# Designing Learning Communities

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During the twentieth century, many societies have become increasingly individualistic. Psychological self-help books are filled with advice how to realize one's personal goals, needs, and fulfillment with acknowledging that our identities, who we are with respect to ourselves and to others, arises from a deep and fundamental relation between self and other. There is a decreasing appreciation of the connection between individual and collective that makes it possible that an individual can engage in, for example, the esoteric pursuit of studying Bose-Einstein condensation in dilute gases (Nobel Award 2001 in physics) without having to worry about the dinner being on the table although he or she is not hunting, gathering, or farming. Our physicists do not have to worry about where to live or where to engage in studying Bose-Einstein condensation because others, including architects, masons, and crane operators construct the office building and laboratory where they engage in their pursuit. Further, they do not have to worry about the work of maintaining the instrumentation, buildings, and offices—the craftspeople in the machine shop, cleaners, and secretaries. But all these activities allow the physicists to find out (learn) and communicate to others evidence for and characteristics of this new state of matter. And yet, despite the complete dependence of these physicists on the society-based division of labor, they receive acknowledgment individually. Thus, the press release for the 2001 Nobel Prize in physics states, among others that

> [t]he condensates [Wolfgang Ketterle] managed to produce contained more atoms and could therefore be used to investigate the phenomenon further. Using two separate [Bose-Einstein condensates] which were allowed to expand into one another, he obtained very clear interference patterns, i.e. the type of pattern that forms on the surface of water when two stones are thrown in at the same time. (http://www.nobel.se/physics/laureates/2001/press.html)

Here the individual is being celebrated without any acknowledgment of the structural relations—community and material resources—that make learning about Bose-Einstein condensates possible in the first place.

Recent work on the nature of knowledge shows that the natural social structures for the ownership of knowledge are communities of practice (Wenger 1998). Although they are everywhere and have been around for a long time, educators have only recently begun to think about how to design communities that support learning. Characteristically, these educational efforts do not lead to sustained communities of learning, in part because the unit under consideration is the individual classroom disconnected from the remainder of school and society. Further, assessments of what students know and have learned, at the classroom level as well as in national and international comparisons (e.g., TIMSS and PISA), always focus on the individual rather than on the collective. They focus on what individuals produce separated from all social and material (tools, computers) resources that normally are available to students in classrooms or the Nobel-winning physicists in my opening example. That is, there are some deep contradictions between communities of practice that have historically evolved and the design and study of communities as seats of knowing in educational contexts. In my view, these contradictions arise from a deep misunderstanding of the nature of communities and of the relation between individual and collective.

This chapter is designed to articulate an understanding of communities of practice that affords collective and individual learning. To make my case, I draw on (a) two detailed examples of learning in contexts where school and village life came to interpenetrate one another and (b) on recent social psychological and sociological theories. I list some key features that designers of learning environments need to consider to benefit from the "community" metaphor.

## Learning Communities: Case 1

Let me begin by providing my account of a French village school of Moussac (Poitou-Charentes, France) where, according to the teacher, "a community really exists." The school has repeatedly featured in the French media, and it has its own website.

### *Learning in Moussac*

It is morning in Moussac. Through the viewpoint of a camera, we see children walk towards their one-room elementary school as they explain that they come to school in the morning at the time when they want to. In fact, their teacher

Bernard does not want all of them to come at the same time. Once at school, the children show the visitors around. There are computers where children publish their own newspaper and write letters to pen pals all over the world. The children explain the function of the music room including homemade percussion instruments and a tape recorder, the discussion room with its long table, the classroom for the little ones (about K–3) and that for the older ones (about Grades 4–6). Then there is their daily "curriculum," which children establish themselves through collective efforts.

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| Journalist: | So, if I understand well, the children in this class do what they want? |
| Teacher: | Not entirely, not entirely. It's not what they want, but what the collective activity of the class, what the events globally bring about. So what I try is to order these events somewhat. |
| Journalist: | Because I get the impression that they, by and large, get by without you? |
| Teacher: | Yes, they do well without me. My own problem is to make this group function as a community. |

Throughout the school day, one can see five-year olds mounting a puppet show or gathering for one of their collective meetings with Jean, their current, but weekly-changing chairperson. In these discussions, Bernard, the teacher, is but one of the members, who waits for his speaking turn as any other member of the community. There is the chess lady who comes every Wednesday who emphasizes that because the children are free, they also make her free. Bernard suggests, "If I am really glad for her presence, it is not for the chess but for her presence as a person. It is because she has a relationship with the children, there are extraordinary things that happen while she is here."

Later, a couple of older kids bring their letters to the post office where the official indicates that the children's posting of letters two or three times a week has become part of normal village life. The post office manager says that it was strange initially to see the children come from school just like this, but it makes for a revival of the village in the school. In the shop, children work on their own projects, sculpting and hammering while Bernard watches the youngest ones, but without interfering. He explains that it is only when people get nervous about failure and accidents that failure and accidents come about. There is also a parent who comes to garden with the children; there are some children in the music room, experimenting with the percussion instruments; a boy who sits in the corner by himself and listens to music with his headphones; in another corner, a boy writes a letter while others read with a group of smaller children.

Journalist: Don't you have this fear weighing over you, "I have to teach them to read, teach them to write, and teach them to count"?

Teacher: No, I don't have this fear at all, absolutely not at all. For slowly I learned that when the children are part of a group that really exists as community, when there is a real setting, when the interactions with this setting, with other children and adults, when this context really exists, at that point, all children without exception learn to read. How? Now, this is another thing. But this isn't really my problem. The gardener's problem is not really how plants grow tall, strong, and well. His problem is to put them at their right spot, to plant them somewhere, to recognize that this might not be the right place, and to replant them somewhere else, and so on. And I have this gardener's job. And when the garden, the community is like a garden, when it really works, children inevitably learn to read. It's like with their teeth, they will inevitably come. But although the children's mothers know about it, they still worry. So here, it's about the same thing. One has the responsibility of not preventing children from learning how to read.

In the end, Bernard talked about failure that students experience in schools other than his own. It is not the children who fail; rather, teachers, schools, and the school system fail the children. Learning is natural, emerges from participation in the collective activities of a community. Learning and participation cannot be separated but are irremediably bound up with each other.

*Analysis*

This documentary information about the school, children, teacher, and community of Moussac contains some elements that have become central to my thinking about learning in schools. What we see here is a school where the transition to out-of-school life in the community is much more transparent than in most other schools. School has become part of village life. Even within school, life operates as an open community in which members pursue activities at different levels of competence; the teacher and other adults are only part of the community. The fact that children of different ages work together in the same open classroom contributes to the distribution of competence similar to the distribution one can observe in the village itself. These adults do not "teach" as such, that is inculcate students with pieces of information that they need to memorize in order to succeed. Rather, the close interaction between school and the entire village of Moussac allows the children to participate in daily activities, that is, to develop into increasingly competent members of the community at large by actively participating from young ages.

In this village, children learn as part of engaging in real activities, activities that are meaningful to them, over which they feel ownership, and that they plan on their own. They publish a newspaper, they communicate with peers in other parts of France and the world, they keep journals to write about the contents of their reveries and reflect on their learning. Younger children learn as they participate in legitimate peripheral ways in the activities of older children. There are meetings of the collectivity, times when older students read to and with younger children; at other times, adults from the community interact and make available their competence as resources to the members of the school community.

An important aspect of the community in the school of Moussac is that children have a sense of self-determination and control over their activities, and with it, over their own learning. But the activities of individual children are not independent of each other, not an odd collection of individualist activities disconnected from those in which other children engage. Rather, the activities of individual children are in part determined by the "sum total" of the collective activity; they are concrete realizations of the possibilities that exist at the level of the group. Individual interests and those of the community influence each other in a reciprocal way: they are mutually constitutive and always tied up with the object of the activity—making it unnecessary to motivate children, that is, to make them do what others want them to. Coming to school at their own time, going to the post office, or determining their daily curriculum are but a few of the outward signs of the children's ownership over their learning contexts. In such a community, teachers' activities change from those they traditionally performed. Here, teachers have to be centrally concerned with setting up the community, keeping it going, and not interfering with children's propensity for learning. They do not have to disseminate information, but only help order emerging collective activity. Bernard's comment that children learn inevitably when the community really exists resonates with Lave's (1993) assertion that we do not need to force children to learn. Learning occurs inevitably, as part of our being-in-the-world and participating in collective activities with everyone else. Nonlearning or mislearning "occur when embarrassment is too great or result from anxiety, from the social delegitimation of learning or the learner, and from the retarding effects of denying learners access to connections between immediate appearances and broader, deeper social forces or to concrete interrelations within and across situations" (p. 16).

The interactions between school and community go even further in the sense that it offers opportunities for others, adolescents and adults, to acquaint themselves with new information technologies or to borrow a book or document.

Middle school to university students come to use the computers to write their essays, research papers, and other forms of homework; adults in the search of work type their CV using appropriate software that has been made available for them. It is also here at the school that the association "Une École Un Village" has its monthly meeting to organize school life, village theatre, and festivals. The local paper is published within the school, the village choir practices here. Initiated by Bernard Collot, the idea of the village-school integration was subsequently supported by the parents and elected officials. Over the years, animated an intense local activity around the concept of continuing education, that is, the readiness of an entire village population as an instrument of proximal learning.

When I talk to teachers about this documentary, I inevitably hear lists of reasons why this is an idyllic situation and cannot be transported elsewhere. However, I have repeatedly observed and documented classrooms that had striking similarities with the school in Moussac (Roth 1995, 1998). For example, during my last three years as a schoolteacher and department head of science, I taught eleventh- and twelfth-grade physics. I turned the physics laboratory into an open place where people, students and teachers, could come whenever they wanted and work at whatever they wanted. There was a community in which older students helped younger ones in grappling with intractable problems in their physics experiments. Mathematics teachers came to do their work on the available computers. (When all computers were used, teachers did something else first, and came back later rather than enacting their "rights.") Other science teachers came to work with students on experiments, to observe and participate. But in this physics laboratory, it was not just the physics students who learned, and it was not just physics that was learned. Students came after school and in the evening to do mathematics projects, write their religion and geography essays, produce graphs for their economy class. Again, there were interactions between students at various levels of competencies, interacting with each other and with the teachers present. I was often sitting in an adjoining office with the door slightly open, doing my own work. Like the teacher of Moussac, I saw my job as keeping the community going, creating an environment in which members learn, inevitably and because they want.

How can we design such communities that support learning, communities in which participants learn school-related things although they pursue projects that they have designed on their own?

## Individual and Collective: A Double Historical Perspective

According to Bernard Collot (1995), the (now former) teacher, the success of schools like Moussac lies in the different social structures that they provide to individual students. They are privileged places where a collective can easily exist, where a group exists despite the contradictions in society more generally. The heterogeneity, rhythm, and space of these one-room schools and the integration into the village more broadly are ideal conditions and the very foundations that of a functioning community of learning. To understand the relationship between individual and society, that is, the societal nature of human beings, we need to take a dual historical perspective. On the one hand, we need to consider how it came that in the process of becoming human, societies emerged characterized by division of labor and social relations so that, for example, in exchange for contributions to the survival of the society, individuals were able pursue activities other than hunting or gathering food (Holzkamp 1983). This allows us to understand psychological characteristics, such as motivation, dispositions, and responsibility as grounded both in individual and collective, personal and social, and always inherent in the relation of subjects the objects of their activities (those that they truly pursue). On the other hand, we need to show that during its development, the individual human being is formed by and incorporates currently existing social structures (Bourdieu 1997).

### *Emergence of the Individual-Collective Dialectic*

In the human evolution, two processes changed developmental patterns from environmentally determined evolutionary to societal, cultural-historical—the increasing use and production of tools and the development of learned social relations, divisions of labor, in which single individuals assumed partial functions in the collective production of conditions. These two processes allowed two qualitative leaps toward becoming human—the production of tools for generalized rather than particular purposes and the eventual shift from adaptation of the prehumans to the environment to the collectively achieved active adaptation of the environment to humans. By contributing to the collective control over living conditions, the individual subject was able to control his or her own living conditions, a process required because humans generally are no longer able to survive barehanded in a natural environment. Collective, societal control thereby annuls the conditions under which natural selection leads to the evolution of species and leads to the determination of conditions through societal, cultural-historical processes.

But this fundamentally changes the way in which humans relate to their environment. The individual subject can control his own living conditions, because these are always individually relevant collective conditions only by participating in the collective control over collective conditions. We can therefore satisfy our needs by contributing to the maintenance of society so that general needs are met rather than by dealing directly with the environment to satisfy individual, particular needs. Being able to control one's life conditions therefore always requires moving beyond individuality and toward participation in collective control over societal processes. Thus, there is a double relation: humans *produce* and *reproduce* the conditions in which they live, on the one hand, and *are subject to* these conditions, on the other.[1] Because there was a phase during which both natural selection and societal development were active, human nature became social.

The individual becomes an *individual subject* by relating to and in union with society, the *social subject*—such relating-to always requires communication and the implied reciprocal social relations. That is, *individual subjectivity* emerges simultaneously with *intersubjectivity*—a human being becomes an individual when she experiences herself as an other to another human being, who experiences herself in the analogous situation with reversed roles (Ricœur 1990). We arrive at the fact that human subjectivity is never just individual subjectivity but always and already intersubjectivity—human nature is dialectic. The psychological is not something isolated but always the psychological side of the possibility to sustain one's own existence through participation in the collective process. Although direct cooperation in the collective process was required initially, further historical development gave rise to the current situation that society sustains individuals even if they longer contributed to its maintenance. The collectively necessary actions are now action possibilities for the individual. As long as the collectively necessary actions are completed, society survives and thereby sustains all individuals. Most importantly, individual action possibilities (including those that do not contribute to the maintenance of society) are always concrete realizations of more general possibilities at the societal level.

Such a conceptualization, which dialectically relates individual and collective, immediately allows us to make predictions about such phenomena as the killing sprees committed by adolescents in their schools—as witnessed recently

[1] Many psychologists and sociologists only study the determination of human actions by and to given conditions but fail to make thematic the human production and reproduction of these conditions.

in the USA, France, and Germany. Locking them up or even subjecting them to the death penalty will not bring about any significant change because it only removed the individual but not the generalized possibility, always societally mediated and therefore existing at the societal level. (The U.S. experience, whereby murder rates are still higher than in other countries despite the enforcement of the elsewhere abolished death penalty, only supports such a theoretical frame.)

This theoretical linkage between individual and collective leads to environmentally determined evolutionary and societal cultural-historically grounded psychological categories, including emotionality and motivation (Holzkamp 1983). In the following, I use motivation as an example to show how it is tied up with and result of the individual-collective relationship and also always inherently embedded in the subject-object relation.

*Motivation: A Social Psychological Perspective*

Psychologists and educators often wonder how to motivate students. Here motivation is equivalent to making students do voluntarily what someone else wants them to do—this question is the motivational formulation of external determination (locus of control). The teacher question, "How do I motivate students?" therefore inherently contributes to the external locus of control rather than to the situation where motivation is inherent in the object of the activity chosen by students on the basis of meaningful grounds. Historically, we can understand motivation to arise from a projection whereby individual needs could be satisfied by participating in the satisfaction of collective needs (Holzkamp 1983). Let us take the famous example of collective hunting activity in which beater actions (frightening the game) and hunter actions (killing game) are coordinated (Leont'ev 1978). In this case, individual and collective motives coincide. That is, the individual who recognizes that the contribution to the collective activity also opens up control over and improvement of individual situation is inherently motivated. Truly collective activities are always characterized by the coincidence of individual and collective motivation—this is most clearly evident in competitive team sports. When individual and collective motivations do not coincide in the course of collective activity, there then exists a contradiction, entailing different coping mechanisms that sustain or remove the contradiction. (The shortsighted solution to school violence is the removal of individuals rather than the making of changes to society as a whole.)

We can generalize, therefore, that learning is motivated when the subject of learning anticipates that learning will lead to greater control over his or her conditions or quality of life, that is, to an increase in the possibilities. Learning, motivated in this way, is inherently *expansive* (Holzkamp 1993). (Learning for the

sole purpose of avoiding a diminishing control or quality of life is *defensive*. It is associated with an external locus of control focused on avoiding or coping with menacing situations.) *Expansive* learning is generally associated when individuals form collectives to deal with problematic situations in order to capitalize on the greater control they have as a collective (Engeström 1987).

*Expansive* learning, in addition to being mediated by the collective, orients itself according to the needs of the problematic situation. Motivation is therefore tied to the object (necessarily as viewed from the individual subject). That is, students who choose goals are inherently motivated to achieve them—even in the case where they desperately want to go to the bathroom to avoid a physics lesson.

As an example, let us return to the students in the Moussac village school. They are not made to learn to read and write; they begin to read and write when they are ready for reading and writing. They are not made to learn musical notes, they learn to play because they play in a context where, no that the "community really exists," others always and already play. In a context where cultural practices include reading and writing, where older children read to younger ones and where children are engaged in writing email messages or sending letters, participation in cultural practices is coextensive with learning to read and write. Motivation to learn is built into the cultural practices ad the objects towards which they are directed. Similarly, the direction of learning is produced and reproduced in practice. As an individual begins to participate in a legitimate peripheral way in an ongoing practice in a process to master the practice at some point, the motivation to learn is built in the process. How it is achieved depends to the particular needs of the individual and happens just in time and as needed. The exact moment of time when learning is needed depends on the trajectory that the particular individual takes, itself a function of the current state, for every future moment on the trajectory depends on where the individual is at the moment, which itself depends on the prior history of the trajectory; that is, during learning, the trajectory integrates over its own history.

*Development of the Individual into Society*

In the foregoing sections, I showed how individual and society, subjectivity and intersubjectivity, emerged together in a historical process whereby natural selection was replaced by cultural-historical processes. Human beings today are born into a world not only structured in a material sense but also in the way other human beings interact with one another and with the child. That is, because the human body is open and therefore exposed to the social and material world it is also susceptible to be fashioned by the sociocultural and material

conditions (Bourdieu 1997). The individual is therefore subject to a process of socialization, a process that even underlies, as I have shown, the formation of our sense of self, other, and community.

At the heart of this conception of patterned human actions (practices) lies the dialectic relation of disposition and field. Children's dispositions to perceive and act in certain ways are shaped by the sociocultural field into which they are born. But the perceptions of different aspects of sociocultural fields involve the dispositions: the social and material structures surrounding children lead to dispositional structures in the form of anticipations and expectations. That is, certainly genetically biased at the beginning (nature), children's dispositions develop in the dialectical relation of existing dispositions and the fields (conditions) in which they find themselves (nurture). This leads to a practical comprehension of the world that does not require an understanding of formal structures. That is, participation in the sociocultural contexts leads to the development of dispositions, which both allow us to reify the fields and develop field-relevant practical mastery. And again, we have the dialectic of individual and society, this time at the level of the individual. As previously articulated for motivation, there is a dialectical relation between individual and collective dispositions. My dispositions are never just mine but always also those of the other; dispositions are never just individual but always already social. It is important to note two issues. First, dispositions are not directly accessible; we can always only see practical actions themselves generated in the dialectical relation of disposition and setting. Second, dispositions are formed not only by what we consciously perceive but also and more importantly by the totality of the conditions to which we are exposed.

After the early development of the child into society, he or she later her becomes a member of this or that community of practice. For example, a child might decide to play soccer; in the context of a club or sponsored team, and under the guidance of the coach and other club and team members—with the support of parents who drive him or her to training and games—the child becomes an increasingly soccer player. Later in life, he or she may decide to earn money by working for a fast-food restaurant as a dishwasher, short-order cook, or sales person. Again, in the context of an existing community, the individual participates and through this participation is exposed to a particular material and social world. Finally, the individual may decide to become a physicist or ecologist. Again, from the interactions with others and the material world, for example, during their fieldwork experience, scientists develop dispositions for looking at and interpreting the formal representations (e.g., graphs) characteristic of their field (Roth and Bowen 2001). By becoming competent, the individual also in-

corporates the tacit assumptions that underlie the particular community of practice, whether this concerns particular ways of dealing with dirty dishes, dos and don'ts of preparing food, or patterns of how to interact with clients. Learning can be thought of as changing participation in the ongoing but changing collective praxis.

**Another Look at Moussac**

In the light of the foregoing comments, let us take another look at the village of Moussac, its students, teacher, parents, officials, and village at large.

In Moussac, there exists a collective responsibility taken by the community as a whole, that is, the responsibility for learning is distributed across the community, students, teacher, parents, elected officials, and others. I understand "distributed" not in terms of being divided up, each individual or group talking a little bit of responsibility. Rather, distributed means that the community takes collective responsibility, which is a generalized referent for action. Individual and collective responsibilities are therefore related in the same way as individual and collective (generalized) possibilities for action, individual and collective motivation, or individual and collective dispositions. That is, individual responsibility then is the concrete realization of the generalized responsibility. At the same time that teacher and the rest of the village take responsibility for learning, each child takes individual responsibility for his or her actions, beginning the day with the outline for the daily program. These actions and projects are not designed willy-nilly but are in part determined, as Bernard said, by the sum total of the collective activity in the class. Thus, we have again the mutually constitutive interaction between individual and collective actions, and between individual and collective responsibility for the context in which children learn. Closest to the children during the day, Bernard enacts his own part of the responsibility, which, concretely, consists in "regularizing what is going on to make the group really function as a community." Parents and other adults (like the chess lady who comes from another village) and village officials, too, take their respective parts, each enacting a concrete realization of the generalized responsibility.

Production and reproduction of practice are always part of practice. The hardest part, as Bernard Collot said, may be to bring the group initially about. Once the collective exists, the number of individuals joining or leaving the group is relatively small compared to the entire group. This, of course, delimits the amount of effort any teacher currently has to spend at the beginning of each school year to socialize students into particular patterns of social interaction. Even more interesting, the Moussac experience continues although Bernard has

retired from teaching and another teacher has taken his place. That is, just as in the "natural" communities of practice studied by social scientists, such groups provide newcomers with an existing, relatively stable social structure into which they can be socialized without any effort on the part of the teacher. An important aspect of schooling in Moussac is the heterogeneity that comes with the composition of the class in a one-room school and with the interpenetration of school and village life. That is, the heterogeneity that seems to be at the core of the success of the Moussac experience, challenges common assumptions about the homogeneity of school classes as a prerequisite of efficient teaching and learning. The well-known social anthropologist Jean Lave, too, challenges the assumption underlying much of education that actors, goals, motives, activities, participants, culture, and meaning of events have to be homogeneous for learning to occur. Her description of situated learning appears to fit well with what happens in Moussac while constituting an antidote to what counts as knowing and learning in the majority of educational systems. Accordingly,

> knowledgeability is routinely in a state of change rather than stasis, in the medium of socially, culturally, and historically ongoing systems of activity, involving people who are related in multiple and heterogeneous ways, whose social locations, interests, reasons, and subjective possibilities are different, and who improvise struggles in situated ways with each other over the value of particular definitions of the situation, in both immediate and comprehensive terms, and for whom the production of failure is as much a part of routine collective activity as the production of average, ordinary knowledgeability. (Lave, 1993, p. 17)

Once the group exists, goals and motives are embodied in the objects of activity; by participating with their older classmates in the ongoing practices, the younger children also take on board the inherent goals, motives, responsibilities, and dispositions. In the process, they experience the need to learn to read, write, and do arithmetic even though the teacher never has to motivate them (or worse, force them). Once the group interacts with children in other schools in their district, their country, or countries around the world, newcomers to the classroom experience from their first day "writing to pen pals" as a common everyday practice.

In Moussac, students take an active role in learning. Rather than merely responding to fixed external conditions, as cultural dopes that blindly follow rules and do what the teacher tells and wants to hear from them, students contribute to producing and reproducing the conditions necessary for expansive learning to occur. In the first place, they reproduce the group characterized by particular practices. In collective activity, individual possibilities of action are viewed as

the concrete realization of generalized (collective) possibilities. Because they are agents rather than dopes, teacher and students have the capacity to change the conditions that frame their activity. However, this agency and therefore control over the context is not unlimited. Objectively experienced structures in the village constrain what teachers and students can do. There are always social and material determinants of action. Teacher and students learn and their group develops, as they increase their control over the events in the classroom.

We can think of learning in the community of Moussac in terms of the notion of zone of proximal development (Vygotsky 1978), which is often used for theorizing activity and learning when a less able individual (student) achieve at a higher level because more able individuals "scaffold" engagement in a task. The zone of proximal development is then the distance between achievements when an individual works alone, on the one hand, and when he or she works with the more able person, on the other. However, the zone of proximal development can also be understood in a wider sense. It can be understood as the distance between the everyday actions of individuals and the historically new and culturally more advanced activity that can be collectively generated (Engeström 1987). In Moussac, the village as a whole constitutes the community that engages in the activity of learning in the course of daily praxis. The community allows for learning not only as adults come to school to provide support or children go into the community (such as to the post office) but also the adolescents and adults come to the school to access resources (books, Internet) or engage in collective activities (meetings, choir practice) that provide contexts for their own learning. School and village life more generally interpenetrate one another.

In a recent research project, it occurred to me that the interpenetration of village and school life might be the central feature that made my science units so successful (Roth and Lee in press). I am using the following case not to suggest that every school science class should engage in environmentalism but to provide a concrete example of what can be done as a first step in organizing school science along the idea of interpenetrating communities of practice.

## Learning Communities: Case 2

One of my projects is concerned with science and science learning in my community, primarily focusing on environmentalism both as everyday activity and as context for school science. My doctoral student Stuart Lee, a trained biochemist, has become a practicing member of an activist group that attempts to change policy and people's practices pertaining to the environmental health of Henderson Creek within the community of Oceanside, where I am also a resi-

dent (Roth and Lee 2002).[2] As part of my contribution to the project, I have taught science to several seventh-grade classes at Oceanside Middle School, where students generated knowledge that they contributed to the community through their exhibits at an open-house event organized by the activists (e.g., Roth 2002). The environmental group and students learn science by focusing on stream and watershed health and its sometimes-severe problems with quantity and quality of water that is threatening Oceanside.

*Village Context*

Oceanside is located in the Henderson Creek watershed. In Oceanside and the watershed as a whole, water has been a problem for many years. Despite being located on the West Coast, Oceanside has a relatively dry climate (about 850 millimeters of precipitation per year) with hot dry summers and moderately wet winters. Concomitant with the climate, recent developments have exacerbated the water problem. Farmers have straightened the local creeks thereby decreasing the amount of water retained in the soil available for filtering into and supplying the aquifer. At the same time, the farmers draw on the creek and groundwater during the dry summer months, further increasing the pressure on the valuable resource. Other residents have individual wells that draw on the aquifers. Their water is biologically and chemically contaminated during the dry period of the year so that they drive five kilometers to the next gas stations to get useable water. Urbanization and the related increase in impervious surfaces (pavement), losses of forest cover throughout the watershed and along the stream banks, losses of wetlands and recharge areas, and the loss of natural stream conditions further worsen the water problem.

In addition to the decreasing amounts, the water has been affected by human activity in qualitative ways as well. Storm drains and ditches channel rainwater—along with the pollutants of suburbia, lawn chemicals and car leakage—into Henderson Creek and its tributaries and away from these newly developed areas. The community of Oceanside introduced an industrial park to the watershed, which is carefully contained within a four-block boundary. The drains of its machine shops and biotechnology labs empty into a ditch (affectionately called "stinky ditch"), which in turn, empties into Henderson Creek. To increase its potential to carry away water in a rapid manner, the creek itself has been deepened and straightened, and much of the covering vegetation has been

[2] Research ethics require me to use pseudonyms throughout this example for the town, people, and students involved.

removed, thereby increasing erosion and pollution from the surrounding farmers' fields. These physical changes have led to increased erosion and silt load in the wet winter months, and are responsible for low water levels and high water temperatures during the dry summer months when (legal and illegal) pumping for irrigation purposes taxes the creek.

An environmental group arose from the concerns about water quality. The actions of the group include monitoring water quantity and quality or contributing the rewriting of community policies related to Henderson Creek, the watershed, and the quality and quantity of water. The group created and actively promotes a stewardship program, builds riffle structures in the stream to increase cutthroat trout habitat, builds fences designed to protect the riparian areas, and monitors the number of cutthroat trout in different parts of the creek. Other activities include replanting riparian areas for increased shading to result in a lowering of water temperature more suitable for fish. The environmentalists engaged in educational activities, which includes giving presentations throughout the community or assisting children in their Henderson Creek-related investigations. Every now and then, a newspaper article features the work of this group. It is with these newspaper articles that I have been beginning the science units at Oceanside Middle School, particularly an article that calls for the community to contribute to the currently available knowledge and direct actions to understand and change the health of the Henderson Creek watershed.

*Learning Science by Producing Environmental Knowledge for the Community*

Given the urgency and importance of the water problems in Oceanside, it was easy to convince the principal and a few teachers at Oceanside Middle School to participate in a study where students would learn science by investigating the Henderson Creek watershed. I offer interested teachers to coteach a unit with them, which means that we take collective responsibility for planning, enacting, and evaluating the curriculum.

Once introduced to the newspaper articles featuring the problems of the Henderson Creek watershed, and feeling addressed by the environmentalists' invitation to the community, the children's interests are sparked by their desire to help. This desire is further fueled when the leader of the environmentalists comes to class to talk in person about the salient issues. Students immediately volunteer to clean up the creek and to investigate its various facets. They design and conduct their own investigations at different parts of Henderson Creek, which they ultimately report, upon my suggestion, to the *community* during the annual open-house event organized by the environmental activists. The idea un-

derlying these lessons is putting students in a situation where they become active citizens who contribute to community life.

This way of organizing the science lesson makes it interesting for other members of the community to participate in various ways. That is, students produce knowledge in the context of a *community* that is much larger than "classroom community" characteristic of most educational practice and theory. School science and village life begin to interpenetrate and, in the process, support one another. For example, members of the environmentalists give talks, participate with students in collecting and interpreting data and, in the process, assist them in learning to use such instruments as dissolved-oxygen meters or Serber samplers. Some parents assist by driving children to their research sites and others provide assistance to student investigators. Aboriginal elders give presentations, middle and high school students who have already gained research experience assist in teaching, and several graduate students of mine assist the children in framing research and collecting data. This participation of community members also changes the traditional division of labor, which leaves schooling to teachers and school administrators and excludes others who validly and competently could contribute to such an enterprise.

Consistent with my belief that emancipation comes with control over the means of production, the students in these classes frame their own investigations and choose the *tools* (e.g., instruments, computers, or camera) with which to represent the creek and its current state. It comes hardly as a surprise that within each class, students produce different representations of Henderson Creek and its surroundings, all legitimate, but contributing in different ways to understanding the creek and its problems. Because they were in control of much of the activity system, including the objective for a particular investigation and the means of production (*tools*), they are generally motivated by their work and the need to overcome problems to achieve their goal (rather than by the teacher) and designed an increasing number of investigations.

When students pursue investigations of their own design, their eyes and minds are fully engaged, productive, and absorbed by their interest—which is not unlike what can be observed everyday in factories when workers have the opportunity to contribute to the shaping of their workplace. Table 1 provides a glimpse (here in the form of an excerpt from Shannon's notes) that the unit provides students with rich experiences during one afternoon in the field. These excerpts document questions, observations, and future directions that opened up and outlines completed actions.

Some of the students are interested in producing scientific representations in the forms of graphs, bar graphs, charts, and tables. Other students are not so in-

**Table 1:** *One student's list of activities and things she learned during the fieldtrip on April 16, 1998*

| **What I Did and Learned** |
|---|
| Researched three different sites, pollution |
| What sites look like (grass, trees) |
| fish population decreased 100 years |
| Testing to see which bugs like what water |
| Working with university and Institute of Ocean Sciences |
| Interviewed the mayor and ocean sciences rep |
| Used to be spawning creek for salmon, only one fish found now |
| Different places on sites: sandy or grassy or shallow site |
| Used D-nets, microscopes, water sampler, buckets, nets |
| Measuring speed of creek |
| Measuring width of creek |
| Testing water temperatures in different places |
| Fish survived in cooler water |
| Measure overhang |
| Measure dissolved oxygen |
| Seen what center of stream was made of |
| Riffles get water flowing faster |
| Farms use water in spring and summer |
| Found dragon flies, sun fish, crayfish, leeches, damsel flies, dragon fly larva |
| Mostly found anthropods |
| Animals have to be placed in ice overnight; always return them back to the creek |

clined, instead opting, for example, to conduct classifications of animal or plant species, construct photo series accompanied by audiotaped reports, conduct interviews, or use a video camera to report on other students' research activities. We support these students by allowing them to learn the use of new tools on a just-in-time and as-needed basis—we found that this is the best and highly motivating way for students to conduct very interesting and very competent investigations. Thus, when the students in a group decide that they want to look at the relationship between the frequency of different invertebrates and stream speed, I make sure that they use the stopwatches in an appropriate way. I also ask students how they want to measure stream speed. When they suggest measuring how long it takes for a floating object to move a certain distance, I ask them whether they think that there are differences between floating objects of different materials (e.g., a stick, a piece of Styrofoam, or an orange). Although they

may begin with wild guesses, they learn in the course of their investigations that a piece of styrofoam may be pushed by the wind, or an orange may get stuck in shallow parts of the creek. That is, in the process of their inquiry, my students learn a great deal about how to make an investigation work despite the continuous and unforeseen problems that arise in the process. In the end, one group recorded time and distances, sampled the creek in different spots for invertebrates, calculated speeds, grouped and counted the microorganisms, and produced line graphs for different organisms.

For example, students used a side-view drawing of an amphipod, which, together with other drawings of other organisms, assisted them in classifying and sorting the invertebrates and to count each incidence. These were later entered in data tables and subsequently plotted. I assisted students in interpreting their results, sometimes by helping them to think of their data points in terms of trends, and asking them to draw trend lines. Sometimes, they make interpretations that differ from those that one of the adult scientists may have made. These scientists then engaged students in an exchange, often involving the concept of "outlier." Students ended by drawing conclusions such as "There are more anthropods where the water runs faster" or "There are fewer amphipods when the creek goes faster."

Ultimately, the children presented the results of their work at a yearly open-house event organized by the activists focusing on environmental health in the Henderson Creek watershed. They presented descriptions and photographs in the form of a website, which the visitors could peruse at the event because the children had brought a computer. Other children presented posters, containing the results of their observations or interviews with community members.

After the unit came to an official end with the open-house event, the result of their work was published in the local newspaper and on the website of the environmental activists. Thus, both through their exhibits during the open-house event and the subsequent publication of their findings, the outcomes of the students' production entered the *distribution* and *consumption* process.

The open-house event and the subsequent publications were key points in the unit because students' work became legitimated and legitimate as the community members accepted what they had done. The following comment by a student was rather typical.

I worked hard in helping my group members out with the model, the home page, and presenting the picture board. In this project I learned that there are invertebrates in the creek, I also learned where Henderson Creek is located. I never knew that the creek through Community Park was connected to Henderson Creek. I noticed that since the Henderson

Creek article was published in the Peninsula News Review that the public has noticed the creek. (Brandon)

To the children, the science unit was successful not because they received high grades but because the unit was useful and contributed to community life. They began to notice the creek and its problems; they also remarked that the community (their parents and relatives) began to notice it. Students' actions had further impact in the community, as the environmental activists told me, because their presence in and contributions to the open house brought a greater proportion of community members (parents, family, neighbors) to the events.

## Learning in and as Participation in Collective Praxis

In this example, my seventh-grade students participated in a collective practice, taking care of and generating knowledge about a creek and its associated watershed. What the students did made sense not only because they chose what to do and how to go about it but more importantly because they engaged in a collective activity with a collective motive. That is, students learned as they participated in a collective praxis, inherently involving other people from their village. The idea of learning in and as participation in collective praxis is, in some ways, a concrete realization of the idea of overcoming *defensive* learning through *expansive, object-oriented* learning. To further articulate what I mean by collective praxis, the relationship between individual and collective, and the role that science and other domains play, I draw on the analogy of a threat and the fibers that constitute it. A thread is made of many fibers, which can differ, among others, in color, strength, thickness, and chemical makeup. Although the thread is made up of the fibers, its properties cannot be understood as a linear superposition of fiber properties. Furthermore, whereas the thread is continuous, the fibers themselves are discontinuous. Shape and properties of the individual fibers contribute to the shape and properties of the thread and the thread, qua context, shapes and affects how we perceive the shape and properties of the fibers. Threads can also be woven into ropes.

We can now think of a community of practice as a rope, constituted by its members (threads), themselves fashioned from many different fibers. In my example of the Oceanside and its middle school, the community constitutes the rope that gives shape to its members, including school students (threads) who, as a class, form part of the rope. The shape of rope and threads are dialectically related because the threads determine the overall properties of the rope but the place in the rope determines the appearance of a particular thread. Once the rope

exists (though this gets us to the limit of the analogy), we can imagine individual threads to be removed and new threads to be added. Each removal and addition does not significantly change the overall aspects of the rope, but changes it nevertheless. Each addition of a thread therefore contributes both to the reproduction of the rope but also produces new aspects of it. In the village of Moussac, the single class is like a (part of) rope that is renewed each year as two or three students joined, and about the same number left. It never changes a lot, though we can assume that with students coming and leaving, collective school life always changes a little bit.

In this analogy, I view science at the individual level as one of the fibers that contribute to a thread; laboratory science is a collective practice that we get when we consider science-dominated threads as a group of threads in the overall rope. This analogy makes it quite clear that we cannot think of the few threads that make laboratory science independently of the rope that allows laboratory science to exist as part of the division of labor to maintain the overall rope.

In everyday life of the community, science is therefore never but one of the many fibers that together make a theme in the rope. When twisted together with all the other fibers, it is not science that becomes continuous but the theme (part of the rope). I think of the rope as a continuous entity that forces me to think of scientific literacy as something that emerges from the collectivity. It is only when we unravel the thread that we find a fiber. I cannot understand the continuity of thread by thinking as if all fibers were going the entire length; I do not understand each fiber by thinking it from the continuity of each thread within the rope. For example, my study of the community of Oceanside showed that science is connected in deep ways with technological, economic, political, and aesthetic issues. In a contested issue over the assessment of local water, for example, there were different water treatment solutions offered, each with its own interconnected range of scientific and technological possibilities and constraints, there are costs to the community and individuals, and there are a variety of potential economic benefits.

The analogy of fiber, thread, and rope for the relationship between science and other forms of knowledge in controversies about problems forces me to rethink what knowledge means in the curriculum. Does everyone have to know the same things? Does every student have to be competent on the same issues? That is, does each thread (student) have to have fibers of the same kind (subject matter knowledge) or is it possible for rope to exist and provide support to each thread even if particular threads do not have any science fibers? It is well known that there is simply too much specific content knowledge for any individual to know the relevant facts even in more constrained contexts. We do not have to

master all areas of knowledge to live successfully in our society, and awareness of this fact may free us to explore more creatively how to deal with questions of scientific literacy. Educators may be tempted to teach science so that all students exhibit knowledgeability at some standard level. But then, we would spend much more time in school even if knowledge transfer from school to workplace and everyday life were less problematic then it already is. If we think of scientific literacy in different terms, as choreography of a particular kind in which we learn to participate by participating from the beginning, we take radically different approaches to teaching science in schools. Our children would already participate in doing things that benefit the community, and participate in the ongoing discourses and concerns that are relevant to their parents and the community at large.

Collectively, the village Moussac and the town of Oceanside have provided opportunity for literacy to become a recognizable and analyzable phenomenon. A new form of collectively generated societal activity was made possible in the organization of the public meeting and in the provision of the questioning and comment periods. In the case of Oceanside, scientific literacy also emerged because the citizens were involved in an issue where there was something at stake. It has been suggested that scientific literacy as practical activity in the face of problems arising from everyday life include a number of competencies (Fourez 1997). These include how to use specialists; how to use of black boxes efficiently; how to invent interdisciplinary rationality islands; how to use metaphors; how to use standardized knowledge; how to translate, negotiate, and transfer knowledge; how to use (different types of) knowledge in everyday life to make ethical and political decisions; and how to contrast the understanding of technology with understanding of its scientific principle. In the present analyses, these aspects of scientific literacy emerge as aspects of irreducibly collective praxis rather than individual prowess. There is no inherent need for all students to be competent in all of these, like there is no need for all people to be able to repair a lawnmower, lay carpet and ceramic tiles, or produce organic vegetables. All that really is required is the ability to participate in the collective choreography and know how to access necessary resources.

When, how and where do we allow young people to be scientifically literate in these terms? The classical approach is to expose children and older students to the images of scientists' science. This science is a pure subject, often taught in special physically separated rooms, unsullied by common sense, aesthetics, economics, or politics that are characteristics of everyday life. It is also a subject in which each individual, so goes the idealist rhetoric, has to appropriate and exhibit a certain "basic skill." Whether students "have" this knowledge and skill is

usually assessed by isolating them from social and material resources normally available in everyday situations. Conceptualizing scientific literacy as a feature of collective praxis changes the situation. Educators now have to think about what to set up situations so that contexts (rather than individuals) exhibit scientific literacy. How can we (teachers) possibly do this? Rather than preparing students for life in a technological world, I propose to create opportunities for participating in this world and to learn science in the process of contributing to the everyday life in their community. Sample contexts are environmental activism, salmon enhancement, farming, or traditional food gathering ceremonies among aboriginal peoples. Early participation in community-relevant practices provides for continuous (legitimate peripheral) participation and a greater relevance of schooling to the everyday life of its main constituents.

The analogy of the rope, threads, and fibers also allows us to rethink the issue of heterogeneity, which was central to the pursuits both in the Moussac and the Oceanside examples. A major goal of educational systems is that they have and continue to attempt to homogenize as much as possible. We only have to go to Germany and its streamed schools of Hauptschule, Mittelschule, and Gymnasium to see the homogenizing along achievement levels; the costs of private school necessarily homogenize student bodies according to social class; and schools organize classes according to age levels. Teachers seek out the most homogeneous classes assuming that these are easier to teach and allow their own routines to be more efficacious, believing that this would lead to a better mapping of achievement onto educational goals (Holzkamp 1992). But the Moussac (and other similar villages) experiences show that the heterogeneity and diversity of one-room classrooms leads to greater efficacy; some schools, like the Sudbury Valley School in Farmington, Massachusetts, call age-mixing their "secret weapon" because creates overlapping zones of proximal development (Holzman 1997). Furthermore, I learned in the Oceanside and similar projects that students can pursue quite different projects drawing on quite different resources and still become highly competent with respect to particular issues, such as understanding the environment. Heterogeneous grouping in terms of age and competence seems to be a basic requirement for creating the stability and capacity for institutional memory that characterizes all the example that show successfully operating communities of practice.

## Implications for Policy

The approach advocated here turns traditional thinking around by putting the collective nature of human experience as the starting point. Participating in on-

going social practice then becomes the central project students engage in; developing identities and becoming more knowledgeably skilled are aspects of this participation (Lave 1997). I think that it would be worthwhile in rethinking science education in terms of collective praxis, which may require us to uncouple the formation of scientists and engineers from the broader goal of allowing each individual to learn and develop into a democratic citizen that contributes to the overall project of maintaining collective life in the society.

Here I am not advocating that all schools become like that in Moussac or that all children engage in environmentalism. Rather, both cases are examples for rethinking (science) education as collective praxis and for drawing implications from such an approach. I know that practices of Moussac cannot be copied exactly as they are into other settings, for they are historically situated practices, deeply interconnected with other practices that bind the village of Moussac into French society. Nevertheless, we can learn some lessons from the experience in Moussac. Furthermore, it will not be possible to copy the Oceanside experience exactly with all of its dimensions into other villages, towns, and cities, for each is characterized by its own practices, laws, population configuration, and contingencies. Rather, policy makers need to develop some trust that by allowing teachers and students control over activities, tremendous learning will come about.

But I think that unless we design into learning environments some of the characteristic features of communities of practice, all we get is simply a grouping for which there is ultimately no real rationale, as long as students are tested independently and, based on these tests, are competing against those that had been in their group. In this case, we do not need "community of practice" as concept to think about learning environments. "What then," might a policy maker ask, "do we need to create learning communities (of practice)?" To answer this question, we need to specify some of the core characteristics. Thus,

1. communities of practice are heterogeneous in terms of practical competencies, with a smaller number of newcomers than there are old-timers;
2. communities of practice focus on particular projects that contain a motive and in the pursuit of which individual participants feel the need to learn;
3. individual members have certain levels of autonomy with respect to choosing what to work on at the moment.
4. communities of practice interpenetrate with other communities and society more broadly; and
5. individual members access diverse social and material resources, including time and space;

When we think about these dimensions for a little while, it becomes evident that traditional educational structures are not set up to accommodate communities of practice. Educators interested in using the community of practice would strive to

1. do multi-age and competence grouping that allow slowly changing communities to come about and sustain themselves over time. For example, a new charter school in Philadelphia was created on the idea to have four pods of one hundred grade 9–12 students rather than four grade levels.
2. let curriculum be organized around projects that arise from the needs of individuals and collectives, allowing the coinciding of activity and motive, and therefore the emergence of intrinsic collective motivation.
3. individual students to chose how they want to contribute to the overall project in which they are currently involved, even when this means that they do not contribute because they are currently "taking a vacation." More likely than not, projects will be multi-disciplinary and thereby allow individual students to divide labor and take different parts best suited to their learning needs.
4. open up to allow school and society to interpenetrate. The environmental project at Oceanside showed how such interpenetration can begin; it also showed that children can take part in and contribute to the pressing issues in the life of the community. There are different projects around the world that have shown the feasibility of this approach.
5. allow open access to the resources that individuals and collectives deem necessary, within the constraints of the more encompassing community that includes parents and city officials. Importantly, and similar to most everyday practices other than hospitals and prisons, students would not be confined temporally (rhythmically shifting to a different subject every 45 minutes) and spatially (confined to seat and classroom). (When engaged in authentic activity, soccer practice, children and adolescents don't have to go to the bathroom all of the time!)

## Coda

The idea of learning communities for thinking about science education is a different conception of knowing that arises from different relations between individual and collective than those that underlie much of schooling in countries around the world. Reconceptualizing the relationship between individual and collective, and therefore the nature of knowing, requires a reconceptualization of learning. Underlying the idea of communities of practice is the fundamental assumption is that learning involves a changing subject-world relation on the part of the learner. Here subject and world are not conceived in terms of content and container, two separate entities, but a dialectical relation from which each

emerges in and as of praxis. Learning to become a citizen can then be understood as part of students' changing participation across the multiple contexts of their daily lives.

Thinking about learning in terms of practice and community requires us to rethink the role of teachers, too. Present day organization of school life is antithetical to object-oriented expansive learning; they interfere with learning rather than supporting it (Holzkamp 1993). To a considerable part, this is the result of the role that society ascribes to teachers, or equivalently, that teachers feel ascribed to them. They are said to be responsible for teaching something to students. That is, in most schools, the subject of learning is not the teacher, who configures the learning environment to make students learn; rather, the subject is the student. Typically, teachers rather than students ask questions, though it seems intuitively evident that we ask questions when we don't know rather than when we know something. In community of practice type learning environments, students ask the questions and others, teachers and peers provide the support in answering these.

In communities of practice, teachers are oriented both (a) to the maintenance of the community and (b) to the object that characterizes the practice rather than to influence, constrain, and control students. Concerning the first point, the village school in Moussac provided an example that shows that such an orientation allows learning to occur because it is inherent in the practices of the community. As part of the second orientation, a teacher engages or talks about problems with the object rather than talking about it. The problem of current schooling practices is that they have no resemblance with the practices of the fields that they are intended to teach. Rather, than doing science, mathematics, or history, teachers do questioning, controlling, getting preparing for tests, and marking and students do responding, submitting to control, getting ready for tests, and ask "what'd I get?" As long as science, mathematics, or history is not the activity to engage in, by teachers and students alike, expansive learning cannot occur.

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