High School Students' Compositions of Ranch Designs

Implications for Academic and Personal Achievement

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This research analyzed the composing processes of two high school students designing horse ranch plans for a course in equine management and production. The investigation focused on understanding the problems driving the design process, the tools through which the students inscribed and encoded meaning in their compositions, and the integration, representation, and mediation of their emerging identities through the design process. The analysis revealed that the students solved problems suggested by the particular culture surrounding the production of a specific breed of horse and constructed unique problems based on their knowledge of horses and ranch facilities. The tools through which they constructed these texts suggested both the cultural dimensions and narrative inscriptions of their designs. The culturally mediated narratives in particular contributed to students' construction of identities, especially with respect to their orientation as members of the managerial (Darin) and working (Riley) classes.

Keywords: *multimedia writing; protocol analysis; Vygotsky; composing across the curriculum*

In this study, we analyze two high school students' production of multimedia texts: designs of horse ranches that support a particular

WRITTEN COMMUNICATION, Vol. 21 No. 4, October 2004 386-418
DOI: 10.1177/0741088304270117

breed of horse for a class in equine management and production. We refer to these compositions as multimedia because they included iconography, writing, measurements of scale, and color to represent meaning. Our interest in multimedia composition falls within an emerging school of thought that views a text as being composed of any configuration of signs (Witte, 1992). In taking this view, we move beyond the conventional definition of text that limits it to representations comprising words alone. We see texts as potentially being composed through a variety of intelligences (Gardner, 1983), modes (Kress, 2000), discourses (Derrida, 1976), sign systems (Suhor, 1984), significant symbols (Geertz, 1973), media (Smagorinsky, 1995), communication systems (Lotman, 1977), literacies (Cope & Kalantzis, 2000), artifacts (Cole, 1996), or tools (Wertsch, 1991), to use just a few of the terms that have been applied to the idea that texts may be produced through multiple means.

We derive our research questions from the Vygotskian notion that the unit of analysis for studying psychological development is volitional, problem-oriented, goal-directed, tool-mediated action in social context (Wertsch, 1991). Our study of the two students' designs of horse ranges is concerned with understanding their goals for their ranches in relation to the problems that they identified and tried to resolve, their selection and use of cultural tools in composing their designs, the ways in which the settings of their experiences helped to shape their work on this project, and the ways in which their work on this project contributed to their formulation of a life trajectory. Our research questions included the following:

1. What problems motivated the students' work on their ranch designs?
2. How, and through what tools, did the students inscribe and encode meaning in their compositions of ranch plans?
3. How did the process of composing these texts help the students to integrate, represent, and mediate their emerging identities?

Authors' Note: This research was supported by a grant to the first author from the Spencer Foundation. The views expressed herein are those of the authors and do not necessarily represent the views of the foundation. Special thanks are due to Raymond, Darin, and Riley for their generous accessibility and contribution of time to this project. Thanks to Chris Haas and the external reviewers of *Written Communication* for their constructive feedback on earlier drafts of this article. Direct correspondence to Peter Smagorinsky at the University of Georgia, Department of Language and Literacy Education, 125 Aderhold Hall, Athens, GA 30602; email smago@coe.uga.edu.

Theoretical Framework

We next review the Vygotskian (1978, 1987) principles that provide us with the constructs and terminology for our analysis of the data for this study. A Vygotskian perspective is appropriate for our analysis because we share his fundamental concern with understanding how any individual's sense of suitable behavior—including the choice of tool for achieving an end and sign system for representing an idea—derives from experience in cultural practice. Vygotsky (1987) argued that "the speech of those who surround the child predetermines the paths that the development of the child's generalizations will take" (p. 143). According to this perspective, cultural practice—especially that mediated by speech—has a dialectic relation to the motive of the setting (Leont'ev, 1981), which Wertsch (1985, 2000) equates with the sense of optimal outcome, or *telos*, that provides a social group with definition and direction. This sense of ideal destination suggests the fitness of particular kinds of action and in turn is the product of recurring kinds of social action (Scribner & Cole, 1981).

We construe a setting as that with which one stands in relation. A setting may include people, physical spaces, social groups, technologies, natural environments, creatures, and whatever else composes the mediational environment for human activity. Furthermore, any setting is likely to be "nested" within broader settings (Cazden, 1988, p. 198) and to overlap with other settings. Settings embody cultural practice over time and thus have a strong historical dimension that in turn helps to channel further cultural practice, as suggested by Cole's (1996) formulation of cultural-historical activity theory (CHAT), Moll's (1990) outline of a sociohistorical psychology, and other schools of Vygotskian thought that emphasize a social group's cultural history as antecedent to current thinking and activity.

The setting of the students' design of horse ranches, like the context for the design of any semiotic space (Blonsky, 1985), structured their activity and problem construction and problem solving in specific, goal-directed ways. Taking Vygotsky's (1987) argument that the speech of those who surround children predetermines the paths of their concept development, we extrapolate to posit that the sense of what is appropriate in a ranch design follows from the speech and other sign-and-tool use through which an apprentice comes to understand domesticated horses and their needs and purposes in relation to their human environment. Of particular importance in this

conception is attention to the role of everyday thinking and acting (Rogoff & Lave, 1984), especially in relation to what Wenger (1998; cf. Lave & Wenger, 1991) calls a community of practice. To become a member of a community of practice with normative ways of acting and being understood, a learner needs to come to the same understanding for words and other forms of representation that elders and other societal veterans have for them. The development of concepts thus involves growing into a culture's values and practices, with the culture in turn growing and changing as its practitioners contribute their understanding of its concepts—the dialectical relation that we discussed previously. Culture provides the overall goals, values, and notions of appropriate action that sanction the use of particular tools for participating in social action in particular ways (Leont'ev, 1981) and of the kinds of signs and texts that people produce through these tools (Smagorinsky, 2001). The culture of school has often been characterized as logocentric, even if in some academic areas drawing, movement, and other symbol systems are sanctioned. The broadened conception of literacy that figures prominently in our analysis is a product of this effort to recognize and understand a wider array of symbol systems, both for the theoretical effort of redefining literacy and the practical advantages that a more inclusive definition can provide to students in school.

Vygotsky (1987) identified two types of concepts, scientific and spontaneous. Wertsch (1991) argued that the Russian term *naychnoe ponyatie*, typically translated as "scientific concept," is more properly translated as "academic" (p. 39) because, as Vygotsky said, "The basis of [scientific concepts'] development is that they have their source in school instruction" (p. 214). Vygotsky distinguished scientific concepts from spontaneous concepts, which are generalizations learned informally through practical activity and everyday social interaction. He further maintained that knowledge of abstracted rules must come in conjunction with worldly action. The development of a scientific concept thus relies on interplay between the learner's conceptual fields: The formal principles of the scientific concept create cultural schemata that enable a greater understanding of worldly experience in cultural practice; and without worldly experience, abstract principles cannot be empirically tested and refined.

Carr and Kemmis (1986) stressed the ideological nature of practice, whether formal or informal. They borrow Freire's (1972) term *praxis*

to describe recurring social action that shapes and changes the world. Ultimately, given the ways in which we see the inscription of social positioning in the students' ranch designs, we regard their work on these projects as one formal occasion in which they inscribe their worlds in their texts—not only in their words, as Freire has theorized, but also in the multimedia drawings that constitute their ranch designs and social futures.

A cultural group's overall goals and values, in relation to various factors presented by the natural and human environment, suggest the importance of solving particular problems to accomplish cultural goals (Tulviste, 1991). These problems are solved through the appropriate use of tools (Wertsch, 1985), particularly the speech that Vygotsky found so important to human development but also including a host of other implements available in a cultural tool kit (Wertsch, 1991). Tools are implements that hold the residue of prior cultural practice and enable one to act on the world, typically according to accustomed practices and modified in response to new problems and situations. Researchers drawing on Vygotsky's (1978, 1987) principles have since revised his singular emphasis on speech to include a host of what Wertsch (1991) called "mediational means." In this expanded view, a psychological tool may include anything that mediates human action, including an artistic or graphic medium (e.g., a paintbrush, pencil, or computer program), a broader community of practice (e.g., a discipline or field of study), a set of procedures or scripts (e.g., the speech genres that govern particular kinds of talk), different types of images (e.g., a narrative of typical action), and countless other alternatives.

Through the use of tools, people produce signs or configurations of signs, such as the graphic texts produced in this equine management and production class to represent horse ranches. Our study is designed to understand how, in the setting of this classroom, two students from the settings of different socioeconomic backgrounds employed their cultural tool kits to identify and solve problems related to the task of designing a ranch to support their own management of a particular kind of breeding and training operation. This classroom site is ripe for such an inquiry because of its close ties to the material world, the availability of multiple symbol systems in the major class project, and the clear ties to the students' practical activity.

CONTEXT OF THE INVESTIGATION

The School

Data collection took place in an American southwestern college town populated by about 95,000 people. The city's public school system served more than 12,500 students, one fourth of whom qualified for free or reduced lunch. Demographically, the school system's student population was 81.4% European American, 6.6% Native American, 6% African American, 2.6% Asian American, and 1.7% Latino.

Central High School was a 2-year senior high enrolling about 1,800 students. (All names of people and places are pseudonyms.) More than 50% of graduates attended 4-year colleges, 26% attended 2-year colleges, and fewer than 5% entered technical schools or the armed services. Students annually scored above the state and national averages on the SAT and the ACT.

The Equine Management and Production Course

The equine management and production course was a semester-long elective in which students learned the range of knowledge and skills needed to breed and maintain horses. Throughout the semester, the 21 students enrolled during our investigation studied the needs and habits of horses so that they could produce them (i.e., breed and maintain them for profit). Their understanding of these issues was incorporated into the ranches that they designed for the course.

The culminating project for the semester was for students to synthesize all of their knowledge of horses in the design of a horse ranch that they might conceivably own someday and that would operate at a profit. The project took roughly a month of class time, during which the students had access to one another's knowledge, to teacher Raymond's expertise, to whatever access they had to real horse facilities, and to the resources of the classroom. Raymond explained that the ranches must occupy 320 acres of land at a specific location within the state, stay within a budget of $750,000, and suit a particular breed of horse. Students were required to design their stalls and training facilities according to the type of horses that they intended to raise—horses for training, performance, breeding (mares), or stud (stallions)—and

their designs needed to include space for trucks and trailers to transport the horses. The ranch also needed sufficient pastures and surrounding fences to exercise, graze, or turn out horses for extended periods of time.

The Students

This study focuses on Darin and Riley, the only students from the class to volunteer for the research following a class visit and description of the study by this article's first author. We profile each student next.

Darin

For Raymond's class, Darin chose to design a performance horse facility for training and showing horses. A junior at the time of the research, he had lived all of his 17 years in the state in which Central High School was located, most of the last 10 years in the city itself. "I've just always liked horses from the day I was born," he said in explaining why he enrolled in this course as part of his college prep curriculum, adding, "I finally had a chance to just take a course that I wanted to instead of subjects that I needed to graduate."

Following high school graduation, Darin planned to spend a year training and showing horses before going to college. His passion had been supported and nurtured by his parents, who were both doctors. They had bought Darin three quarter horses, which Darin had been training and showing for the previous 4 years, and had for the past 2 years provided him with a monthly salary to support his equine interests. He credited this allowance with teaching him how to budget money.

Darin appeared to embody many of the corporate traits described by Eckert (1989) in her account of jocks and burnouts in American schools. His privileged background, we inferred, led him to associate himself with the managerial class both in the school's social hierarchy and in his projected social future as ranch proprietor. In contrast, Riley, our other participant, came from outside Darin's parents' white-collar identity and affiliated himself more with the horses than with ranch management. We describe Riley next.

Riley

For the assignment, Riley chose to design a training facility for both quarter horses and thoroughbreds, breeds with which he was familiar through his experiences at racetracks and with which he ultimately hoped to work. He was a senior at the time of data collection. A native of the city, he had moved to an adjacent state to live with his father when he was 14. The parents of his father's fiancée owned racehorses which, Riley said, "hiked my interest." He developed this interest by working at the track, attending and betting on races, and hanging around the barns as often as possible. He said, "If I wasn't in school, I was at the track during the spring. And then when I moved back here, one of the main reasons I moved back was the opportunity to work with the horses back here because I eventually want to try to go to a vet school."

Riley lived with his father for 3 years before returning to live with his mother. Riley's ideal job would be to become a jockey, which he admitted would be unlikely because he filled his 5-foot-5-inch frame too broadly to meet the weight standard. In addition to the equine management and production class, he was also taking agricultural mechanics with Raymond, suggestive of his orientation to the vocational track rather than the college prep curriculum taken by Darin.

METHOD

Data Collection

Classroom Observations

Observations were made by the third author, who visited Raymond's class each time it met from early February to early May. Field notes from these observations helped to provide an account of the instructional context in which Darin and Riley designed their ranches.

Interviews

The first author also visited class several times, enjoying such pleasures as the homemade molasses that Raymond brought in one day to

share with his students. Based on these observations, Raymond provided an extended interview for the first author that probed for the content, curriculum, and goals of the equine management and production class.

Protocols

Think-aloud protocol. Darin and Riley each provided two types of protocol through which they revealed their composing processes as situated in this setting. One was a think-aloud protocol. Rather than relying on the controlled conditions described by information-processing theorists for the collection of think-aloud data (e.g., Ericsson & Simon, 1993), this study solicited situated protocols: that is, those provided during the regular course of events (see Smagorinsky, 1997, 1998).

Raymond's class was too noisy for clear protocols to be provided, so Darin and Riley worked at opposite ends of the nearby empty classroom of Mr. Anthony, who taught agricultural mechanics during Raymond's class. As the boys worked, they occasionally talked with each other, with other students who dropped in to talk with them, with Mr. Anthony during his periodic visits to get something from his classroom, and with Raymond as he made his rounds talking over drawings with his various students. Darin completed his drawings in four 55-minute class periods, Riley in nine, with protocols provided in the company of the first author, whose role consisted of occasionally prompting the students to speak louder but also included chatting with the students before and after the protocol sessions and, on one occasion, breaking up a fight between Ryan and another student who came into Mr. Anthony's classroom.

Retrospective protocol. The second type of protocol was retrospective (Ericsson & Simon, 1993; Greene & Higgins, 1994). Each student provided a retrospective interview based on the series of drafts and final design plans he produced during the semester. Questions were prompted by various aspects of their drawings and ranged to related topics such as how they learned to produce drafts or parts of the drawings, what had happened during Raymond's class, how they thought as they worked, and other queries designed to get them to explain their process of composition in its cultural context.

Data Analysis

The protocols were transcribed and then collaboratively coded by two raters (the first two authors); that is, we read the transcripts and discussed each segment of text until agreeing on which codes should be applied. This collaborative coding produced a measure of reliability for the analysis in that the coders agreed on all codes. A segment of text was one that we agreed concerned a discrete design decision. The same coding system was used for both the think-aloud and retrospective protocols.

The coding system embodied principles of a Vygotskian (1978, 1987) perspective. Our goal with the research was to understand how, within the context of the equine management and production class, Darin and Riley composed their texts. We identified three general types of codes to help us understand their composing processes: *setting,* which served as the arena in which Darin and Riley learned to use the tools; *problem* to be solved; and *tool* to be employed. We explain each of these major categories in greater detail next.

Setting

Formal. Formal knowledge described the kind of academic instruction that teachers provided Darin and Riley about equine management and production, either during class (attributed during the retrospective protocol) or when Raymond or Mr. Anthony dropped into their classroom and spoke with them about their work.

Informal. Their informal knowledge—knowledge learned incidentally or spontaneously rather than through formal instruction—included the interaction with peers that occurred as they worked, their knowledge from personal recreation, and knowledge they had gained from their previous work experiences on horse ranches, family farms, and racetracks.

Problem

Completion of task. Darin and Riley were involved in a school task that had particular requirements that served as problems for them to solve. They produced their drawings with attention to two problems: the appearance of the drawing and the requirements of the assignment that both guided and constrained their work.

Economics. Raymond's assignment specifically required the ranch to operate at a profit. Darin and Riley worked to solve an array of problems connected with this task: containment (usually in the form of fencing to keep the horses within boundaries); fertilization (usually a recycling of horse manure to fertilize the ranch's crops); maintenance of equipment and facilities; providing parking for customers; production of the horses as financial commodities; turning a profit; designing the ranch so that facilities were arranged for efficient proximity and logistics; situating the ranch in its economic context (e.g., placing it strategically along an interstate positioned between two large markets); dealing with sanitation (typically in the form of manure removal or recycling); consideration for scale (e.g., the relative sizes of pastures and paddocks); designing for spatial efficiency; considering the facility's structural soundness; providing for storage of equipment, supplies, and food; and designing roads and other passageways for efficient and unconstrained traffic flow.

Equine production. Raymond's assignment included identifying a specific breed of horse and designing the ranch to accommodate and breed it. Solving the problem of equine production required concern for maximizing conditions for breeding, caring for the horses' comforts and needs, attending to the horses' medical needs, ensuring the safety of the horses, providing the horses with shelter, providing the horses with sustenance and provisions (i.e., food and water), and designing the facilities for training them to maximize their value.

Needs of people. Darin and Riley also designed their ranches to accommodate the needs of people, including addressing problems associated with the availability of leisure (e.g., a pond for fishing), physical needs (e.g., convenient locations for bathrooms in the indoor arena), and the ranch's aesthetics.

Tool

Although we looked for tool use throughout our analysis of the boys' ranch design processes, we found that what we termed *schematic tools* were most germane to our analysis. Schematic tools serve as broad mental codifications of experience or knowledge, mediating production in a broad sense. We found three subcategories of schematic tools: fields, cultural mediators, and images.

Fields. Darin and Riley drew on the following fields to inform their decisions: agriculture, architecture, climate, construction science,

economics, geography, geometry, graphic design/drawing, housing, materials science, mathematics, natural resources, natural sciences, sanitation, traffic control, and veterinary science.

Culture. Darin and Riley invoked design conventions in producing their plans, such as including a stretch (a straightaway section) in a racetrack.

Images. Schematic tools also included images generated by the participants during their composing: mental maps that provided them with images that guided their design and narratives of how people, animals, and natural elements might move about the premises.

Example of Coded Text

We next provide a sample from Riley's retrospective protocol to illustrate how we coded the protocol transcripts.

> *Researcher:* Why did you put this vet[erinary] facility here instead of close down to the other barns the way you said it is on your property?
> *Riley:* Well, mainly I wanted it kind of away from the training part of it. It is still close enough that if the horse from here needs to come over there, then they can just walk them over. But it also is away so the vet kind of can have a little privacy and you don't want—you know that horses that are recovering and stuff. You really don't want them around the racehorses. It is just that racehorses are just so high that—
> *Researcher:* Are so high?
> *Riley:* Yeah, they are built up on vitamins and everything else. They are just like a marathon runner built himself up for a race and the same with a horse, and they tend to get other horses startled up. And just being back there kind of by itself is a little bit secluded and private.

We bracketed this segment of text for coding because all of Riley's remarks concerned the same design decision: why he located his veterinary facility in a specific place. The setting from which he drew his understanding of how to use these tools was informal: his experience of work on his own family farm, inferred from the questioner's reference to the arrangement of facilities on Riley's own property.

We saw him addressing four problems. Riley was concerned with two economic problems: locating the veterinary area for spatial efficiency (that is, arranged for time-saving travel) and locating it with concern for logistics/proximity (that is, close enough for ease of transport but far enough away for privacy). He also needed to solve

two problems of equine production: one related to providing medical care (the veterinary facility itself) and one regarding caring for the horse's comforts/needs (the need not to agitate other horses during a medical examination).

Riley relied on schematic tools from each of the three subdivisions within this category. He drew on the field of veterinary science for his knowledge of the effects of vitamins and the needs of recovering horses to inform his decision of where to situate the medical facility. This decision was also influenced by the design convention—which we determined to be a function of the culture of ranch design—of secluding the veterinary area from the training area. Finally, he employed two types of image: a mental map of what the facility would look like and a narrative of the horse being walked to the veterinary area and potentially startling the vitamin-enhanced horses in the training area. These images helped him make decisions regarding how to arrange his ranch features relative to one another.

RESULTS

Table 1 provides a list of the codes we used to analyze Darin's and Riley's protocols and the frequencies for each code. We organize our presentation of the results according to the three research questions we identified previously, finding evidence in the coded data: the concurrent and retrospective protocols. Our findings suggest that both boys identified and resolved a host of problems in designing their ranches, from the relatively simple (e.g., deciding on how to color sections of the drawing for appropriate representation) to what we regard as the most complex, such as scaling and locating facilities to increase the economic potential of the enterprise.

Through their decisions, they inscribed their compositions with meaning, particularly in the ways in which their design decisions embodied narratives of how they, their families, their horses, and their clients would use and navigate the grounds and facilities. The meanings that they inscribed in their compositions revealed much about how they positioned themselves in relationship to others involved in the ranch operation and more broadly in society, suggesting that their ranch designs were as much about their own conceptions of selves as they were about horses and their production.

Table 1
Codes and Frequencies

	Darin	Riley	Total
Setting: formal			
Setting: formal: teacher	35	18	53
Setting: informal			
Setting: informal: interaction with peers	0	17	17
Setting: informal: recreation	0	5	5
Setting: informal: work	53	39	92
Problem: economics			
Problem: economics: containment	24	15	39
Problem: economics: fertilization	7	0	7
Problem: economics: maintenance	3	4	7
Problem: economics: parking	0	5	5
Problem: economics: production	16	36	52
Problem: economics: profit	36	26	62
Problem: economics: proximity/logistics	23	66	89
Problem: economics: ranch in economic context	6	5	11
Problem: economics: sanitation	7	6	13
Problem: economics: scale	23	32	55
Problem: economics: spatial efficiency	11	44	55
Problem: economics: structural soundness	6	1	7
Problem: economics: storage	11	19	30
Problem: economics: traffic flow	14	27	41
Problem: equine production			
Problem: equine production: breeding	10	1	11
Problem: equine production: care for horse's comfort/needs	29	58	87
Problem: equine production: medical	4	12	16
Problem: equine production: safety	7	8	15
Problem: equine production: shelter	13	7	20
Problem: equine production: sustenance/provisions	31	24	55
Problem: equine production: training	9	12	21
Problem: needs of people			
Problem: needs of people: leisure	8	8	16
Problem: needs of people: physical	7	18	25
Problem: needs of people: aesthetics	2	5	7
Tool: schematic: field			
Tool: schematic: field: agriculture	17	3	20
Tool: schematic: field: architecture	1	4	5
Tool: schematic: field: climate	8	3	11
Tool: schematic: field: construction science	3	3	6
Tool: schematic: field: economics	33	38	71
Tool: schematic: field: geography	9	5	14
Tool: schematic: field: geometry	7	19	26
Tool: schematic: field: graphic design/drawing	22	10	32
Tool: schematic: field: housing	7	14	21

(continued)

Table 1 (continued)

	Darin	Riley	Total
Tool: schematic: field: materials science	7	10	17
Tool: schematic: field: mathematics	23	44	67
Tool: schematic: field: natural resources	12	14	26
Tool: schematic: field: natural sciences	8	2	10
Tool: schematic: field: sanitation	6	5	11
Tool: schematic: field: traffic control	14	28	42
Tool: schematic: field: veterinary science	2	10	12
Tool: schematic: culture			
Tool: schematic: culture: design conventions	1	16	17
Tool: schematic: image			
Tool: schematic: image: mental map	19	105	124
Tool: schematic: image: narrative	46	42	88

Problems Motivating the Ranch Designs

Our first research question sought to understand the problems the students identified that they needed to solve to produce an economically viable horse ranch. The general problem that Darin (see Figure 1) and Riley (see Figure 2) worked to solve was outlined in the assignment that Raymond presented to them and their classmates. To review: The ranch needed to produce (i.e., breed, train, and market) a particular breed of horse and do so at a profit. It needed to occupy 320 acres of land, be situated within the school's state, and stay within a budget of $750,000. The ranch needed to provide everything required for the profitable production of the horse breed each student selected to focus on: fenced pastures, barns with stalls, storage areas for equipment, veterinary facilities, breeding facilities, roadways, parking, and whatever specialized features a particular breed might need: a racetrack for thoroughbreds, training areas for show horses, and so on.

Within this defined yet open-ended task, students identified their own problems to solve depending on the breed of horse they chose to produce and the goals and experiences that guided their compositions. Beyond completing the task itself (i.e., following the assignment and attending to the appearance of their drawings), these problems fell into three general areas:

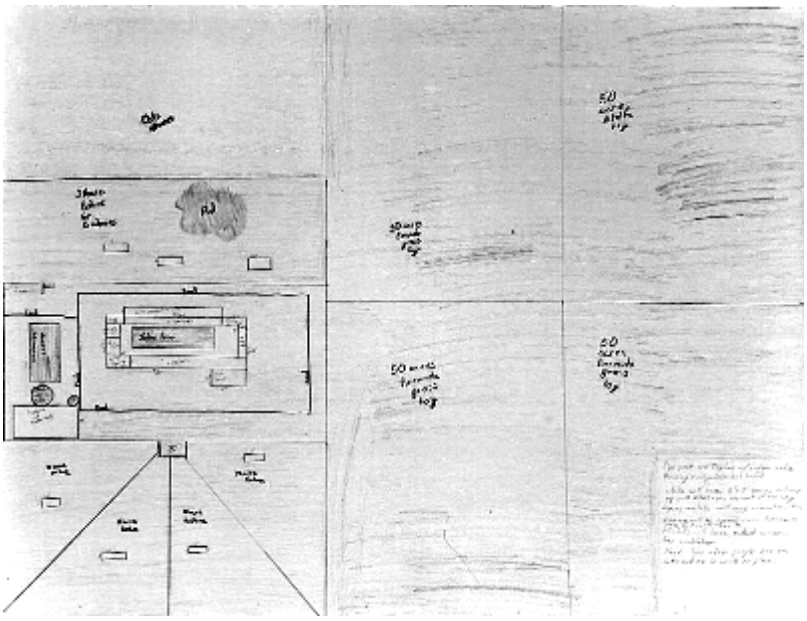

Figure 1. Darin's ranch.

- the economics of ranch operations, particularly the efficiency and soundness of the design and structure;
- the actual production and care of the horses;
- the needs of the people who lived and worked at the ranch and visited it as customers.

We next illustrate each of these sets of problems with data from Darin's and Riley's protocols.

Economics of Ranch Operations

The students' ranches needed to function successfully as an enterprise. This focus was realized in both their attention to the cost limitation of the project and their sense of functional economy, particularly in terms of configuring the ranch's various elements to minimize movement from one area to another. We next review the kinds of economic problems the students identified and solved as they produced their designs, including their efficient execution of tasks, the upkeep

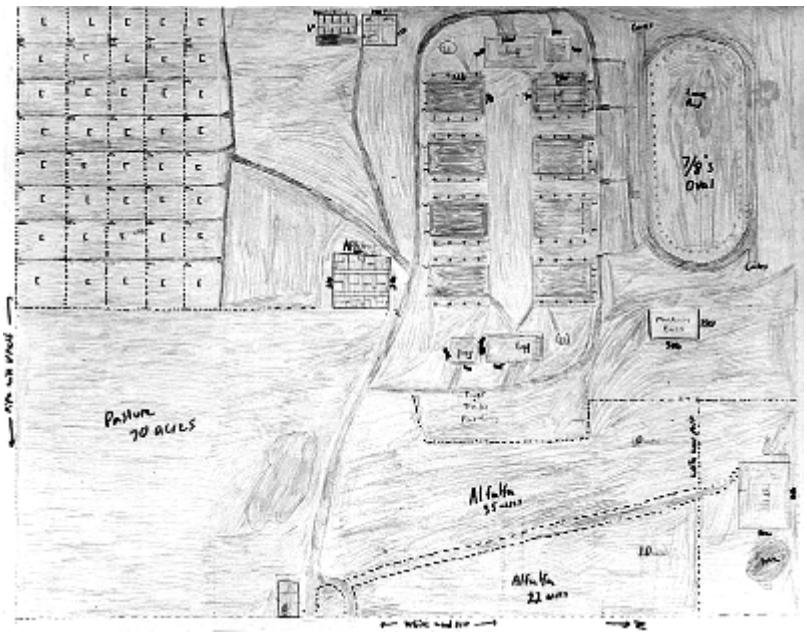

Figure 2. Riley's ranch.

of the ranch, the storage of equipment, and the income generated by the ranch.

Efficient execution of tasks. Darin and Riley were concerned with designing their ranches to enhance the efficient execution of work related to their particular ranch operations. Their attention to these matters was identified in the coding system by the *problem: economics* codes in the areas of proximity/logistics, spatial efficiency, traffic flow, and scale. Riley, for instance, included a training track for both thoroughbreds and quarter horses in his design, breeds of different physical stature and racing endurance. For his track, he included two chutes (i.e., sets of gates from which horses are released to begin a race). Based on his experiences working at racetracks, he knew that the two types of horse begin their sprints at different locations on the track: Quarter horses typically race a quarter mile and begin on a spur, whereas thoroughbreds race longer distances and begin on the oval. To make the track more profitable, he explained during his retrospective protocol, he wanted to service both thoroughbreds and quarter horses.

> If you have thoroughbreds wanting to work and come around the turn and everything, you have got gates up here the quarter horses can work and get out of their way. . . . Out of 480 horses, there will probably be quite a few that will need to be schooled in the gates and while they are doing that, down here you can be gating horses for workouts and stuff.

Riley's sense of economy included at least two considerations here. First, he opened his market of potential customers by servicing horses of two types. Second, his differentiated chute design enabled owners of both types of breed to train on the track simultaneously, maximizing the potential of his facilities for serving clients and increasing profits.

Upkeep. Another economic consideration was the upkeep of the ranches, as indicated by the *problem: economics* codes of containment, fertilization, maintenance, sanitation, and structural soundness. The students needed to consider a host of problems in the upkeep of the ranch. Darin, for instance, judiciously selected materials that were both structurally sound and aesthetically appropriate. When Raymond asked him what kind of fence he would construct, he replied,

> *Darin:* On the fences I am going to use the, like you suggested, that nice PVC type fence on the front end. And then on the back fences where looks aren't as important, they have got a fence up at the [state agricultural university] Equestrian Center up there that has the pipe tops. But instead of cable, it is a rubbery type cable that they use for underwater stuff that the horse can't get their legs skinned up on, and that is what I am going to use everywhere else.
>
> *Raymond:* What are you going to build your stalls out of?
>
> *Darin:* I am going to have them be solid planks of wood 12-by-6's, about halfway up, and then the rest of the way it is going to be pipe about yea far apart, about 6 inches apart, going up and down, so that the horses can't bite through to each other, but they will also have ventilation. And then on the outside walls, I will have a door on each stall to open up to keep ventilation going through.

This exchange reveals Darin's understanding of horses' needs in terms of materials that are strong and durable but not injurious. The fences needed to meet aesthetic goals when visible to customers yet be strong enough to contain a horse weighing more than a thousand pounds without causing injury. Darin also showed an understanding of the behavior of horses while contained in stalls where they required strong yet safe containment materials. Furthermore, Darin

revealed a sophisticated grasp of both horses' tendencies and need for fresh air through his decision of how to structure the wood planks in the barns and stalls to create favorable ventilation patterns and at the same time to prevent the horses from biting one another.

Storage. The *problem: economics* codes also included the areas of parking and storage, which required an understanding of traffic patterns and the volume of machinery and other goods they would need to store. The locations of these facilities required the students to know both the economics of ranch operation and the economics of movement which, as we have argued, contributed to the profit potential of the ranch. During his concurrent protocol, while designing his barns, Riley recognized the need to include tack rooms (i.e., rooms in which his customers would store their stable gear: harness, saddle, and so on).

> I'll design one of them barns as an example. I want to do it—I kind of want to make it a combination of the few ones I've seen. I kind of think let's make a path over here with stalls. Gap, stalls, gap, stalls? Okay. We'll have a wash rack right here, where you come into the barn. We'll have another one at the end of this row. And we'll have, let's see, kind of a tack room there. Storage, bathrooms, of course. More storage. Another tack room on that end.

We viewed these decisions as economic because the storage areas needed to be placed in convenient locations relative to the parts of the ranch where the items would be used. For this barn accommodating 64 horses, a number of tack rooms were distributed evenly throughout the premises to make it so that no customer had to travel far between a stall and a storage area.

Income. The final consideration in terms of *problem: economics* was the need for the ranch to generate income for the owner. We saw issues of income realized through two codes in the *problem: economics* category: profit and ranch in economic context. When Raymond visited Darin during his concurrent protocol, Darin described how his ranch design included plans to earn a profit by growing crops that he could both sell and feed to his horses.

> *Raymond:* Two hundred acres of bermuda grass is going to make worlds of hay.
>
> *Darin:* Yeah, but since I'm going to have somebody else do the cutting and do that split it in half, they do all the work on it and they take half of it and I take the other half. . . . I can cut it just two or three times during the

> year and then my excess I can sell off to get a little bit of spare money coming in because if you got good bermuda grass hay, people are going to come from miles around to buy it.

Darin's understanding of market principles, the relative value of different crops, the relation between acreage and crop production, and other factors enabled him to meet one of the assignment's primary requirements: to operate the ranch at a profit. Darin was able to achieve this goal through a variety of economic decisions, including judicious use of pastureland and savvy ideas about paying for work with harvest rather than taxable income.

Production and Care of the Horses

The second major problem solved by Darin and Riley was the production (breeding and training) and care of the horses. Their attention to these concerns was revealed through the *problem: equine production* codes. In the area of production, we included codes for breeding, medical attention, safety, shelter, sustenance/provisions, and training. Central to producing horses was care for the horse's comfort/needs. We next detail how the students attended to these concerns during their processes of composition, including the production of horses and the needs of the people who used the facility.

Production. During his retrospective protocol, Darin revealed how he combined his attention to horse production with his sense of economy of both finances and movement.

> That's a loafing shed—so if you've got bad weather or its real hot, the horses can get in underneath that and get some shade or protection from the weather. . . . And then I have three of them up in the 28-acre pasture for the brood [breeding] mares. . . . And then [the pasture] is on the other side because I've got my lab over here, and it's a lot easier to access—just coming straight across and right in than it would be if they were right next to each other having to walk.

In this excerpt, Darin shows his concern for the horses' needs for comfort through his design of loafing sheds (i.e., sheltered areas where they could retreat from the sun in this area's blistering, sunny summer climate). Respite from the heat would contribute to better breeding conditions, as would the availability of ample pastureland where they could graze and roam until ready to give birth to their

foals. Darin's economical configuration of his facilities further contributed to the likelihood that the mare and foal would have good medical attention and the veterinarian would have the most efficient arrangement for healthy delivery of the colts.

Needs of People

The final problem that Darin and Riley sought to solve in their designs was care for the needs of people who used the ranch: proprietors, veterinarians, trainers, jockeys, customers, riding students, and others. Often these concerns were exhibited in the design of the owners' living quarters—their house location and related amenities such as swimming pools. At other times, the students saw the needs of people related to the economics of ranch operation. During his retrospective protocol, for instance, Darin described his decisions about where to locate his veterinary lab as follows:

> I didn't want to put the office or the tack room over by the lab and the wash rags because it can get pretty smelly over there sometimes. . . . Sometimes you'll get chemical smells from the lab where they do work there. And I just didn't want to have any of those smells coming into my office. . . . If I had people coming in to look at horses or want to purchase something, I want them to be as comfortable as possible.

In this case, Darin's understanding of customers' needs—their likelihood of finding a chemical scent to be malodorous—motivated his decision about where to locate the lab and his business office relative to one another. This issue of comfort presumably would affect the business operation of the ranch: leasing space at the facility, buying and selling horses, negotiating contracts, and so on under conditions that were comfortable for clients and thus conducive to negotiating business agreements.

Summary

In this section, we have reviewed the range of problems that Darin and Riley solved during the composition of their ranch designs. They invoked knowledge of a variety of disciplinary fields to configure space for the greatest economy of movement and consequently the greatest economy of enterprise. Although the drawings themselves might appear crude compared to professional art design graphics, the

cognition behind their production involved the analysis, synthesis, and evaluation found at the upper end of Bloom's (1956) venerable taxonomy of abstract thinking. Indeed, although some mundane problem solving was required for this task, the majority of codes for our analysis were applied to problems requiring what Bloom would consider to be the most sophisticated kinds of thinking.

Inscription and Encoding of Meaning in Ranch Designs

Our second research question was designed to understand how, and through what tools, the students inscribed and encoded meaning in their compositions of ranch plans. With this inquiry, we sought to understand not only the technical aspects of design revealed through the *problem* codes but to use the *tool: schematic: image* codes—comprising both mental maps and narratives—to understand what kinds of meaning the boys embodied in their drawings.

We found that by attending to the narratives the students told when explaining their designs, we could see much richer explanations of their decision making than were available by simply looking at the completed drawings. In the following excerpt from his retrospective protocol, Darin described his decision about where to locate his ranch (*problem: economics: ranch in economic context*) in terms of the site's excellent soil composition. In doing so, he drew on a variety of tools from the *tool: schematic: field* category, including his knowledge of climate, geography, materials science, and natural sciences, all packaged in both mental maps and narratives about how particular configurations would function together.

Darin: The [nearby small town] area has really good land around it or parts of it are really good.
Researcher: What do you mean by good?
Darin: They have good top soil that has a good nitrogen level and good nutrients in their soil to give you a better pasture and field crop. . . . If [the soil] was down by the river, you know, that would be because the river would overflow and deposit soil and that sort of thing all over the top of the land and give you better nutrients there, but—
Researcher: Is it near enough to it that that would happen?
Darin: Not in my facility exactly because I wouldn't want my pastures and my barn to go under water.
Researcher: Uh huh.
Darin: Not if the river floods.

Researcher: So you put this on high ground?
Darin: I put it on a slope with the barn and the house being pretty much like on the top of the hill, where you would have the breeze coming along to cool it off in the summer time.
Researcher: Uh huh.
Darin: And it would be well insulated so in the winter time, the horses can generate their own heat to keep them warm.
Researcher: Inside this?
Darin: Uh huh, inside the barn.
Researcher: Huh. So does it slope down from the house—this is all downhill?
Darin: Right. Uh huh. Not a real big slope, but just enough that water would run off of it and I wouldn't have any standing water.

As Table 1 reports, both Darin and Riley frequently drew on a variety of what we considered to be schematic tools: that is, broad mediational means such as a field of study. In this excerpt, Darin describes how his knowledge of geography—the gravitational effects of slopes on water, the tendency of rivers to overflow their banks—informed his decision to locate his facility on high ground. He further used imagaic schematic tools to envision what his ranch would look like. His description is replete with small narratives: rivers overflowing and barns going under water, summer breezes providing cool air, horses generating heat in insulated barns to reduce heating costs. These images, likely generated from his prior experiences, served as scripts that guided his decision making about how movement would occur around the ranch and how a careful design could minimize problems and harness energy for the sound fiduciary operation of the facility.

Furthermore, Darin's decisions reflected the interplay between conceptual fields that Vygotsky (1987) found so critical to concept development. Table 1 reveals a preponderance of setting attributions in the informal realm—spontaneous concepts in Vygotsky's terms—that worked in concert with the students' formal (to Vygotsky, scientific) knowledge from Raymond's class. In particular, the boys' experiences at work provided them with the practical knowledge that allows for empirical testing of formal rules. Darin, for instance, used formal knowledge of soil nutrients, which Raymond covered in class, in conjunction with his worldly experiences working with horses to refine his understanding of how to situate the various parts of his facility relative to the ranch geography.

We regarded these decisions as matters of inscription of meaning in the drawings. Rather than simply designing a facility, the students were projecting their experiences into their designs and transmediating those experiences into appropriate iconography. The interactions we have described in which Raymond discussed their drawings with them suggest that as a member of this community of practice, he recognized their inscriptions in a general way; that is, he could tell a barn from a fence and largely understood the reasoning behind the students' decisions.

What is not evident from the drawings—at least to us as lay readers—is the complexity of the thinking that produced them: the understanding of how the proximity and logistics of configuring the various elements of the facility contributed to economy of movement and profit, the knowledge of which materials best suited particular needs, the awareness of how geography and climate affected decisions on how to situate structures and areas in relation to one another, and much more. As we outline in the next section, the students inscribed even more personal meaning into the texts than Raymond could identify with his lifelong affiliation with the ranching community and career of teaching students to produce such texts, meanings that were central to how the boys viewed themselves in relation to their industry and society as a whole.

Integration, Representation, and Mediation of Culturally Mediated Identities Through Design Process

Through our final research question, we sought to understand how the process of composing these texts helped the students to integrate, represent, and mediate their emerging identities. As we have argued, the task enabled students to make connections between personal experiences and this school assignment. We viewed the meanings inscribed and encoded in the drawings as culturally mediated. Our purpose with this inquiry is to understand how these students' construction of this graphic text was mediated by culture and suggested something about their emerging identities.

Simply by producing a text that conformed to Raymond's expectations, Darin and Riley were engaged in a cultural practice. Otherwise, Raymond would not have been able to recognize the symbols used to indicate fences, roads, barns, and other structures; the colors associated with particular ranch elements (e.g., blue for water); and other iconography inscribed in the texts to be easily recognized and read by

an informed reader. More subtle aspects of culture were written into the texts as well. We next review how we understood each student's meaning-making work during his process of designing his ranch.

Riley

In his concurrent and retrospective protocols, Riley revealed an affiliation with the proletariat of ranch operations: the least secure and most vulnerable participants in the culture, the horses and the peripatetic workers, a.k.a. the ranch hands or "help." Although not from a poor family, Riley had a working-class orientation, taking low-paying jobs at tracks and viewing college as peripheral to his future needs. His inscription of meaning in his design—available through his protocols—suggests that he viewed the ranch operation from the perspective of these low-status workers and the animals themselves.

In general, the students' production of their designs followed cultural norms. Raymond provided the parameters for the task with the assignment, reinforced through his formal instruction and informal discussions with students as they worked. Raymond was the source of many of the basic norms for ranch design used by the students: the dimensions and materials of various structures, the cost of the investment, the need for economy of movement, the basics of veterinary science, the calculations for different feed mixes, and others. Raymond's knowledge came from his experiences on his own family's ranch, supplemented by information available in books. From these sources, the students learned the cultural expectations for how to produce a capitalist enterprise built around the production of a horse breed, particularly in relation to this state's geography and climate.

Each individual student then applied this general knowledge to the design of a facility to support a particular breed. For Riley, this breed was the racehorse, an interest he developed through his family orientation and the opportunities to which he availed himself in both this state and the state in which his father lived. For Darin, this breed was the show horse, a breed he had developed an interest in with the support of his parents and the opportunities their affluence provided. Each student's selection of a breed to produce suggested a particular experience that was mediated by the cultures that surrounded the unique purposes and practices engaged in by their participants.

Riley, for instance, spent a lot of time around racetracks both as an observer and participant. His knowledge of how to design training

facilities for racehorses was in large part a consequence of his engagement with this community of practice. During his retrospective protocol, he discussed one aspect of his overall design, the housing he provided for the ranch hands, as follows:

> *Researcher:* Now we have some other stuff here—it looks like apartments?
> *Riley:* Yeah, I put those in because like [a nearby ranch operation] has theirs in the barn, which I don't like.
> *Researcher:* The hands live in the barn?
> *Riley:* Yeah. They were tack rooms and they turned them into apartments. . . . The trainers probably would not live out here. Most of them would go and have places around here and stuff, but a lot of their help is hired and they are looking for cheap places to live real close, which this would allow.
> *Researcher:* Do you provide free room to the hands or do you rent those out?
> *Riley:* It would be rented. It would be fairly cheap rent.
> *Researcher:* That looks like another huge complex.
> *Riley:* Yeah, it's pretty big. I never did—it has about 16 apartments in it or something pretty close to that.
> *Researcher:* Is that roughly how many hands you would hire?
> *Riley:* It would not be me. I would not hire the hands. As the trainers pull in, they will bring people with them.

Riley's explanation reveals a complex knowledge about the community of racing practitioners. The nearby ranching operation provided a layout that Riley felt was inadequate to the living needs of the itinerant ranch hand population, whose families he had observed firsthand during his employment in the entry-level positions available to a young teen. Rather than housing them in converted tack rooms, odoriferously imbued with the fragrance of racing accoutrements and crudely adapted to serve as living quarters, Riley sought to construct apartments better suited to a comfortable if inglorious living space for the ranch hands whose needs he appeared to identify with and provide for. In particular, he appeared to understand their nomadic existence and need for convenient, comfortable, and affordable housing, a sympathy not shared by the owners of the ranch with which he was familiar.

Riley's decisions were thus a function of both formal and informal learning, the interplay between his scientific and spontaneous conceptual fields. He learned general cultural principles from Raymond and specific cultural knowledge from work at the state's largest

racetrack, with his mother's horses, at various tracks near his father's residence, and at a nearby ranch. His position as an entry-level worker gave him a perspective informed by the needs of the horses and the lowest-paid employees, those with whom he appeared to share the greatest sympathy in his design.

Darin

Darin, in contrast, appeared to identify with the managerial class in his design. The son of two doctors, Darin had confidence in his entitlement as proprietor of the ranch he designed. He described his approach to ranch economics in terms of far-sighted financial planning, as in the following excerpt in which he determined how to operate the facility at a profit:

Darin: I've got a lot of land here set aside for my feed so I won't have to be out laying any more money there.
Researcher: So you've got 40 acres for oats?
Darin: Uh huh.
Researcher: Two hundred for bermuda grass?
Darin: Right.
Researcher: So that's all going to go to feed these animals?
Darin: Right. Except on the bermuda grass, a hundred of that will go to whoever it is that ends up doing my cutting for me. I'm going to do it a 50-50 split where they do all the labor and I provide the land.
Researcher: Uh huh.
Darin: And then whatever I have left over, I can sell to help pay the mortgage note on the place.
Researcher: Where did you learn about things like that—about these economic things?
Darin: For the past 2 years, I have been given a monthly salary to spend on the horses, and I've had to learn how to budget that myself.
Researcher: Was that from your parents?
Darin: Uh huh. Yeah. And whenever you're given just so much to use, you have to learn how to make it last.

Darin's monthly allowance placed him in a commanding position, enabling him to engage in financial planning and management early in his high school "career," a term that Eckert (1989, p. 103) applied to those students who identify with the managerial class in a school

social hierarchy and organize their activity toward achievement-oriented goals. This planning included a strategy we observed several times in Darin's design, that of growing more crops than he needed so that he could trade resources for labor and avoid paying taxes on his income. We also inferred that the allowance his parents provided led him to conceive of ranch operations from the standpoint of ownership rather than workers or horses. When asked, for instance, how many employees would be required to operate the ranch, he replied,

> I'm going to have two other people besides my wife. And they're going to do like the cleaning stalls and taking care of the fence and all the manual work and I'm going to do the training aspect of it. I am going to make sure that my wife goes through the Vo-Tech [Vocational-Technical] school so she'll know how to do all the breeding stuff because I've seen ladies are just a little bit more neater than I am so I want to make sure everything's nice and clean.

Darin's projected wife appears to be more of an asset to the company than a loving companion, someone to attend to the niceties of the operation. The hands would do the manual labor and Darin would oversee the training of horses, the more glamorous and specialized work of the enterprise. As he put it later in this session, "Hired help would be cleaning the stalls, feeding, mend a fence whenever it needs to be fixed, doing pretty much the junk work, and I'll be doing all the training." This workforce, he revealed when discussing his design with Raymond, would have a specific makeup:

> That is going to be the entrance to the [house], right up there and then my help's house is going to be right down there and I am figuring one man and his wife or two guys or Mexicans can live in the house together, and then me and my wife will live up there in the house and I figure between the four of us we can manage the place.

Darin thus envisioned himself as playing a corporate role in his life as a rancher, with his wife-assistant keeping the ranch clean and his immigrant help maintaining the ranch while he trained horses, the ranch's primary commodity. In this sense, Darin was not only designing a ranch but a privileged future for himself.

DISCUSSION

In this study, we investigated the socially situated composition processes of two high school students as they produced horse ranch designs for a class in equine management and production. We hoped to understand better the kinds of thinking engaged in during the production of a multimedia text that represented students' understanding of a horse breed and how to produce it at a profit. Our original conception of composition as a literacy act was reconceived as we began to appreciate the breadth of conceptual work the students engaged in, not only in terms of cognition (the focus of traditional protocol analysis) but also in terms of identity construction and social positioning.

We learned that such a composition required the students to draw on and synthesize knowledge from a variety of fields. They would routinely integrate knowledge and practices from mathematics, geography, geometry, earth science, veterinary science, and a host of other fields to design facilities that would provide safe conditions for horses and employees, convenient access to necessary resources, efficient spatial organization of related facilities, necessary accoutrements for the production of particular kinds of horses, astute organization for the profitable management of the enterprise, and other aspects of an economically feasible business operation. They further used their composition of this facility to represent and integrate their own emerging personalities, designing not only a ranch facility but also their social futures (The New London Group, 2000).

Given the students' inscription of a potential life trajectory in their drawings, we regard their work as an instance of praxis: that is, not simply participation in a cultural practice but an effort at positioning themselves within a broader web of social relationships. To Gee (1990), discourse is inherently ideological, serving to apprentice learners into particular social groups. As Finders (1997) has found, secondary school students engage in a variety of literacy practices, both consciously and unconsciously, through which they mark their social positioning. Our research method—focused on the discourse that accompanied their text production rather than on the texts themselves—provided us access to the narratives through which they represented their affiliation with different social classes.

Our study, then, enables us to consider several issues of importance to educators. First, we find this agricultural education class to be the site of sophisticated, socially situated composition. Composition researchers have argued that writing has a variety of potentials:

- that it can promote new insights at the point of utterance (Applebee, 1981);
- that it involves an extended, multifaceted process (Hillocks, 1995);
- that it may serve as a problem-solving tool in many disciplines (Elbow, 1981);
- that it is a tool through which one may construct an identity (Schultz, 2002), a self (Newkirk, 1997), and a social world (Dyson, 1993);
- that it serves as a means of communication and representation (Nystrand, 1986);
- that it is a key medium for self-discovery (Atwell, 1998);
- that it is a codified and socially and culturally mediated process (Russell, 1997).

Our analysis suggests that most if not all of these virtues are available through compositions produced through the medium of a multimedia (primarily graphic) design; we would disagree with Emig (1977), who argued that writing has a unique potential for accomplishing these ends. Consideration of this potential for multiple sign-and-tool systems in school could liberate teachers and students from formal education's logocentric bias and provide opportunities for new learning across the curriculum through a host of expressive and representational systems.

Furthermore, this composing process potentially enables learners to construct and represent not only social worlds but their roles within them. Street (2003) argued "that literacy is a social practice, not simply a technical and neutral skill; that it is always embedded in socially constructed epistemological principles . . . particular versions of it are always 'ideological'" (http://www.tc.columbia.edu/cice/articles/bs152.htm). Although Street appears to conceive of literacy in terms of reading and writing, we find his remarks useful in understanding Darin's and Riley's production of horse ranches. That is, their compositions embodied not only a set of skills—although we found skills aplenty behind their designs—but a deeper personal investment that was revealed through their problem-oriented, goal-directed, tool-mediated action in the context of their life experiences and under Raymond's formal mentorship. We would argue that this interplay between conceptual fields enabled the students to use the cultural tools of graphic design to work successfully in the realm of ranch design while simultaneously reflecting on, synthesizing, and reconceiving their personal experiences and knowledge through the meaning they inscribed in their designs.

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