negative school-related experiences when I switched from attending fourth grade in my rural village school to an academically oriented (grammar school-like) "Gymnasium" (in a nearby small city), which I could do only by attending a boarding facility for students from rural communities run by monks of the Franciscan order. I abandoned the idea of becoming a teacher because I did not do well – in part because of an undiagnosed hearing loss – and the city folks, teachers and peers alike, thought that I was just a dumb kid from a farm in the backwoods. But now, searching for a job, I noticed the opportunities available, even without an education background, for teaching in remote and isolated communities in eastern and northern Quebec, 700 km from the next city (Sept Isles). I applied and immediately was offered a job under the condition that during the summer months I would attend university until I obtained the equivalent of a bachelor's of education.

At the moment I interviewed, I did not know where precisely I would be teaching, but the school board in urban Montreal, where I interviewed, represented 15 village schools on the Lower North Shore of the St. Lawrence River stretched out along the 400-mile coastline, most of which to this day is not connected to the road system of the remainder of the province. These villages could be accessed only by boat, by bush plane, or by snowmobile in the winter months. One of these was St. Paul's River (Fig. 1, left), where I arrived one late afternoon during the second week of September. The people there worked as fishermen during the summer or hoped to complete the necessary 10-week employment in the local fish plant so that they would qualify for 40 weeks of unemployment insurance payments. Electricity, running water, and indoor plumbing had been in existence for only a few years

Fig. 1 St. Paul's River on the Labrador peninsula is one of 15 villages on the Lower North Shore of the St. Lawrence River and, in the early 1980s, nearly inaccessible from the outside for many weeks and months of the year (© Roth 1994. With permission)

(since the mid-1970s). But the snowmobile had replaced the dog teams in the late 1960s and the boats had changed: from being rowed to using outboard engines, though none exceeded 27 ft in overall length (Fig. 1, right).

The climate was harsh, and there was snow for 6 months of the year. In the fall, the lakes in the hills near the villages froze over in October and did not open up until May or June. The open ocean beyond the chain of islands that sheltered the estuary was frozen to a thickness of 3 ft. The only way to get to the village was to fly into another, 35-mile distant village and to take the 1.5-h snowmobile ride. There was a Hudson Bay Company store and three smaller stores for the 500 inhabitants, but no restaurant or bar; a snowmobile dealership and a sawmill completed the lineup of businesses.

There were three schools in three different buildings: a pre-school and kindergarten run half-day; an elementary school, grades 1–6; and a middle school ranging from seventh through ninth grades. The middle school where I was to teach turned out to be a tiny building with three classrooms for the 41 students, bathroom facilities, and a staff room for the five teachers (the principal for the elementary and middle schools had her office in a separate building). There was very little equipment of any kind. And yet, I wanted to make a difference in my science teaching; and, equally, I wanted to make a difference in teaching the other subjects I was asked to teach in the course of the 2 years that I spent in the village, including physical education, arts, personal development, and mathematics.

My first "innovation" in the school curriculum came about in science. It turned out that the school had a kit for doing a hands-on science course, Introductory Physical Science, a 1-year course spread over eighth and ninth grades that nobody had used before. Nobody had been using it since the science advisor of the *Commission scholaire du littoral* (i.e., the school board) had shipped it to the school. I wanted to teach science in a way that I had encountered in graduate school, experimenting, the moment I liked best in all of my schooling. I also wanted to have a place to leave the equipment out on the table or in some other storage area. For lack of another room, I explored the basement, which turned out to be a big room with a 6-ft ceiling, which was lower in spots because of the air ducts. (I earned more than a few bumps on my head for not watching.) It was found only after my departure that the two fire extinguishers in the basement were not functioning and that there were cracks in the basement walls making it a dangerous place to be.

More frequently than not we went to the "lab." Because there was no running water, this meant that the students had to bring buckets of water that we needed in some experiments. Since the booklet was small and only had sufficient experiments for a 1-year course, I added other experiments by extending existing ones. For example, we had available the materials to conduct a simple experiment on the thermal expansion of matter. In fact the experimental setup is so simple that it can be made from household and other cheap and readily available materials in a hardware store (Fig. 2).

The idea of the original experiment was simple (Fig. 2a). Get some steam into a pipe fixed at one end with a clothespin and the pipe will expand, especially in length. If the free end of the pipe rests on a needle with a cardboard dial attached to it, even a minute extension in the length of the pipe will be translated into a noticeable turn of the dial, amplified by the small diameter of the needle pin. In the original experiment, comparisons were made between different materials (e.g., aluminum, glass, and copper). As a physicist I knew that the thermal expansion in

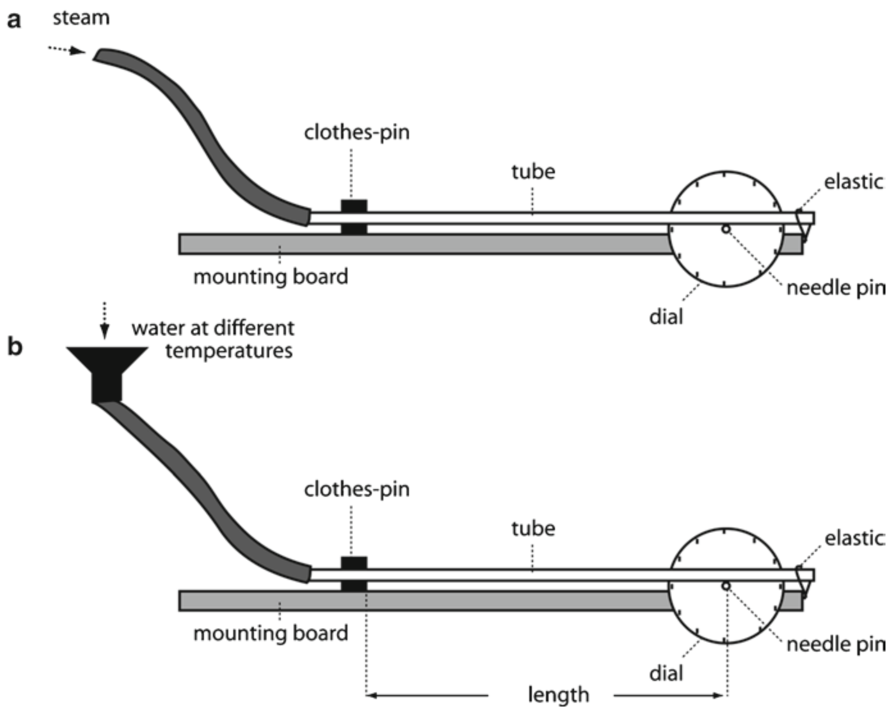

Fig. 2 A simple eighth-grade science experiment on the thermal expansion of matter. (**a**) The original experiment. (**b**) Several variations were made to allow determining the dependence of expansion on temperature, material, and length

length depends not only on the material but also on the temperature difference and on the length of the material.[1] Thus, I modified the experiment so that students could pour water of different temperatures into a funnel allowing them to produce different temperature differences (i.e., ΔT). I also asked them to bring the needle pin to different distances within the clothespin, which varied the effective length of the expansion which was measured. The students now conducted several experiments over the course of nearly 2 weeks, in which they varied the different parameters, noted their results, produced graphs, and so on. I learned from this experience that with a little innovation, the use of any equipment or any experiment could be extended for the benefit of student learning.

I designed and produced other novel learning resources, such as, for example, a slide rule for assisting students in doing or checking their multiplications and divisions. In those days, calculators were expensive and slide rules were slowly going out of fashion. Because I noted that the students had difficulties with their multiplication and division, I asked the janitor to help me build a giant (8-ft) slide rule, which I painted and marked off in an appropriate manner to be able to do multiplication and division (this requires a logarithmic scale). I not only taught my science students how to use it, but also had them employ it for their own applications.

In the seventh-grade biology course, we had a heyday. Nature was just outside the entrance door (Fig. 1), and all I had to do was come up with some useful curriculum. One aspect I felt students should learn is doing scientific research. Every week during our double period, which took all afternoon, we went outside to do experiments. Students learned about random sampling using hoops homemade from wire clothes hangers; students tossed these behind themselves and wherever the hoops fell they sampled plant and animal life. We manufactured 1 by 1-m squares from four wood strips and thereby produced a tool for conducting systematic counts of plant life within the same reference area. We used a 100-m long string, which we marked off in 1-m intervals to produce a reference line for strip sampling. Once the students had learned these techniques on the hill behind the administration building and teacher residence, we were ready to go out and sample different kinds of ecological succession processes – bare rock succession, forest fire succession, pond succession, and so on. A succession is an orderly change from one type of ecological (plant, animal) community to another type. They exist both diachronically, for the same area over long periods of time, and synchronically, with geographical variation. Thus, for example, by laying a strip from a forested area to a pond, students were studying the different plant and animal communities in places where there used to be a pond; or they studied bare rock succession by going on a rock outcrop and then sampling along a strip into a nearby grove. Given that nature started right behind the school, there was so much we were able to study just with the few simple techniques that students increasingly honed as they participated in using them. How often do city

[1]The formula for the thermal expansion Δl of a rod with length l is $\Delta l = \kappa l \Delta T$, where κ is a constant characteristic of the material, thus different for glass, aluminum, copper, steel, etc. and ΔT is the temperature difference.

school kids get to go out to study nature for one afternoon per week? I had begun to love teaching in this rural community and, from then on, appreciated the opportunities village life offered to teaching science specifically and to teaching more generally. It turned out that many years later, I watched a documentary on French village schools extolling the opportunities of rural schooling and not only began featuring it in my arguments for an education involving the entire village community (e.g., Roth 1998; Roth and Lee 2006) but also came to interact with the teacher himself (who wrote to me that more than anyone else in France, I was understanding what he attempted to tell others about the benefits of teaching in small rural schools).

It was not only in the science classes that I made do with what was at hand and thereby created a learning environment that students enjoyed and which allowed them to be successful. In the arts classes, I had students systematically explore color, beginning with one color producing a strip from white to the deepest form they could achieve. Then they did the same with two colors, mixing them along a strip. Then they did the same with three primary colors. In each case, after producing one or more simple (sample) strips, they then painted a picture with the means just explored. Thus, the first picture was made from only one color with differences in intensity. The next one included everything they could and wanted to do with two colors.

In another project, I used black construction paper that I found in the stockroom at the school. I also found four rolls of differently colored transparency film. I asked students to bring scissors, leftover razor blades, and any sharp construction knives that their parents might have. I then asked the students in the three grades I taught simultaneously to make “church windows” graded by age level: abstract designs in seventh grade, rosettes in eighth grade, and Christmas scenes in ninth grade. They began by producing a pencil design, from which they then cut the desired shapes using one of the available tools. To provide them with a greater range of options, I showed how new colors could be created by producing layers from the same or different colors of transparency film. We hung the final pieces onto the school windows, leaving the lights so that – because it was winter and it was dark at 4 pm – the entire village could see their colorful designs even during the late afternoons and early evenings. Again, the simplest of means, and help by students and parents, had provided many opportunities to explore a domain formally and in detail, allowing students to learn tremendously despite, and perhaps because of, the limited amounts of resources we had available. The students had added “value” to their village, their place, by contributing to the way it appeared to them on a daily basis. That is, it was not only a sense that developed *from* living in and appreciating a particular place, but also they were producing a sense for the same place.

For another project, I went with the students to the estuary and we gathered driftwood for the subsequent construction of “feelies,” objects that felt good in the hand. Again I asked students to bring tools from their homes, including (carving) knives, rasps, planers, and sandpaper. I asked them to pay attention to the grain of the wood and they learned, through experience and feedback from me, about working with wood in ways that draw on its strength and possibilities. In this case, the village was a resource and we capitalized on it for providing a better educational experience. The wood had come from the river that they knew so well and provided them and their parents with a living and a resource for leisure activities. I realized only decades later that students could, in turn, enrich village life as part of their educational experience. Because students began to value their village for its natural resources and the opportunities these provided for them including their outdoor life and their artistic interests, they developed a tremendous sense of place in a double sense: place both as a resource and something that one can care for, enhance, and keep as a livable place.

In this rural school, as in other rural schools where I subsequently taught, I also learned to deal with and appreciate the different levels of academic ability. This was important because if I wanted to do justice to the abilities, interests, and needs of each student, I had to come up with ways of addressing what turned out to be tremendous variations. Thus, in my seventh-grade biology course, I had three boys reading at the first-grade level on the Gates–MacGinitie reading test and one girl reading at the tenth-grade level. But these and other students did very well in my course because they loved the environment, knew a lot about it, and, because of my flexible way of allowing them to express themselves, they achieved well, nevertheless.

I also got to teach in the elementary school. Because of the size of the village, there were no substitute teachers available. So when one teacher was ill, the others took on the load. I was the only middle-school teacher willing to help out in the elementary school. By rearranging my schedule, having other teachers take over my middle-school classes, I was freed up to work, for as long as necessary, in a variety of elementary classes, spanning, over the course of the 2 years, all of the six grade levels.

In summary, teaching in this school was a great experience and many times subsequently I was longing to be back in the village and to teach the mix of courses, range of students, and to be close to an entire village as a whole. In my experience, the village had provided opportunities for teaching because life was less regimented, busy, and fast as it had become in the city. There was a general support among students and among the parents to create the best education with the things at hand, even if it meant as little as providing the students with some tools or leftover building materials, or hiking along the beaches to pick up driftwood.

There was very positive feedback from both students and parents, although I had made all decisions about what would be included in the curriculum and what we would do. I was teaching with the belief that knowledge could somehow be found out there or learned through experience. I did not think about the concept of "meaning," although I knew that the students who knew their outdoors also turned out to do much better in my biology class than they were doing in the classes of other teachers who only approached their subjects through the academic route. But I personally did not have the conceptual means that would allow me to design curriculum so that it made explicit use of the inhabited world as a meaningful entity; and by participating in this world all actions took on meaning rather than having to be constructed. That is, it took me many more years until I came to understand that new words and actions accrued to the already meaningful world students are familiar with rather than new words and actions getting meaning as a new attribute. It is for precisely the same reason that some educators now emphasize the role of *place* in learning, which has led to the emergence and development of the concept of "place-based education." But place in itself does not have meaning, it is human interactions and practices that make the lived-in world predictable, produce human control over the environment, and sustain society and, with it, the individuals that constitute it. One theory that captures all these dimensions is cultural-historical activity theory, which I develop in the following section because it underpins much of the curriculum work that I have conducted over the past decade.

A Brief History of Society and Consciousness

In this brief theoretical excursion, I write about the evolution of humanity, because it shows very nicely, intelligibly, and plausibly the core elements of cultural-historical activity theory (Roth and Lee 2007). Pre-hominids were directly exposed to their environmental conditions and could do little but cope. Individual and group, if applicable, accessed the available resources for sustaining their lives. Structurally, this relation between individual, group, and the environment can be expressed in a triangle (Fig. 3).

The figure shows the direct dependence – that is, unmediated by consciousness – of the pre-hominids on the environment. They did not engage in building shelters to protect themselves from a storm. Changes in the environment were detrimental to the group (species as a whole) because required adaptations could not be made within the life span of individuals. But we see that there was a role for the group that already mediated access to the environment, for example, food, such as when wolf hunt as packs or bees cooperate in the securing of food. The matters, however, began to change once new avenues for interacting with the environment opened up, as apparent from the structural relations in Fig. 4.

With tool use, new forms of relations with the environment become possible. For example, different chimpanzee groups have developed different methods by means of which to extract ants or termites from their mounds. Other groups developed means to crack nutshells and thereby access the edible and nutritious seed. This would not have been of much help, however, if one individual had invented such a

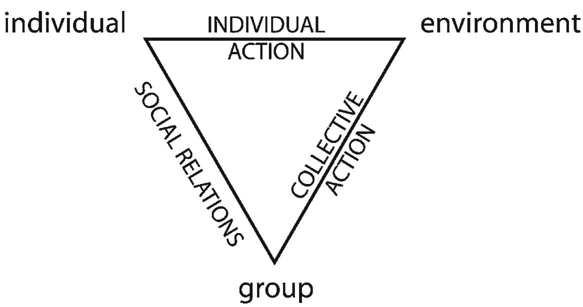

Fig. 3 Structural representation of individual, group, and environment of the life world of pre-hominids

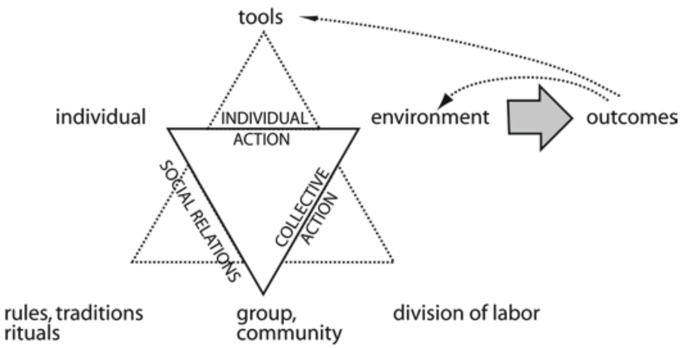

Fig. 4 When forms of relations and orientation toward the environment became available, the latter came under the control of the species

behavior without transmitting it to others in the group. In such a case, the behavior would have been lost. But with the hominids (great apes), traditions emerged; individuals learned how to fish for termites from other individuals (often the mothers). Knowledge came to exist no longer at the individual but at the collective level. Even if one or two individuals never were to fish for termites, never appropriate the skill, as long as there were others practicing the skill and making it available through observational and mimetic means to others, the knowledge survived. This knowledge that allows humans to control the environment has increased tremendously, leading the human hubris of a nearly almighty agent in the environment. But the required knowledge and practices concerning the responsibility for place and a sense for ecojustice – the concept that we cannot make others and other organisms pay for our own power and excesses – has not grown in the same way.

Among the great apes one can also observe a third feature, division of labor. Thus, chimpanzee males hunt for monkeys clearly dividing the task. Some climb adjacent trees thereby blocking escape routes and the "hunter" climbs up the tree where the monkeys sit killing one, which is to be shared subsequently with all others. Alexei Nikolaevich Leont'ev (1978), the father of cultural-historical activity theory, used such an example (his involves "hunters" and "beaters") to explain early forms of division of labor that actually formed the basis for diverse human societies. More advanced forms of division of labor began when some individuals stayed back, producing the tools others used in hunting and gathering, and exchanging the tools thus manufactured against food: The first barter systems emerged and with it, human forms of society. That is, because there are two forms of activity, individuals have the choice to participate in one or the other, and as long as they participate, their needs are met because they can exchange the fruits of their labor with others trading what they have for something that they need. In fact, as long as there is sufficient food produced, even those who do not or cannot engage in one or the other form of activity can survive feeding on the leftovers or what is given to them. These societies are characterized by the conscious production, exchange, distribution, and consumption of things important to the group as a whole. The structure of society is shown in Fig. 5.

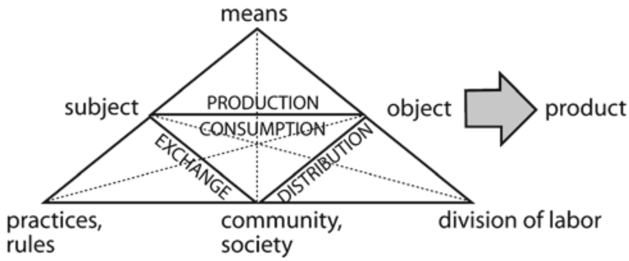

Fig. 5 The structure of human activity systems

Early forms of division of labor led to new forms of activity all of which were important to the survival of the society as a whole. Progressive divisions of labor – including the one that led to the division of those who employed sophisticated theories and those who employed sophisticated practical skills (architects and master builders, education professors and teachers) – led to increasingly diversified societies and eventually to the emergence of early cities (in what is today northern Iraq). But each of these activities is producing something that others need and are willing to exchange something else for it. The theory is powerful because it even explains why professional sports exist, although they do not produce anything useful: People are willing to spend (exchange) money to be able to watch a game for their enjoyment, and the players are willing to do nothing but practice to be able to play at a level where they can make sufficient income to meet all their needs.

An important activity system in the present context is that of formal schooling, where teachers and professors teach, that is, make available the theoretical forms of knowledge that each generation bequeaths to the next. Up to the present day, schooling has prepared younger generations for the work in factories in a more or less stable world, whereas our current lives show – economic turmoil, environmental disasters such as Chernobyl or the cane toad in Queensland – that we need to prepare new generations that are forward looking, prepared for an ever-changing world that may bring more dangers than safety.

Each system has its special forms of knowledge, its means of production, and its physical and social environments. Each system also has its motive that links present materials and final products, such as producing grain (wheat, corn, rice) or making bread, which orient everything that happens on a grain-producing farm and in a bakery, respectively. These systems are inherently meaningful to those who participate in them in knowledgeable ways. Thus, what is a meaningful action in one system would not be a meaningful action in another, or, if there are in fact two actions in different systems, they tend to have a different sense (meaning). Knowledgeable participation, therefore, is meaningful because it occurs within and in the form of a connected and meaningful whole. Participants do what they do because it makes inherent sense to act in this rather than that manner; and individuals participate without asking the question about theories that explain what they do. An easily accessible example is grammar. Children learn to speak their mother tongue fluently without ever having a problem with grammar. And even without knowing any formal grammar at all they distinguish grammatically correct from grammatically incorrect sentences. That is, *knowledgeably participating* is *(the same as) knowing.* A more recent example I have used repeatedly is that of a multi-age, one-room French village school, where newcomers learn as they participate with ongoing forms of activities and the oldest participants leave to go on to different schools. The classroom culture maintains itself because there is a low turnover each year.

To sum up, human activities have evolved in culturally specific and historically contingent ways. Because activities have inherent collective motives (growing grain, baking bread, educating children), everything during participation attains its sense in relation to the overall motive. This allows us to hypothesize that there are opportunities in rural life (villages, municipalities) where students can contribute to the collective life, which is inherently meaningful, and in the process come to accrue new practices to an already meaningful way of living and participating.

This has immediate implications; and once I understood these, I changed the way in which I was teaching and designing curriculum. The first thing I came to understand was that the motive of schooling is not education (knowing), as one might think, but as apparent from teacher and student behaviors, it is the production and exchange of grades (marks), which are ultimately accumulated, like a symbolic form of capital, to access real capital and further opportunities (jobs, coveted university admissions). I realized that if students were to buy in and participate in an existing form of societal relevant activity outside of schools, what they were learning and doing would inherently make sense and students would be able to learn by observing and participating with others they know. More so, what they would be doing would profit the community as a whole and would not just end up in the garbage can – in the way of so many assignments, notebooks, and exams. Throughout my professional career as a teacher and as a critical intellectual, I felt that rural life and rural communities provided so many advantages to creating learning environments that did not exist in the same ways in urban and suburban schools. And I desired to teach in multi-age classrooms because of the possibilities to create conditions for true communities, those that reproduce themselves rather than the ones that teachers spend so much time and effort to create anew each year. All I had to do is find ways in which students picked up some activity, where the motive already existed and orient the actions of participants, then learning was guaranteed. Once students bought into participating in this or that activity, the motive would orient what they did, give sense to their actions, and make participation inherently meaningful because of an already meaningful world preexisting the participation of the student.

Place-Based, Expansive Learning in Environmentalism

Taking my cues from the deinstitutionalization of psychiatric and prison systems, where the residents of formal institutions (with mental disorders or developmental disabilities and prisoners) were moved into community-based and family-based environments and halfway houses, respectively, I argued as early as the mid-1990s for a change in the way we think about and theorize science education (Roth and McGinn 1997). The fundamental findings that led me to this conceptualization was based on the research in situated cognition whereby the everyday mathematical competencies of people in supermarkets, street markets, factories, scientific research, and in a variety of jobs were not at all related to levels of schooling, to the number of mathematics classes they had taken, and not even to the introductory knowledge of their own discipline in the case of academics. Thus, my question, "Why teach mathematics and science in schools if what students learn is not used or unusable in the everyday life?" led me to argue for creating opportunities for children to participate in everyday, by now legitimated activities such as environmentalism. I did so not because of a sense that disaster was impending but because I had developed a sense of, and for, place, organic living, and a protection and enhancement of the environment (e.g., creating a garden that is part of a transit corridor for wild life, including insects and birds), and because I saw the pleasure that comes from growing one's own food. And I provided already more than a decade ago existing examples of how children and students already participated in a variety of activities, including:

- *Environmentalism*, such as when the elementary children of my city neighborhood school were participating in seeding a new green corridor with butterfly pupa.
- *Monitoring pollution,* such as when the high-school students of a nearby municipality monitored pollution levels of the ocean inlet around which their city is built.
- *Salmon enhancement*, such as when the high-school students of another nearby city were repopulating local streams by running small salmon hatcheries in which they raised salmon to the smolt stage and then released them into the creeks where they were imprinted by the mineral environment so that after a long ocean journey they would return, spawn, and thereby bring to life an extinct salmon run.

All of these forms of engagement already were existing activities, with their varying object/motives that orient what people do and give sense to their actions. Because these activities have their own culture, patterned actions, and characteristic tools and instruments, they constitute forms of life; and participating in these life-forms is inherently meaningful, providing meaningful grounds to which new and unfamiliar words, practices, ideas, or resources can accrue and thereby become associated with existing forms of meaning. Students work with others in the community who already participate in these life forms and become acquainted with the way people act toward and talk about the object/motive of their activity. In participating with others, students adopt the object/motives, talk, and patterned actions and thereby expand their own room to maneuver for accomplishing the goals they set themselves.

In subsequent work, I extended these ideas, partially responding to critics who charged that "not everybody has a salmon stream to enhance" and suggested that there are not general or generalizable forms of activities that should drive school curriculum. Rather, it is the local context, the local community, which identifies what is salient and important to the community. This may be a certain form of environmentalism in one instance, salmon hatching in another setting (Roth 2002b), but it may be doing something for the physiological or environmental health of the local community in one instance or a project in ethnobotany and the economic revival of an Aboriginal community in another instance (Roth 2002a). For example, I suggested that some of the Aboriginal communities of British Columbia could bring back part of their culture by taking school children to the traditional seaweed camps where they, through participating, not only contribute to harvesting this traditional food staple but also produce and reproduce the whole culture within which the harvest and consumption of seaweed has been lodged. The main point of all these activities that I had been writing about was to engage students in activities that already existed in the communities where children and students live, and which therefore constituted a meaningful form of life and experiential ground to which new concepts – e.g., scientific, mathematical, cultural, historical, sociological – could accrue.

To show that all of this is feasible, I piloted three times a project of student engagement in environmentalism. So that the teaching strategies would not get lost, I cotaught the unit with local teachers, the later ones learning to teach the unit by participating with earlier participating classes and teachers or by having previous participants come to their classes once the unit had started. The proposal for the work to my funding agency *explicitly* argued for community involvement such that others from the community not only came to the school but that the children in the school would actually get out of their institution and into the community. My sense always has been that such a move of taking students out of the institution and thereby to deinstitutionalize would work especially well in rural schools where many of the hazards present in and characteristic of urban areas – e.g., traffic, distractions – do not exist. That is, place-based education appears to be particularly relevant in rural areas, which not only provide so many resources for educating students of all grades in the community but where the students come with a wealth of knowledge about the local environment, which provides them with many resources for learning – just as I had previously experienced it in Southern Labrador during my first years of teaching. In my own situation, I chose environmentalism for two reasons. First, there already existed a vibrant environmental group in my semirural area, concerned with the ecological health of our main watershed and the creek emptying it into the ocean. Second, I am personally committed to the environmental cause and enact sustainable practices (walking and cycling instead of driving, recycling, and composting, producing all vegetables we eat year-round, etc.). Third, I was able to document a 12-year struggle of one group of residents in my community who did not have access to the water grid and who faced the opposition of politicians and others in their effort to come to be connected. It was this case in particular that allowed me to become aware of the need to include forms of justice – eco-, environmental, and distributive justice – as an integral part of any education.

Fig. 6 Much of the valley has retained its rural character with a mixture of fully functioning and hobby farms, wineries, and orchards (© Roth 2007. With permission)

The Place: Community, Environment, and Watershed-Related Activism

Central Saanich, the community in which I live has retained much of its rural character (Fig. 6), though in the three more heavily populated areas in which much of the municipality's population concentrates (Fig. 7), urban-type (low-density) developments are increasingly appearing. Geographically, much of the community lies in the Hagan Creek watershed, which is dominated by Hagan Creek and its main tributary, Graham Creek (Fig. 7). The map makes it quite clear that the distances from the school to the different, easily accessible sites at which the students investigated the streams are relatively short, within minutes of driving. The landscape is peppered with farms, riding stables, hobby farms, berry farms (Fig. 8), tree and plant nurseries, commercial greenhouses, and wineries.

Despite its location in an area of temperate rain forests, the microclimate of Central Saanich is such that it only receives about 850 mm of rain annually, most of it falling in the November-to-March period and very little during the remainder of the year. The local aquifers are insufficient to supply the community with water, which therefore has to be piped about 40 km from reservoirs situated in the nearby Sooke Hills region. Recent developments have exacerbated the issue by altering the water flow over and through the ground.

To drain the bogs that used to exist before the arrival of the European settlers, farmers had straightened the creek, thereby turning it into a channel (Fig. 9a). These changes allow the water to flow away faster – with the effect that in the summer months, the creek is but a trickle (10–20 l/s), supplying insufficient water for resident farmers to water their fields. A considerable number of wells are used for irrigation.

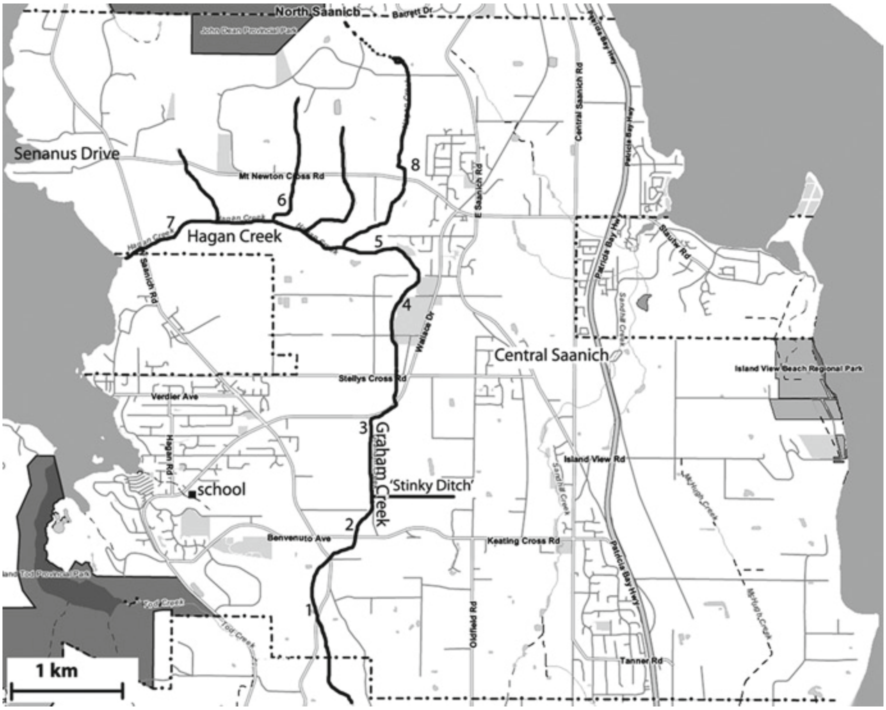

Fig. 7 Along the creek (heavy dark line), farmland is prevalent. The more heavily populated areas are discernible from the density of the streets. The locations of the participating school and the main observation and the research sites along the creek (numbers) are indicated

Fig. 8 The landscape is peppered with berry farms (© Roth 2008. With permission)

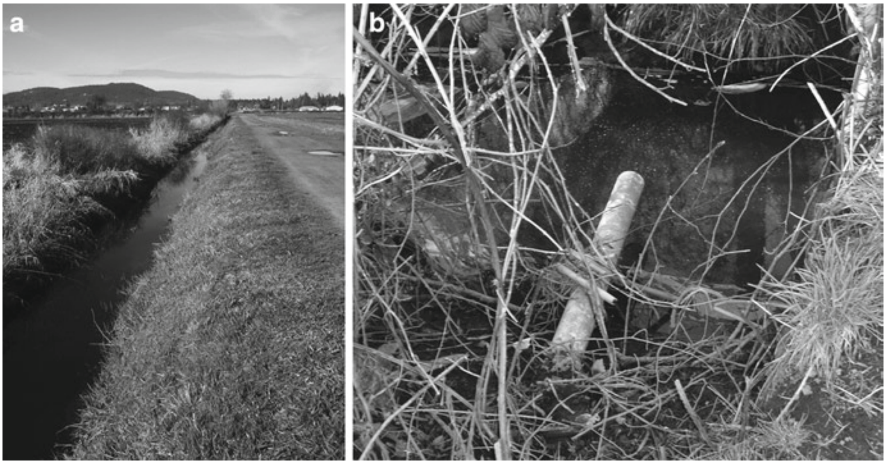

Fig. 9 Industrialization and farming have created heavy pressures on the health of the watershed. (**a**) To drain the water from the heavy winter rains, the creek has been straightened and left without vegetation. (**b**) An industrial site led its effluents into a side-arm of the creek affectionately called "Stinky Ditch" (© Roth 2005. With permission)

The combination of quick runoff and groundwater use for farming heavily tax the aquifer system. Other changes are related to urbanization and the increase in impervious surfaces (e.g., pavement, roofs, and concrete driveways) that come with a concomitant use of storm sewers. Losses of forest cover throughout the watershed and along the stream banks, loss of wetlands and recharge areas, and the loss of natural stream conditions, further increase the pressure on the aquifers. In 1997 and 1998, the leader of a local environmental group quickly pointed out that the Hagan Creek watershed is at the upper limit of total impervious surfaces that still allow for healthy watershed and streams. In addition, stress on the water system came from the many companies situated in a local industrial area (Fig. 7) that spilled their effluents into a side arm of Graham Creek affectionately called "Stinky Ditch" (Fig. 9b).

The water situation in Central Saanich is precarious, and each year beginning with May there is a water advisory, limiting the amounts of water that can be used and the types of application that it can be used for. Each year, lawns may only be watered on 2 days of the week, and then only prior to 9 am and after 7 pm; during other years, the restriction becomes more severe disallowing all overhead watering, car washing, and other forms of open water use. The effect of the restrictions are evident, as all normally deep-green lawns turn brown, a tremendous exception in this area where they are green even during the generally snowless winters, one of the only places in Canada where golfers can play during this season (Victoria is known as "the garden city").

Water problems also have made the news for more than a decade because the residents of Senanus Drive (see Fig. 7, top left), an area without access to the local water main, draw their water from individual wells. These wells take their water from bedrock fissures fed by the local watershed. For years, the local and regional newspapers reported that in the summer months, some well water in the Senanus

Drive area was biologically and chemically contaminated. Sometimes, the residents were advised by the Capital Health Region not to use their water at all or to boil it considerably; many residents have opted to get their water from gas stations in one of the two areas of higher concentrations. In recent years, residents have increased the frequency of their demands and sought exposure in the local media in support of their cause. The residents brought the issues forward to the Regional Water Commission, which decided that the issue was a municipal concern. They were therefore caught and frequently made their plight being heard through the local newspapers. But despite increasing concerns with the water supplies in over 200 communities in Canada, there was no sense of ecojustice in this community, until only a few days ago when, in the face of several large grants, the local politicians finally voted a bylaw allowing the extension of the water main into Senanus Drive. Water and its quality and the environmental health of the entire watershed therefore are at the forefront of many residents' minds and at the forefront of the local newspapers (there have been many title-page features).

The Hagan Creek–Kennes Project arose from the concerns about water quality of three watershed residents, a farmer, professor of environmental policy at the local university, and a stream biologist working at the Institute for the Ocean Sciences, who obtained funding from a federal agency concerned with stream restoration. They used this funding to hire a coordinator, Misty MacDuffy, an experienced environmental campaigner who is very familiar with political conflicts around water. Her experience includes international as well as local campaigns, and she is an accomplished writer and presenter of visual materials. Although she is familiar with the politics of environmentalism and media relations, she is not from the region, and her past credentials as a campaigner do not necessarily help her in her interacting with the largely conservative community members.

Misty was supported by a steering committee of about five-to-seven volunteer members, all from Central Saanich. The steering committee met weekly to discuss the recent events and to plan future activities. Its members included a retired civic engineer, an ecologist/local politician/farm products promoter, a water chemist, two retirees with experience in campaigning and project management at the federal level, and a member of one of the old families of the region who provided the activists with an important connection into daily community politics. The committee members were dedicated participants, but for the most part, were not known as major political players in the community – though the ex-councillor and old family member knew most of those who were "pulling the strings."

The Hagan Creek–Kennes Project enlisted the support of many other people and institutions within the region to help get work done. My graduate students and I helped out in specific areas of the Project at the nexus of numerous personal (research, personal activism) and institutional (community participation, fulfilling degree requirements) concerns. There have been many others who have become involved for the duration of a project or for a summer job while there was sufficient funding. There were rarely more than 15 people actively engaged at a particular moment, and Misty provided for the connection between the volunteers who contribute several hours per week of their own time. In the process of changing the community (e.g., bringing about changes to the Official Community Plan by engaging in the political process), the Hagan Creek–Kennes Project was part of sets of continuously changing relations, along with the creek around which the people have rallied and the community in which they work.

The activists believed that they were working in and against an adverse political climate. Farming continues to be the predominant form of land-use in the municipality. The other major landowners tend to be wealthy individuals living on large 2–10-acre “rural residential” lots. Both of these types of landowners are considered to be conservative, pro-property rights, and suspicious of people who “tell them how to manage their land.” Since most of the land in the municipality is private, the activists felt that building and maintaining good relationships with everyone they possibly could was paramount to their success in bringing about desired changes. There is not yet a broader sense that valuing this place, in which we dwell and which provides for us, also requires a broad-based, shared sense of ecojustice. Such a sense, as I articulate below, is part of what got seventh graders so excited about doing something for their community by engaging in Hagan Creek-related activism.

In doing their work, the activists transformed the creek and community (e.g., Fig. 10). For example, as they were planning the construction of a large riffle[2] in a very strategic location, the horse riding community insisted that they still be

Fig. 10 The environmentalists have already brought about changes in the watershed, such as the split-rail cedar fencing (front) that prevent access to the creek and signs that explain historical, biological, and environmental issues (front left). This section of the creek has been revitalized and is trout-bearing once again (© Roth 2007. With permission)

[2]A riffle is a structure from rocks and wood (logs) designed to make the water tumble, thereby introduce oxygen into the water and increase the levels of dissolved oxygen.

allowed access to a section of the creek in the park, so they could train their horses to cross Graham Creek (see location #4 on the map in Fig. 7). Despite the fact that the horse ford was just downstream of the riffle they had planned, and despite the fact that the horses would be passing close to an active trout spawning site, the activists agreed to the removal of some of the riffle structure so that the horses could cross the creek. The activists agreed to do this even though the park manager had previously approved the blockage of the ford if it was important for the fish. The activists made an arrangement with the most vocal horse owner that would allow her access to the stream at times when the fish did not spawn. To the steering committee of the Hagan Creek–Kennes Project, it was more important to have the horse owners "on-side" than it was to have a perfect riffle – that is, a riffle that emerged from a perfect translation from an imagined world, the world on paper, into its material format. The riffle, in this location, was a hybrid that included the concerns of the horse owners. Stream restoration science was transformed in its re-creation as a set of local relations at this particular site.

A Place-Based School Curriculum Oriented Toward EcoJustice

Given the water-related problems in Central Saanich, it was not difficult to convince teachers to participate in an experimental curriculum where students would learn science by investigating the Hagan Creek watershed. During 1998–2000, I cotaught science to three seventh-grade classes over 2–4-month periods. In these classes, students designed and conducted their own research in and along Hagan Creek, Graham Creek, and their tributaries (see Fig. 7) with the intent to report their findings at an open-house event organized each year by the members of the Hagan Creek–Kennes Project. The underlying idea in these science classes was to get students to become active citizens and to contribute to the knowledge available in and to the community. Other students at the middle school – and at the local high school – already conducted research in the watershed as part of their involvement in the regionally funded "Streamkeepers" program or for producing entries in local and regional science fair competitions. In this way, some students already participated in creating knowledge available to their community and the activists. Members of the Hagan Creek–Kennes Project, the authors, parents, and First Nations elders contributed in various ways to the teaching of the children in my experimental curriculum by providing workshops, talks, and assisting them in framing research and collecting data.

It was not difficult to enlist the students in this curriculum, especially after we were reading with them an article in which Misty MacDuffy called for community participation in doing something about the poor environmental health of the watershed. The children, many of whom came from farms, hobby farms, and (hobby, commercial) fishing families knew firsthand about the water problem. Their parents, especially those from the local First Nation, could no longer gather shellfish along the beaches because the pollution of Hagan Creek also polluted the inlet (left, Fig. 7).

The students from the farms knew about the problem accessing water, the building of ponds, the use of wells, and the problem some of the wells had with their levels of biological and chemical contamination. During the first lesson, almost all students wanted to do something about the creek out of a sense of environmental justice. More so than their parents and older village inhabitants, they sensed that something was wrong and that *they could and should do something about it.* And the desire to do something became even stronger once Misty MacDuffy herself had given them a presentation about the work she and her project had been doing.

Individuals already working in their professions on issues concerning the creek assisted not only the Hagan Creek–Kennes Project but also participated in introducing our students to research and practices. For example, Kelly Cabreras, a water technician working for a local farm, showed the students where and how she measured the water levels, how she measured the temperature and oxygen levels, and how the construction of riffles and the planting of trees alongside the streams increased oxygen levels (e.g., in sites #6 and #7 on the map, Fig. 7). Chris Parks, a biologist normally working for a consulting firm, spent one afternoon with the students, showing them, among others, how to use a colorimeter to measure the turbidity (cloudiness or haziness caused by suspended particles) of the water (Fig. 11). The students subsequently got to use the instrument to conduct measurements in various parts of the creek and to correlate these measurements with other variables of their interest, for example, with the speed of the stream or with the kinds and frequencies of certain microorganisms, worms, and so on.

Fig. 11 A trained biologist working with and for the environmentalist group explains middle-school students how to use a dissolved oxygen meter, which they subsequently use to conduct measurements (© Roth 1998. With permission)

Parents, activists, aboriginal elders, scientists, graduate students, and other community members were an integral part of the science units. They mediated, as shown in the activity theory structure (Fig. 5), what, how, and who for the students worked, researched, and learned. For example, every other week the classes spent one entire afternoon (noon–2:30 pm) in and around the creek. Parents assisted both in driving children to the different sites along the creek and participated in teaching by asking productive questions, scaffolding, and supervising children. Thus, Mr. Goulet, for example, was very eager to contribute to the teaching of students. I therefore invited him every time we went outdoors; and during the 4-month period, he only missed one outing. After I had told him that there was only one rule, "No Answers! Only Questions!," he always went off with a group of male students (i.e., not including his daughter) and, through his questioning, allowed students to learn a lot not only about biological phenomena and relations, but about physical and chemical characteristics of soil, the creek, and the water (e.g., which objects float in the creek).

Members from the environmental activist group also contributed giving presentations, assisting in teaching kids how to use particular tools and how to do research in the creek and how to analyze the data and organisms brought back to the classroom. Students from classes that had already completed or were near completion of their unit talked about their work in another class that was just beginning, and assisted their peers during fieldwork and data analysis (Fig. 12).

This involvement of community members, therefore, integrated the children's activities with activities in the community in two ways – much in the way it had done

Fig. 12 The middle-school students conduct various kinds of research projects in and alongside the creek. In the back (white shirt and shorts), a boy who has previously completed the unit assists newcomers to field study (© Roth 1998. With permission)

in the French village of Moussac that often served me as an example. First, the village community came to the school, assisting students and teachers in their activities. Second, the student activities were concerned with a pressing issue of the community; the science lessons took children out of the school and into the community. That is, the children's activities were motivated by the same concerns that drove the activities of other community members. In terms of the activity theoretic model (Fig. 5), there is, therefore, legitimate (peripheral) participation because the motivation that drives the activity system shares many moments.[3] It is this overlap with the activity system characterizing everyday life in the community (motivation, subjects community, and tools) that makes the children's work "authentic." Rather than preparing for a life after school or for future science courses, children participated in and contributed to social life in the community. It is in the process that learning – belonging to the various conversations of which individual persons are – was occurring.

Although the activity–system-defining object was the same in most instances for all student groups, Hagan Creek and the watershed it drains, different tools and rules mediated the relations in different ways leading to very different outcomes (Table 1). Nevertheless, the various outcomes ultimately contributed in their own ways to the totality of the findings generated by one or more classes. Here I understand the students' activities authentic in the sense that their activities were motivated in the same way and by the same concerns that other activities in the community were motivated. Table 1 also shows how different members of the community in general and the activist group in particular participated in the activity system that describes the students' activity. Other similarities with the activity systems in the community (Table 1) are some of the tools (colorimeter, rules). Not surprisingly, some of the *outcomes* of the student-centered activity system were, therefore, similar to those in the activity systems in the community. For example, the use of colorimeter, pH meter, or dissolved-oxygen meter all led to numeric representations of stream health. Similarly, middle-school students and students working on the Hagan Creek–Kennes Project as a summer job produced very similar graphical representations – such as stream cross sections. In addition, forms designed by scientists (water-quality assessment, physical assessment) assisted students in their summer job and middle-school students in producing representations (*outcomes*) that could be used by the environmental activists to pursue other goals (e.g., getting grants, proposing restoration work).

The unit ended with a presentation of students' work as part of the open-house event that the Hagan Creek–Kennes Project organized every year. At the open house, the children were not away in some corner designed to present "kiddies' stuff," but rather they were central participants of the event and, according to the environmentalists, a reason for the great success of it. Thus, the students' exhibits

[3]In activity theory, a *moment* is a part that cannot be understood independent of the other parts because each enters the definition of the other. Thus, a subject is a subject only in relation to a specific object, and the object exists only with respect to the particular subject engaged in the production of something in which the object constitutes the material resource.

Table 1 Outcomes in an activity system (seventh-grade science class) as mediated by the tools

Outcomes	Correlation between stream speed and profile	Classification and frequency of organisms, stream speed	Radio-like reportage, slides, website	Processes of investigating, environmental health	Dissolved oxygen levels, organism type/oxygen level correlation
Division of labor	Timer, releaser, measurer, recorder	Measurer, recorder	Roles in research team		Roles in research team
Rules	Repeated timing and averaging	For use of stopwatch			
Community	Central Saanich parents (Mr. Goulet) activists, scientists	Teachers, students from other classes [Davie]	Teacher, Michael, Stuart	Researchers, fellow students	Teacher, Michael, Misty, community
Tools	Stopwatch, tape measures, ruler	Tape, stopwatch, Serber sampler	Cassette recorder, camera	Video camera	Dissolved oxygen meter, Serber sampler
Object	Hagan Creek	Hagan Creek	Graham Creek, shore line	Student researchers	Hagan Creek
Subject	John, Tim	Seventh-grade students (John, Len, et al.; Lisa et al.)	Michelle et al., Kathy et al.; Chris	Gabriel	Jodie et al.

could be found right next to the water-level chart that Kelly Cabrera had recorded on her farm, enhanced by adding bars for the size and date of rainfall events, and that Kelly now explained to interested visitors (Fig. 13).

Given the different tools that the children had used to conduct investigations and construct their representations, the variety of the displays came as no surprise (Table 1, last column). There were maps, photographs, drawings of invertebrate organisms, instruments and tools, live invertebrates and microscopes to view them, larger organisms in a glass tank, interview transcripts, and a variety of scientific representations (graphs, histograms). The type of representations used was little different from those used in the various exhibits by the environmental activists. That is, the children's representations were a reflection of those that are characteristically used in a community-based science. In the following, I provide several brief descriptions and transcripts to articulate scientific literacy in the community involving children.

Michelle and her three (female) teammates had been interested more in qualitative than in quantitative representations of the creek. For example, one of their

Fig. 13 At the open-house event: A water technician, who also works with the environmentalists, explains a chart on which she records in a continuous manner the water levels in the creek, and onto which she has mapped the daily rainfalls for an entire year (black spots on the top of the chart) (© Roth 1998. With permission)

projects involved a tape recorder, used to record verbal descriptions of several sites along the creek, and a camera for saliently depicting some issue identified by the girls. Accordingly, their exhibit contained many photographs, exemplifying, for example, the differences between the creek where it had been turned into a ditch and where it was in a natural state. The work they had conducted in the field was represented in narrative form.

In another situation, Jamie came to interact with one of the cofounders of the Hagan Creek–Kennes Project (Fig. 14). Unbeknownst to Jamie, the cofounder political scientist living in the community was interested in assisting local people in empowering themselves concerning the environmental health of their community. As Fig. 14 shows, the political scientist was very interested in the outcomes of the students' investigations and interacted with a number of them. In one instance, he asked Jamie about an instrument on exhibition, the same type of instrument that the summer work-study students had been using to conduct and produce water-quality assessments. In the course of their interaction, knowledgeability relating to a particular instrument and its operation was being produced.

Miles: What is this?
Jamie: A calori– meter. It measures the clarity of the water.
Miles: Ah! A calori– a colorimeter?
Jamie: You take the clear water and you put it in this glass and then here [puts it into instrument] (*Pushes a few buttons*) and you take the standard which is like the best there is. And then you switch this (*takes different bottle*) and put the one with

Fig. 14 At the open-house event: A middle-school student explains the use of a colorimeter, which is used to measure turbidity of water by comparing it to a sample of clean water, to local resident very interested in the environment (© Roth 1998. With permission)

the water from the creek. (*Covers sample*) And then you scan the sample. And then you see what the things floating in the water is.
Miles: Over-range, what does that mean?
Jamie: (*Pushes a number of buttons*)
Miles: Oh, it is when it is over the range, I see.
Jamie: First I have to do the standard again. (*Does standard*) Then I take the creek water. (*Enters bottle into instrument. Pushes buttons.*)
Miles: Oh, I see. This is really neat.

This interaction did not lead to a contrast between an all-knowing adult (expert) and a child; there was no belittling. Rather, the conversation involving Miles and Jamie allowed the articulation of an honest request for understanding and an illustration of the operation of the device. Scientific and technological literacy emerged from the dialectic tension between a request for information and the production of an answer in the form of a demonstration.

In summary, then, this (triple) teaching experiment that I conducted with my graduate students showed that children participated in activities with similar motivations as those of adults, and they participated in a variety of forms of conversations with adults other than the regular teachers. More so than most of their village elders, they had felt spoken to their sense of ecojustice when they heard about the dire straits of the local watershed; and more so than most of their village elders, they felt the need to do something about the situation. The conversations they had with individuals and collectives, therefore, broke the mold of normal modes of schooling, opening up the possibility for lifelong participation in such an activity and therefore the possibility for lifelong learning without the discontinuities that characterize the transition from formal schooling to other aspects of life. If the motives underlying school science and environmental activism, stewardship, or volunteerism are similar, based on the nature of tools, rules, divisions of labor, and community, we can expect individuals (subjects) to move along trajectories that do not exhibit discontinuities characteristic of other transitions. Students who participate in activities that contribute to the knowledge available in their community will develop into adolescents and adults, continuing to participate in the activities relating to environmental health. The possibility for such transitions is clearly indicated by a variety of situational organizations that foster the participation of students and nonstudents alike. For example, as a result of my work in the schools, middle- and high-school students conducted science–fair-related investigations. As part of their career preparation, some local high-school students chose to participate in "Streamkeepers," a program fostering the recovery and restoration of ecosystems, and open to any individual or group. Three national youth teams worked together one summer to help the Hagan Creek–Kennes Project to improve the watershed by moving native plants before clearing 11,000 m^2 for a pond and wetlands that helped improve the water quality in the area.

High-school and university students contributed to the data collection as part of funded summer-work projects. Masters students at the local university became key people in constructing community surveys to yield multilayered (GIS) representations, involving maps that displayed groundcover (vegetation), surficial geology, soil, aquifers, topological, and present land-use (housing, zoning, or cadastral) information.

Rural Education Has Great Advantages

In this teaching experiment, knowing and learning were taken as moments of culturally and historically situated activity. Learning, which I understand as changing participation in a changing world, is discernable by noticing self and others' changing ways of going about interesting and community-relevant issues. Because interaction and participation cannot be understood as the sum total of an individual acting toward a stable environment, learning cannot be understood in terms of what happens to individuals. Rather, if learning is culturally and historically situated and distributed in this way, educators must focus on enabling changing participation, that is, enabling new forms of societal activity that is collectively generated. I am, therefore, particularly interested in forms of participation that are continuous with out-of-school experiences and, therefore, have the potential to lead to lifelong learning rather than to discontinuities between formal and informal learning settings. Building on children's sense of, and *for*, place, which constitutes their real dwelling, also awakens their sense of ecojustice.

In my view, rural education comes with the advantage that the kinds of engagement described here are much less problematic than they might possibly be in urban situations. Here, the parents participated driving their children and peers to the different research sites and thereby engaged to make this interesting educational context possible. The sites were close and easily accessible, facilitating such a curriculum in a (semi-) rural setting, whereas they may not be easily accessible in (sub-) urban settings. Given the size of the municipality, it was not surprising that the participating parents knew each other; they were chatting about this different approach to teaching and learning and compared it to the normal approaches that also characterized their own schooling. In the past, I have written a lot about another rural school, this one in France, about which I had seen a documentary; I subsequently exchanged emails with the teacher (Bernard Collot) and he sent me the book he has written about teaching in rural schools. Like I, he is actually in favor of the context, which, in his situation, meant teaching in a 500-soul village. Here, too, elementary school children went into the village, for example, to post the letters they had written to pen pals around the world; and parents and other village folk came to the school to engage the children in various forms of activities, like the older lady coming to play chess with them or the gentleman who helped them build and tend a vegetable and fruit garden. It turned out that the school eventually became a totally open environment where young and old would come after school and in the evening to make use of existing resources that allowed them to expand their own room to maneuver, such as using computers and accessing the Internet.

Bernard Collot (2002) suggests that the schools in rural communities have an advantage in that they may constitute small heterogeneous assemblies that are the sources of dissipative, self-organizing structures. Once the structure is in place, you do not need much to sustain these structures because they are self-sustaining. For example, when there are classes gathering all students from K–6, then each year there are only a small number of incoming and a small number of outgoing students, the remainder being the same as during the previous year. Thus, students just continue what they have done before and the incoming students become part of the existing patterns of doing things. When I took my seventh-grade students and allowed them to become part of the network of conversations and actions surrounding the health of the watershed, they, too, were like the incoming students in Bernard's class, learning by participating in doing what others already were doing.

Bernard Collot suggests that small villages also can function like dissipative structures concerning knowing and learning more generally, structures that stand in a mutually constitutive relation with the school. In fact, school life and village life no longer is distinct – schools become deinstitutionalized in the way I have been advocating for some time now. Bernard showed that one does not have to regulate children to achieve *better* than the national average on standardized examinations. In fact, his students arrived at the school in the morning when they wanted, and then wrote *their* own daily curriculum objectives on a chalkboard. They were completely free in their choices, though they tended to enact particular activities, composing music, writing to pen pals, gardening, constructing something, attending a play put on by other individuals, or participating in a discussion (e.g., the one I watched was a discussion among K–3 students concerning the question of whether god exists). The teacher Bernard never lectured, and when he wanted to talk he had to ask the current chairperson (a student from the group) permission as anyone else participating in the situation.

The literacy that the students in this study evolved constituted the outcome of a live, place-based curriculum. It was a form of literacy that had as one of its central features an ethico-moral dimension that characterized not only the activity (Roth 2008) but also the particular forms of identity that students developed (Roth 2007). Such ethico-moral dimensions are central to a form of education that I refer to by the term *education as ecojustice project*. Such a project is inherently open-ended, always to come (Fr. *à-venir*), with results never achieved and achievable but always in the future (Fr. *avenir*). In this nonfinalized way, we can never be satisfied with having achieved ecojustice, but always have to strive further, always enacting rather than achieving it – ecojustice as performative:

> A performative produces an event only by securing for itself, in the first-person singular or plural, in the present, and with the guarantee offered by conventions or legitimated fictions, the power that an ipseity gives itself to produce the event of which it speaks – the event that it neutralizes forthwith insofar as it appropriates for itself a calculable mastery of it. (Derrida 2003, p. 152)

As performative, we cannot ever achieve ecojustice other than in concrete praxis. That is, ecojustice achieved is ecojustice not attained, for, as other phenomena including forgiveness and democracy, only an inner, irresolvable contradiction keeps it alive. Moreover, it is only in the first person that ecojustice gives itself as ipseity, which is neutralized as soon as we think we have attained and mastered it. The children in my studies practice ecojustice but never can attain it, even if they practiced for the remainder of their lives. And precisely in such reproduction and transformation of ecojustice praxis, they retain it as a viable form of human life.

Ethico-moral stances, ecojustice, and sense of place in rural communities contribute to a greater aim than transmission and handing down of knowledge. Rather than studying to be admitted to higher levels of learning (school subjects as propaedeutic) students actively participated in the social life of their community – both in Bernard Collot's and my examples; they did so in my case by contributing to the available database on the health of one local stream. For my students, science was a lived curriculum, in which students "have a feeling that they are involved in their own development and recognize that they can use what they learn. This venture in science curriculum development recognizes the socialization of science and its relevance to how science impacts our culture, our lives, and the course of our democracy" (Hurd 1998, p. 411). A lived curriculum requires a collective endeavor involving not only one subject (e.g., science) but also disciplinary knowledge in the social sciences, humanities, ethics, law, and political science. However, an interdisciplinary approach gives all subjects an epistemologically equal place among all others rather than attributing to it an epistemologically exceptional status. Truly democratic forms of education (not in the sense of serving capitalist interests) allow individual members to develop their own representations of salient issues.

In my approach, education moves outside the school and thereby becomes, at least partially, deinstitutionalized. Conceptually, this deinstitutionalization shares some similarity with the institution of halfway houses or with the group homes that replaced mental hospitals in some countries. In both situations, the members are no longer locked up in institutions (prison, psychiatric clinic) but participate in (limited ways, sometimes under supervision) the everyday affairs of their community. In my situation, students' activities take their place in the community more broadly rather than being something relegated to particular locations (schools) with local and temporal effects. The outcomes of students' work has relevance and contributes to the broader life world that they inhabit together with their parents, siblings, elders, town council members, and others in the community. If science is to be for all, then there have to be opportunities to participate in ways that emphasize students' strengths, and address their interests, rather than setting up situations that bring out inability, disability, and problems. Science in rural communities thereby contributes to the reproduction of village society so that we may conceive of education as one that focuses on the achievements of the collectivity and consider "best teaching strategies" to be those that lead to new forms of collective activity. Science education conceived in this manner not only builds on the sense of place that locals feel, but also builds on the sense *for* place, which generally comes with a sense for the need of ecojustice.

When rural educators focus on creating situations with the potential for scientific literacy to emerge and for lifelong learning along trajectories not marked by currently prevailing discontinuities when school boundaries are crossed, new instructional possibilities and difficulties are likely to emerge in nondeterministic ways. This is a direct result of the school and rural community being small, order-generating entities that produce and evolve new self-sustaining structures. Documenting these possibilities and difficulties, as well as knowing and learning what emerges from them, remains virtually uncharted terrain. Much research remains to be done to study the forms distributed and situated cognition to take in the approach we propose. Before policy recommendations can be validly made, such research has to show that our proposal can be implemented more widely in a number of different domains and with more diverse student populations than that participating in this research.

Coda

Academics often decry the poor state of rural education. The situation may well be such that it can be decried, but this is not a fault of the nature of *rural* schools and communities. There are other moments of society mediating what happens in rural schools, the undesirability of teaching there, poverty, poor funding and endowment, or low teacher pay. The fact is that only the sky is the limit for someone wanting to innovate and capitalize on the opportunities rural communities offer to the educator and to its students. In this chapter, I provide a number of examples of how with very simple means rather innovating curriculum can be planned and enacted.

Academics also can do something for developing a sense of place in their colleagues and through their own actions. Writing about ecojustice in the disembodied and dispassionate ways of an Immanuel Kant can only do disservice where the core phenomena, such as sense of place and ecojustice, are related to embodied knowing and emotion. In this article, I use photographs to communicate more than a successful approach to teaching in rural settings. One of my purposes is to produce a gut-level understanding of what these places are like where I have taught and to which I have developed a deep sense of emotional belonging, awe, and responsibility. I am growing here the food I eat, and I contribute to the maintenance of an environment that also is my dwelling on which I depend. But these specific places I inhabit are only placeholders, metonyms for the world we inhabit more generally and in which we ought to take the place of caretakers rather than of abusers. There are other places, where through my actions I can contribute to ecojustice and a sense of place, by buying organic and fairly traded products (e.g., clothing from organically grown cotton and bamboo, organically grown and fairly traded coffee). I abandoned my car and now do everything by bicycle and bicycle trailer. We cannot just write about changing the world, we must change it both through action and by example. Place, ecojustice, and rural community *ought not* remain (empty) slogans and lines in the manuscripts we compose but have to be taken up in the way we conduct our lives.

Michael Mueller (2009) suggests, we must not take "ecological crisis" as the lynch pin of our arguments on ecojustice or sustainability. I agree. My own sense for ecojustice and caring for the environment emerged when I was a child. My mother often talked to us about the hoopoe – which, because it defecated in its own nest, was to stink to such an extent that "stinking like a hoopoe" has become a familiar expression – when she wanted to make sure that we did not litter and make sure we were clean. Ever since those days, the image of human beings on earth like the hoopoe in its nest – we pollute our own place of dwelling. It is out of this sense of dwelling and the care it needs that my own sense of place and ecojustice has evolved rather than out of a sense of environmental crisis and sustainability (which may in fact not be possible when viewed on a global scale).

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