A cultural historical activity theory [CHAT] analysis of technology integration:
Case study of two teachers

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Abstract

Classic research methods are ineffective in capturing the dynamic relationships among users, technology, and outcomes for technology integration research. Cognitive research attempts to eliminate environmental variability and test for recall and transferability of knowledge representations. Such approaches lead to arguably ineffective measures of learning. Activity theory provides a holistic framework to investigate relationships among the elements present in a technology integration activity. These research approaches are compared. A CHAT framework is suggested as an appropriate structure for analyzing technology integration efforts. This approach focuses on the dynamic relationships among individuals, goals, tools, community members, and mediating factors that are the elements of any human activity. An example of this framework in practice is presented. A research model generated from applying CHAT approach is proposed.

Introduction

As educational technology has become more prevalent in educational settings, research efforts have increased to study technology's uses and impacts. Although by nature technology is a tool used within human activity, the traditional research approaches tend to focus only on the user of the technology, specifically outcomes as a result of using technology (Matheson et al., 1999). In an attempt to eliminate the variability of the environment investigators ignore or control for key elements of the activity itself such as historical background and motivations of the subjects, the technology's role in achieving goals, and relationships among others within the activity. Activity theory is a socio-cultural and historical lens through which human activity systems can be holistically analyzed (Engestrom, 1999; Jonassen & Rohrer-Murphy, 1999). This approach focuses on the interaction of human activity and human thought within its relevant environmental context. Since learning is not a precursor to, rather it emerges from activity, research should attempt to examine the individuals(s) involved in the activity and activity elements such as the product of the activity, mediating tools, community members, and guiding rules while the individual(s) is/are acting on and attempting to produce an outcome. This paper provides a comparison of CHAT and traditional cognitive research methods and an example of how CHAT was used to analyze the impact of a technology integration intervention. A research model generated from this project is also proposed and discussed.

Brief Overview of Activity Theory

Activity theory adds value to assessment processes in that it suggests that the combined foundational elements of an activity are the unit of analysis that represents the minimum elements of an object-oriented, collective, and culturally mediated human activity (Engestrom, 1987). It is the internal tensions and contradictions within and among the elements of a human activity that lead to the transitions and transformation of knowledge. The basic elements of an activity include subject, object, tools, community, rules, and division of labor (Engestrom, 1987; Kuttii, 1991; Kuttii, 1996).

The main focus of any activity is in the production of an outcome (object), physical or mental. The subject, an individual or group, determines that there is a need or motive to fulfill, the object. Using the tools (e.g., technology, training, conceptual ideas, people) the subject moves toward accomplishing the object.

The community members set rules and norms under which the subject operates and establishes how the community members organize (division of labor) to meet goals. All of the elements influence the others and are influenced by social, cultural, and historical factors, such as background knowledge, personal bias, availability of tools, and other factors. Each individual activity is also affected by other surrounding activities that may have

a primarily tool, community, rule, or some other activity element focus. Thus, activity has motive and is complex, dynamic, historically-driven, and transforming. See figure 1.
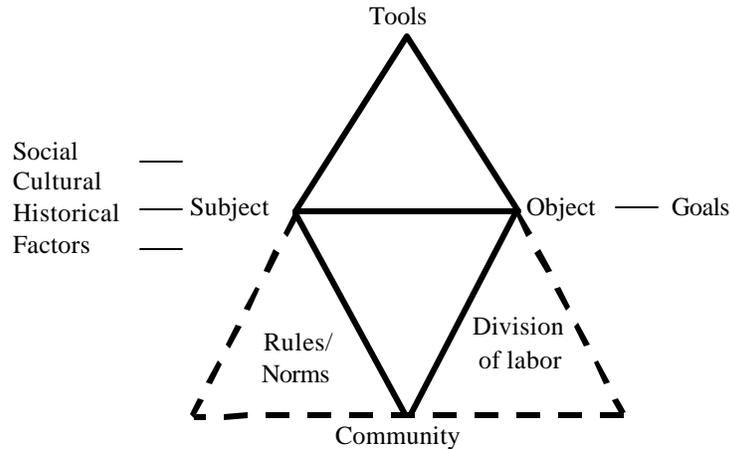

Figure 1. Activity Theory framework

Comparison of Traditional Cognitive Research and CHAT Paradigms

      Traditional cognitive research paradigm. It is argued that most educational research focusing on cognitive development (learning) takes a narrow view that does not represent the true complexity of the learning process (Gay & Bennington, 1999). Learning is defined as a change in schema precipitated by sensory reception and active manipulation of new information until new information is memorized, stored, and readied for recall in existing mental structures (schema). During this type of research there is a struggle to reduce the environmental variables in the study environment that influence the hypothesized cognitive changes so that findings can be generalized to specific treatments or environmental variables. Such research has included investigating outcomes measures like attitudes toward use of technology in the classroom (Koszalka, 2000; Koszalka, 2001), teachers' views and beliefs of technology related to teaching practices (Dexter, Anderson, & Becker, 1999; Honey & Moeller, 1990), and teacher (e.g., skill level) and classroom factors (e.g., access) as predictors of technology use (Becker, 1999). This approach generally attempts to control the multiple factors that may have influenced, and are currently influencing, change and structure of knowledge (Mathison et al., 1999). See table 1.

      Cultural historical activity theory research paradigm. In an activity theory approach each activity is analyzed as part of the collective and with a social-historical context of the individual and the collective, thus CHAT. This approach requires, at minimum, a shared understanding of the character and history of the subject, the object unto which the individual is attempting to reach, the characteristics of the surrounding community, and the tools available to the subject. The focus of the analysis is on the interaction of human activity and the whole of the individual's mentality as they interact within a relevant environmental context. Activity theory is thus a framework for understanding the totality of human activity in context (Bodker, 1991).

Traditional cognitive and CHAT paradigms hold different points of views toward research related to human learning. Each suggests differences in the how they define (i) learning (ii) technology's role (iii) assessment focus (iv) assessment context (v) evaluator's role and (vi) data collection context. Those who use traditional cognitive paradigms believe that learning is a permanent change in schema that occurs through assimilating and accommodating external information into schema. During the learning process, technology provides the information that the learner acquires. Thus, this paradigm assumes that improving technology use can result in the facilitation of learning. Assessment research focuses on the changes in the subject as a result of using technology. Refer to Table 1.

      The CHAT paradigm argues that learning is a process of constant interaction with the environment and others. Knowledge is constructed by individual learners, building on existing historical experiences, within the learners' context. Technology is a mechanism to actively engage learners in the learning process, the use of technology is influenced by the rules of and interactions with the community, and it is a tool that mediates learning activities with which to construct individual knowledge. Thus, the CHAT paradigm assumes that outcomes (knowledge) are constructed by interaction within an activity among users, technology, and environmental factors all within a context. CHAT assessment research therefore focuses on understanding the interaction process of the activity within the naturalist environment. Thus this research provides a more holistic

description of the knowledge construction activities.

Table 1. *Comparison* of traditional cognitive paradigm and CHAT paradigm*

	Traditional Cognitive Paradigm	CHAT paradigm
Definition of learning	Learning is permanent change in schema (assimilation and accommodation to existing memory structures). Knowledge is transferable from one individual to another.	Learning is a process of constant interaction with the environment and others. Knowledge is constructed by individual learners, built on historical experiences, within his or her context, knowledge is not transferred, rather it is constructed differently in all individuals
Technology's role in learning	The technology provides information by simulating the initial sensory perception in users' cognitive process and provides mechanisms with which the user can manipulate, organize, and represent information in ways that will prompt memory storage	Technology provides user with mechanisms to actively engage in the learning process, access multiple forms and perspectives of information, think critically, communicate during inquiry, and engage in other activities with which to construct own knowledge.
Assessment focus	Technology itself -- the evaluators are dedicated to improving the technology because they believed improvements in the technology will result in the high quality learning outcomes.	The interaction between users and technology -- the evaluators are dedicated to understanding and creating better interaction between technology and users because they believe that outcomes (knowledge) are constructed by an interaction among user and technology.
Assessment context	Assessment is conducted within the control environment, excluding any factor other than technology itself, reduce environmental variability	Assessment is conducted within the natural environment (same context as if the user were using the technology 'at work,') considering users' social-cultural, historical, and technology background.
Evaluators' role	Outsiders to objectively judge the evaluation results.	Facilitators in the assessment process and interactions among user and technology.
Data collection context	Controlled environments and interventions. Data collection techniques are used to gather information based on self-reports and participants' recall. Talk–alouds are used to gather data on the users thoughts during technology use (no interaction with evaluator)	Data collection occurs within the naturalist environment, using technology as a collection tool. Web logs, interactive talk-alouds, observations of technology in practice techniques are used to collect data on the natural interaction between technology and user.

* Adapted from: Matheson et al., 1999

A Case Study of CHAT to Investigate Technology Integration

Research Context

      The *Initiative to Develop Education through Astronomy and Space Science* (IDEAS) project was initiated to promote enrichment of science, mathematics, and technology education through the use of NASA's

mission-based, technology-based astronomy and space science research resources. The object was to help K-12 educators (subjects) develop computer technology integration skills and integrate NASA space science and astronomy web resources into their classrooms to enhance teaching and learning. As such a teacher academy was developed to (1) immerse educators in astronomy topics, (2) expose teachers to NASA space science and astronomy web resources, (3) train teachers in computer technology integration techniques, (4) help teachers develop strategies to reduce barriers for computer use, and (5) provide teachers with time to create lessons that integrated NASA web resources into their classrooms. The 4-day academy was followed by 2-years of observation and follow-up support for the first cohort and 1 year of follow-up for the second cohort, from which the data were collected on classroom environment, teaching strategies, NASA web resources use, and technology integration practices.

CHAT was used to both inform and create a research framework to facilitate collections and analysis of the data. See figure 2. For example, the CHAT framework helped to identify the factors that were measured including previous training and experiences of the subjects' before participation, interactions with peers and administrators during technology implementation, established policies and support structures for teaching and technology, and changes in availability of technology and curriculum resources throughout the data collection period, to name a few.
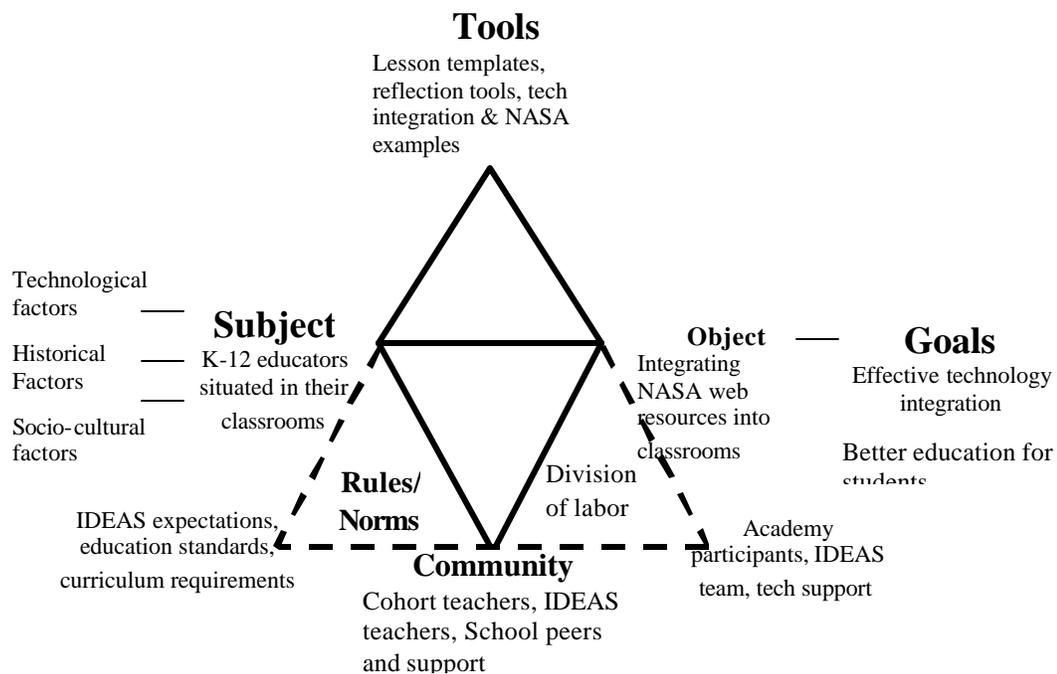

Figure 2. CHAT research and data collection framework

Methods

Research Questions

The following research questions were investigated using a case study approach:
1. How did teaching methods, technology integration strategies, and use of NASA astronomy and space science resources change over time?
2. What elements of the academy affected educators' teaching methods, technology integration strategies, and use of NASA resources overtime?

Subjects

The participating educators were from schools within an urban school district in upstate New York. School administrators were asked to help recruit middle and high school science and math teachers, of which the subjects volunteered to participate. In the first year 7 educators participated. In year 2 there were 11 new subjects from the district. The teachers were required to have at least 3 years science or math teaching

experience, basic computer and internet skill, and access to an internet-connected computer at school.

Data Sources and Analysis

Five sources of data were collected on each of the educators during the academy and in follow-up observations in the classroom: (1) initial background survey, (2) workshop evaluations, observations, and feedback, (3) classroom observations and photographs, (4) mid-year survey and (5) on-going interviews. The surveys probed for attitudes, perceptions, practices, and demographic information of the teachers. The observations focused on classroom environmental factors and teaching practices including technology and resources use, teaching methods, and classroom events. The interviews were used to solicit feedback on teaching technology, and resources uses and issues, as well as teachers' thoughts, ideas, and explanations of their practice. The researchers collected data both in the etic (as the outsider) and emic (engaging with the teachers and students in the classroom). These data points were used to identify the trends of changes in teaching and technology and NASA resource integration.

Quantitative data were organized to describe of the entire group of educators. The complete set of data was analyzed to identify interactions among the teachers, tools, community, and objectives identifying trends on both individual and group levels. Data regarding the educators' teaching methods, use of technology, and use of NASA web resources were tracked using a time series approach to capture temporal changes. A profile for each teacher was created and used to identify resulting themes.

Results

The two cases presented here were chosen from a representative sample of educators who participated in the initial year of the project. These two cases were selected based on maximal variety of participants' responses to the initial survey. The two cases described in this paper were selected to represent the extremes of teaching experience and web use. See Table 2.
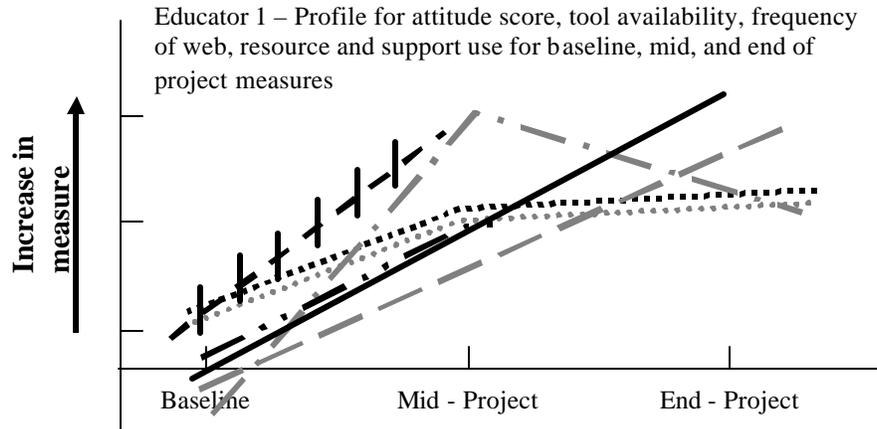
Table 2. *Baseline demographics for first year participating educators.*

Educator	Initial Attitude score (-30 to +30)	Teaching exp.(<5 yrs / +5 yrs)	Self-rated computer expertise (low to experienced)	Self-reported web use (lesson prep, in class)
1*	-8	+5	Experienced	Weekly for prep/class
2*	10	< 5	Low	Rarely for prep only
3	19	+5	Intermediate	Monthly for prep/class
4	12	+5	Intermediate	No data
5	10	+5	Low	Monthly for prep/class
6	24	+5	Intermediate	Weekly for prep/class
7	23	<5	intermediate	Monthly for prep only

* educators included in comparison.

Educator 1 profile

Educator 1 participated in the project for two years. She taught 6th grade science for more than 5 years. She spent more than 60 percent of time teaching science and less than 20 percent of the time on mathematics topics. Teacher 1 self-identified her primary teaching strategy as inquiry and indicated that she also uses hand-on activities, collaborative work, and problem-based learning regularly. In the baseline survey, she rated herself as an experienced web user, holding a slightly negative attitude toward web use in education (-8 on a scale of –30 to +30). Data collected during initial observations indicated that her classroom environment contained one computer with web access, a printer, instructional TV, and an overhead projector. She indicated that she often used the computer and web to search for school-related information and to prepare lesson weekly, however rarely used technology in the classroom with students. See figure 4.

Educator 1 – Profile for attitude score, tool availability, frequency of web, resource and support use for baseline, mid, and end of project measures

KEY

Data	Scale / *Scores or Level*			Graph Symbol
	Baseline	**Mid-project**	**End project**	
Web use attitude **Score**	-30 - - - - - - - - -0 - - - - - - - - - -+30			–|–|–
	-8	*15*	*NA*	
Tool available in the classroom	Low	→	High	
	Computer	Computer	Computer	
	Internet	Internet	Internet	
	Printer	Printer	Printer	▬▬▬▬
	Overhead	Overhead	Overhead	
	TV	TV	TV	
		SMARTBoard	NASA web	
		NASA web	resources	
		resources	Web-based	
			reflection tools	
Level	*L*	*M*	*H*	
Frequency and purpose of web use	Low	→	High	
	less than monthly		daily to	
	primarily to prepare		prepare lessons	•••••••••••
	lessons		and use in class	
Level	*L*	*M*	*M*	
Strategies for technology use	Low	→	High	
	None	teacher use	students use	
		to present	during learning	∙∙∙∙∙∙∙∙∙∙
Level	*L*	*M*	*M*	
NASA resources used	Low	→	High	
	None		many types	– – –

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Level	L	M	H	
Amount & types of support	Low	→	High	― · ―
	No support…………………………frequently from IDEAS team			
Level	L	H	M	
	No support…………………………frequently from school sources			▬ · · ·
Level	L	M	M	

Figure 4. Trends for educator 1

Educator 1's frequently communicated with the IDEAS support team and other educators from the academy to share teaching information from the project and her new ideas for technology use. In addition, at her request, the IDEAS support team provided her with a portable SMARTBoard and projector and technology support to operate these new resources, additional NASA web resources for specific science topics, reflection tools to help her think more about how to use such technologies, and use of the IDEAS online lesson plan templates. She also shared examples of the lessons she created as a result of year 1, NASA resources and web resources she found most useful given her teaching objectives, and examples of student projects that were produced from her classroom with the year 2 participants.

The two-year observations, summarized in figure 4, indicated several changes throughout project participation. She developed higher attitude scores, used NASA tools and resources more frequently, and made changes in her teaching methods and the types of resources she used in her classroom over the two years. There was an increase in the number of NASA posters and other resources used to 'decorate' her classroom and that she used to engage her students in activities and discussions. In a final debrief educator 1 reported that she now begins all web searches, to support any science topic, at the NASA search site. Although rarely using this approach before participating in the IDEAS project, teacher 1 also began incorporating web resources more regularly into her teaching and engaging her students with the web to support their learning.

Educator 2 profile

A similar profile was created for educator 2, showing his activities within the academy and classroom and how his teaching, technology, and NASA resources practices and uses changed over time. These data also provide evidence of the factors within the activity may have influenced noted changes.

Summary of Results

Many changes were observed in both of the subjects with regard to teaching, technology, and NASA resources practices. These changes, and lack of changes, were traced to historical and activity factors from the academy and classroom environment. Factors included development of new knowledge of strategies and resources gained during the academy, project and school support mechanisms and resources, curriculum requirements, peer collaborations and support, sharing of ideas within and outside the subject cohort, classroom contextual factors such as room layout and technology access, school policy such technology rules and regulations, and teachers' personal perceptions, attitudes, and experiences.

Discussion

The data collected was rich and full of illustrative stories that explained emerging patterns and how these teachers interacted with the resources, community, and objectives for which they were striving. Many examples described how teachers helped each other, reorganized their classrooms, accessed new technologies and resources they had not previously thought about, worked through issues of educational technology union rules, identified new support resources at their schools, and generally changed the way they were thinking about teaching and resources use. These two educators for example, similar to the other participating educators from both years of the academy, began to make changes in their teaching, technology, and NASA resources use strategies. The academy itself, and follow-up support, seemed to have set off a variety of activities and interactions that supported, or perhaps influenced, these educators' changes over time. Four main themes emerged: teaching methods, technology integration, NASA resources are rich sources on information, and NASA resources as technology-based resources.

Theme 1 - movement toward more student-centered methods. The most commonly used (reported and

observed baseline) teaching methods prior to the academy were presentation and hands-on methods. Both inquiry and collaborative learning emerged after the academy in both of the studied classrooms. Both teachers began to use inquiry to prompt students to associate current events, daily life, and their experiences with new concepts. In addition, the educators prompted the students more to define important concepts and rephrase their understanding of the content in their own words. These inquiry sessions were often accompanied with discussions on examples of NASA scientists at work, for example why it was important for NASA mission scientists to understand weather topics, communicate during major projects, and use similar metrics. Thus the use of the new resources and technologies seems to have had some affect on the methods the teachers began to use to further engage students in the classroom.

Theme 2 – movement toward technology enhancements. These educators did not have the same technology available for use in their classrooms, yet both used the web to help them prepare for lessons. The data indicated however, that both also began to use technology as a media to present content and gather and print teaching resources. The web was used more often at the end of the project by both educators to search for additional resources that would be used to support their teaching and as a presentation, prompting, or exploration tool in their classroom.

Theme 3 – inclusion of 'richer' information resources. Both educators began to use NASA resources in three ways: teaching resource (supportive of presentation, inquiry, activity), motivational classroom decorations (supportive of explanation and inquiry), and as a sharing tool with peers (sharing new resources and lesson ideas). They incorporated more illustrative (pictures) resources in their teaching approaches to help students visualize content. They both began to use NASA resources and websites more frequently, including lesson plans, information related to the content, and vocabulary, when preparing to teach. Both educators also shared several web resources with peers and students across the school district.

Theme 4 – engaging with technology resources for teaching and learning. Both educators, provided with the NASA resources and technology by the IDEAS project, were motivated and increased their use of NASA resources and technology into their teaching. The NASA resources enriched both teachers' access to scientifically accurate resources and their teaching methods. Additionally, both teachers made use of more technology to aid in their searching and preparation activities and in presenting information and activities to students.

The technology integration efforts resulted in a complex process of interactions with tools and community members. The use of computer technology and NASA resources seemed to provide motivational context for many topics from studying weather and measurement to creative writing. Many of the new ideas were inspired by examples presented in the academy or from collaborations with peers and the IDEAS support team. Yet, as illustrated by these two different educators one engaged a great deal with the IDEAS team and the other only slightly to allow classroom observations and brief interviews. Therefore, the influence of the IDEAS academy and personnel may not be the major factor in the changes observed. Introduction to the content and resources of technology integration models and NASA resources and the characteristics of the teachers and their interactions in their environment may have played a larger role in prompting them to engage in new behaviors.

Limitations

The CHAT approach, as opposed to a traditional cognitive research paradigm, to study the impact of IDEAS on these educators provided a much richer understanding of the interactions among teachers, new content, and their environment as they made change in teaching methods and began to adopted new technologies and resources into their teaching practices. Given this was a pilot test of a new research and analysis methodology findings must be interpreted cautiously. Only two subjects were investigated and Davydov's (1999) stages were not followed completely. As a result, additional analysis will be conducted to include the resulting lesson plans as data points, all of the participating educators will be included in the final analysis, inquiries will be made to other educators who were not directly involved in the academy, and significant features of the environment will be further explored. More observations and in-depth semi-structure interviews will also be conducted.

A Research Model Generated from the CHAT Case Study

CHAT research paradigm provides enlighten researchers with a more holistic method for exploring technology integration efforts. This requires a shared understanding of the character and history of the subject, the object unto which the subject is attempting or required to reach, the characteristics of the surrounding community, and the technology/tools available to the subject etc. A research model based on CHAT paradigm

and this research demonstrates how to explore the research context and review the literature to focus on the interaction of human activity and the whole of the individual's mentality as they interact with a relevant environmental context and ultimately finalize appropriate research questions and methodologies. This model also demonstrates how a research conceptual framework can be established to integrate research questions, data collection, analysis, and reporting.

Stage1: Research Context Exploration. The CHAT framework reveals the holist research context. It helps researchers to conceptualize the complexity of the research context in terns of the characteristics of the technology integration activities, the factors that affect change, and the interactions among factors. In this stage, researchers need to explore (1) social, historical and technology attribute characteristic of the target population; (2) the environment in which the target population operates including community, rules, and division of labor; and (3) the goals the target population is trying to reach. Identifying the characteristics and issues surrounding these factors provides a research context.

Stage 2: Literature review. Based on understanding the general characteristic of the research context, researchers can begin to review the literature regarding (1) the relationship between the characteristics of the target population and the technology use (2) the interactions among target population and environmental factors, and other relevant relationships. The review should focus on such relationships and methods used to capture data and understand the complexities of the similar environments.

Stage 3: Define Research questions. Based on the results of the stage1 and 2, researchers further define the impact of technology interaction and narrow down research questions to "what" and "how."

Stage 4: Establish research conceptual framework. A specific research conceptual framework is then developed based on the research questions guided by an analysis of the activity structure. Elements of the research process such as research design, measures, data collection instruments, data analysis and interpretation are defined based on current understanding of the activity framework. For example, in the aforementioned case study we identified (i) academy *tools* (ii) the establishment of *rules* of engagement and other factors as critical to this study. Thus, it is suggested that researchers integrate the finding of previous stages to establish a specific research conceptual framework, describing the research purpose, context and methodologies. Refer to figure 2 for framework.

Stage 5: Data collection. The CHAT framework is then used to design appropriate research methods and select an appropriate sample of representative participants that account for the attributes of populations and the contexts in which they are engaged. In the IDEAS case study we selected teachers that were representative of the target audience for the technology integration academy, who had a variety of experiences and different levels of attitudes toward the use of technology in the classroom and were currently engaged in a variety of teaching contexts. The variables for study, situated within the research framework, also need to be defined and the data collection methods established to effectively view the activity under investigation from multiple perspectives. In the IDEAS project data were collected at time intervals to investigate changes based on an intervention. Repeated measures methods were used to collect both quantitative and qualitative data, either of which could have been analyzed to show change over time, and both were used to show change and interactions at different times throughout the project.

Stage 6: Data analysis. Research conducted based on CHAT framework yield richer data, which provides more comprehensive results and a stronger "feeling" of understanding of the changes within the activity. The researchers are better able to picture a holistic view of the changes by investigating the relationships across different analysis results, using a variety of data. The profiles created for each educator, in this case study, presented a picture of how the individuals changed over time. Such data were also used to compare and contrast the change across several individuals engaged in the activities. In addition, as the change is dynamic, having measures of the multiple factors within the activity added to ability to identify causal and intervening variables. Such rich data however requires strong data analysis skills that inform the interpretation process.

Stage 7: Data interpretation and report. Technology integration activities are complex in nature and unpacking the factors that encourage changes, temporary and sustained, is a difficult process. Having richer data that provides insight on the foundational elements of an activity, e.g., subject, object, tools, and community, provides perspective on the whole activity. Gaining insight in a comprehensive and understandable manner is

still a matter of skillfully applying analysis and interpretation techniques, not unlike complex quantitative or qualitative data analysis . It is recommended that interpreting the results begins with basic analysis of changes between start and finish state of the subject moving toward a goal such as changes in attitudes, or measures of learning. The analysis then continues by looking at the relationships between the other elements within the activity. Either, or both, may be using quantitative or qualitative techniques, however the key is to work through the complexities of the entire activity and the factors that influence the ebbs and tides of changes. Therefore, it is suggested that interpretation begins in simple terms and eventually considers the wholeness of the activity and the interactions that occur among the different elements.

Conclusion

Traditional cognitive research approaches to technology integration research do provide valuable information, but generally lack the robustness to fully understand the dynamics of this activity. Conducting such research using a CHAT strategy helped to reveal technology integration activity's content, structure, organization and fundamental characteristics as they exist within the training and classroom context. Although much more complex design, such an analysis helped shed light on the complexities of technologies use to enhance teaching and learning and how such tools are adopted to meet instructional needs of educators. Developing this understanding will help in the development of more comprehensive research and evaluation methodologies as well as technology integration training and strategies.

References

Becker, H.J. (1999). Internet use by teachers: Conditions of professional use and teacher-directed student use. Irvine, CA & St. Paul MI: University of California Center for Research on Information Technology and Organizations.

Bodker, S. (1991). Activity theory as a challenge to systems design. In H.E. Nissen, H.K. Klein, & R. Hirschheim (Eds.), *Information systems research: Contemporary approaches and emergent traditions.* Amsterdam: Elsevier.

Davydov, V. (1999). The content and unsolved problems of activity theory. In Y. Engestrom, R. Miettnen, & R. Ounamaki (Eds), *Perspectives on activity theory*. (pp. 39-52), Helsinki, Finland: Orienta-Konsultit Oy.

Dexter, S., Anderson, R., & Becker, H.J., (1999). Teachers views of computers as catalysts for changes in their teaching practices. *Journal of Research on Computing in Education, 31*(3), 221.

Engestrom, Y. & Miettinen, R. (1999). Introduction. In Y. Engestrom, R. Miettnen, & R. Ounamaki (Eds), *Perspectives on activity theory*. (pp. 1-16), Helsinki, Finland: Orienta-Konsultit Oy.

Engestrom, Y. (1987). *Learning by expanding: An activity theoretical approach to developmental research.* Helsinki, Finland: Orienta-Konsultit Oy.

Gay, G. & Bennington, T. (1999) Reflective evaluation in a "technology textured" world: An activity theory approach. In G. Gery & T. Bennington (Eds.), *Information Technologies in evaluation: Social Moral, Epistemological, and Practical Implications*, (pp. 3- 21), San Fransico: Jossey-Bass Publishers.

Honey, M., & Moeller, B., (1990). Teachers' beliefs and technology integration: Different values, different understandings. (ERIC Report). New York: Center for Technology in Education (ERIC Document Reproduction Service No. ED 326 203).

Jonassen, D. H. & Rohrer-Murphy, L. (1999). Activity theory as a framework for design constructivist learning environments. *Educational Technology, Research and Development, 47,* 61-80.

Koszalka, T. (2000). The Validation of a Measurement Instrument: Teachers' Attitudes Toward the use of Web Resources in the Classroom. *Quarterly Review of Distance Education*. 1(2), 139-144.

Koszalka, T. (2001). Effect of Computer-Mediated Communications on Teachers' Attitudes toward using Web Resources in the Classroom. *Journal of Instructional Psychology*. (28)2, 95-103.

Kuutti, K. (1991). Activity theory and its applications to information systems research and development. In H.E. Nissen, H.K. Klein, & R. Hirschheim (Eds.), *Information systems research: Contemporary approaches and emergent traditions,* (pp. 529-549). North Holland: Elvsevier Science Publishers B.V.

Kuutti, K. (1996). Activity theory as a potential framework for human-computer interaction research. In B.A. Nardi (Ed.), *Context and consciousness: Activity theory and human-computer interaction*. Cambridge, MA: MIT Press.

Mathison et al. (1999). Using verbal protocol methodology in the evaluation of software and hardware. In G. Gery & T. Bennington (Eds.), *Information Technologies in evaluation: Social Moral,*

Epistemological, and Practical Implications, (pp. 96-118), San Fransico: Jossey-Bass Publishers.

Acknowledgement