

The Problem of Wide-Scale Implementation of Effective Use of Information and Communication Technologies for Instruction: Activity Theory Perspectives.
Presentation 1. Tracking adoption and non-adoption of ICT activities by teachers

Robert J. Bracewell, Carmen Sicilia, Jonghwi Park, and I-Pei Tung

McGill University

Montreal, Canada

The objective of our research is to examine the problem of achieving wide-spread and effective use of information and communication technologies (ICTs) by K-12 teachers in their instructional practice. Despite increased access to ICTs in both classroom and home environments in the past decade, and increased support and opportunity for relevant professional development, the use of ICTs in instruction remains either infrequent or at a minimal level of drill-and-practice activities for a majority of teachers (Becker & Riel, 2000; Cuban, Kirkpatrick, & Peck, 2001; Ertmer, 2005; U.S. Department of Education, 2003).

In analyzing this problem, our claim is that the recent achievement of ready access to large amounts of information, near-instant communication inside and outside the classroom, and professional-looking text and graphics output through the use of ICTs in schools brings to the forefront a looming crisis over the implementation of constructivist instruction in the classroom (Windschitl, 2002). The principal reason for this crisis is the tension between traditional instructional approaches that assume a receptive role by students and the productive capabilities of ICTs that invite a much more initiating and participatory role by students. In this effect, ICTs can be regarded as a catalyst. And just as a catalyst in a chemical reaction accelerates the process but is not otherwise involved, we can expect that the further provision of ICTs capability and support in schools will increase the tension but will not resolve the crisis. Although ICTs will play a part, its resolution will be found in other areas and by other means.

We make the above claim based largely on our experience over the past decade in classrooms that have been well equipped with ICTs, and have adequate and in some cases substantial technical and pedagogical support and training for the use of ICTs in instruction. In spite of these near optimal conditions, effective and advanced use of ICTs for instruction has stalled, with best practices confined to early adopters, and the majority of ICT use being to support traditional teaching activities. In these classrooms the reluctance of most staff to make advanced use of ICTs cannot reasonably be attributed a lack of equipment, or inadequate maintenance, or lack of professional development opportunities, or even a lack of time. Rather, the reluctance appears to be related to fundamental contradictions between more traditional beliefs and practices about instruction (and, indeed, about the fundamental goals of education) and the types of

activities, particularly for students, that the new ICTs afford.

The fact that the large-scale transformation of teaching practices across classrooms in North America is not occurring as quickly as expected in the 1990's has been a topic of investigation for a number of years (Becker & Riel, 2000; Cuban, Kirkpatrick, & Peck, 2001; Blumenfeld, Fishman, Krajcik, & Marx, 2000). For example, teachers who are more engaged in professional activities (e.g., giving workshops) both structure their teaching differently and use ICT resources differently than teachers who are less engaged. The more engaged teachers have students do more collaboration, tackle more open-ended problems, and carry out more and longer work projects. These teachers also have students use more types of software and have them use ICT resources for collaborative, communicative, and presentation purposes (Becker & Riel, 2000). A major concern is that the engaged teachers account for only 14% of the population of teachers. Over 50% of teachers, labeled as private practice teachers by Becker and Riel, engage in few professionally-oriented activities, espouse much more didactic approaches to instruction, and tend to use ICT's for drill and practice.

Analysis of traditional instruction and the contrast with instructional modes and learning that are enabled by ready access to ICT capabilities require comprehensive theoretical and methodological approaches that adequately treat the complexity of school life—ones that take account of context in terms of existing policy and management practices of schools and boards, in terms of the capability to implement and sustain innovations (e.g., professional development resources, technical resources), and in terms of the culture of teachers and schools (e.g., teaching and evaluation beliefs, philosophies, and practices) (Blumenfeld, Fishman, Krajcik, & Marx, 2000; Fishman, 2000; Fishman, Marx, Best, & Tal, 2003; Windschitl & Sahl, 2002). Hence, researchers have turned to frameworks such as communities of practice (Barab & Duffy, 2000), problem solving (Jonassen, 2000b), cultural psychology (Brown & Cole, 2000), and activity systems theory (Jonassen, 2000a) and systematic design methods (Fishman et al, 2003).

Applications of these frameworks are revealing new phenomena and issues regarding how teachers use ICTs for instruction. One of the principal new phenomena concerns the growing awareness that implementation necessarily involves 'reinvention' by teachers of recommended new practices so that they take account of significant factors in the local context, and the related issue of how to maintain the congruence of new practices as this reinvention occurs (Fishman, 2000). This issue presents a serious challenge, on the one hand to professionals who are charged with implementing best practices, and on the other hand to researchers who must account for how context facilitates or interferes with implementation of best practices. Indeed, one could go further--the limit of reinvention would be where teachers simply abandon a recommended and beneficial implementation. If we want to track adoption, we need methods to investigate why and in what manner new practices are taken up by teachers.

One of the comprehensive approaches that has developed constructs for all aspects of

school life is Activity Theory. Originally inspired by Vygotsky's work on the significance of symbolic and material mediation for the development of higher mental functions (Vygotsky, 1987; Vygotsky & Luria, 1994), activity theory has been developed and applied broadly to human affairs by Vygotsky's successors, such as Leont'ev (1978), Engeström (1987), and Wertsch (1985) (to name just three). Apart from the comprehensive nature of this approach, one of its additional advantages is that activity theory is not a finalized theoretical edifice—a factor that will allow for the analysis and development of new constructs that may be required to deal with the complexities found while investigating school life.

Overview of Activity Systems Theory

The theoretical framework that we have been using to analyze practices in schools is Activity Systems Theory (AST). AST is a comprehensive framework developed by Engeström that characterizes practical human activity and learning (Cole & Engeström, 1993; Engeström, 1987), and is based on the cultural/historical psychology of Vygotsky (1987) and the activity theory of Leont'ev (1978). As do cultural/historical psychology and activity theory, AST assumes a material and social basis for thought, action, learning, and development. As a Marxist-based big-picture framework AST has also been constructed to be generally in accord with what we know about human phylogenetic and historical development: Phylogenetically, the initial constructs assumed by the framework are the individual, the population, and the environment. Each of these are viewed as affecting the other via stimulus-response associations (see Vygotsky, 1992, pp. 144-145). These constructs and relationships are represented schematically as a triangle (see Figure 1).

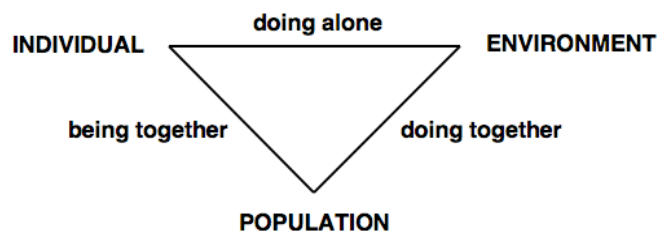


Figure 1. Initial configuration assumed by AST

The emergence of sentience and human society is characterized by 'ruptures' along each of the direct lines of relationship between the initial components, such that the relationships become mediated by technical, social, and communicative constructs. Thus, how the individual interacts with the environment ('doing alone') becomes mediated by the tools developed to enhance action, tools which can be either material (e.g., a flint axe) or symbolic (e.g., language). The interaction of the population with the environment ('doing together') becomes mediated by division of labor as groups set up complementary roles for accomplishing different parts of a task. And interaction of the individual with

the population ('being together') becomes mediated by rules and norms of communication and social interaction (see Figure 2).

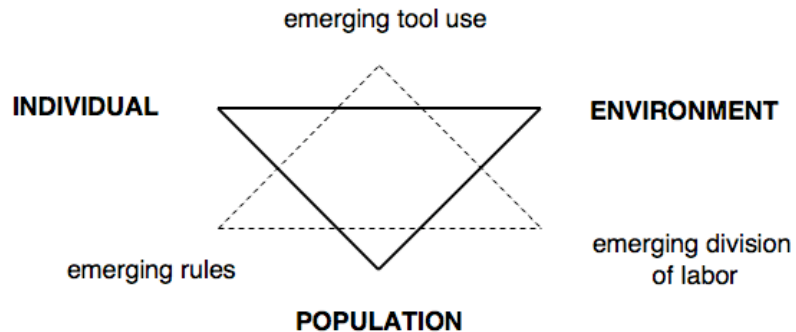


Figure 2. Emerging mediation among initial constructs

Historically, the development of sentience and human society sees the increasing prominence of the mediating constructs, a prominence which has at least two effects. First, they transform the nature of the initial three components: The individual becomes an agent, capable of consciously and intentionally changing the environment and influencing others. The environment becomes partitioned into objects which can be acted upon for various purposes (hence, the dual term "object/motive"). And the population becomes partitioned and transformed into communities. Second, the mediating constructs realize new domains of human activity: The initial domain that consisted of the relations among individual, population, and environment remains and is regarded as the domain of consumption activity. The domain created by agent, tool, and object yields production activity; the domain created by objects, division of labor, and community yields distribution activity for the new objects created by production; and the domain created by agent, community, and rule of interaction yields a domain of communication (also sometimes labeled as exchange) (see Figure 3)

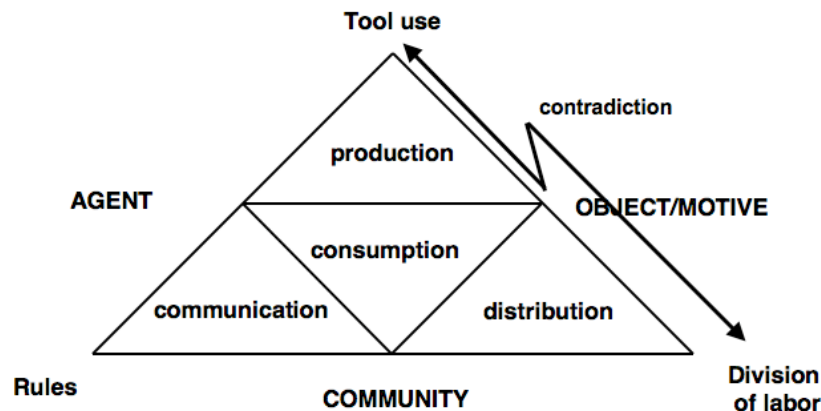


Figure 3. Constructs and structure of Activity Systems Theory

The dynamic construct that causes activity systems to change and evolve are assumed to be contradictions that:

- a) are inherent in the nodes themselves (the prototypical example is borrowed from Marxist economics, where the produced object has both use value and exchange value, hence the dilemma of whether to sell it or use (that is, consume) it oneself),
- b) occur between components of the activity system (e.g., new techniques of production often run into conflict with existing rules of interaction and ways of dividing up labor (this type of contradiction is indicated by the broken arrow in Figure 3), and
- c) between differing activity systems (e.g., the activity of the child entering school is focused on play and companionship, whereas the teacher wants the child to begin to focus on learning).

Use of the activity system framework for analyzing practices of people in a particular situation involves investigating and interpreting the characteristics of the construct for that situation. Evidence for the characteristics can be taken from interviews, observation of talk and action, and written documentation and correspondence produced by practicing participants. More specifically, interviews and the discourse of participants as they carry out a task are particularly informative for identifying potential object/motives of an activity system because participants' expressed goals and subgoals can be coded reliably from transcripts. Of course participants must attempt to implement such goals in order for them to qualify as an object/motive. (Note that failure to implement declared goals is also informative because it can indicate as yet unrevealed object/motives.) Participants' evaluations of what they are doing can also be reliably coded from transcripts. Negative evaluations are particularly useful for identifying potential contradictions within an activity system that may lead to change. Finally, the tracking of who says what, to whom, and when they say it serves to reveal patterns of communication and social interaction. And who takes on which task and subtask serves to reveal roles in the division of labor of an activity system. Examples of the analysis of discourse and interaction to identify activity structure can be found in Bracewell and Witte (2003), Sicilia (2004), and Sicilia, Bracewell, Tung, and Park (2007). We have used all of the above sources in analyzing the practices of participants in our schools.

Case study 1: The significance of existing activity systems for implementing changes in teacher practice

The setting for this case study is a suburban elementary school of about 150 students that draws students from a middle to low socioeconomic background. The students are split about equally between dual and single parent homes, and many of the students are working in school in a second language. The school is well-equipped with ICTs: The grade 5 and 6 classrooms have 8 multimedia, networked computers attached to the internet and supplemented by printers, scanners, and cameras. The remaining classrooms are also equipped with at least one computer station (computer, printer, and internet connection). In addition, teachers can book a laptop cart with 12 laptops for special

project work. The teaching staff are flexible and cooperative with respect to adjusting instruction to make use of resources: For example, the grade 4 students are taught mathematics by the grade 5 teacher in her equipped classroom, while the grade 5 students are taught art by the grade 4 teacher.

We present a summary of two practices that we have analyzed using the AST framework—the first has been successfully implemented and adopted by the school community which includes teachers, students and administrators, and second has met with minimal success. Both practices are from the same school, which adds an interesting aspect of control to the analysis and complexity to the outcomes, because it indicates that school communities are not globally resistant to change in practices. Rather, the adoption of changes of practice in schools appears to depend on the correspondence of a number of factors.

First practice: The Technobuddies program

The Technobuddies Program was implemented to deal with an increasing need for technical support and maintenance of the hardware and software in the school. The objective was to train a group of grade 6 students so that they could fulfil two functions. The first was to provide basic system maintenance such as hard disk backup and also to troubleshoot and repair commonly occurring technical problems such as corruption of a printer driver and recovery of crashed floppy disks. The second was to provide a training and resource function, such that in the course of the Technobuddies maintenance and troubleshooting tasks, teachers and other students would also acquire these skills. The students for the program were selected by the grade 5 and 6 teachers and were trained by a university researcher who remains as a resource, communicating with the Technobuddies both face-to-face and remotely via synchronous and asynchronous means. The program was received enthusiastically by students and teachers. It meets a real need in the school for ICT maintenance and troubleshooting (delays in requests for technical help from school board technical staff are on the order of four weeks). Technobuddies have access to all computer-based classrooms, and often are seconded from classroom activities in response to requests for assistance from the teachers. Our analysis of the activity system involved in this practice is presented in Figure 4.

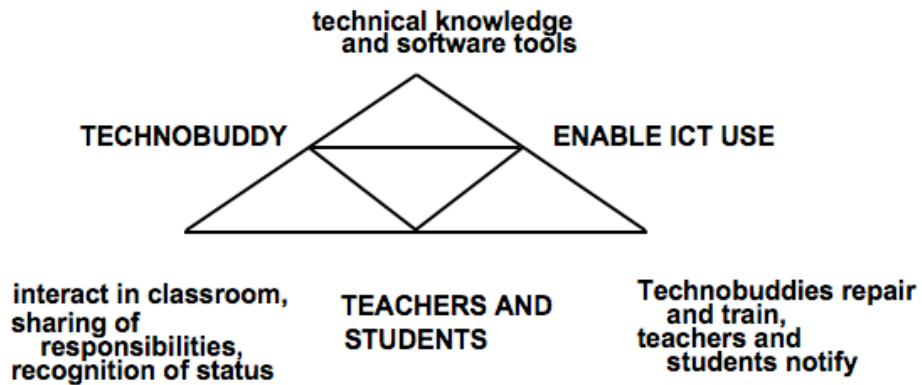


Figure 4. Technobuddies activity system

We believe that the reason for the enthusiastic uptake of the Technobuddies program by the school is related to the existence of a similar program in the school, called the Reading buddies program. In this second program, senior grade 6 students spend classroom time each week reading to grade 1 and 2 students, in the grade 1 and 2 classrooms. The similarity of the two programs can be seen by examining our analysis of the Reading buddies activity system presented in Figure 5.

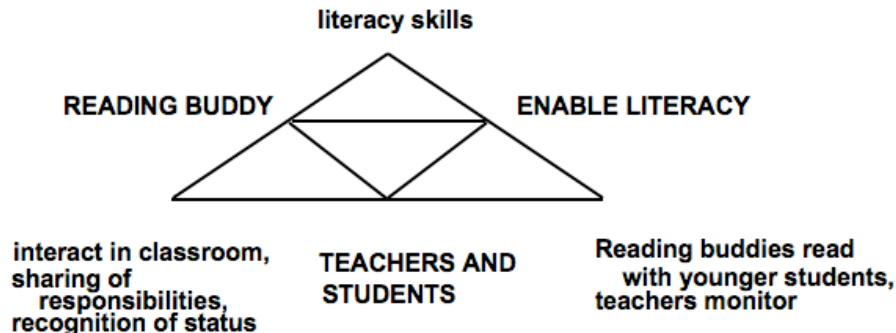


Figure 5. Reading buddies activity system

Both the Technobuddies and the Reading buddies have a recognized and valued task to do in the life of the school. For each, characteristics of their interaction (e.g., movement around the school) and the assuming of responsibility and the recognition of status are aspects of the activity which would probably be seen as being quite intrusive and potentially disruptive in more traditionally run schools. Thus, we would predict that a Technobuddies program would be more difficult to implement and sustain in a more traditional school.

Second practice: Teacher professional development program

The professional development program was designed to address teachers' own expressed interests and needs with respect to learning more about how to use ICTs in instruction. The initial components of the program included the following: a) a survey designed and conducted by the teachers that established their interests and needs, b) securing of funding for release time and for retaining knowledgeable ICT consultants as resources, c) access to a knowledgeable consultant who was known to and had the trust of the teachers, d) a planned schedule that had teachers participating in professional development activities in their own classrooms on the equipment they used with students. This last component was intended to make what was learned more applicable in instructional practice and foster ICT knowledge and skill that would be worth sharing among the teaching staff. The envisioned activity system for the professional development program was as presented in Figure 6.

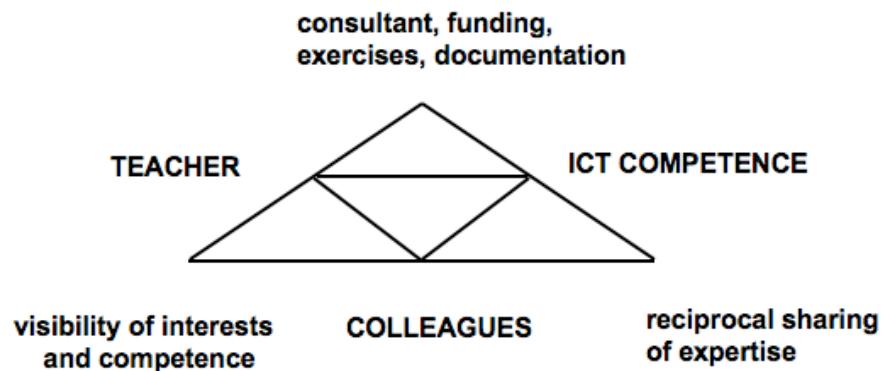


Figure 6. Envisioned activity system for professional development

In fact, however, the program has never got off the ground. Only two professional development activities were scheduled and conducted in the twelve months following the survey of teacher needs and interests.

In analyzing why this program has not yet been realized, we think it helps to examine professional development activities as they actually exist in the school. This existing activity system is presented in Figure 7.

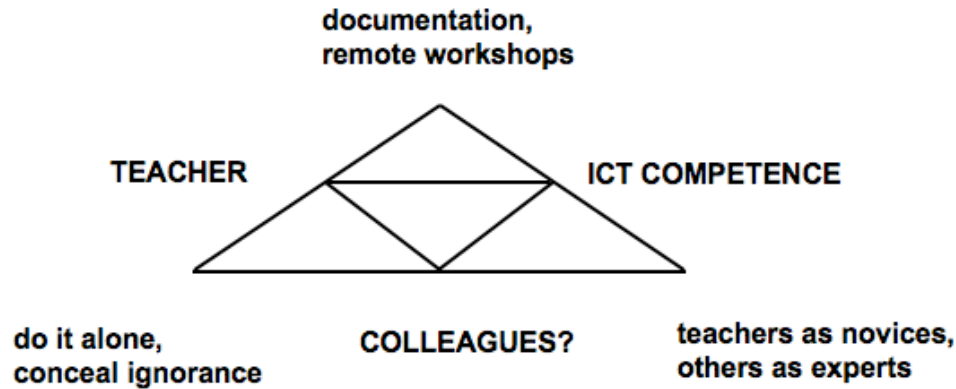


Figure 7. Existing activity system for professional development

In comparing the envisioned and existing activity systems for professional development, we see major differences on each of the three mediational constructs. Tool mediation in the existing system occurs in off-site workshops on equipment that does not match the teachers' classroom set-up. Although teachers return with experience and documentation, this tool mediation is impoverished compared with the envisioned system. The existing division of labor represents a large gap between those who can do with ICT (the expert others) and those who cannot (the novice teachers)—a characteristic that is very different from the envisioned mutual support. And the norms of doing ICT work alone and concealing one's ignorance are the opposite of the envisioned transparency of interests and competencies. In fact, the characteristics of the division of labor and the norms of communication for the existing professional development system call into question the construct of a community (one's colleagues) for this activity system. Until these differences are addressed, it appears highly unlikely that the envisioned system of professional development will be implemented.

Discussion

These analyses of two types of practices within the same school using an activity system framework are preliminary but highly suggestive. The contrasting outcomes of the implementations indicate that schools are not globally resistant to nor accepting of changes in their practice. Rather, what determines whether a change will be adopted and carried on with depends on what the similarity is with existing practices. Analysis using the activity system framework particularly highlights mediational constructs that characterize existing practices—where there is a similarity a new practice is likely to be adopted, with more and greater differences new practices are less likely to be adopted. The differences that are found between existing and envisioned mediations can also serve as focus points for efforts to reduce the differences and thereby increase the chances that existing practices will be adopted and sustained.

Case Study 2: Ubiquitous ICTs as a catalyst for revealing problems with instructional practice

The setting for this case study is private K-11 school of 570 students who come from a middle to upper social economic background. The school is abundantly equipped with ICTs; all teachers and all students in grades 7 through 11 have wireless equipped laptops; classrooms are equipped with printers, scanners, and smart boards; servers provide email and course management systems; and a variety of academic software such as Geometer's Sketchpad is installed on each computer. Furthermore, the school employs three technical support staff plus a full-time pedagogical teacher/consultant who specializes in instructional use of ICTs.

Despite these material and personnel supports, teachers and administrators are facing real difficulties in implementing the wide spread and effective use of ICTs for instruction, a condition that is of real concern given the monetary resources devoted to ICTs and the public commitment of the school to being a leader and innovator in this area. Beyond the early-adopters there is either little use of ICTs or use for drill and practice activities (indeed, the phrase "early-adopters" is something of a misnomer, since there appear to be no "late-adopters").

Over the past two years, our analysis of this situation drew on interviews with teachers, administrators, students, and technical staff, video and audio recordings of classroom instruction, field notes, and documents produced by participants.

In their interviews the teachers spoke of four challenges that they faced in integrating ICTs into their instructional practices: the need for more professional development concerning the effective use of technology, the time available to master ICTs and integrate them with their teaching, the lack of adequate technical support, and classroom management given the distractions available to students via the ICTs. Evidence from our other data sources allows us to divide these challenges into what we call perceived challenges and actual challenges (Sicilia, 2005; Sicilia, Bracewell, Tung, & Park, 2007). We label the first three listed above as perceived challenges because of the resources available to the teachers in this particular school: There is ample access to professional development opportunities both within the school and from external sources; there is more time available than is usually the case for developing new curriculum because teachers are in class from 12 to 15 hours a week and class sizes average 20; and the technical support is prompt and organized (e.g., students who are having problems with their computer can obtain a loaner while theirs is remirrored). In contrast, the last challenge, classroom management, is an actual one; and our claim is that it manifests itself in multiple ways primarily because of the ubiquity of the ICTs present in the school and classrooms.

One of the effects of so much ICT is to radically increase the heterogeneity of the classroom environment (Bracewell, Le Maistre, Lajoie, & Breuleux, in press). In turn this heterogeneity has two results. First, it provides much greater temptation for students to goof-off with their laptops during class by playing flash games or surfing for information on their favorite sports teams. Second and more importantly for instruction, it produces a much greater frequency of students getting lost when using software for academic

purposes and having to seek help. The general (although not universal) practice of teachers is to provide this help themselves during the lesson, a practice which considerably decreases the continuity and cohesion of the teachers' instruction.

A second effect is to increase expectations for both students and teachers concerning student academic performance and interaction. For example, the presence of email and electronic forums allows students to query teachers and access curriculum content outside of class. When teachers do not update materials and do not reply in a timely manner, students become alienated from using the ICTs for learning purposes. Another example, related to the capabilities for communication using email and electronic forums, concerns teacher expectation for student collaboration. The teachers are putting increased emphasis on joint project work using ICTs; however, the students themselves have received no training in cooperative learning. A final example, related to the increased potential for producing products such as text, graphics, digital audio and video, concerns teacher expectation about student output. In general, teachers are expecting students to produce a great deal of the material that they work with in doing academic tasks (e.g., geometrical figures in Geometer's Sketchpad). Often this production is complicated and frustrating for the students. (Undoubtedly this particular expectation and practice is exacerbated by both the general movement for a more student-centered curriculum, and a specific Quebec ministry of education policy that mandates a "constructivist" curriculum).

In order to deal with this challenge of classroom management, and the various frustrations listed above, the teachers draw on their practices concerning curriculum development and instruction. These practices, as they are for most teachers in the school, are summarized in the activity system of Table 8.

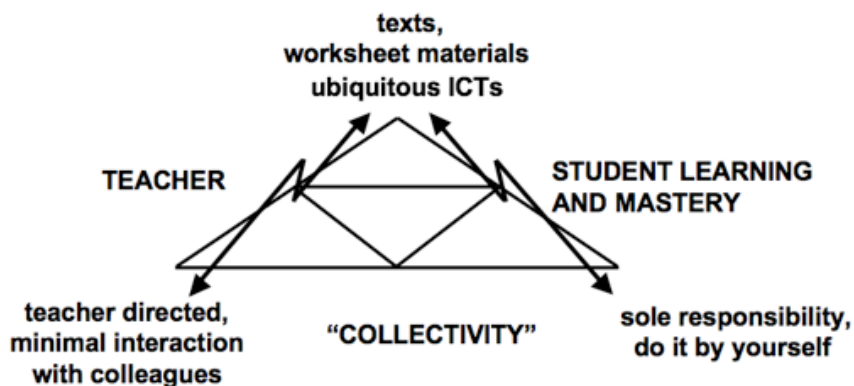


Figure 8. The current Activity System of teaching in an ICT equipped classroom

With the teacher as agent, the object of the activity system is to foster student learning and mastery in academic matters, using traditional materials and also the ICTs as mediating tools. With respect to mediation concerning division of labor and rules for interaction, most of the teachers are quite traditional, taking sole responsibility for most

academic task both inside and outside of the classroom, largely directing what students do in the classroom, and interacting minimally with colleagues around curriculum development. In this they resemble Becker and Riel's (2000), "private practice" teachers--teachers who engage in few professionally oriented activities, espouse much more didactic approaches to instruction, and tend to use ICTs for drill and practice.

One of the effects of these traditional practices is to weaken the community construct of the activity system for teaching, with the result that the group more resembles a collectivity rather than a community. More significant effects are seen with mediation by use of ICTs. The introduction of ubiquitous ICTs creates contradictions with both the existing division of labor (especially around how to work with ICTs in the classroom) and with the rules of interaction concerning academic work (Park, Bracewell, Sicilia, & Tung, 2007). A teacher's sole responsibility for academic matters in the classroom cannot be sustained in the face of having to deal with technical problems and with project work in which students work independently of the teacher both individually and in groups. And a reliance on teacher direction and minimal interaction with colleagues cannot deal with the press for greater teacher-student and student-student communication and the development of curriculum materials that make effective use of the ICTs.

What is required is a redefinition of the division of labor and the rules of interaction in order to reduce these contradictions. Expertise concerning technical matters is distributed throughout the student body and should be further fostered and relied on to resolve minor technical matters about hardware and software on the fly in the classroom. This would mean that students should be able to consult briefly with other students even as the teacher is presenting a lesson. The viability and non-disruptive nature of this consultation would benefit from shifts in the rules of interaction toward cooperative learning practices. In addition, training in this type of interaction is required for effective group project work on academic tasks. Teachers themselves need to engage in much more collaborative interaction, both with students inside and outside the classroom, and with each other inside and outside the classroom, particularly in terms of sharing expertise and taking the initiative in designing, implementing, and evaluating instructional materials and tasks that make use of ICTs. This redefined and elaborated activity system is presented in Figure 9.

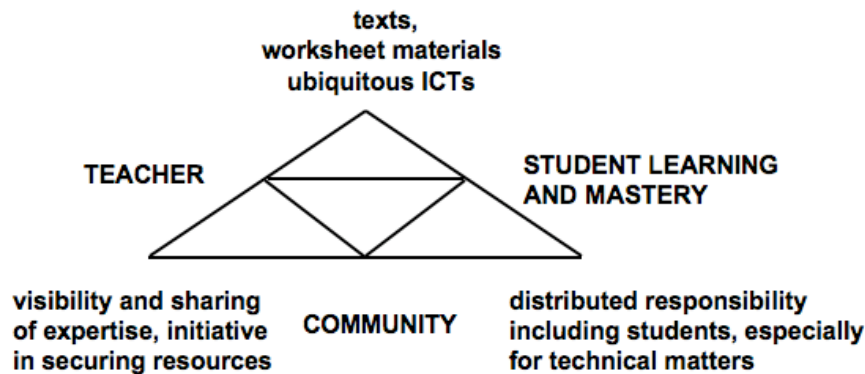


Figure 9. Envisioned activity system of teaching in an ICT equipped classroom

Discussion

As with the first case study, analysis of the effects of ubiquitous ICTs using an activity system framework has highlighted problematic professional practices; in this second case, these practices were directly concerned with instruction and the design of instructional materials and activities. As with the first case, the problematic practices have to do not with ICTs per se but with the division of labor and rules of interaction that teachers follow when carrying out their professional work. One of the major strengths of this analysis is that it highlights recognizable and delimited areas of professional practice.

General Discussion

For all the activity systems considered in these case studies, the specificity of the analyses indicates the heuristic power of an activity system perspective. Case study 1 revealed that the successful implementation of a new practice depended on the degree correspondence of the mediating means (tools, roles, and rules of interaction) with existing and accepted practices within the school. Where correspondence was high the new practice was a success; where correspondence was low the new practice encountered major difficulties. Case study 2 presented a similar pattern in that the correspondence between existing and envisioned roles and rules of interaction in the classroom and between teachers was low, thereby revealing a major challenge to the teachers and contradictions which inhibited the effective use of ICTs in instruction.

In spite of the specificity of these analyses, a major issue remains of who it is that "buys into" the analyses--as researchers we can see the differences contradictions, but change will only come about if teachers and administrators also see the contradictions. And even then, a progressive outcome may not be achieved. For example, in Case study 2 we can see three possible outcome scenarios. First, the teachers and staff could resolve the contradictions by removing the ubiquitous ICTs. This could be done most easily by abandoning the laptop program, while presumably maintaining more limited workstation access to ICTs in the classrooms and laboratories. Second, the teachers and staff could resolve the contradictions by ignoring them. This continuity of the current state would maintain the contradictions, and would indicate that other and not yet revealed object/motives are in place that block their reduction. Third, the teachers and staff could resolve the contradictions by expanding their practices around division of labor and rules of interaction in order to realize a constructivist pedagogy. It is only this last possibility that realizes a progressive outcome.

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