Using Activity Theory to assess the effectiveness of an online learning community: A case study in remote collaboration using a 3D virtual environment

Theodor G Wyeld  
Flinders University

Ekaterina Prasolova-Førland  
Norwegian University of Science and Technology

ABSTRACT
Remote, collaborative work practices are increasingly common in a globalised society. Simulating these environments in a pedagogical setting allows students to engage in cross-cultural exchanges encountered in the profession. However, identifying the pedagogical benefits of students collaborating remotely on a single project presents numerous challenges. Activity Theory (AT) provides a means for monitoring and making sense of their activities as individuals and as a collective. AT assists in researching the personal and social construction of students’ intersubjective cognitive representations of their own learning activities. Moreover, AT makes the socially constructed cultural scripts captured in their cross-cultural exchanges analysable. Students’ reflection on these scripts and their roles in them helps them better understand the heterogeneity of the cultures encountered. In this chapter Engestrom’s (1999) simple AT triangular relationship of activity, action and operation is used to analyze and provide insights into how students cooperate with each other across different cultures in a 3D collaborative virtual environment.

KEYWORDS
Activity Theory, 3D Collaborative Virtual Environment, Online Learning Community, Learning Community.

INTRODUCTION
As part of an ongoing study in online learning communities by the authors, a series of remote collaboration pedagogical exercises have been conducted since 2000. They involve ITC, multimedia, and design computing students from three different universities on different continents and in different timezones collaborating on a single project using the online 3D Active
Worlds environment, in conjunction with social software such as MSN, Skype and Blogs. This chapter uses the latest iteration of these remote collaboration exercises as its case study for the establishment of a consolidated methodological framework for these types of exercises using Activity Theory (AT). AT provides a methodological framework that situates the individual’s contribution within a collective. In this manner it is possible to identify the pedagogical benefits from the exercise at the level of the individual’s goals and activities leading to goal attainment, and the individual historically situated within the collective goals and its associated activities.

AT is based on the idea that culturally defined tools, or artifacts, mediate all activities. These tools and artifacts are historically situated within the activities in which they are used. For learning environments, social interaction and the way activity is organized can only be understood from its historical context: learners complete multiple cycles in attaining their goals and those of the collective; create an identity within the learning community; and, trade their cultural capital in the relationship between their actions and socioeconomic structures. However, much of the analyzable data is derived from heuristic methods, thus being open to interpretation. AT helps concretize this otherwise subjective information by providing a structure for its interpretation. It does this by incorporating Leont’ev’s (1978, 1981) three-level schema: activity, action and operation; corresponding with: motive, goal and instrumental conditions, and the transformations between these levels. In so doing, the meaning-making object of their endeavours is taken from the surrounding activities they engage in, in their learning practices.

The AT framework outlined here is used to analyse, guide and influence the construction and conducting of the remote collaboration exercises. It may be useful to others interested in formalising their own remote 3D collaboration exercises who wish to extract the pedagogical value of these exercises and guide their formation. The AT framework is particularly pertinent to students using online technologies in collaborative exercises, as it assists in the research of personal and social construction of intersubjective cognitive representations in education. Indeed, there is a pressing need for long-term development of thoughtfulness and personal and social identity in an increasingly globalised society. AT makes socially constructed cultural scripts analysable (Hedegaard 1986, 1987, 1990; Bruner, 1986; Wittgenstein, 1953). Graduating students need the cultural tools (Bruner, 1986; Cole, 1990; Wertsch, 1990) to enable them to manage the heterogeneity of the cultures they will encounter in a global work environment.

**THEORETICAL LINKS AND MOTIVATION**

**Activity theory**

Cultural-historical theory of activity, or Activity Theory for short, is based on the work by Vygotski (1978), Leont’ev (1981) and later Engestrom (1987). The fundamental unit of analysis is human activity. Activity Theory is based on the idea that culturally defined tools, or artefacts, mediate all activity. Individuals and groups can be seen as situated within the context of larger communities mediated by rules of participation and division of labour. Artifacts are continuously modified and shaped to meet evolving needs. We can use work activity as a basic unit for analyzing cooperative working situations (Kuutti, 1994; Bedny & Meister, 1997). Activity Theory can help us understand the way work activities are cooperatively realized in order to better understand learning communities. Marx (1968) is referred to in AT to demonstrate how, within the concept of activity, social change cannot be reduced to individual self-change but is a society-wide process.
AT is a method for understanding learning focused on the cognitive capabilities and needs of the learner. The emphasis is on the social nature of learning and learning as participation in a cultural practice. All activities are part of what Engestrom (1999) calls an ‘expansive learning cycle’. In this context, learning development can be defined as a continuous motion through successive forms of participation, connecting the past, the present and the future (Wenger, 1999).

Other elements in the model are cultural tools (artifacts), teachers and collaborative user groups. These serve as a checklist for the design of learning environments. The implications for the design of learning environments are:

- Social interaction and conversation plays a fundamental place in learning.
- The way activity is organized can only be understood from its historical context.

This means learning designers should pay attention to the interaction between the multiple cycles of the learner. The cycles include the development of cultural practice, the development of people within a practice and development of ways of participating within the cultural practice. An example can be a student’s movement through different forms of participation in a project group: from novice to expert and leader.

**Learning communities**

Communities of practice situated within workplace environments is a central component of Activity Theory. In a pedagogical context, communities of practice can be thought of as sharing a history of learning, or a learning community. Each activity is situated within a learning cycle. Learners move through activities, progressing from partial to full participation (Gifford & Enyedy, 1999; Wenger, 1999). Continuous negotiation of meaning is the core of social learning and involves two processes: participation, reification and reflection, forming a shared repertoire. The repertoire of a community includes routines, tools, words, ways of doing things, stories, actions, and concepts, that the community has produced or adopted in the course of its existence, and which have become part of its practice. Participation is the complex process that combines doing, talking, thinking, feeling, and belonging. It involves the individual’s whole person including body, mind, emotion, and social relations. Reification is the process of giving form to one’s experience by producing objects that congeal this experience into ‘thingness’ (Wenger, 1999). The collection of shared artefacts can be used by individuals in the community for further activities and to support their movement through the learning cycle as well as self-reflection and construction of meaning.

Identity within learning communities is defined by Wenger (1999) as negotiated experience, community membership, learning cycle and nexus of multi-memberships. A learning community can strengthen the identity of participation by incorporating its members’ past into its history and opening new cycles. As identity is connected to the activities in the learning cycle, it can be expressed by the artifacts that comprise the outcome of the activities. In this way, the past experiences and history of community members are reified within the shared repertoire as documents, and plans of action. Multiple memberships, involve the reconciliation of boundaries and creation of bridges across a landscape of practice. In some cases, the boundaries are reified with explicit markers of membership, for example, titles and degrees. They connect and coordinate different practices and communities. Participation and reification can create continuities across boundaries. For example, an artifact, or product of reification, can be present in different communities. At the same time, people can participate in different communities. In this scenario, learning should be primarily addressed in terms of identities and modes of belonging and only secondary in terms of skills and information. From this perspective,
experiences involving new forms of membership, multi-membership and ownership of meaning are at least as important as the curriculum itself. Social relations and interests thus play an important role in the development of a learning community.

Within communities, members join in interactions, forming groups. Members of groups go through different cycles of participation and build up a history of their own. We can consider a group as a subgroup of the larger community. The result of activities performed by the subgroups of a community is an artefact – a reification of experience. A group goes through a number of phases during its development: belonging, control and interdependence (Schutz, 1958), thus moving through common learning and participation cycles. In order to perform activities and proceed through the phases successfully, negotiate the roles and division of labor, it is crucial to provide effective group communication. Communication structures in the group are also important as indicators of the group’s power structure (Cartwright & Zander, 1968). The distribution of resources and control over them provide a clue of the patterns of relationships within the group.

**METHODOLOGY AND STUDY DESIGN**

Prior behavioral and social science studies have tended to focus on the division of labor, separating socioeconomic structures from individual behavior and agency. This makes the socioeconomic structures appear stable and self-sufficient – the actions of the individual not impacting on these structures. But this does not help us understand the deep relationship between human action and these structures.

The focus of AT, on the other hand, is on the relationship between human action and socioeconomic structures. Human activity takes multifarious, mobile and rich forms (Engstrom, 1999). AT attempts to develop a theory of a self-organizing system of interacting subjects or participants. The difficulties are that the research methods rely on both vague and concrete data.

AT addresses the apparent anomaly between vague and concrete data by identifying ‘situated action’ as an important part of its research agenda (Suchman, 1987). The notion of situated action is used to overcome the dualism of imposed structure and individual experience. Whereas prior methods focused on actions that highlight goal attainment and problem solving per se, AT reveals much of the socio-cultural and motivational basis of the forming of goals and problem identification (Engestrom, 1999). It incorporates Leont’ev’s (1978, 1981) three-level schema: activity, action and operation; corresponding with: motive, goal and instrumental conditions, and the transformations between these levels.

AT identifies discursive communication as an inherent aspect of all object-oriented activities. It unifies labour actions and social intercourse, generating a shared object action. Hence, objects (which can be words, physical objects, virtual objects, images, symbols and so on) take their meanings from the activities that surround them. Activity, action and operation can thus be seen as a simple triangular relationship (see figure 1). In the remaining of this chapter, we discuss how this model was used to frame and analyze how students cooperate with each other across different cultures using a 3D collaborative virtual environment (3DCVE) and various types of social software.
A Virtual Tower of Babel

The virtual construction of a Tower of Babel by remote collaboration in a 3D virtual environment was formed as an exercise to address the need for graduating ITC students to work in increasingly internationalized cross-cultural environments. The Tower of Babel story was chosen as a historically and culturally distant text to bring into sharp contrast differences with contemporary culture and within its own story – the confusion arising from the diversity of languages interfering with communicating a common goal. Using a suite of tools, central to which was the 3D collaborative virtual environment ActiveWorlds, students worked in teams collaborating across time zones on a single project complimenting each other’s skills and learning about new ways to work and learn in a global environment. This fostered deeper understandings of alternative meanings to everyday occurrences and work practices. The project involved students from The University of Queensland (Australia); the National Yunlin University of Science and Technology (Taiwan); and, the Norwegian University of Science and Technology Trondheim (Norway). It built on previous exercises conducted by the authors (see Wyeld et al, 2006).

The introduction of cultural interaction to the curriculum in the form of a remote collaboration exercise was made adaptable and flexible so that it reflected and respected the various local conventions of the learners involved. This was conducted in a playful atmosphere where students were actively encouraged to experiment with the tools given and cultures encountered within and across teams. This is a known approach to effective learning (Hubbard, 1980; Bourdieu & Wacquant, 1992; Dewey, 1957). This followed a process of acculturation to a new knowledge community (Leidner & Jarvenpaa, 1995), resulting in participants reinforcing and expanding their ability to comprehend new challenges, risks and opportunities. Trust was a crucial mitigating factor in cooperation between remote team partners and hence, overall feelings of control and satisfaction of the students within the exercise (Clear and Kassabova, 2005; Jarvenpaa & Leidner, 1998; Seifert, 2004; Marks et al, 2001).

A key factor in groupwork motivation for the students was addressing the need for explicit and implicit ‘meaning’ in the project – how it related to the wider world of the students’ experiences. Recognizing their own cross-cultural understandings tended to occur after the exercise had been completed and they were reflecting on it. It was then that the ‘click’ of recognition of alternate cultural understandings occurred (in Kuhn’s (1996) terms of a paradigmatic shift in understanding) that led to transformative outcomes and more culturally aware ITC professionals. The reflective reports the students prepared following completion of the exercise were central in this shift in cultural awareness.
Groups were formed with members from each institution, thus representing all 3 cultural views. Each group included a team leader who organised various forms of contact, including email, chat, videoconferencing and meetings in AWs. Explicit tasks were allocated to Australian, Norwegian and Taiwanese team leaders by the teachers. Norwegian team members were allocated the task of choosing 20 different building blocks to use in the final tower design. Taiwanese team members were required to assist in the scripting of specific functions for the building blocks such as hyperlinks, teleports, textures, animations, and so on. Australian team members were required to direct the building of towers using the allocated blocks and their scripts.

All other decisions were the domain of the individual groups to negotiate amongst themselves. Teachers only intervened if irreconcilable difficulties arose – these were rare. Construction of the tower involved the manipulation of the blocks, managed through the simple 3D AWs interface. It allowed students to move, copy, and change the type of blocks and add simple scripts. These blocks were then stacked on top of each other to create a tower. Restrictions to the tower construction included the use of only twenty different types of blocks and a maximum height that represented the limit of the AWs application (see figure 2). Various social software applications were used (videoconferencing, email, blogs and chat). Videoconferencing was essential as an initial ‘ice-breaker’ to get members of a team to start collaborating with their other, remote members. It was here that many interesting cultural exchanges took place (see figure 3).

![Figure 2. Typical construction space in Active Worlds browser showing chat field below](image-url)
Email and Blogs were used to exchange images and textual explanations. The exchange of images and serendipitous meetings in the AWs environment itself proved instrumental in overcoming some of the confusion due to text-only communication (see figure 4).

In the final performance, towers were constructed from scratch in a one hour time limit per group (3 groups constructed at the same time, hence total time for all groups was 3 hours). A number of practice constructions preceded the final construction. Towers constructed during the practice sessions were critiqued by group members and designs were continuously being
modified until considered appropriate within the constraints given. On completion of the project, students were required to prepare reflective essays on their cross-cultural experiences in the teamwork exercise.

**ACTIVITY THEORY AS MODEL FOR INVESTIGATION AND ANALYSIS**

AT was used as a framework for both organizing the exercise and to analyze its pedagogical outcomes. With AT, we could explore the notion of the mediation of the students’ activities with the given tools and communities to isolate an individual student’s actions from the collective. In this way we could transcend the apparent oppositions between activity and process, activity and action, and activity and communication. Engestrom’s (1999) simple triangulation of an individual’s activity system (see figure 1) can be expanded to formulate a structure for the more complex group activity system (see figure 5).

As a collective system, the subject in this case is not the individual per se but the group that the individual identifies with, the subgroup of the larger collaborative community in general. The object is what connects the individual’s actions to the collective activity. The projected outcome consists of important new objectified meanings and lasting patterns of interaction. It is the “projection from the object to the outcome that, no matter how vaguely envisioned, functions as the motive of this activity and gives broader meaning to the individual’s actions” (Engestrom, 1999, p31). The rules are largely tacit conventions of exchange, and the division of labor consists of multiple layers of fragmented and compartmentalized tasks within the project structure.

![Engestrom's (1999) triangulation model for a group activity system.](image)

This model was used to move from the analysis of individual actions to their broader context within the group collective and back again. Actions involve failures, disruptions and innovations normally difficult to explain at the level of the actions themselves. At the broader level however, the contradictions that give rise to these failures, disruptions and innovations can be illuminated. The model highlights the interrelationships between subject community and communicative relations as an integral aspect of the activity system as a whole. In turn, these systems interacted with other activity systems (go-betweens, internal, one-to-one and so on).

From this model, we saw that, over time, externalization (of an individual’s internalized creativity contributing to the group as a whole) tended to dominate. On the other hand, internalization of the collectives’ rules was requisite for socializing and training students to become competent members of the joint activity. From here, discrete individual innovations could
feed externalized creativity. But this was not without its disruptions and contradictions by other members of the group. When this happened, it was the critical self-reflection on these external forces which is where the search for solutions occurred. Only when these were resolved could a new model for the activity be fully externalized and thus realized or implemented. Once stable and accepted by the group, the individual returned to their internalized innovative thinking and the cycle repeated. It was in these cycles that learning and development occurred.

Engestrom (1999) tells us that such activity systems represent the collective voices of a group; that, expansive cycling of learning and developing, identifying problems and solving them, is a constant reorchestration of these voices – the different viewpoints and approaches of the various participants. Its historicity is contained in identifying the past cycles – precedents which informed current or future understandings. Hence, these collective, historically situated voices, can be seen as complementary competencies within an activity system. Based on this model we were able to move from identifying the role of the individual and the individual as a member of a subgroup to the collective whole – the explication of the components and internal relations of the collective activity system revealing patterns of interaction.

**Patterns of Interaction**

The Babel project represents a social setting, circumstantially framed by the Babel story and its collaborative reconstruction in a 3DCVE. It involved three different universities on different continents across different time zones. These are institutions that cooperate with adult students, and specific external bodies (academic and commercial). Hence, several simultaneous social worlds or frames are operating:

- the project required participants from the 3 different institutions to cooperatively construct an imaginary Babel tower;
- the teaching staff from the 3 different institutions cooperated with each other towards a common pedagogical goal; and,
- an essential aspect of the whole enterprise was mutual collaboration between all teaching staff and students, and students and students.

This mutual collaboration can be interpreted as the merging of two activity systems: pedagogy and cross-cultural understanding (the pedagogical motive). They had a common object: training ITC students in cross-cultural understanding. Interactions between collaborating students took place in a university setting, home, and other, with the guidance of the teaching staff. Space and facilities were provided for the activities, time was set aside for assistance, a program was developed and the students were expected to follow it. From the students’ point of view, their role was dictated by circumstances. They could not choose who their peers were and the time they could construct their interactions – due to time zones and other scheduled university responsibilities. Hence, some common objects were a problem for both the students and teachers alike. These manifest themselves as conflicts, difficulties or technical flaws. In such cases, the teacher had to intervene. Hence, the co-construction of common objects was not always seen by all students. The students could see the teachers as outside their activity system interfering with their interactions. Yet, students’ interactions took place in a social situation created by the teachers. Hence, any withdrawal from the interactive situation by the teachers did not necessarily eliminate their influence through the mediation of the social setting.

The students’ interactions can be mapped as a collective Endeavour constituted by the two activity systems of pedagogy and cross-cultural understanding. The co-construction of a common outcome was the result of the merging of institutional knowledge and student knowledge which
evolved through the realization and implementation of the project (see figure 6). Various groupware applications were used to facilitate the collaboration (AWs, videoconferencing, email, blogs and chat). These are the mediating artifacts of their cultural exchange activities (see figure 7). These artifacts of mediation provided a conduit for cultural evolution within the system. The specifics of which depended on the institutional contexts. We were working with our students within their activity and the history of the activity itself. This involved a ‘within-context’ and ‘between-context of the interactions as constitutive of the activity itself’ approach. In so doing, we were able to link theory with practice. At the individual level, we can see the role of one of the mediating artefacts, email, as a microcosm of the greater exchange (see figure 8). The subject was the need to communicate information, represented as both goal and motive. The object was the need for a response to the request for information, which is also represented as both goal and motive. The outcome of this exchange was a shift in understanding.

Engestrom’s (1999) activity system as a model for investigation and analysis proved useful in terms of isolating the individual’s actions from the collective yet retaining the context of those actions as a part of a whole. Contradictions in the system manifest as disruptions, interference and innovation. As a mapping exercise, it was possible to see the students’ patterns of interaction as part of a collective voice. The impact of this collective voice, while always present, was most recognisable on reflection – an important feature of the pedagogical benefits of such exercises is getting students to reflect on their own understandings and recognise the shift to new understandings an the role of the tools employed to do this.
Figure 6. Using Engestrom’s triangulation to map the common outcome of the merging of two activity systems (pedagogy and its motive: cross-cultural understanding) from two different knowledge bases: institutional and the students'.
Figure 7. Array of mediating artifacts and their forms of communication used in the students’ cultural exchange activities

Figure 8. The role of email as a mediating artifact in the exchange of information resulting in a shift in understanding
DISCUSSION

Following the AT model we are able to identify the constitutive elements of the individual’s actions within their subgroup actions within the whole collective. A central feature of the Babel project was the playful nature of the interactions. As ostensibly a socialising activity, play was an integral part of the pedagogical motive for getting students to engage in the task (Dewey, 1957; Schon, 1983). The exercise was couched as an opportunity to meet and play with fellow students from other institutions its seriousness was in the pedagogical goal of inculcating cross-cultural understandings. This was background in favour of semi-structured tasks in a game-like environment (the 3D AWs interface). This was also manifest by the sorts of activity structures that emerged from the exercise. The nature of the interchange was predicated on the role of the students’ (actors’) prior knowledge and history of the text used. Within the process of revealing their prior knowledge and history they were able to establish constructive identities within their subgroup and the collective as a whole. This can be understood as part of Engestrom’s (1999) expansive learning cycle – the role of tacit and explicit knowledge, witnessed as a shift from abstract to concrete understandings.

The Structure of Activity

AT tells us that activities dictate what a person does and the environments they find themselves in. In activity, actors take into account the laws and rules of the collective. When we listen to the actors’ stories we begin to understand the meanings they attach to their activities. Using AT to analyse what students said and did, we got a better idea how new meanings emerged through their group activities. We had many opportunities to do this throughout the project (online, emails, unstructured interviews and reflective essays).

We found two basic processes were operating continuously. The internalisation and externalisation of their activities. The internalisation of their activities was related to the reproduction of their prior cultural understanding of the tasks at hand, and externalisation was the creation of new artefacts making possible new transformations in understanding (Engestrom et al, 1999). Individuals acted in collective practices, not reducible to sums of individual action, but more like a string of goal-directed acts.

From this, the structure of their activities began to emerge. We can think of the difference between activity and action as the difference between the project and the individual’s role within the project. The gross activity was the project, while the actions of the individual may have been peripheral to the outcome (Leont’ev, 1981). It was the purposeful change of natural and social reality that was being acted out in the specific form of a societal existence or activity (Engestrom et al, 1999). The goals of the activity manifest itself as visualisations of an end product of a collective creative effort (a virtual tower of Babel). Transformations in understanding occurred when the individual saw the nature of their purposeful activity in light of its social and historical context – when they reflected on their activity. Thus, activity determined the individual’s social being, and collective social laws were revealed through their activities. Hence, transformations in understanding occurred when they recognised the essence of their prior understandings and altered them.

We can define the structure of their activity as including needs, motives, goals, actions, operations, and the means to solve a problem. This involved perception, imagination, memory, thinking, feelings, and will. The products of their activities helped concretise their perception and
thinking. It was in this concretisation, in the product or artefact of their creativity, that solutions and methods for solutions to sensory or cognitive problems were found.

Each type of activity had definite needs, motives, tasks, and goals. A morphological model of their structural interrelationships could be developed from the particular context of the activity. The individual or collective ‘ideal’ manifestation of the activity was the object or artefact created, revealed through group dialogue on values, perceptions, beliefs, likes, dislikes and so on (Davydov, 1999).

The Role of Play

Play was an integral part of their social interaction. It allowed for a subjective reflection on the reality of the task at hand. As such, creative activity gave new meanings to their actions and objects (Engestrom et al, 1999). It provided for risk-free interaction between members of the local and extended groups. Learning communities benefited from play as a pedagogical motive in that rules, activities and outcomes were easily recognisable by all. The serious component of play was the subsequent revelation of new meaning and transformative outcomes on reflection.

Their motive for play was not conscious, although the rules may have been explicit. Students were able to master new ideas and engaged in more advanced actions than are normally possible through their play. Play raised the demand on the students, bringing them into Vygosky’s (1978, p86) zone of proximal development, defined as

the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers.

New knowledge, skills, and actions appeared through their play activity. Play changed the situation and through this change new content emerged. In play, students moved from unconscious motives to conscious motives. Role play helped students become conscious of their own role in an activity and master new forms of play, with rules. In planning for play, decisions were formulated verbally, in drawings, diagrams and other models. Such models helped students with self-esteem, awareness of their own role in the collective, and encouraged reflective thought (Davydov, 1990).

However, motives did not always correspond to goals in play. Some players simply adjusted themselves to the circumstances they found themselves in rather than connect with others around them and made the necessary shifts in understanding. In this case, the student concerned felt the context went beyond their zone of proximal development (more than they wanted to engage in). This was displayed in the way they tended to wait for other students in their group to take the initiative.

In play, students reflected their own life experiences and took independent initiatives. They ‘played up’ to each other and made use of the challenges they were confronted with. They brought each other into the zone of proximal development. The play drew on the students’ pre-existing interests and motives, and first-hand experiences connected with the task at hand. Such organised play contributed to the development of qualitatively new understandings and meaning structures in the students’ psyche and activity which continued after the exercise was completed (Engestrom et al, 1999, p232) (see figure 9).

We found play was intrinsically motivating because it was internally rewarding. Socially situated play was a social activity that expressed relations between peers. Through the guidance and collaboration with their peers, cooperating students raised their actions to a more advanced
level initiating new processes of development, through which new knowledge, skills, and actions appeared (Vygotsky, 1978).

![Mapping 'play' as an activity system](image)

**Figure 9. Mapping 'play' as an activity system**

**The Role of Text**

We found individual acts were abstracted out of whole social acts (Mead, 1938). For example, serendipitous meetings in the 3D AWs environment led to individual feelings of contribution to a whole, particularly if prior collective misunderstandings were resolved through the individual’s actions. Hence, the study of small groups and their internal effectiveness was useful revealing the local, idiosyncratic, contingent, nature of action, interaction and knowledge. It uncovered local patterns of activity and cultural specificity of thought, speech and discourse (such as the misunderstandings of specific words used in different contexts). To make a connection to the greater structure of the collective within which they fell, we recognized that the localized activities, by their very nature, drew on historical contexts common to the collective as a whole. For example, different conversational ‘tones’ were attributed to different cultural expectations of acceptable individual behavior in a local context not always understood by the other’s culture. The overall network provided for the movement of these novel cultural artifacts which were recombined in new ways. This resulted in individuals solving problems using general means created by other team members applied in new contexts (Latour, 1994).

Within the intersubjectivity of knowledge and concepts represented in their discursive practices, meaning was essentially collective. As such, an individual’s questions and judgements were initially framed by their own cultural state of knowledge – understanding the meanings of words in their cultural contexts. For example, the use of the word ‘fit’ in the Australian context had different meanings in other cultural contexts. In Australia these included: ‘physically fit’ (going to the gym), ‘a good fit’ (the way a nut fits a bolt) and ‘fit for the job’ (suitably competent), among others. While these were often understood also by the other cultures present, the specific exchange context in which they were uttered did cause some inter-cultural confusion. Hence, meaning had to be embedded in the typified action sequence to be understood – going to the gym, screwing a nut onto a bolt, or being assessed for job suitability. This is where the text-rich chat interface, used extensively for communicative purposes, did not always support the sorts of tacit understandings more common in face-to-face communication (see figure 10). It follows that, students acquired and handled knowledge in ways that were partly culturally universal,
partly spontaneous, and partly internalized notions of a self culture. Students had trans-cultural experiences and others that were products of enculturation to a local or shared culture also.

Figure 10. Typical online chat interfaces used extensively for real-time communication between remote team members

Vygotsky’s (1981) heuristic framework was used to research these multifarious forms of intercultural discourses and shared conventions. This was useful in making sense of the sociocultural processes involved, situated within specific sociocultural contexts identified by Bruner (1986). Even within local contexts, the intersubjectivity of understandings could be seen. For example, teachers and learners were not equal in their understandings of all situations. They learned from each other. The teacher-learner dynamic, in hypothetical and critical thinking activities, was a discursive activity in which the teacher’s job was to try to provide the students with worthwhile socio-semiotic activities. Under the Vygotskian framework, it was the intertextuality of exchange where the focus on the production of new personal meanings was achieved. Constructing the exercises within the text provided (the Babel storyline) was one way of allowing students to subjectively collectively reinterpret both the text and their textual communications about the text (Davydov, 1988).

Not only were new collective meanings fostered and enriched by this but, students’ self-identity development was influenced by the refraction and reconstruction in these socioculturally mediated joint interactions. Students did not create new, meaningful images of the world from scratch, rather they built on pre-existing ones, and these shaped how their activities proceeded. Their prior understandings of the Babel story fed their natural inquisitiveness and need to debate the issues raised as a raison d’être for communicating with their remote partners.

Students drew on their constructive social relationships for this personal growth. This was both selective and socially oriented. In terms of the pedagogics of collaboration, cooperation as a learning task depended on inter-individual interaction involving explicit transactions and negotiations (Amonashvili, 1984). Students were confronted with alternative views of the world which led to better understanding of their own beliefs. Students introduced to the activity of shared meaning construction in which pre-existing sociocultural canons played a central role, was
used as a didactic model to challenge their pre-held cultural perspectives. Hence, productive learning was essentially a multi-perspective activity including the belief systems of the students in question and the historically constructed representations of the given sociocultural content – the virtual construction of a tower of Babel and what this meant to them specifically and generally.

To concretize this concept, the historically culturally distant Babel story was useful. Students contemporaneously re-contextualized the text and defended it publicly (in a playful format). As such, their prior didactic understandings were challenged. The outcome was the establishment of a new personalized mode of communicating their new intercultural knowledge of the world to each other and better understanding their own beliefs.

Engestrom’s Expansive Learning Cycle

Analysis of work, within and between teams, involved detailed insights to the discursive processes, practical actions, and mediated artifacts employed in a step-by-step production of innovative solutions or ideas (Argyris and Schon, 1978). Using AT, we found this approach was well suited to analysis of innovative learning in work practice for three main reasons:

- it was contextual and thus inclusive of historical and local practices, their objects, mediated artifacts, and social organization;
- it focused on the creativity potential of their cognitive understandings; and,
- it helped explain qualitative changes in their practices over time (Engestrom, 1999).

We recognized the two main types of knowledge activity in their team work as tacit and explicit. Following Lektorsky (1984, p380-381) we saw:

human cognition and behaviour as embedded in collectively organised, artefact-mediated activity systems. Activities are social practices oriented at objects. An entity becomes an object of activity when it meets a human need. The subject constructs the object, singles out those properties that prove to be essential for developing social practice, using mediated artifacts that function as forms of expression of cognitive norms, standards, and object-hypotheses existing outside the given individual. In this constructed, need-related capacity, the object gains motivating force that gives shape and direction to activity. The object determines the horizon of possible actions.

From this we found, the object of their activity was not the goal itself. Actions proceeded from their goals. They had beginnings and ends. However, their activity systems evolved from historically situated social cycles making their beginnings and ends difficult to determine. Hence, goals could not be used to explain their actions as they emerged concurrently and could only be explicated on reflection (in their reflective essays and interviews).

Their goals emerged from their team action through their internal representations externalized by their speech, gesture, writing, and physical means. The artifacts of their creative activities were used to identify objects that they built with (such as the elements of the tower itself), but they were also used as a symbol of cooperation (how high, large or resolved was theirs compared to others?). This was recognized on reflection. The goal of the building element was not a symbol of status. However, in the activity of a struggle for recognition in the wider community, the elements were often appropriated as a symbol of their status within the greater activity.

It was in reflecting that they moved from abstract to concrete conceptions of their own activities. Engestrom’s (1999) expansive learning describes this process. An object first takes form as an abstract concept. This can be traced through its historical formulation. This is concretized in an expanding learning cycle from the simple to the complex idea and finally transformed into a concrete object and new form of practice in its production. The expansive
cycle begins with the questioning of existing practices, and evolves into a collective movement or instituted practice (Latour, 1987). Such epistemic or learning actions facilitate the move from the abstract to the concrete. They form an expansive cycle of epistemic actions involving: questioning, analyzing, modeling, experimenting, implementation, reflecting, and consolidating (Engestrom, 1999) (see figure 11).

The process of their expansive learning as a team can thus be understood as construction and resolution of successively evolving tensions or contradictions in the complexity of the activity system they were engaged in. It included the object of their endeavor, the mediating artifacts that brought it to fruition, and the reflective perspectives of the various participants. The various large scale expansive cycles involved also smaller cycles.

![Figure 11. Engestrom's (1999) expansive learning cycle](image)

**CONCLUSIONS**

According to Vygotsky (1981, p161), “the analysis of reality on the basis of a concept emerges much earlier than analysis of the concept itself.” We observed this where participants engaged in successful goal-directed activities yet experienced difficulty in communicating the strategies and concepts that underpinned their actions. In their reflective essays and recorded chats, they were required to explicate what they were doing and communicate this to others. This need to reflect upon their activities and communicate it to others was one of the major educational benefits of the system in place, promoting deep learning and self-reflective development in cross-cultural understandings and self understanding.

By incorporating AT as a framework to guide the formation of the remote collaboration exercises and their subsequent analysis, two goals were met: pedagogical justification for inclusion of remote collaboration exercises in the curriculum and a method for its framing. Although not as widely adopted as a method for pedagogical direction or analysis as Guba and Lincoln’s (1981; 1998) constructivist method – AT is more familiar to workplace analyses – AT provides a rigorous methodology and clear guidelines for qualitative understanding of pedagogical activities. With the specific task of ascertaining the effectiveness of shifts in cross-cultural understandings – a valuable attribute for graduating ITC students – we found AT instrumental in its revelations. The simple triangular mapping of subject, object and mediating artifacts resulted in definable outcomes. This was consistent at the level of the individual, group
and collective alike. It was a useful resource for better understanding learning communities in general.

REFERENCES


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