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INTERDISCIPLINARY INTEGRATION IN PROFESSIONAL EDUCATION

Tools and Analysis from Cultural Historical Activity Theory

by

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Abstract: The purpose of this paper is to introduce readers of *Issues in Integrative Studies* to cultural historical activity theory (CHAT). CHAT represents a systems approach to understanding the sociocultural matrix in which knowledge is transmitted and transformed. Although it was developed in the context of early-childhood learning, CHAT is now invoked in a wide variety of educational and organizational settings. To ground an overview of this intricate theory, we begin the paper by summarizing our own recent study of an issue in integrative learning. That study addressed the challenges of cross-disciplinary integration for students in a professional graduate program of water resources science, policy, and management. In the paper's second major section, we present the origins and development of CHAT and current research based on it. In the final section, referring again to the water program study, we explain how CHAT's conceptual and descriptive tools could be employed to help students integrate knowledge across disciplines in the context of water-related social issues. We hope that this introduction to CHAT suggests to readers other applications of the theory in situations where the object is to understand dynamic connections among interlocked systems. The general relevance of CHAT to the integrative studies community may lie in its demonstrating the critical importance, to the productive growth of any collective endeavor, of identifying, engaging, and expanding beyond inevitable systemic contradictions.

During the past half-century, in the United States and throughout the

world, interdisciplinary education, research, and organizational practice have become increasingly widespread. Because interdisciplinarity raises many interesting questions, it has stimulated lively thought and discussion. In this energetically developing field, pioneer scholars William Newell (Newell, 1983, 1992, 1994, 1998, 2001; Mar, Newell, & Saxberg, 1985; Newell & Klein, 1996) and Julie Thompson Klein (Klein, 1985, 1990, 1994, 1996, 2001; Klein & Doty, 1994) have been joined by a host of scholars, researchers, and practitioners (for example, Barnmark & Wallen, 1980; Chubin *et al.*, 1986; Sproull & Hall, 1987; Fiscella, 1989; Journet, 1993; Myers, 1993; Gibbons *et al.*, 1994; Kline, 1995; Sill, 1996; Richards, 1996; Kelly, 1996; Gilbert, 1998; Lattuca, 2001; Frodeman, Mitcham, & Sacks, 2001; Mansilla & Gardner, 2003; Rhoten, 2003, 2004; Creamer & Lattuca, 2005). In the area of interdisciplinary education, one long-running question concerns responsibility for facilitating integration across disciplines. Where does that responsibility lie? Should posing and answering this question be integral to the program planning? Or, at the planning stage, is it enough to determine which disciplines are relevant to and deserve inclusion in the program? One perspective, noted by Klein, is that program faculty should bear the burden:

Self-synthesis, the assumption that students can integrate materials and ideas themselves, is inadequate. Synthesis does not occur by osmosis. Jonathan Z. Smith's iron law bears repeating: 'Students shall not be expected to integrate anything the faculty can't or won't' (Gaff, 1980, pp. 54–55, as cited in Klein, 1996, p. 214).

Where, as in our own experience, issues of integration have not been directly confronted at the instructional level, assigning responsibility seems premature. Our paper is meant to clarify interdisciplinary integration within a single program. It is about understanding, in a particular situation, whether interdisciplinary integration has taken place and, if so, when, where, and how. And what steps would be necessary and appropriate for spreading or augmenting it? Without disparaging the goal of a general understanding of cross-disciplinary integration, we have sought a framework that would help pinpoint the learning and teaching challenges of interdisciplinarity in ways that suggest practices for effectively meeting them.

In "A Theory of Interdisciplinary Studies," Newell (2001a) argued that the enterprise of interdisciplinary studies is well captured, if not uniquely captured, by complex systems theory. In separate articles, six

authors responded (Carp, 2001; Klein, 2001; Bailis, 2001; Mackey, 2001; Meek, 2001); some reinforced Newell's assertions, others challenged them. This scholarly exchange about interdisciplinary studies programs as self-organizing systems called to mind our own conversations about an appropriate theoretical frame for the University of New Mexico's Water Resources Program (WRP). Similar in some respects to the interdisciplinary studies major, the WRP is also different: it is a graduate program focused on professional practice. Likewise, our candidate theory, cultural historical activity theory (CHAT), parallels complexity theory in that it concerns dynamic linkages among systems. But complexity theory is impersonal whereas CHAT orients strictly to human systems. It is rooted in human interactions, at scales ranging from the individual actor to collective subjects in small groups to whole societies. That complexity theory applies both to natural (physical, geological, chemical, biological) systems *and* to human systems is a plus. But educational systems are pre-eminently social. Why not, then, invoke a theory that is expressly concerned with what is unique to human systems: the creation of reflective thought, language, and mediation by signs and symbols? We present CHAT not as a rival to complex systems theory in comprehending interdisciplinary integration, but as, possibly, an overlapping, companion theory.

The paper has three main parts. The first, Issues of Interdisciplinary Integration in the WRP, describes a graduate professional program at the University of New Mexico (UNM), summarizes an earlier case study of student perspectives on the program's core interdisciplinary courses (Minnis & John-Steiner, 2005), and reports our own revised conceptions of cross-disciplinary integration produced through that study. The second part, Overview of Cultural Historical Activity Theory (CHAT), presents basic concepts of two closely related dialectical theories about the development of mind and the development of culture and society. The final part, Applications and Conclusions, suggests uses of CHAT analysis to improve course planning and instruction in the WRP.

Issues of Interdisciplinary Integration in the WRP

The Water Resources Program

The WRP, the only program of its kind in the country,³ was created by a UNM faculty committee in the late 1980s. The WRP offers a 39-credit professional degree, the Master of Water Resources. WRP students

typically hold undergraduate degrees in civil engineering, environmental studies, or the sciences. They come to the program to further develop water-related technical knowledge and to verse themselves in the social contexts of water issues—that is, in political, cultural, economic, legal, governmental, and community-based approaches to water management. Graduates typically obtain positions in governmental, non-governmental, or private organizations concerned with water administration, law, planning, policy analysis, or research, as well as with related public interest and environmental issues.

Curriculum

Figure 1, a schematic of the WRP curriculum, shows it to be multidisciplinary, in the sense that 24 credits, over half of those the students earn, are acquired in regularly offered graduate courses in various academic units on campus. The rectangles at the top of Figure 1 include sample titles of these disciplinary courses. Individual course plans for the multidisciplinary electives depend on a student's career interests and his or her concentration in either a hydrosocieties track or a water policy and management track. Whichever track a student chooses, he or she must earn six of the 24 multidisciplinary credits in the other track.

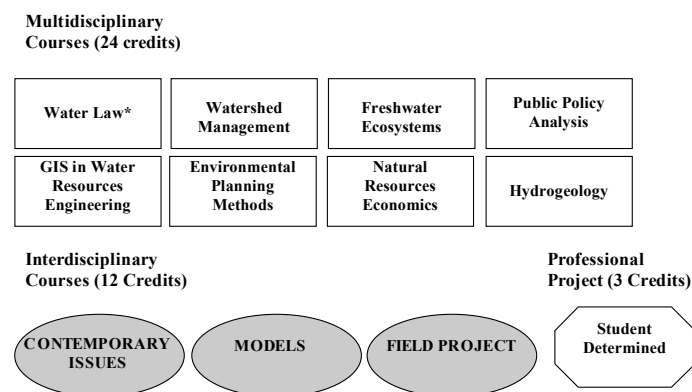


Figure 1. Water Resources Program Curriculum

*These eight boxes represent examples of the 3-credit elective courses open to WRP students.

The most unusual of the WRP courses are the core, interdisciplinary courses, indicated by the ovals in Figure 1. These courses—*Contemporary Issues*, *Models*, and *Field Project*—are required and must be taken in the order shown. All three focus on current, situated water resources problems and include extensive practice in written, oral, and graphic communication. These courses are described more fully in a section below.

The hexagon in the bottom right corner of Figure 1 represents the final degree requirement, a 3-credit individual professional project. These projects often involve original research and modeling; they are supervised by a faculty committee and are comparable in scope to a master's thesis. Most students complete their professional projects in the year after they take *Field Project*.

Faculty

The WRP-based faculty consist of a program director, a tenured professor who holds a joint appointment with the WRP and a disciplinary home department, and the communication specialist, an adjunct professor who has a part-time position with the WRP. All other members of the program faculty have tenure-track appointments in home departments. They participate in the program by teaching disciplinary courses taken by WRP students and by serving on the Program Committee (WRP governance body), on WRP students' professional project committees, and on teaching teams for the core courses.

Interdisciplinary Core Courses

Contemporary Issues and *Models*, the first two interdisciplinary courses, are taught in classrooms and, aside from having four teachers present at every session, are fairly conventional lecture and discussion courses. *Issues* focuses on identifying, critically examining, and proposing comprehensive solution strategies for water-related conflicts in real-world settings. The object of the course is to learn to define water issues in ways that take account of local communities and constraints, while invoking several disciplines, levels of analysis, and short- and long-term time frames. Each student writes a term paper on a topic he or she has chosen. To ensure that they move out of the comfort zones of their undergraduate majors, students are assigned to approach their topics from the perspectives of two disciplines, at least one of which, at the beginning of the course, is unfamiliar to them. Students

develop their papers by repeatedly presenting and revising partial drafts. Each iteration brings higher faculty expectations for rigor, precision, and critical depth in examining the issues. Although students write the papers individually, they are exposed to their classmates' drafts and assigned to comment on them.

In *Models*, students learn a generic software program for constructing rudimentary "stock and flow" dynamic simulation models of natural and economic systems (STELLA^{®4}). Here, too, the main assignment is situated in the outside world. In this case, however, all students focus on the same situation. The object is to construct a multi-layered simulation model of the water resources in, for example, a specific river reach. The reach would be defined by length in terms of river miles, by area in terms of the square miles it drains, and by various measures of annual water flow and yield, including recharge and discharge rates of tributary groundwater. The model designs must incorporate historic water availability and water use by area plant and wildlife communities and by the resident human population. Rather than working primarily as individuals, students work in teams of three or four. In the latter third of the semester, as the hydrologic models are completed, students add to them economic models that can be used to simulate short- and long-term consequences to the local economy of various water-allocation practices.

In *Field Project*, the third course, the students help build a gravity-flow water-delivery system for a village in Honduras. The destination in Honduras changes every year but is always a subsistence-farming community in the mountains. The host villages have no electricity or running water and, usually, are accessible only on foot or by mule. Students and professors, only two professors in this case, live on site in tents. During their stay, they work daily with the villagers on the water project. It has three main parts: a concrete dam that is approximately four feet high and crosses a stream at a much higher elevation than the village; a 5,000-10,000-gallon concrete water tank set nearer the village; and polyvinylchloride (PVC) or steel pipes connecting the dam to the tank and the tank to individual homes on the hillsides.

In this capstone course, the team effort in *Models* is extended to the class as a whole. All *Field Project* participants work jointly on the water project and production of the course report, which includes a watershed model of the host village and a related environmental, educational, or sociological study. Students are asked to maintain journals. Table 1 compares the three courses in terms of basic features described here.

Table 1. Summary of three WRP interdisciplinary courses.

	<i>Contemporary Issues</i>	<i>Models</i>	<i>Field Project</i>
<i>Teaching Team</i>			
Number of Members	four	four	two
Disciplines and Perspectives Represented	<ul style="list-style-type: none"> • resource economics • law and geography • hydrogeology and global water development • psychology and communication 	<ul style="list-style-type: none"> • civil engineering • economics and geology • hydrogeology and global water development • psychology and communication 	<ul style="list-style-type: none"> • hydrogeology and global water development • psychology and communication
<i>Focus</i>	Define, contextualize, and analyze real-world water issues. Include the perspectives of at least two disciplines, one of which is unfamiliar to the author at the outset.	Create a dynamic simulation ground water and surface water model of a particular locale; incorporate local economics variables and water-allocation alternatives.	Assist local residents in building a gravity-flow water-delivery system in a rural mountain village in Honduras.
<i>Format</i>	16-week lecture-discussion classroom course, two 2-hour weekly sessions	16-week lecture-discussion classroom course, two 2-hour weekly sessions.	8-week summer session; two weeks' intensive field work, six weeks' student-directed production of report.
<i>Main Assignments</i>	Write term paper that identifies and comprehensively assesses a water-resource issue in a specific location.	Design, couple, and test dynamic simulation water and economic models of a designated region.	Help build a concrete dam and tank and thread and lay pipe. Create a course report that includes a local watershed model and an environmental or sociological study.
<i>Division of Labor</i>	Students work individually on papers but review each other's drafts.	Students work in teams of three or four.	All students in course work with village residents as a single group or in sub-groups.

Teaching Teams

For the past several years, aside from temporary replacements for faculty on leave, the teaching teams for the core courses have been essentially unchanged. The program director, a hydrogeologist, and the communication specialist, a psychologist and the first author of this paper, are members of all three teams. Other team members include a geology professor, who is also an attorney, and professors of civil engineering and resource economics. In conducting the core courses, all teaching team members attend every class

session. Occasionally, during a semester, or even a session, the team will meet ad hoc to sort out instructional or administrative questions. But most of the course planning takes place in meetings scheduled approximately six weeks or so before the semester begins. These meetings tend to address topical and assignment sequences in the syllabus, proposed additions to the reading list, and, in the case of *Models* and *Field Project*, designing the problem or project on which the class will be focused. Team building is informal, accomplished primarily through the members' shared histories of teaching together.

Interdisciplinary Integration

Although the need to integrate the parts of the curriculum is implicit in the purpose of the WRP, the core course faculty has not looked systematically at whether students strive to make a whole of the parts. Discussions in the planning meetings sometimes turn to pedagogical questions such as how to introduce a specific assignment and when and why to break the class into teams for an exercise. But basic questions about interdisciplinary integration—whether it is an essential goal of the program, what forms it might take, who is responsible to make it happen, and how to determine the success of the effort—have not been directly addressed. The core-course instructors have proceeded as if effective interdisciplinary integration is accomplished simply by presenting multiple perspectives on contemporary water-related conflicts and assigning students to analyze and report on these conflicts. In short, the core-course faculty has not articulated for students a model of interdisciplinary integration or a strategy for identifying, observing, framing, diagnosing, and acting, as professionals, in the context of a developing or long-standing water resource problem. The teaching teams have come to expect that students will feel overwhelmed by the complexity of such problems and object strenuously to the demands of the interdisciplinary courses. Recognizing this likelihood, the teams often have argued that, as students approach graduation and enter the work force, they will be grateful to have been charged in the core courses to find solutions on their own. In the Program Committee, as well, a primary focus on executing the main curriculum has meant that faculty discussions rarely concern the more subtle pedagogical issues of interdisciplinary integration.

An Earlier Case Study of the Interdisciplinary Courses

In 2004, we undertook a case study to explore interdisciplinary integration in the context of the three core courses. We wanted to determine the extent to

which students' responses to these courses indicated an interest in integrating what they were learning and a sense that they were acquiring that ability. We ourselves were unsure exactly what interdisciplinary integration might mean in the WRP context and were hoping that relevant data would be illuminating. Here, to provide points of reference for discussions later in the paper, we briefly summarize that study (Minnis and John-Steiner, 2005).

The data on which we relied primarily were transcribed compilations of student evaluations of all three interdisciplinary courses produced by the cohorts of 2001, 2002, and 2003. Table 2 shows the contents of the resulting database: repeated measures within courses across cohorts (columns) and repeated measures within cohorts across courses (rows).

Table 2. Database of student evaluations of the three core courses.

Y E A R	C O U R S E		
	<i>Contemporary Issues</i>	<i>Models</i>	<i>Field Project</i>
2001	Cohort ₀₁	Cohort ₀₁	Cohort ₀₁
2002	Cohort ₀₂	Cohort ₀₂	Cohort ₀₂
2003	Cohort ₀₃	Cohort ₀₃	Cohort ₀₃

The evaluation questionnaire for each course was tailored to specific features of the course. The questionnaires included a combination of Likert-type rating scale items and short-answer items calling for elaborations of responses on those scales. The items concerned course variables of content, format, sequence, reading materials, assignments, teaching effectiveness, and the respondent's course participation. Because students were required to complete and turn in a course evaluation, our samples for each course include the evaluative responses of nearly all, if not all, students enrolled in it. The course evaluations were used exclusively by the teaching team for improving the course—rather than for public dissemination or administrative decisions about tenure and promotion—and, consistent with the dictum of Chen and Hoshower (2003), were presented as such to the students.

For supplementary data, we also drew upon volunteered contributions from the *Field Project* journals in the cohorts mentioned above ($N = 29$). The journal excerpts had been submitted as appendices to the end-of-term reports produced by the *Field Project* classes. Finally, to obtain student comments on questions of integration *per se*, we convened a focus group about the interdisciplinary courses. The focus group took place in fall 2004, in the week after classes had ended for the semester. It was attended by nine WRP students; all were in good academic standing and had completed one or more of the interdisciplinary courses (two attendees had taken all three). The session was moderated by a colleague. Her questions and those on worksheets completed by the participants sought comparisons of the experience of integrating course material in a WRP interdisciplinary course and in a standard, solo-teacher, disciplinary course.

While student course evaluations have been criticized as a source of reliable data, Kuh's review of the research literature suggests that that critique is moot where the requested information concerns (1) clearly-referenced (2) recent activities (3) known to the respondents and (4) where the respondents consider that the evaluation deserves serious, thoughtful answers that (5) will not threaten their privacy or otherwise be misused (Kuh, 2005, p. 58). Although evaluation of the core courses was not conducted with these conditions in mind, the evaluation instruments and their administration satisfied the first three. Moreover, student comments about the evaluation process—either on the forms, in the focus group, or to professors outside of class—gave us no reason to doubt that conditions 4 and 5 also were met. As indicated in Table 2, the repeated measures contained in our database provided multiple opportunities to detect unusual variances in the responses and thus served as a kind of reliability control.

The question of the reliability of course evaluation findings of general student satisfaction from one offering of a course to its subsequent offerings was less important to us than the goal of uncovering specific integration-related concerns. That is, we mined the data for details about the experience of attempting cross-disciplinary integration. We reasoned that students' subjective reports of this experience would help in answering our research questions and in planning future offerings of the courses.

Data Analysis

Enrollment in the nine offerings of the interdisciplinary courses ranged from 11 to 21. We analyzed a total of 117 questionnaires and assumed that,

within cohorts, most of the data were produced by the same core group of students. In reviewing the course evaluation data, the hundreds of item-specific responses and comments, we followed practices of grounded research (Charmaz, 2004; Dick, 2002; Glaser & Strauss, 1973). Specifically, for each course, we created data tables for comparing questionnaire responses across the three consecutive offerings of the course. Each row in a table was headed by a single questionnaire item; each column was headed by the year from which the questionnaire data were drawn; each cell contained a year's worth of responses to the item identified in the row. Reading the tables, we looked for and sorted the data by themes. That is, when we noted recurring response patterns or statements, we identified them as provisional themes and used them to screen the other tables. Where the themes proved productive, that is, captured ideas common to more than one item or table, we repeated this process three or four times, refining the themes in each iteration and, where appropriate, applying them to the journal and focus group data.

Results

Integration-related extracts from the data were largely consistent within courses and, to some extent, between courses as well. Specifically, comments about integration in the *Contemporary Issues* and *Models* data were similar in kind and differed from comments about integration in the *Field Project* data. Because of these findings, we have summarized themes for the first two courses separately from themes for the last. Briefly, our results for *Issues* and *Models* showed that (a) students valued the professors' expertise, the course content and assignments, but (b) they were frustrated by minimal or contradictory teacher feedback on their efforts. On the latter points, several students indicated that the novelty, complexity, and difficulty of these two courses demanded much greater faculty involvement and better models of collaboration than the teaching teams provided. These impressions are partly illustrated in the following comments:

Whew . . . glad it's over! I learned a lot about researching, writing, time management, and the scope and depth of water issues. At times, I became frustrated because I felt like I was receiving different messages from the instructors. At some moments, I even felt like the same instructor would tell me to do one thing then tell me something different the next time we met (*CI* '01).

[P]rofessors need to 'practice' working together (*CI* '02).

The professors should spend more time up front (before the semester starts) on planning the class. A class on integrating different elements requires integrated teaching. They should know more about what the other professors intend to teach, including the level of knowledge, not just the general topics (*M* '02).

I think all of the instructors have valuable information to impart. However, I don't think that some of the information is presented in a manner conducive to learning (*M* '03).

Students' remarks in the focus group session, which concerned mainly the *Issues* course, amplified the emotional tone of frustration, while reinforcing the conflicting impressions of respect for the instructors and disappointment in their performance as a team.

In contrast to their split opinions of *Issues* and *Models*, students evaluating *Field Project* almost uniformly approved it. Their responses tended to underscore three themes: (a) that the field project grounded and reinforced concepts introduced in the other core courses; for example, the idea that community support determines the success or failure of water projects; (b) that teamwork was vital to accomplishing the building projects in the village and the production of the course report; and, (c) that intense immersion in an unfamiliar culture heightens awareness of both the new situation and one's home situation. On the latter theme, many students said that living among subsistence farmers in Honduras sharpened their perceptions of both similarities and differences in the host community and their own communities in the United States. For example, a number of journal entries expressed surprise at the constraints on villagers, particularly health and safety hazards, while noting as well the villagers' resourcefulness, skill, mutual dependence, and generosity. Such acknowledgments were often contrasted with the high living standards and privileges the students enjoyed at home. The following comments touch on the themes in the series above:

One gets to see personally what one learns in the classroom, especially about the problems of water shortages and contaminated water and the solutions to repair the damage (*FP* '02).

[This course] was a fantastic opportunity to gain 'hands on' experience in the field. I gained a great deal of appreciation for the difficulty in actually implementing a water resources project. Throughout my

career at the University of New Mexico I have learned about how to evaluate problems, model them and then design some type of solution. The Honduras trip illustrated to me the magnitude that planning and community relations play in making such projects a reality (*FPJ* '01).

Our group worked side by side with the men of Nueva Vida breaking rocks, shoveling dirt, and moving boulders in the moist, tropical heat. It was definitely hard work and you had to know how to pace yourself (otherwise, you could end up hurting yourself or those around you). Despite the often-exhausting work, it was extremely satisfying to know that we were working *with* the people of Nueva Vida to supply their families with reliable, clean water and to improve the sanitary conditions of the people that we had come to know (*FPJ* '02).

It most definitely changed my outlook on my career. It was the experience of a lifetime and I would do it again tomorrow. This class taught me how to be more compassionate, more understanding, more appreciative, how to be a better team player, etc. Those are qualities that are relevant to any career (*FP* '03).

The dam building project taught me a lot about teamwork and that good things can and do happen when people work together. I thought the whole project was a wonderful example of teamwork at its best (*FP* '03).

I liked the compiled paper—we went as a group, we worked as a group, we slept as a group—the paper just seemed natural to do as a group (*FP* '03).

Because factors said to have hampered knowledge integration in *Issues* and *Models* apparently did not operate in *Field Project*, it may be tempting to conclude that, where integration is concerned, the two former courses were no match for the latter. But there are other interpretations of the course evaluations review that are less definitive, equally plausible, and more intriguing. For example, we wonder whether, without the priming of *Issues* and *Models*, students would have experienced *Field Project* as integrating theory and practice. Also, had the *Issues* term papers not nudged students outside their technically-oriented home disciplines, would so many of them have noticed and recorded in their *Field Project* journals the indispensable

role of community commitments in enabling the village water projects? And, had the students not worked in teams during *Models*, would they have so readily relied on each other at the work site in the villages and in writing the course reports? In short, instead of resolving our questions about interdisciplinary integration, the course evaluations study led us to return to and question our assumptions.

Diverse Conceptions of Integration

To us, the most interesting outcome of the study was a greatly expanded idea of interdisciplinary integration. At the outset, our image of the process had been of a single actor consciously and laboriously endeavoring to fit together, as if they were jigsaw pieces, key concepts, functions, and terms from many different disciplines. But, after reviewing the core courses and students' responses to them, this image seemed seriously incomplete. The students' remarks led us to imagine that an integrating subject, or integrator, could be a collectivity as well as an individual. Moreover, our work with the data suggested that achieving integration, that is, coming to recognize the intimate connectedness of realities treated as independent by separate disciplines, might happen not only through focused, sustained thought, but also subconsciously, in the course of physical activity. Further, we saw that interdisciplinary relationships might be perceived instantaneously, through a flash of insight, or, in a manner akin to Csikszentmihalyi's conception of flow (Csikszentmihalyi, 1996), through the cumulative effects of several interwoven learning processes. Other implications of our findings include the following: (a) knowledge *disintegration*, through abandonment of long-held notions, is part of the integrating process; (b) situational factors, such as whether cross-disciplinary connectivity is modeled in context, will affect the probability of integration; and, (c) the salience and significance of variables in the integrating situation will depend on the participant's previous knowledge. These examples indicate the impact of our research in changing our sense of what we were studying. In making the context and object of integration more concrete, the students' remarks about the core courses had also made the process of integrating appear more various, complex, conditional, and dynamic. We had come to think of that process as a recursive one involving multiple facets, levels, venues, phases, actors, and roles.

Our more nuanced understanding of integration grew from the particular, goal-directed character of each of the core courses and of the overall curriculum. That is, the students' comments, linked as they were to specific

assignments, divisions of labor, and events, reminded us that, for the most part, cross-disciplinary integration in the WRP is motivated by discrete situations or scenarios. The same is true of professional practice. The work of modern water managers is action- and results-oriented and held to account by the public. Success is measured in terms of efficiency and effectiveness rather than by elegant logic or other formal standards.

As we pondered our evolving conception of integration in light of the students' future careers, our conception of a useful theory changed as well. We came to view as desirable a theoretical approach that was utilitarian and capable of serving water professionals in their work as well as educators preparing students to undertake that work. What came to mind was an all-purpose tool, a set of heuristics for detecting and diagnosing complications in the situation at hand. Whether the objective of the moment was a course syllabus or an assignment, a long-term water plan or a water development project, such an approach would help identify critical variables and clarify their relationships from many perspectives, at many scales, and in longitudinal, dynamic, comparative, and pragmatic terms. Additionally, in either the academic or professional context, the useful theory would help colleagues better understand and communicate what they were attempting, the effects of their efforts, and corrective actions when they strayed off course. It was these criteria that led us to cultural historical activity theory, a theoretical line with which we were well acquainted but as applied to early childhood development and education.

Overview of Cultural Historical Activity Theory (CHAT)

The acronym CHAT does not denote a single theory but, instead, the intimate linkage between cultural historical (CH) theory and activity theory (AT). These two grow from the same philosophical roots, have been historically related, and complement one another. But they are not identical and can be invoked independently. Both theories concern processes through which, over time, humans are formed by and transform culture and thereby their nature.

The fundamental insight underlying CHAT is that the cultural history of humankind is an unbroken dialectical process wherein each new arrival, like a pinch of yeast, is folded into the ongoing system, being partially absorbed by or partially appropriating its nature, but also partially affecting the direction and shape that the system assumes as it changes. In short, at every scale of human existence—from the level of the individual through that of

societies and of the species as a whole—cultural creation, appropriation, continuity, and change are mutually implicated. To understand these manifold implications in terms of specific creative or dampening effects, one must examine the dynamics of the human system from many angles, in multiple contexts, at various scales, and over long time intervals. Discussions to follow in this part of the paper are meant to clarify these general concepts by explaining specific critical terms and relationships in CHAT's component theories.

Cultural historical theory, also known as sociocultural theory⁵, among other names, is associated first and foremost with the early 20th century Russian psychologist Lev S. Vygotsky (1896-1934). The potential reach of Vygotsky's ideas appears to expand with every new generation of scholars. Current and past explorations of his thought have tended to concern socially rooted *psychological development* as mediated by cultural artifacts. Activity theory, which traces to Vygotsky's student and colleague Alexei N. Leont'ev, builds on cultural historical theory, but is more *sociologically* oriented, at least in some prominent contemporary extensions of it to be discussed below. But the psychological-sociological distinctions, while anchoring CHAT component theories in familiar categories, should be interpreted cautiously and may even do it a disservice by obscuring the more important point that, in CHAT, the focus of analysis is neither the individual nor the group, but the relationships among and outcomes of transactions over time. The latter point is key. Vygotsky, Leont'ev, and most others in their philosophical lineage are *developmentalists* with respect to everything: they treat all phenomena to be studied as processes in motion and change and conceive the task of the social scientist to be one of reconstructing the origins and developmental course of whatever is being observed. In its present, elaborated form, CHAT is often invoked not so much as a framework proper only to psychology, but as a general methodology for observing human systems over time.

In the past quarter century, work in the CHAT tradition has grown profusely, spreading into new countries and research communities (for example, Rogoff & Wertsch, 1984; Wertsch & Minick, 1990; Engelsted, 1993; Engeström, 1994; Engeström & Mazzocco, 1995; Nardi, 1996a; John-Steiner, 1999; Middleton, 1998; Rogoff, 1998; Engeström, 1999a; Hedegaard, 1999a, b; Moro, 1999; González Rey, 1999; Roth, 2004a, b). The richness of this tradition makes succinct summary difficult. Cultural historical theory and activity theory will be separately and briefly treated, below. For more detailed accounts, refer to the works cited.

Vygotsky's Cultural Historical Theory

From Vygotsky's most productive period, in the 1920s and early 1930s, to the late 1970s, his original work was known primarily in the Soviet-sphere countries and, to a limited extent, in Europe (for example, Luria & Leont'ev, 1968; El'konin, 1967; Luria, 1971, 1976a, 1979; Leont'ev, 1978, 1981; Ilyenkov, 1982; Lektorsky, 1984; Kozulin, 1984; Davydov & Radzikhovskii, 1985; Tobach, 1981, 1987; Hedegaard, 1990; Zinchenko & Gordon, 1981; Zinchenko, 1985). Since publication of English translations of Vygotsky's *Mind in Society* (1978) and *Thought and Language* (1986) and a six-volume collection of his works (Vygotsky, 1987), however, Vygotsky's writings have been studied, interpreted, and elaborated on by scholars in the United States (Wertsch, 1981, 1985, 1990, 1991, 1998; Cole, 1985, 1996; John-Steiner & Soubberman, 1978; John-Steiner, 1997, 1999, 2000; John-Steiner & Mahn, 1996; Bruner, 1985; Scribner, 1985, 1986) and elsewhere. Following Wertsch's lead (Wertsch, 1990, p. 64), the next three subsections set forth ideas central to Vygotsky's conception of human psychological functioning: *cultural source*, *mediation*, and *historical development*. These ideas underlie activity theory as well.

Cultural Source

Vygotsky investigated the ontogenesis of what he called *higher psychological processes*. By this term he denoted, among other faculties, memory, reasoning, imagination, problem solving, and, especially, speech and language—powers that, in their human expressions, define humans as such and are proper to no other animals. To understand Vygotsky's approach to the development of higher psychological processes, it is helpful to consider alternative explanations that he considered too limited. For example, although he regarded models of animal learning as relevant to humans in some respects—in explaining physiological and motor development, for example—he saw little use for them in explaining humans' intellectual capacities and achievements. Models of animal learning treated cognitive behavior as internal reaction to sensations produced by external stimulation. For Vygotsky, stimulus-and-response explanations, however elaborately wrought, were too passive and mechanical to account for human intelligence. Neither did he look for the source of intellectual development inside the individual, in biological maturation that either unfolded gradually or emerged suddenly. By Vygotsky's reasoning, in humans, unlike other animals, biological and psychological development followed separate courses but

were mutually influential. To explain *psychological* development, Vygotsky looked first to immediate social surroundings, particularly to the assumptions, relationships, and practices that, in combination, we call *culture*.

Why did Vygotsky so confidently seat the source of human intellect in culture? He saw culture, human ways of organizing and comprehending the natural world, as the material trace of human history. Equally important, he saw each individual's appropriation of culture as his or her quintessentially humanizing act. For him, culture comprised both specific content—human practices of naming and organizing the natural world—as well as the operating system, so to speak—peculiarly-human ways of combining, remembering, manipulating, and transforming information about the natural and social worlds.

Vygotsky's concepts of culture owed much to Marx's dialectical materialism. Speaking of Vygotsky, Cole and Scribner describe his life's work as "a psychologically relevant application of dialectical and historical materialism" (Cole & Scribner, 1978, p. 6). Elsewhere, showing parallels between Vygotsky's work and that of Marx and Engels, Scribner explains:

One of their kernel ideas was that the human species differs from all others because, through its manipulation of nature, it frees itself from biological determinism and begins to fashion its own nature. Productive activities (generically 'labor') change in the course of history as new resources and new forms of society come into being. This history is material because it establishes the material activities of people and their intercourse with one another as the source of ideas and mental life (Marx & Engels, 1846, cited in Scribner, 1985, p. 122).

Thus, Vygotsky regarded the psychological processes of remembering, reasoning, comparing, designing artifacts, and so forth as inventions by humans to ease their labor, extend their control over the physical world and, thereby, change their own nature. These highest of the higher psychological processes, in contrast with what Vygotsky called practical human intelligence, were not proper to humans in their primitive biological aspect but, rather, were products of human history that continually are reproduced and transformed over the ages. Vygotsky viewed higher psychological processes as continuous with human history and discontinuous with human biological processes and the practical intelligence proper to all animals. Accordingly, from Vygotsky's point of view, to posit the origins of higher psychological processes anywhere other than in human culture would be to misconstrue both mind and society.

If culture is most powerfully represented in higher psychological processes, by what means does culture cross human generations? This is where *mediated means* comes in.

Mediated Means

Vygotsky said that mental faculties originated indirectly, through the *mediation* of tools and signs. Although he saw similarities between tools and signs, he thought signs were the more versatile, more essentially human mediators. Highly intelligent animals such as chimpanzees had been shown to use objects as tools (Koehler, 1925), but not to have created shared sign systems. By signs, Vygotsky meant symbol systems of any kind and, most especially, in terms of their role in early childhood and all learning, speech. Distinguishing his meaning of signs from others, Vygotsky dismisses any idea that signs somehow inhere in a child's mind:

Our research has led us to quite different conclusions. We have found that sign operations appear as a result of a complex and prolonged process subject to all the basic laws of psychological evolution. *This means that sign-using activity in children is neither simply invented nor passed down by adults*; rather it arises from something that is originally not a sign operation and becomes one only after a series of qualitative transformations. Each of these transformations provides the conditions for the next stage and is itself conditioned by the preceding one; thus, transformations are linked like stages of a single process, and are historical in nature (Vygotsky, 1978, pp. 45-46, emphasis in original).

Vygotsky's most often-cited illustration of sign acquisition concerns a child's learning the gesture of pointing. Picture a child constrained in a high chair and leaning with outstretched arms and hands toward an object that is out of reach. "At this initial stage," Vygotsky writes, "pointing is represented by the child's movement, which seems to be pointing to an object, that and nothing more." He continues:

When the mother comes to the child's aid and realizes his movement indicates something, the situation changes fundamentally. Pointing becomes a gesture for others. The child's unsuccessful attempt engenders a reaction not from the object he seeks but *from another person*. Consequently, the primary meaning of that unsuccessful

grasping movement is established by others. Only later, when the child can link his unsuccessful grasping movement to the objective situation as a whole, does he begin to understand this movement as pointing. At this junction there occurs a change in that movement's function: from an object-oriented movement it becomes a movement aimed at another person, a means of establishing relations. *The grasping movement changes to the act of pointing*. As a result of this change, the movement itself is then physically simplified, and what results is the form of pointing that we may call a true gesture. It becomes a true gesture only after it objectively manifests all the functions of pointing for others and is understood by others as such a gesture. Its meaning and functions are created at first by an objective situation and then by people who surround the child (Vygotsky, 1978, p. 56; emphasis in original).

The mother and child story, while concretely demonstrating sign acquisition, also reveals a key principle, a two-step process, critical to cultural historical theory: "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level: first, between people (*interpsychological*), and then inside the child (*intrapsychological*)." Vygotsky cautions that the child's internal reconstruction of what, initially, had occurred externally, results from "a long series of developmental events" (Vygotsky, 1978, p. 57) which, as he notes elsewhere, proceeds in a spiral, "passing through the same point at each new revolution while advancing to a higher level" (Vygotsky, 1978, p. 56).

One of the ways in which Vygotsky and his students demonstrated mediational means was by comparing how quickly and by what paths adults and children achieved competence on complex response-choice tasks that, initially, were beyond their skill levels. The method involved gradually supplementing verbal instructions for performing the tasks with auxiliary stimuli that were either directly or arbitrarily cued to appropriate responses (Vygotsky, 1978, pp. 58-75). As Cole and Scribner observe, "With all these procedures the critical data furnished by the experiment is not performance level as such but the *methods* by which the performance is achieved" (Cole & Scribner, 1978, p. 13, emphasis added).

Describing the power of *auxiliary stimuli* to transform human development, Vygotsky contrasts psychological and neurological processing produced by direct (nonmediated) impressions of external stimuli on humans with those produced through use of the most elementary tools:

Even such comparatively simple operations as tying a knot or marking a stick as a reminder change the psychological structure of the memory process. They extend the operation of memory beyond the biological dimensions of the human nervous system and permit it to incorporate artificial, or self-generated, stimuli, which we call *signs*. This merger, unique to human beings, signifies an entirely new form of behavior. The essential difference between it and the elementary [nonmediated] functions is to be found in the structure of the stimulus-response relations of each. The central characteristic of elementary functions is that they are totally and directly determined by stimulation from the environment. For higher functions, the central feature is a self-generated stimulation, that is, the creation and use of artificial stimuli, which become the immediate causes of behavior (Vygotsky, 1978, p. 39).

Remarking the profound import of Vygotsky's insights about mediation, Engeström writes:

Mediation by tools and signs is not merely a psychological idea. It is an idea that breaks down the Cartesian walls that isolate the individual mind from the culture and the society.

This expansive potential is evident if we look at the notion of *control*. The traditional division between social sciences and psychology has created the still prevalent dichotomous notion according to which humans are controlled either from the outside by society or from the inside by themselves. In the former case, the possibility of human agency and transformation of social structures from below becomes an unexplained mystery. In the latter case, the origins of individual self-determination are attributed to the equally mysterious sources of biological urges or inherent free will. When Vygotsky formulated his idea of mediation, he was very conscious of the revolutionary implications concerning control. Calling the mediating artifact *auxiliary stimulus*, he wrote:

Because this auxiliary stimulus possesses the specific function of reverse action, it transfers the psychological operation to higher and qualitatively new forms and permits humans, by the aid of extrinsic stimuli, *to control their behavior from the outside* (Engeström, 1999a, p. 29, quoting Vygotsky, 1978, p. 40, emphases in the originals).

Historical Development

Finally, we turn to the descriptor *historical*, which has been forecast in the preceding account and, perhaps, is the most critical of all to explain. Vygotsky's preference for a developmental approach to observing formation of higher psychological processes applied not merely to children's initial learning but to all psychological development, regardless of the subjects' ages or relationships or the situations under study and their time frames. His interest in knowing the history of a phenomenon was at the root of his philosophy and method. Observation of *processes*, not objects or static pre- and post-data snapshots, or "fossilized behavior" (Vygotsky, 1978, pp. 63–68), were, to Vygotsky, the secret to understanding whatever he sought to know. "To study something historically means to study it in the process of change," he wrote, to grasp it on the fly (Vygotsky, 1978, p. 65). The researchers' job, then, became one of reconstructing each developmental stage: "the process must be turned back to its initial stages" (Vygotsky, 1978, p. 62).⁶

A widely known concept derived from Vygotsky's research and useful in detecting incremental developmental processes is that of the *zone of proximal development (zpd)*. The *zpd* is also used in activity theory. It denotes the learner's immediate horizon in a specific knowledge or performance domain; in this zone, with the bridging assistance of someone more advanced in the task or field, the learner may act at a level of competence higher than that at which he or she could have acted alone (Vygotsky, 1978, pp. 84–91). In Vygotsky's words:

The zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. These functions could be termed the 'buds' or 'flowers' of development rather than the 'fruits' of development. The actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively (Vygotsky, 1978, pp. 86–87).

Activity Theory and A.N. Leont'ev

Considering the brevity of Vygotsky's public life and the obstacles he faced—chronic ill health, anti-Semitism, and suppression of his writings by Soviet authorities (van der Veer & Valsiner, 1993)—it is not surprising that

completion of the framework he outlined has been left to his successors. Notable among those who were his contemporaries are Alexander Luria and Alexei N. Leont'ev. Early on in his association with Vygotsky, Luria conducted extensive studies of language, memory, and problem solving in rural communities in Central Asia (Luria, 1932, 1934); ultimately, however, the bulk of his research and writing was in the field of neuropsychology (Luria, 1973, 1976a & b, 1981, 1990). Leont'ev, for his part, undertook the creation of a general psychology (Engelsted, 1993). In this endeavor his greatest challenge, as he explains it, was to effectively close the divide at the core of "classical Cartesian-Lockean psychology—the distinction, on the one hand, of the external world, the world of space to which external physical activity also belongs, and on the other hand, the world of internal phenomena and processes of consciousness" (Leont'ev, 1978, p. 61). Leont'ev's solution to the dilemma lay in a more thorough understanding of *transformations in activity*. Indeed, even while recounting his mentor's groundbreaking contributions, Leont'ev highlights his own theme, the centrality of *activity* in human and societal psychological and material development:

The original ideas that brought Vygotskii to the problem of the origin of internal psychic activity in external activity differ principally from theoretical concepts of other authors who were his contemporaries. These ideas came from an analysis of the features of specifically human activity—work activity, productive activity carried on with tools, activity that is indigenously social, that is, develops only under conditions of cooperation and sharing by people. Correspondingly, Vygotskii isolated two principal interrelated features that must be considered basic to psychological science. These are the equipped ('instrumented')⁷ structure of human activity and its incorporation into the system of interrelationships with other people. It is these features that determine the characteristics of psychological processes in man. Equipment mediates activity connecting man not only with the world of things but also with other people. Owing to this, his activity draws into itself the experience of humanity. This is also the basis for the fact that psychological processes in man (his 'higher psychological functions') assume *a structure that has as its obligatory link socially-historically formed means and methods transmitted to him by the people around him in the process of cooperative work in common with them* (Leont'ev, 1978, p. 59, emphasis added).

Acknowledging that, for the most part, Vygotsky's and Leont'ev's fundamental ideas were the same, Stetsenko distinguishes their respective emphases. Whereas Vygotsky focused on "the transitions from inter-subjective to intra-subjective forms of psychological processes by means of cultural mediation," Leont'ev "focused relatively more on how the material practical forms of activity are transformed into intra-psychological processes" (Stetsenko, 2005, p. 74).

Object-oriented Activity

When Leont'ev speaks of activity, he is not referring to activity as the dictionary defines it, as "actions or reactions in response to external stimuli"⁸ or to theories based on similar definitions. Nardi describes one such theory, situated action, as emphasizing, "the emergent, contingent nature of human activity, the way activity grows directly out of the particularities of a given situation" (Nardi, 1996, p. 71). By contrast, Leont'ev spoke of cognitive as well as visible correlates of activity. He refers to *object-oriented activity*; that is, to organized tool or sign usage, by an individual or by groups of people, *directed to an object*. The actors may be co-located or geographically and temporally dispersed. Examples abound: preparing a meal, participating in a political campaign, producing compositions of various kinds, performing plays, driving to work, repairing broken equipment, caring for youngsters.

Leont'ev maintains that, although types of activity may differ in form, execution methods, emotional intensity, time and space requirements, and physiological mechanisms, they differ most importantly in terms of their objects: "The main thing that distinguishes one activity from another ... is the difference of their objects. It is exactly the object of an activity that gives it a determined direction. ... The object of an activity is its true motive" (Leont'ev, 1978, p. 62).

Leont'ev points out that the emergence of coordinated activity in human history coincided with humankind's transitions to life in society (1978, p. 63). "[W]hat is human life?" Leont'ev asks, "It is that totality, more precisely, that system of activities replacing one another" (1978, p. 50). His often-quoted example of object-oriented activity, which illustrates, particularly, its systemic nature, is a hunting party stalking a quarry (Leont'ev, 1981, p. 210). Division of labor in the party—some hunters flush the prey from the bush by drumming, some close off its escape routes, others approach for the kill—enhances the effectiveness of the hunt, the *object of which is a food*

supply for the participants and their families. Analysis of any instance of activity, says Leont'ev, will reveal that all participants are engaged not only in the overall processes of the activity but at two other levels—at the level of conscious choices and discrete *actions* that accomplish short-term purposes pursuant to the object, and at the level of more routinized, less-conscious, condition-determined *operations*. In the example of driving-to-work activity, deciding to take a side-street short cut when traffic flow on the interstate stalls would be an *action*, whereas spotting an exit ramp, signaling, looking over one's shoulder, changing lanes, and downshifting would all be *operations*.

Engeström, like Nardi, contrasts activity theory's *object-oriented activity* with psychological research concerning situated action, in which the units of analysis are individual *goal-directed actions*. Citing Tikhomirov (1988, p. 113), he explains that the latter, narrower focus, at the level of actions, while highlighting goal attainment and problem solving, "makes it very difficult to analyze the *sociocultural and motivational basis of goal formation and problem finding*" (Engeström, 1999, p. 22, emphasis added).

All of the above examples of object-oriented activity involve tangible referents, observable actors moving. According to Leont'ev, these visible referents are but activity's physical face. In addition to this outward face, there is another that is inter-related, similarly structured, and simultaneously in play. This second face is the nonobservable process of *subjective activity*. That is, according to Leont'ev, activity involves two essential exchanges: (a) "a transfer of an object into its subjective form, into an image"; and (b) "a transfer of activity into its objective results, into its products" (Leont'ev, 1978, p. 50). "Taken from this point of view," he writes, "activity appears as a process in which mutual transfers between the poles 'subject-object' are accomplished" (Leont'ev, 1978, p. 50). As Kaptelinin explains, elaborating on the same point:

The object of activity has a dual status: it is both a projection of human mind onto the objective world and a projection of the world onto the human mind. Employing the object of activity as a conceptual lens means anchoring and contextualizing subjective phenomena in the objective world and changes one's perspective on both the mind and the world. Instead of being a collection of 'mental processes,' the human mind emerges as biased, striving for meaning and value, suffering and rejoicing, failing and hoping, alive, real. On the other hand, the world is no longer just a collection of physical bodies, organizational structures, and so forth, but a place full of meaning and value, a place that can be comfortable or dangerous, restricting

or supporting, beautiful or ugly, or (as it is often the case) all of these at the same time (Kaptelinin, 2005, p. 5).

Transformations of Activity

In propounding such intricate and, certainly, non self-evident dynamics between observable and nonobservable activity, Leont'ev restates his ideas, approaching them from different angles, as if to catch the reader who has lost his drift. For example, asserting what activity is *not*, he writes:

Activity is a molar, not an additive unit of the life of the physical, material subject. In a narrower sense, that is, at the psychological level, it is a unit of life, mediated by psychic reflection, the real function of which is that it orients the subject in the objective world. In other words, activity is not a reaction and not a totality of reactions but a system that has structure, its own internal transitions and transformations, its own development (1978, p. 50).

The mention of internal transitions and transformations brings us directly to the heart of activity theory, to the concept of incessant movement, realignment, accommodation, and communication that brings about change—enlargement, reconfiguration, or collapse, for example—in activity systems. Documenting such change is the mission of researchers in the activity theory tradition. In Leont'ev's words:

Investigation of activity requires an analysis specifically of its internal systemic connections. Otherwise we will not be in a position to decide even the simplest problems—such as making a judgment about whether or not we have an action or an operation in a given case. In this respect *activity represents a process that is characterized by continuously proceeding transformations*. Activity may lose the motive that elicited it, whereupon it is converted into an *action* realizing perhaps an entirely different relation to the world, a different *activity*; conversely an *action* may turn into an independent stimulating force and may become a separate *activity*; finally, an *action* may be transformed into a means of achieving a goal, into an *operation* capable of realizing various actions (Leont'ev, 1978, p. 67, emphasis added).

Activity's transformative nature is characteristically dialectical; change emerges from contradictions, from conflicting forces. These may be internal to the activity or arise between activities. The role of contradictions in developmental change will be a recurring theme in the remaining sections of the paper.

A Generational Perspective on Contemporary CHAT

Our application of CHAT draws primarily on the research of Yrjö Engeström and his colleagues, many of whom are based at The University of Helsinki Center for Activity Theory and Developmental Work Research.⁹ Their work has demonstrated CHAT's practical relevance to systemic problems in organizational and learning settings (Engeström, 1994; Engeström & Mazzocco, 1995; Engeström 1999a, b, c, d; Engeström, Engeström, & Vähäaho, 1999; Engeström & Miettinen, 1999; Hyysalo, 2005; Lompscher, 1999; Nardi, 1999; Saari 1999, 2003; Saari & Miettinen, 2001; Bedny, Karwowski, & Bedny, 2001; Hasu & Engeström, 2000; Hasu, 2001; Miettinen & Hasu, 2002; Tuomi-Gröhn & Engeström, 2003).

Engeström characterizes present organization-based activity theoretical research as representative of CHAT's third generation (Engeström, 2001, p. 134). Vygotsky, the theory's originator, focused on human psychological functioning. His work in that vein clarified the *sociocultural source* and *mediation* of complex psychological processes. Vygotsky held that understanding acquisition of any psychological function required awareness of the relevant *historical context* and *zone of proximal development (zpd)*. Leont'ev, prominent in the second CHAT generation, explored the role of *object-oriented activity* in producing and transforming human psychological capacity. Leont'ev's research, rooted as it was in psychology, looked to the individual human as the subject of or in activity. By contrast, contemporary investigators in Leont'ev's line speak of activity in the context of *activity systems* and as much of *collective subjects* as of individual subjects. Although our discussion of current CHAT issues highlights Engeström's work, there are many CHAT innovators in the field whose work we might have presented.¹⁰ For example, Anna Stetsenko and others (John-Steiner, 1997, 2000; Hasu, 2005; Kerosuo, 2005) have begun to address an issue previously unexamined by the CHAT community. Stetsenko has stated that neither Vygotsky's analysis of the role of social exchange in the development of human consciousness nor Leont'ev's treatment of material activity's similar function recognized the

concomitant and interwoven development of *individual human subjectivity* and related powers of intervention and creativity:

[T]he idea that still needs to be spelled out is that all three processes at the very foundation of human life and development—the material production of tools, the social exchanges among people, and the individual mechanisms regulating this production and these exchanges—all co-evolve, interpenetrating and influencing each other, never becoming completely detached or independent from each other. All three types of processes need to be viewed as truly dialectically connected, that is, as dependent upon and at the same time conditioning and influencing each other, with this dialectical relation emerging and becoming more and more complex in human history (Stetsenko, 2005, p. 74, emphasis added).

The following discussion of activity-theoretical organizational change research will show the continuity of this work with Vygotskian and Leont'evian concepts and explain the terms *activity system*, *expansive cycles*, and *expansive methodology*.

The Activity System as a Unit of Analysis

In a landmark treatise on activity theory, *Learning by Expanding: An Activity-Theoretical Approach to Developmental Research* (1987), Engeström outlines what he termed an *expansive methodology* for observing developmental cycles in activity. In a related discussion, Engeström and Miettinen explain activity theory's conceptual tools for approaching theoretical and methodological questions of interest in all the social sciences: for example, "How might micro and macro levels of analysis be related?" and "How, within the social sciences, is causality to be understood and explained?" (Engeström & Miettinen, 1999, p. 8). Arguing that activity theory plus expansive methodology better answer such questions than do other theories,¹¹ these authors propose as a new unit of analysis: "*object-oriented, collective, and culturally mediated human activity, or activity system[s]*"¹² (Engeström & Miettinen, 1999, p. 9, emphasis in original). Briefly defining an activity system, Engeström states: "Activity is here seen as a collective, systemic formation that has a complex mediational structure. Activities are not short-lived events or actions that have a temporally clear-cut beginning and end. They are systems that produce events and actions and evolve over lengthy periods of socio-historical time" (Engeström, 1994, p. 45).

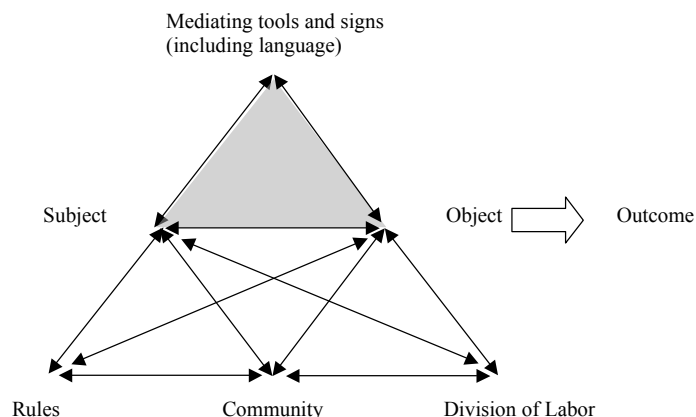


Figure 2. Graphic model of the mediational structure of an activity system (Engeström, 1994, p. 46, adapted from Engeström, 1987, p. 78).

Figure 2 is Engeström's graphic model of an activity system. The shaded top portion of the figure depicts Engeström's interpretation of Vygotsky's early, triadic representation of the mediated interaction of humans and the sociocultural world (Vygotsky, 1978, p. 40). In Figure 2, however, stimulus and response,¹³ the base poles of that original simple sketch, have been replaced by 1) the motivated *subject*, 2) the *object* of activity that is organizing the subject's activity, "subordinating it to itself," and 3) *mediating artifacts*, including inter-subjective communication, as well as other, "less visible social mediators of activity: *rules*, the *community*, and *division of labor*" (Engeström, 1994, p. 45).

Although the utility of the Figure 2 model can be appreciated without being versed in its history, its meaning may be deepened when it is anchored to its philosophical roots. True to the historical method and CHAT's own history, Engeström alludes to Marx's historical materialism and economic analyses in explaining the nodes, axes, and relationships in the triangle and its subtriangles in terms of production, distribution, exchange, and consumption. In this context, he asserts, "there is no activity without the component of production." Noting the origin of production in the division of labor, he identifies as human activity's pervasive primary contradiction "its *dual existence* as the total societal production and as one specific production among many." Thus is any particular activity independent of while also subordinate to total societal production. Drawing out related smaller scale

implications Engeström adds, "Within the structure of any specific productive activity, the contradiction is renewed as the clash between *individual actions* and the *total activity system*." (See Engeström, 1987, Ch. 2, emphases in original.)

The Figure 2 graphic, while generic in form and static in appearance, nonetheless indicates the potential of this model to define a territory of interest, while indicating associated critical centers and trajectories of movement. Lack of content in the model may be corrected by populating it with particular actors, motives, and so on. The vectors represented—community, rules, and division of labor—are common loci of contradictions. Even so, the usefulness of the diagram is limited by the absence of vectors less easily shown: the history of the system; the types, functions and interconnections of mediating instruments and communication; specific operations and actions; processes through which objects become actions and actions become operations; and the layers of tension and cross-tension that are either maintaining the system in a mode of iterative reproduction, edging it toward a collapse, or pushing it toward a completely new configuration and object. As will be suggested through illustration, however, most of these deficiencies can be overcome.

In Figure 2 the *subject* in the diagram might be either an individual or a collectivity. Here, and in studies of organizational change (e.g., Engeström, 1994; Engeström, Engeström, & Kärkkäinen, 1995; Engeström, 1999a, b, c), Engeström makes a collective subject¹⁴ the actor, a possibility Leont'ev mentioned but did not illustrate.

The concept *object of activity* is complicated, if not paradoxical. It has been described as a collective construction that exists in both material and ideal forms (Foot, 2002, p. 134), that is at once less conscious and more durable than the short-term goal of an *action* (Engeström, 2000, p. 964), and that stabilizes the activity while also functioning as a moving target for it (Engeström, 2001, p. 136). Foot (2002) speaks of the *object* as an activity system's organizing idea, an idea the participants may not have expressed but, were they to try to express it, would express variously. Different definitions of the object reflect differences in participants' roles and investment in the activity and the system's many potential levels of resolution. The nature of the activity also is a factor in specifying it: naming the object of an activity system oriented to manual labor is easier than naming that of one oriented to intellectual labor (Foot, 2002, p. 137).

Recently, the *object of activity* has been a topic of lively and critical debate in the journal *Mind, Culture, and Activity* (Foot, 2002; Kaptelinin &

Miettinen, 2005; Kaptelinin, 2005; Hyysalo, 2005; Miettinen, 2005; Nardi, 2005; Stetsenko, 2005) and in that journal's extended online discussions (See xmca at <<http://lhc.ucsd.edu/MCA>>). The inherent complexity of the concept *object of activity* is compounded by translation-related problems. Kaptelinin (2005) mentions sources of misunderstanding of the term *object* due strictly to the limits of language and translators' options. Noting that there were many difficulties in translating activity theory's original papers, Kaptelinin writes that the English word *object* has been used to translate two Russian terms: *objekt*, which "deals mostly with material things existing independently of the mind," and *predmet*, the term Leont'ev used to refer to the object of activity, and by which he meant "the target or content of a thought or an action" (Kaptelinin, 2005, p. 6). Nardi is careful to clarify that she uses *object* in the first sense to denote "that which is to be realized, such as a cure for cancer" and in the second sense "as a system [or] motive object, such as making the world a better place linked as a motive to the object of a cure for cancer" (Nardi, 2005, p. 39). She suggests that it may be helpful for English speakers to think of that second sense as "the object of the game" (p. 40). For his part, Engeström has this to say on the subject:

A collective activity is driven by a communal motive. The motive is formed when a collective *need meets an object* that has the potential to fulfill the need. The motive is thus embedded in the object of the activity. The object, in turn, is to be understood as a project under construction, moving from potential 'raw material' to a meaningful shape and to a result or an outcome. In this sense, the object determines the horizon of possible goals and actions. But it is truly a horizon: as soon as an intermediate goal is reached, the object escapes and must be reconstructed by means of new intermediate goals and actions (Engeström, 1999c, p. 65; emphasis in original).

Mediating tools and signs, shown at the top of Figure 2, suggests such things as ladders, serving utensils, clocks, maps, e-mail messages, mathematical formulas, printed instructions, telescopes, opera tickets, project proposals, and the like. To activity theorists, however, the array of possibilities is much broader. It includes, for example, a patterned sequence of sounds, a juxtaposition of thoughts, another's words or body language, remembered rhythms or group decisions, as well as imagined logical relationships, dialogues, or situations. In the WRP *Models* course, estimates of water yield in the river reach being modeled could be mediated by relevant

U.S. Geological Survey records of annual flows. Estimates of future water availability could be mediated by National Weather Service long-range projections of regional weather and climate. Pressures on the water supply could be estimated through site visits to observe and characterize watershed vegetation and conditions in the area, quantify dependencies of the human occupants on the local water resource, and assess potential effects on the local economy of planned new development upstream and downstream. The students' conversations about and previous experiences in judging the importance of each of these variables would mediate their decisions about translating estimates into model inputs. Regarding the researcher's task in detailing mediating tools and signs, Engeström maintains that categorizing mediating artifacts by type—e.g., external and practical versus internal and cognitive—will be much less informative than observing associated processes and functional relationships:

[A]s the activity unfolds ... [a]n internal representation becomes externalized through speech, gesture, writing, manipulation of the material environment—and vice versa, external processes become internalized. Freezing or splitting these processes is a poor basis for understanding different artifacts. Instead, we need to differentiate between the processes themselves, between different ways of using artifacts¹⁵ (Engeström, 1999b, p. 381).

Returning to the example of the WRP students building their simulation model, consider another attribute of an activity system, its *multivoicedness*. Describing the friction and negotiation, the rough and tumble, that characterizes an activity system's mediated creation of the object, Engeström writes:

The artifact-mediated construction of objects does not happen in a solitary manner or in harmonious unison. It is a collaborative and dialogical process in which different perspectives (Holland & Reeves, 1996) and voices (R. Engeström, 1995) meet, collide, and merge. The different perspectives are rooted in different communities and practices that continue to coexist within one and the same collective activity system (Engeström, 1999b, p. 381–382).

The arrows in Figure 2 indicate interaction between the object of activity and all other vectors within the system. The object's dynamic modification is driven by internal contradictions, either in the object

(Engeström, 2005, p. 65) or, as suggested above, in system disturbances resulting from a collision of differing perspectives. Any departure from the norm—any snag in the streamflow so to speak, whether malfunctioning equipment or chronic misunderstandings, complaints, and tensions among participants—may indicate structural vulnerability in the system. This idea is well illustrated in Engeström and Mazzocco's study of disturbance management in a television production team. That study involved observing from several vantages within- and between-group interactions of network and remote site production crews preparing for a broadcast of a one-time-only ABC Sports program on the Professional Bowlers' Tour. The authors' analysis of the situation identified seven activity systems and seven modes of managing disturbances at three levels: local, intermediate, and global. Local disturbances were reported strictly among the control room crew and ranged from minor clerical mishaps to disagreements that resulted in on-air mistakes. Intermediate disturbances were those that interrupted the interactions of control room personnel with members of crews in charge of videotape, announcers, cameras, or other activities. Global disturbances involved all seven activity systems and demanded their immediate, coordinated response. Although none of the disturbances precluded broadcast of the program, they and the responses to them revealed strains that hampered optimal performance of these temporarily conjoined systems. Engeström and Mazzocco hold that disturbances in an activity system provide critical clues about "persistent resident pathogens" (Reason, 1990) or "weak points" (Rogalski, 1994) in the work activity (Engeström & Mazzocco, 1995, p. 4).

Recognizing system conflicts may be necessary to working through them but may or may not be sufficient to resolving them in an expansive way. Eventually, moreover, whether recognition of conflict and revisions in the work activity are expansive or contractive, new disturbances will surface. In adopting an expansive approach, the main idea, as developed in the following subsection, is not to suppress or deny conflict but to expect it, confront it, and deal with it creatively.

Expansive Cycles

Elaborating on the work of E.V. Il'enkov (1982), especially the idea that activity systems invariably contain internal contradictions unnoticed by the participants, Engeström maintains that expansive cycles require conscious apprehension of and response to system disturbances:

The new activity structure does not emerge out of the blue. It requires reflective analysis of the existing activity structure—one must learn to know and understand what one wants to transcend. And it requires reflective appropriation of existing culturally advanced models and tools that offer ways out of the internal contradictions ...

[T]he expansive cycle of an activity system begins with an almost exclusive emphasis on internalization, on socializing and training the novices to become competent members of the activity as it is routinely carried out. Creative externalization occurs first in the form of discrete individual innovations. As the disruptions and contradictions of the activity become more demanding, internalization increasingly takes the form of critical self-reflection—and externalization, a search for solutions, increases. Externalization reaches its peak when a new model for the activity is designed and implemented. As the new model stabilizes itself, internalization of its inherent ways and means again becomes the dominant form of learning and development (1999a, pp. 33–34; see also Engeström, 1987, pp. 327–328).

Detecting, if not augmenting, development in organizational activity systems is the purpose of expansive methodology. This methodology requires reflective, longitudinal observations by researchers, as well as their collaboration with participants. The following short description gives but a general picture of it.

Expansive Methodology

Defining expansive methodology, Engeström notes that, in Vygotsky's approach to documenting the two-step process through which young children develop social and self-awareness, "[T]he general direction of investigation proceeded from the socio-culturally given to the individually acquired and interiorized." Left unanswered by this approach were questions about "how the socio-culturally mediated forms of behavior, or the activity settings, or even societies, are generated or created in the first place" (Engeström, 1999a, p. 35). History is not only interiorization, Engeström asserts, but also expansion:¹⁶ "People face not only the challenge of acquiring established culture: they also face situations in which they must formulate desirable culture"¹⁷ (Engeström, 1999a, p. 35). It is the latter process with which Engeström is concerned. His expansive methodology, which, he says, "does not easily fit into the boundaries of psychology or sociology or any other

particular discipline,” (1999a, p. 35) is designed to study “the generation of socio-culturally new activity systems by collectives of concrete human beings” (1987, p. 322).

Execution of the expansive method calls upon researchers to take a hands-on approach to real-world work settings undergoing struggle and transition. These have included factories, offices, schools, hospitals, industrial sites, technology development labs, and other institutions. Typically, the researchers work as *in situ* embedded teams which, with the cooperation of participants, conduct extensive interviews and make videotapes of interpersonal interactions, procedures, routines, and use of workplace artifacts. Through group meetings held in the course of these observations, the researchers report their preliminary impressions to the participants and, with them, assess the implications of the findings. The purpose of the analysis is to discern and make visible local activity systems and their inherent contradictions. Special attention is devoted to minor disturbances in the system or efforts to initiate change, both of which may point to systemic conflicts. Over a period of months, the effort of the group is directed to restructuring activity by devising and testing alternative approaches to reducing friction in the system(s) (Engeström, 1999, p. 377ff.). Ultimately, the goal is to create new tools that will expand the system through and beyond the contradictions to a new steady state (Engeström, 2005, 2001, 1999b; Engeström & Middleton, 1998; Engeström & Mazzocco, 1995). Regardless of the solution devised, however, new internal contradictions in the activity system(s) are expected to occur. All the same, analysis of settings so rich in actors, motives, levels of engagement, and intersecting modes of activity cannot but benefit from what Nardi points to as activity theory’s defining strength, its power as “a clarifying and descriptive tool” (Nardi, 1996, p. 7). For participants in an intervention conducted in this manner, the most enduring benefit may be simply experiencing the process itself (Engeström, 2001, p. 152).

Describing proper stance, method, and attitude for researchers conducting a workplace intervention, the kind of intervention that will put activity theory to the acid test of practical relevance and validity, Engeström writes:

Activity system as a unit of analysis calls for complementarity of the system view and the subject’s view. The analyst constructs the activity system as if looking at it from above. At the same time, the analyst must select a subject, a member (or better yet, multiple

different members) of the local activity, through whose eyes and interpretations the activity is constructed. This dialectic between the systemic and subjective-partisan views brings the researcher into a dialogical relationship with the local activity under investigation. The study of an activity system becomes a collective, multivoiced construction of its past, present and future zones of proximal development (Engeström & Miettinen, 1999, p. 10; Engeström, 1987, p. 169).

Engeström’s invocation of the *zone of proximal development* (Vygotsky, 1978, p. 86) is a reminder of the continuing importance in the CHAT community of Vygotsky’s original insights. In the context of an expansive cycle, which Engeström describes as a reorchestration of the multiple voices, viewpoints, and approaches that constitute a particular activity system, the *zpd* is the possible future state of the system—whether contracted or expanded—toward which, in light of the system’s history and current trends, it is tending. Figure 3, used here strictly for example, suggests how the zone of proximal development (shaded area between three central triangles) might be depicted using the triangular model.

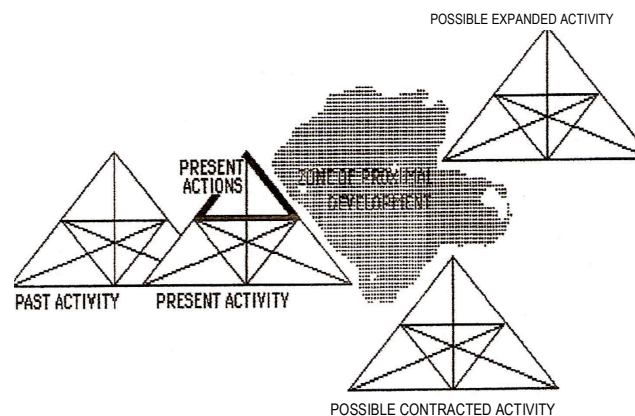


Figure 3. Diagram showing possible futures of an activity system (Figure 2. The zone of proximal development, reprinted from Engeström, 1999c, p. 67).

Table 3. Comparison of Vygotsky's experimental-developmental method* (Vygotsky, 1978, pp. 58–78) and Engeström's expansive method (Engeström, 1999a & b, 2001; see also, Engeström, 1987, pp. 318–321).

	VYGOTSKY Experimental-Developmental Method	ENGESTRÖM Expansive Method
Object of investigation	The higher functional system or the higher form of behavior in its ontogenetic development.	The generation of socioculturally new activity systems by collectives of concrete human beings (1987, p. 322).
General direction of investigation	From the socioculturally given to the individually acquired and <i>interiorized</i> .	From the individual to the societal.
General Steps	<ol style="list-style-type: none"> 1. Observe contemporary everyday behavior. 2. Reconstruct historical phases of the development of behavior. 3. Experimentally produce the change from rudimentary to higher functions in individual subjects. 4. Observe actual development in naturally occurring behavior. 	<ol style="list-style-type: none"> 1. Observe situation/organization phenomenologically and delineate the activity system[s]. 2. Interview participants; record interactions, procedures, routines, and use of workplace artifacts. 3. Engage participant in an historical analysis of the system, focusing on recurrent tensions and disturbances. 4. With participants make the activity system(s) and its contradictions visible. 5. Propose new tools or procedures that will override systemic contradictions. 6. After allowing time to test proposed innovations, evaluate outcomes and, as necessary, continue the process from steps 3 or 4.

*As presented by Scribner, 1985, pp.135-138, and summarized by Engeström, 1987, pp. 318-321, and 1999a, p.35

Table 3 presents abbreviated versions of Engeström's expansive method (1987, pp. 318–337) in comparison with Vygotsky's experimental-developmental method (Vygotsky, 1978, pp. 61–65, as described by Scribner, 1985, pp. 135–138; for a more recent description of both, see Engeström, 1999b, pp. 383–384).

Applications and Conclusions

At the beginning of this paper we said that we wanted to gain an understanding of what interdisciplinary integration means and could mean in the Water Resources Program. Our study of the core courses began that inquiry. CHAT, as presented by Engeström and other developmental work researchers, clearly suggests the next steps we might take. Such practicality is a welcome attribute in a theoretical framework, particularly when the research concerns a pragmatic endeavor such as the Water Resources Program. In the end, the WRP is all about enabling its students to integrate knowledge for decision and action. That is, the WRP is strongly oriented to a professional community that must decide—or at least must effectively communicate to a broad constituency—vital public issues of water protection and allocation. In good hands, CHAT offers user-friendly tools for observing, describing, analyzing, and collaboratively improving purposefully organized human systems of this kind. In this final section, we consider how CHAT might be used to address our research questions about interdisciplinary integration in two areas: diagnosis of conflicts in the core courses and in the program generally; and instructional and course planning in light of those conflicts.

The Program as Activity System

CHAT can be employed to detect and address chronic conflicts in an organization. That utility is illustrated here by considering the overall water program and the core courses as activity systems. In studying the WRP, we have only begun to implement the expansive method. The research reported in this paper may be regarded as an approximate first step: Observe the situation/organization phenomenologically and delineate the activity system (Table 3). Figure 4, our first attempt to delineate an activity system, treats the water program overall, from the point of view of a *collective subject*, a student cohort. In beginning the program, members of the cohort enter an activity system the *object* of which is mastery of water management or hydrosociences through interdisciplinary integration. Figure 4 suggests that, in addition to the program's formal *mediating means*—the curriculum, course syllabi, readings, and other assignments—the students' pursuit of interdisciplinary integration may also be mediated by the faculty's and each other's expertise. Regarding the latter, or intersubjective mediation, Lektorsky develops Bakhtin's ideas about the differences between subject-object and intersubjective relations:

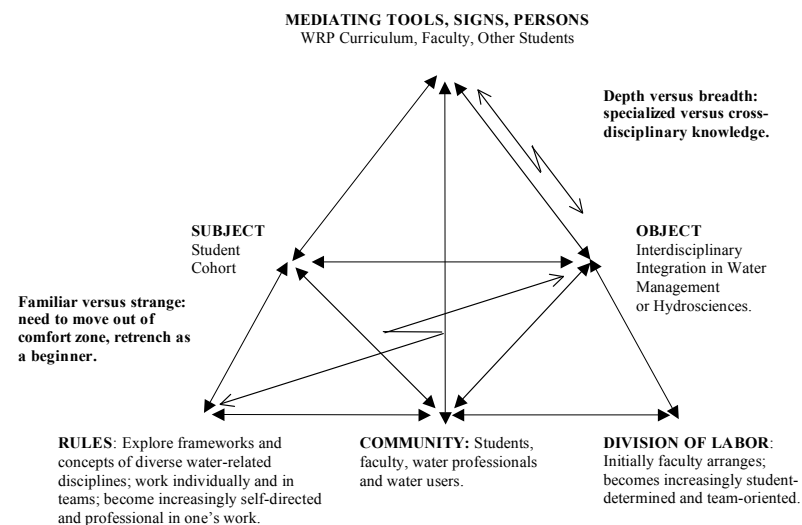


Figure 4. Water Resources Program as an activity system.

Successful communicative activity presupposed taking into account the position and values of the other, an ability to look at oneself from this position and to perform an 'inner dialogue.' It is a complicated system of interactions between 'my own image of myself,' 'the image of me by another,' and 'the other's image of him- or herself.' It is an activity, it is a process of change, but it is not like the process of transforming physical things. The latter is included in intersubjective relations and can be understood only in this context (Lektorsky, 1999a, p. 68).

As for guidance by *rules*, there are the predictable expectations that the students will explore the frameworks and concepts of diverse water-related disciplines and will become increasingly self-directed in their professional work. There is also the perhaps unfamiliar rule that they will work not only individually but also in teams. Finally, there are the broader underlying customs about academic responsibility and proficiency that are so much a part of the academic atmosphere that we do not think about them as rules.

The first-year cohort's *community* consists of fellow students, some of whom are farther along in the program or are differently experienced than

they, and the program faculty. But there are other members of the community relevant to the WRP activity system, shadow community members as it were: the water professionals and water consumers whose various interests entering students must learn to acknowledge. *Division of labor* is a factor rarely mentioned in discussions of graduate education, as it tends to center on individual performance. In the WRP system, however, the alternation of individual and group or team assignments begins in the first term, in *Contemporary Issues*, and becomes more pronounced as the cohort advances through the curriculum.

All program features just noted may be gleaned from descriptions of the WRP on its Web site. The Figure 2 representation of the program differs from such descriptions, however, in showing the program's attributes as interacting and, possibly, in opposition. Figure 2, for example, shows internal *contradictions* in the WRP that become salient when the program is viewed as an activity system. The first contradiction lies in the tension between seeking *depth* of knowledge in a single area of interest—the typical object of graduate study—and, in keeping with WRP's particular object, seeking *breadth* of knowledge across several water-related disciplines. Conflicts of this kind boil down to decisions about distribution of study time and, no doubt, are common to all first-semester graduate students. In the first semester of the program, however, as the core-course evaluations revealed, such conflicts are heightened by the diverse and competing demands of the four members of the *Contemporary Issues* teaching team. Responding to these particular pressures, students in the 2003 cohort restructured their predicament in a way that may exemplify an expansive cycle. That is, when faced with complex, short-deadline library research and reporting assignments, students in *Contemporary Issues* 2003 organized study groups that divided the assignments into subtasks and distributed those tasks among the members.

The depth-versus-breadth tension presents a slightly different face in the context of *rules*, as is indicated in Figure 4 by the jagged arrow connecting the lower left corner (*rules*) with the *object*. Here, the conflict is between the *familiar* and the *strange*: the desire to stick close to the known and the program requirement that students venture into the unknown; that is, read and write about water research and policy in unfamiliar disciplines. While adhering to this rule is consistent with the object of the program/activity system, it may challenge students' confidence—unless and until, that is, they recognize and determine to work through the conflict.

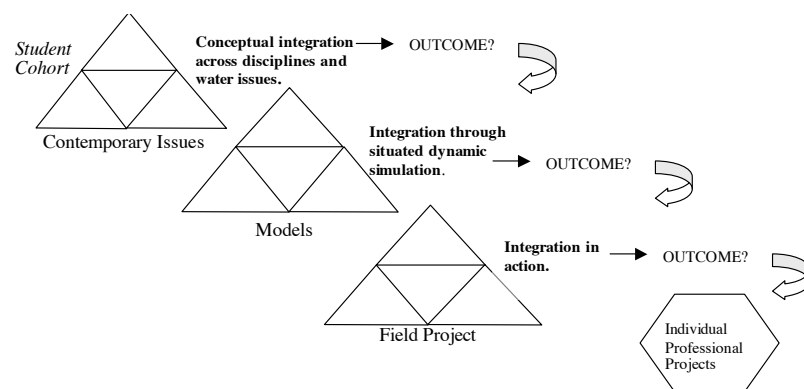


Figure 5. The core interdisciplinary courses as sequential activity systems with student cohorts as subjects and different modes of integration as objects.

Instructional and Course Planning

Triangle diagrams such as the one in Figure 5 could be constructed with and for members of the program community—faculty, students, water professionals, water consumers, or all of the above. The diagrams might be used to identify the program’s internal conflicts or to uncover prime opportunities and means for assisting students in integrating subject matter. Our study of the core courses provides an example. That study created a discourse-and-problems profile of WRP integration issues. It also indicated that each of the core courses might afford students a different type of interdisciplinary integration: for *Contemporary Issues*, conceptual integration of disciplinary frameworks and assumptions; for *Models*, integration through simulation of situated systems; for *Field Project*, integration in action in a real-world water project. Figure 5 succinctly displays the results of that study. In the figure, the three courses are treated as separate but sequentially linked activity systems. We show as *subject* of the activity system series a *student cohort*. As the *object* of each course/activity system, we indicate the type of integration for which the course seems best suited. That is, the diagram is designed to show a *collective subject* proceeding in one direction through a series of time-delimited activity systems that are directed at *different objects*. One implication of this scenario is that, in advancing through the series, the subject may *learn how integration is done*; that is, may build connections across the experiences and appropriate, in a way that becomes second nature, the process of detecting

and invoking connectivity between disciplinary paradigms while working in the field and other professional contexts. Specifically, Figure 5 suggests that students will begin *Models* as more capable integrators than they were when they began *Contemporary Issues*, will begin *Field Project* as even more capable integrators than they were when they began *Models*, and will begin their individual professional projects as even more well-seasoned at cross-disciplinary integration than they were when they began *Field Project*. But, as is indicated in Figure 6 by the uncertainty of *outcome* for each course, *development of integrative capacity across the core courses is not assured*. *Although it has been assumed by the faculty and, as the course evaluation data show, often reported by students following the Field Project course, it has not been expressly pursued as a pedagogical objective*. In thus representing the core courses, disconnections and untested assumptions become apparent. In the same moment, however, situations ripe for thoughtful discussion and creative intervention are also revealed. The importance of having such discussions is reinforced by Engeström’s claim that, while possibilities for transformative change are ever present in an activity system, they are unlikely to be realized without conscious intervention:

A large-scale, expansive cycle of organization transformation always consists of small cycles of innovative learning. However, the appearance of small-scale cycles of innovative learning does not in itself guarantee that an expansive cycle is going on. Small cycles may remain isolated events, and the overall cycle of organizational development may become stagnant, regressive, or even fall apart. The occurrence of a full-fledged expansive cycle is not common, and it typically requires concentrated effort and deliberate interventions (Engeström, 1999b, pp. 384-385).

Another related reading of Figure 5 is to think of its three courses/activity systems as successive *zones of proximal development*, each affording a 16-week concentration on a certain kind of integrative activity, and each, in turn, expanding students’ integration repertoire and refining their preparation for the challenges of the professional projects. Again, however, for the courses to reliably function as *zpd*s, they would have to be regarded and treated as such. At the very least, that is, the *integration syllabus* would have to be made explicit. Participants in all three courses/activity systems would need to identify and work to focus and coordinate several means of nurturing integrating ability: for example, learning from peers, learning from faculty, learning from course material, and learning from direct application.

In *Contemporary Issues*, for example, the activity theory triangular diagrams could be used in the classroom to represent and compare complex water management issues. In the hands of an experienced theorist very broad and surprising applications can be made. Engeström provides relevant examples in his analyses of Mark Twain's *Huckleberry Finn* (Engeström, 1987, pp. 175–193), Peter Høeg's *Borderliners* (Engeström, 1996), and historical events such as the Manhattan Project (Engeström, 1987, pp. 267–278) and discovery of the periodic law (Engeström, 1987, pp. 257–266).

Parts of the WRP curriculum not shown in Figure 5, the elective courses and the professional project, could be added to the system analysis. That is, although we have not attempted to show how the core courses might be synchronized with particular elective courses in a manner designed to enhance the students' development as interdisciplinarians, such a representation might well be made and critically analyzed.

Figure 6 and Figure 7 provide close-up views of *Models* and *Field Project*, respectively, as activity systems. In the *Models* graphic, Figure 6, a subset of the class, a team of three or four members, is shown as the *collective subject* of the activity system. In this course, there may be as many as five or six such teams/systems. Depending on the moment in the term and the assignment of the moment, the teams might be either competing or cooperating. In *Models* the teams are consciously intent on integration. They collaborate within teams

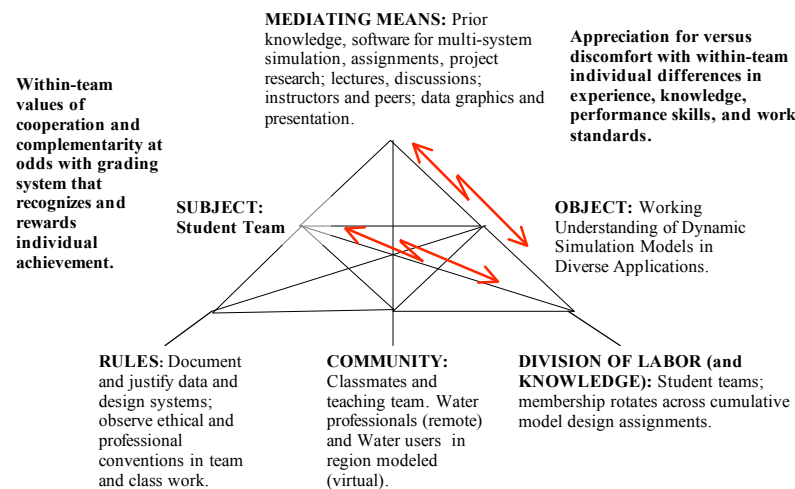


Figure 6. The *Models* course as activity system for interdisciplinary integration through situated simulation (multi-system dynamic regional model) by teams.

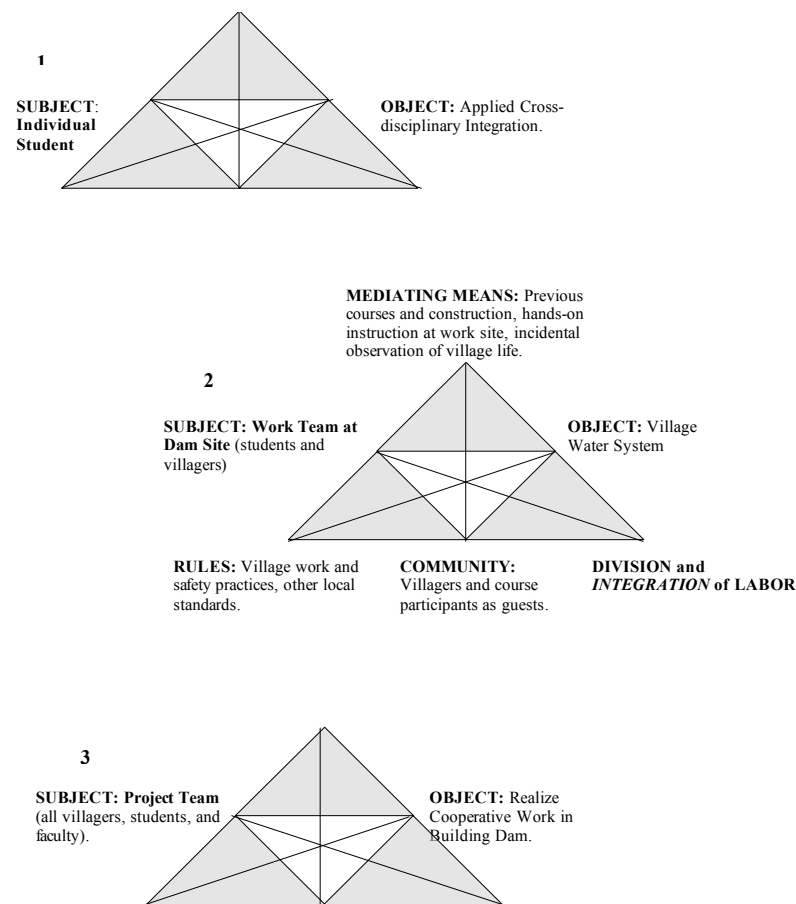


Figure 7. The *Field Project* course as a multi-layered activity system.

to combine their surface water and groundwater models into a joint model; they collaborate among teams to merge the best elements of their separate team models into a collective class model. The conflicts highlighted in Figure 6 are those related to team membership in the context of this course; i.e., simultaneously *valuing collaboration* and *valuing solitary achievement*; simultaneously *appreciating and being discomforted* by fellow team

members' differences in experience, knowledge, performance skills, and work standards. Awareness and discussion of these inevitable tensions could inspire strategies for using the energy of conflict to further the course purposes. If there is any take-away message from the study of CHAT, it is that *active engagement with the conflicting forces in an activity system is critical to the system's expansion*. The role of such engagement as the precursor to positive reorganization of activity systems has been repeatedly demonstrated (see, for example, Engeström & Mazzocco, 1995; Engeström, Engeström & Kärkkäinen, 1995; Engeström, Virkkunen, Helle, Pihlaja, & Poikela, 1996; Bujarski, Hildebrand-Nilsson & Kordt, 1999; Engeström, 1999c, 2005).

In Figure 7, *Field Project* is shown as an activity system of three tiers: level 1, where the *individual student is subject* and his or her agency and conflicts are focal in analyzing the larger, village-scale system; level 2, where *a working team of students and villagers is the subject* of an medial-scale activity system within the larger, village-scale system and may be examined either on its own or in terms of its part in the larger system; and level 3 where *villagers and guests constitute a collective subject* of the complex project that has brought all of them together. Figure 7 is meant to roughly illustrate multi-level analyses rather than to show many details. But one detail is worth mentioning. In constructing Figure 7 from our data, we realized that, while in many instances, *division of labor* is an aid to interdisciplinary integration, *integration of labor*, which is gradually built within cohorts as they progress through the program, can serve the same end. In *Field Project*, that is, in their joint work, students and villagers had diverse roles and responsibilities. But, when they enacted these roles and responsibilities, when they worked most effectively together, their work was *integrated*. It built upon their complementarities, their respective strengths, and created the very process that was intended by this program—namely, interdisciplinary integration that is achieved both individually and collectively and, most importantly, in implementing theoretical learning into practice in a real-world and critically meaningful situation.

Biographical Note: Michele Minnis is emeritus adjunct professor of water resources at the University of New Mexico. She holds a PhD in Developmental and Child Psychology from the University of Kansas. In the early 1980s she created and directed a legal writing program for first-year students at the UNM School of Law. Later, as Associate Director of the Law School's Natural Resources Center, she was a co-founder of the UNM Master of Water Resources Program. For 15 years she served as the communications faculty member on the teaching team of the program's three core interdisciplinary courses. She

is presently writing a biography of Albert E. Utton, a leader in preventive diplomacy for cooperatively managing international transboundary resources.

Vera P. John-Steiner is professor of Language and Literacy and Sociocultural Studies in the College of Education and Presidential Professor in the Department of Linguistics at the University of New Mexico. She is the recipient of the prestigious Lifetime Achievement Award given by the American Educational Research Association. The AERA's division, The Social Context of Education, recognized her for lifetime work on collaboration, creativity, multicultural and bilingual education, and cultural-historical theory at its national meeting held in Chicago in early April 2007. John-Steiner is a frequent lecturer and guest speaker in the United States and abroad. Several of her books have contributed to an emergent understanding of the relationship of language and thought in the course of development.

Notes

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² Emeritus Professor of Linguistics and Education, University of New Mexico, Albuquerque, NM 87131.

³ <http://www.unm.edu/~wrp>, A Message from the Director. Retrieved August 6, 2007.

⁴ See Deaton and Winebrake (1999) and Ruth and Hannon (1997).

⁵ See Scribner, 1985, p. 121 and Wertsch, 1990, p. 65.

⁶ Scribner contrasts Vygotsky's uses of history with stage theories of history, which she illustrates with Herbert Spencer's idea that "societies develop over history, becoming increasingly complex and more highly organized, each marked by more complex forms of thought" (Scribner, 1985, p. 131). Rather, Scribner notes, "Vygotsky addressed the question of *general processes of formation of particular functional systems*, a project quite at variance from one aimed at delineating a particular sequence of general functional systems" (Scribner, 1985, p. 132, emphasis added).

⁷ That is, mediated.

⁸ *The American Heritage Dictionary of the English Language*, 1992, 3rd ed. Boston: Massachusetts: Houghton Mifflin Company, p. 18.

⁹ A research unit of Finland's University of Helsinki, The Center for Activity Theory and Developmental Work Research uses CHAT as a theoretical framework in conducting developmental work research. The Center sponsors five research groups and a graduate school with 30 students. (<http://www.edu.helsinki.fi/activity/>). Retrieved August 6, 2007.

¹⁰ See International Society for Cultural and Activity Research (ISCAR), <<http://www.iscar.org>>. Retrieved August 6, 2007.

¹¹ Among alternate new concepts advanced in addressing these questions,

Engeström and Miettinen (1999, p. 9) mention “the principle of the *coevolution* of social, material and technical factors (Bijker, Hughes, & Pinch, 1987), Freeman’s interactive system model (Freeman, 1994), and Valsiner’s (1988) principle of *co-construction*.”

¹² For a discussion of the development of the activity system as a unit of analysis see Engeström, 1987, Chapter 2.

¹³ Of Vygotsky’s use of this diagram, Cole and Scribner caution, “It is important to keep in mind that Vygotsky was not a stimulus-response learning theorist and did not intend his idea of mediated behavior to be thought of in this context. What he did intend to convey by this notion was that in higher forms of human behavior, the individual actively modifies the stimulus situation as a part of the process of responding to it. It was the entire structure of this activity which produced the behavior that Vygotsky attempted to denote by the term ‘mediating’ (Cole & Scribner, 1978, pp. 13–14).

¹⁴ Davydov identifies as one of the unsolved problems of activity theory, “the relation between collective and individual activity or between collective and individual subject.” He is concerned not only with how the structure of the two types of subjects/activities are similar, which is often taken for granted, but with how they differ. While he does not challenge the possibility of collective subjects, he is bothered by some unanswered questions: *viz.*, “If the collective subject is external to particular individuals, can it be imagined in the form of some totality or group of persons, and in what exact sense does it exist outside the particular individuals who form this group? . . . [W]hat must be the essential features of a group of persons who carry out the joint activity so that this group may be defined as a collective subject? (Davydov, 1999, p. 44). On related topics, see Lektorsky (1984).

¹⁵ In some analyses, (e.g., Engeström, 1999b) Engeström categorizes mediating artifacts by function.

¹⁶ Engeström acknowledges that concepts of expansion were not foreign to Vygotsky, but “remained unintegrated into his general methodology” (Engeström, 1987, p. 323). He also recognizes that Leont’ev was concerned with expansive transitions, but primarily in the context of “actions growing into activities.” (Engeström, 1987, pp. 132–133).

¹⁷ For a discussion of how processes of interiorization and expansion are similarly structured, see Engeström, 1987, pp. 322–337.

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Appendix

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Figure 3. Diagram showing possible futures of an activity system (“Figure 2. The zone of proximal development,” reprinted from Engeström, 1999c, p. 67).

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