

Activity Theory as a Methodological and Analytical Framework for Information Practices in Emergency Management

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ABSTRACT

Emergency situations are chaotic in nature. It is however, necessary to understand the context in which Emergency Responders work such that information practice issues can be highlighted and addressed by the system designers. In this paper, Activity Theory is proposed as a methodological and analytical framework to study information practices in the context of Emergency Management. Activity Theory aids in achieving a holistic approach to understanding the work activities context unlike some other analytical methodologies, as it focuses on use of artifacts for the interaction of humans with their environment. In this paper, an activity system model is used to investigate information practice issues of response phase of the emergency services in the UK. Using Activity Theory as an analytical framework, several tensions and contradictions emerged which keep the system unstable but which are also a source of innovation. It is also argued that Activity Theory can usefully be applied to the analysis of information practices over short period of time.

Keywords

Information systems, crisis management, emergency management, qualitative research, activity theory

INTRODUCTION

Activity Theory is proposed to study the Information Systems (IS) needs in any complex situation such as an emergency. Activity Theory can be used both as the methodological and the analytical framework. In this paper Activity Theory is used to investigate information practices in the management of major incidents focusing on the activity of officers with tactical command (the Silver Commanders).

There is a consensus in Emergency Management research that information management is of particular significance in an emergency (Dantas and Seville, 2006; Eleftherios and Christos, 2001). However, it can be argued that much of the analysis provided still remains at a superficial level. Research has not to date, for example, provided conclusive answers to the questions such as, what is the format of information that the emergency responders prefer, what are the main sources of information they look at, what are the issues when information is sought from formal and informal sources, do they use all the technologies available to them, is there any difficulty in using any of these technologies, how is the reliability of information looked at? These are, however, of particular interest to practice (Pitt, 2008). This research aims to look at these information practices to address the gap in the literature.

The concept of using Activity Theory as an analytical framework is not new in IS studies (Collins, Shukla and Redmiles, 2002; Kutti, 1999, Lim and Hang, 2003). It is widely used in human computer interaction (de Souza, 2008; Diaper and Lindgaard, 2008; Rogers, 2008). Its application can also be seen in Artificial Intelligence (Engeström, 1995), education (Engeström, 2001). The use of Activity Theory in the context of time critical, complex and chaotic situation, such as emergency has not been studied in depth before. Chen, Sharman,

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Chakravarti, Rao and Upadhyaya (2008) did use Activity Theory to design a system for emergency. However; their use of Activity Theory is primarily to find out the user requirements for system development. In contrast, in the current paper, use of Activity Theory goes much beyond this level to inform IS governance and management too. In short, a more holistic approach is taken, using Activity Theory to study very fully the real time, complex situation of emergencies.

Activity Theory offers benefits over other theories of action. According to Nardi (1996, p.36), using Activity Theory, allows context (activities) to be studied. Moreover, in Activity Theory the goal for any action is fully examined unlike other action theories (such as situated action) where only human interaction with the environment can be studied. A further advantage of Activity Theory is that, rather than only *illustrating* what users are doing, it helps in identifying reasons for doing any activity. In Activity Theory, the unit of analysis is an activity which starts with some motive. Activities can be decomposed into actions (directed towards a goal). When the same action is repeated over time, under similar conditions, it becomes an operation which is not a conscious process. However, with the change in conditions, an operation can become an action. Thus a bidirectional relationship exists between activities, actions and operations (Jonassen and Roher-Murphy, 1999). This multi-level composition of activities allows a much more comprehensive micro level analysis which is not possible using other theories.

In the following sections, a brief description of the type of data collected from different samples will be presented, followed by an activity model which will also be used to explain the properties of Activity Theory and its contribution as a methodological framework. Contradictions within a system are delineated to illustrate the extent to which Activity Theory can be used in the study of complex and time critical environments. Findings and discussion follow next. The paper concludes with an assessment of the contribution of Activity Theory, arguing in particular that, contrary to some views expressed in the information systems literature (Nardi, 1996; Wilson, 2006), this theory can usefully be applied to the analysis of information practices over very short periods of time.

RESEARCH SETTING

Emergency Services in the UK include Category 1 and Category 2 responders. Category 1 responders are commanders from the police, fire and ambulance services (Secretariat, Civil Contingencies Act 2004). Category 2 includes Local Authority, Environment Agency, and humanitarian aid. In this research Category 1 responders are studied. Category 1 responders are further divided into Gold (strategic), Silver (tactical) and Bronze (operational) Commander levels depending on the nature of the work they are involved in (Bland, 2007). Silver Commanders were chosen for the purpose of this study because their task is both very complex and transparent, as a result of which they are under more pressure (Haddow, Bullock and Coppola, 2008). Moreover, Silver Commanders are also fully responsible for all the management of given emergency thus need to be able to provide justification during debriefing, which further increases their work pressure.

Participants

In total, 20 semi-structured interviews were carried out with tactical commanders in the UK. The experience of the commanders ranged from 5 years to 30 years. An effort has been made to interview commanders from different parts of the UK, and not limited to only one region, for broader understanding of the context of emergency services as a whole. 7 tactical commanders from the Police Force, 7 from Fire and Rescue Services and 6 from the Ambulance Service were interviewed. The interview questions were designed using Activity Theory. The critical incident technique (Flanagan, 1954) was used to underpin the interviewing. Each interview lasted for an average of 70 minutes. 35 hours of multi-agency training and exercises were also observed. In the observation, participants were Category 1 and Category 2 responders. Government reports and operating manuals from different emergency services were analyzed. To guarantee anonymity, data obtained was first anonymized before coding in the computer package NVivo. The data analysis involved axial coding to inductively create theory which was then developed by a constant comparative approach. In order to assure generalizability of data different contexts were studied: floods, terrorist attacks, riots, road and train accidents, major fire and chemical incidents. In the next section how Activity Theory is used to understand the activity of Silver Commanders is explained.

THE ACTIVITY MODEL FOR SILVER COMMANDERS

Activity Theory makes several contributions such as linked activity systems, holistic approach which enables the focus on the role of tools within an activity system and hierarchical decomposition of activities which provides a framework for micro level analysis of the human interaction with its environment.

According to Zott and Amit (2010), activities are linked in an activity system. Different physical and informational activities related to information are performed by the Silver Commander from the moment s/he is notified of a major incident, for example, collecting more information related to the incident, knowing about the resources being dispatched to the incident location, asking for more resource allocation, looking at operating manuals to decide on the next action, making different types of decision such as where to be based (in the headquarter or near the incident scene), wearing the PPE (personal protective equipment) before entering the scene, talking with the first commander on the scene after reaching the incident location, communicating with Silver Commanders of other agencies, having a silver meeting and so on. Thus activities are linked with each other in an activity system. One activity leads to another activity. These activities can be studied on a temporal basis.

Activity Theory can also be used to provide a holistic model for a particular activity. For purposes of illustration, in this paper, activities carried on when the Silver Commander reaches the incident location are examined. For the activity undertaken when the Silver Commander reaches the incident location, a model derived using the Activity Theory proposed by Leont'ev and represented by Engeström (2000, p. 962) is shown below in Figure 1. Explanation of the meaning of the nodes is provided in Table 1. Upper triangle in Figure 1 states that the Subject (Silver Commander) uses tools (VHF Radios, Airwave Radio, Pager etc) to act upon the object (incident location) to achieve the outcome (situation awareness and dynamic risk assessment). Other tools used by the Subject are face to face interactions with other commanders on the scene and visual cues from the environment. Lower part in the triangle of Figure 1 states that the Subject is influenced by other factors too such as rules, community and division of labor. In this research context, Silver Commander (subject) is governed by rules and social norms to perform his/her task. S/he is also constrained by the division of labor which defines his/her work role. Apart from the Silver Commander, there are other people engaged in this activity such as Bronze Commanders on scene, tactical advisors and people in Command and Control (C&C). These people constitute of a community as they all have a common motivation of understanding the situation such that effective emergency management can be achieved.

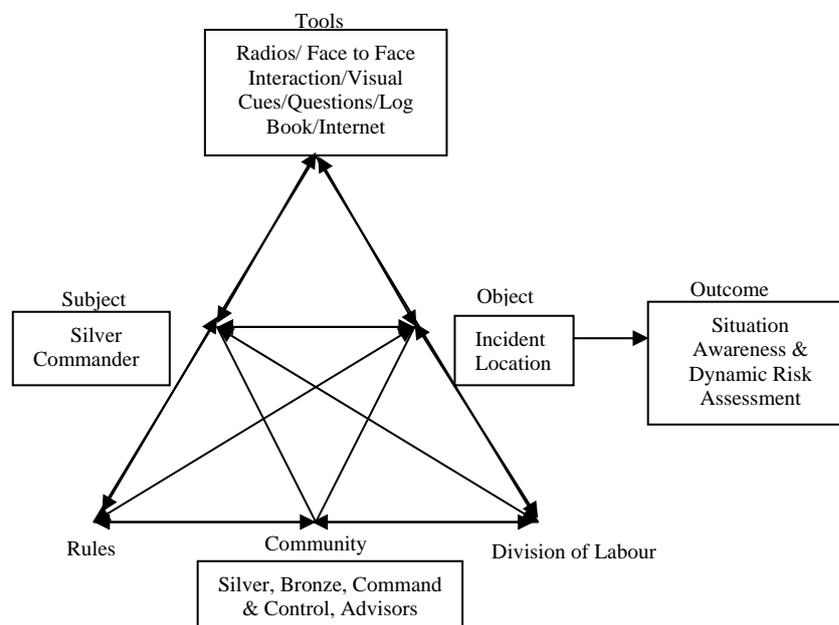


Figure 1. Activity Model for the Silver Commander after reaching the incident location

Nodes	Description
Subject	Silver Commander who acts upon the situation to reach to the desired objective of situation awareness and dynamic risk assessment. The Subject can be a group of people too
Object	Problem space on which the Silver Commander acts to get the desired outcome. In this case it is the emergency situation which the Silver Commander acts upon.
Tools	Physical or conceptual tools which are used by the commander to act upon the situation, such as radios, face to face interaction, commander's previous experience, log book etc.
Rules	Plans, policies, protocols to be followed
Community	The people whose interest is similar in terms of outcome for example, Bronze Commanders of own agency, C&C, Silver Commanders from other agencies. All want the effective management of the emergency; thus they all belong to the same community
Division of Labor	The Task allocation for each individual in the system – e.g., the task for a Silver Commander from the Police Force is different from the task of a Silver Commander from the Ambulance or Fire services. Similarly, Bronze Commanders have their own tasks which are different from the task of Silver Commanders

Table 1. Description of the Nodes within an Activity System

The holistic modeling of context enables focus to be placed on the role of tools within the activity system and the way in which they mediate behavior. Tools are described within Activity Theory as being physical (such as an IT artifact) or intangible (such as language or meaning which is inscribed within or ascribed to a tool). Mediation is an important property in Activity Theory. It emphasizes that without any mediator, the Subject is not able to obtain the desired outcome. In other words, a desired outcome (solution) can only be obtained by using some kind of mediating artifacts on the object (problem space). According to Engström (1999, p. 66), for the subject and object interaction, various mediators comes into play, as depicted in Figure 2. The Subject interacts with the object using tools. In the emergency response context, Silver Commander uses different physical tools such as radio, internet, mobile or pager for managing an incident. S/he also uses mental tools such as experience to understand the situation. Rules are mediating artifacts which governs how the Silver Commander acts to manage an Emergency. The Community can also play an important role. Division of labor can similarly affect the interaction between subject and object.

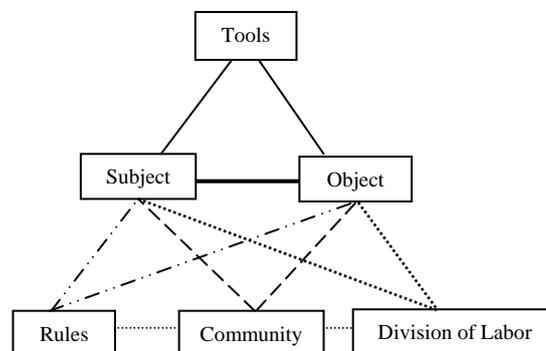


Figure 2. Mediating Artifacts (tools, rules, community and division of Labor) between Subject and Object

In realizing this within a research framework the mediation can be used in formulating interview questions. For example, when a tool is considered a mediating artifacts between the subject (Silver Commander) and the object, questions that can be asked include: how a subject uses different types of tools and technologies to work

on the object such that the object is transformed into an outcome; how is information sought; is information sought from C&C, from Bronze Commanders, from other agencies; what tools are used to communicate with these people; are the tools and technologies provided to the commander sufficient; what type of tools and technologies is preferred by the commander; what type of tool aids in his/her task?

Questions can also be designed using rules as the mediating artifacts between subject and object such as: what are the rules Silver Commander needs to follow; are there any social norms that affect the decision making process; do Silver Commanders stick to the rules, does s/he ever deviate from the rules; in what conditions might s/he deviate from the rules; are the rules sufficient to perform the task effectively; what is done when the situation is novel and plans and policies are not sufficient?

Also, the mediating artifacts involving division of labor can be used to articulate questions such as: what is the role defined for Silver Commander; does s/he encounter difficulties when working with Bronze Commanders from his/her own agency or with other agencies? Thus, the components of the activity system provide a very supportive template to design the interview questions.

Activity Theory can also be used to hierarchically deconstruct the selected Activity System which allows micro level analysis. An activity can be deconstructed into goal driven actions (which are conscious) and operations (which are sub conscious). In this example of activities carried out by the Silver Commander after s/he reaches the incident location, different types of actions and operations emerged from the analysis. Information assimilation; command, control and coordination; and decision making were found to be the major actions for situational awareness and dynamic risk assessment. Within command, control and coordinate as an action, different operations were found such as book in, checking the list, or going through the aide memoire. To illustrate how the micro level analysis is done, just one action, information assimilation, will be considered, as it informs how commanders use information to obtain situational awareness. The Silver Commander needs to assimilate information once s/he reaches the incident location because information is arriving to him/her in fragments and from different sources. Information needs to be assimilated so that the situation can be properly understood. In Activity Theory, actions are carried out by the subject to fulfill the main objective. In this example, for the action information assimilation, the goal is sensemaking. Silver Commander assimilates information such as to make sense of the situation.

Different sources are used by Silver Commander to assimilate information such as: information from Bronze Commanders; tools such as pagers, mobiles, websites, log books; CCTV coverage; and the media. Experience was also found to be a source of information which helped in finding the location of information, i.e., experienced Silver Commanders knew where to look for information and, whom to contact to get certain types of information. Similarly, visual information from the environment was used to understand the situation better. Intelligence unit, tactical advisors and the command unit were found to be source of information too. The Emergency Contact person of the company where the incident took place, for example, in the chemical industry, was also found to be very useful as an information source.

The Silver Commander engages himself/herself in different operations when s/he reaches the incident location. These operations depend on the condition. S/he needs to book in attendance by calling command and control (C&C) or through booking in, with the command unit to say that s/he is in attendance. If the Silver Commander is not experienced then booking in might be an action which s/he does consciously, reminding himself/herself that s/he has to book in such that other people will know of his/her presence. For experienced Silver Commanders, however, it is not a deliberate task but a subconscious process. This is called internalization in Activity Theory. If the task is routine, the Silver Commander internalizes it and thus an action is converted to an operation. An operation can be an action too if the condition changes. For example, looking at the environment for cues may be an operation for Silver Commanders in normal incidents where there is a fire. However, if the incident is also a chemical incident, s/he may not get the information about what kind of chemical is present just by looking at the environment and thus the condition is changed for the Silver Commander. In such a situation, getting information from the environment becomes an action (externalization) for which the Silver Commander will have to consciously make a call to the Environment Agency for information on the chemicals in the plume. Activity Theory thus provides a framework for micro level analysis by decomposing an activity into actions and operations which in turn aids in analyzing the tensions and contradictions within a system which will be delineated next.

TENSIONS AND CONTRADICTIONS

Activity Theory provides a framework which aids in identifying the tensions and contradictions between nodes of the activity system. Contradictions may be present at different nodes within the activity system. However, due to the focus in this paper on interaction between the subject and the object using mediating artifacts, only

the mediating artifacts will be explained here. From the analysis of the data gathered through the interviews, several contradictions were seen among the components of the activity system, as shown by the lightning line in Figure 3. These tensions and contradictions are explained here along with excerpts from interviews to give the reader an understanding of the concept of tensions and contradictions within an activity system.

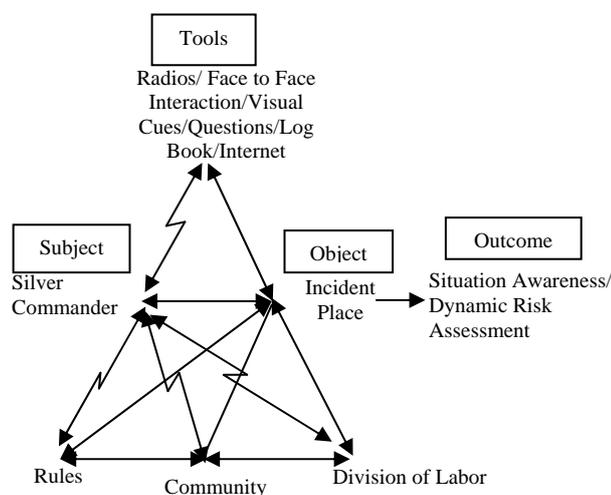


Figure 3. Action model for Information Assimilation showing Contradictions

Contradiction between Subject (Silver Commander) and Tools (Technology)

The data suggests that the use of technology is increasing in the management of incidents. However, there are still issues which need to be addressed. As shown in the excerpt below by Interviewee I18, there are many technologies being introduced in emergency services. However, reliability is found to be a major issue.

it does when it works, It's alright having all these gadgets but they have got to work and there is lots of gadgets out there gathering information and IT software and so on that are brilliant.....but I say, it is good if it works.... It's good as well if you can understand how to use that piece of equipment (I18)

Concern is also found in relation to the difficulty of technology. In the UK, the Airwave radio has recently been introduced with a view to have a common radio across the emergency services so that interoperability is possible. However, as stated by one of the interviewees, because there are many channels on the Airwave radio, it may be difficult for the commanders to know which channel to go to for communicating with a particular person.

The radios can be difficult if you are not familiar with them. So, for other staff who are not familiar with them- sometimes different radios, put a lot of channel and say well this is how to contact us- and they struggle with this (I12)

Contradiction between Subject and Rules

Contradiction also emerged between the subject and rules. In the incident mentioned by an interviewee below, the Silver Commander from the police is not supposed to go inside a building even if someone is trapped there; he/she needs to wait for a fire crew, as they are the experts in rescue. However it was found that even when things are not within policy, people tend to do what they feel they need to.

One of the things that used to very often be a problem is the police officer attendance of fire and instincts are, if fire services are not there and somebody is trapped, police officer goes in, policy is you not going in. So they know that going in is not in the policy because they are not trained and the fire service are the expertise (I16)

Contradictions between Subject (Silver Commander) and Community (Bronze Commander, Tactical Advisors)

It was found that, although Bronze Commanders were the main source of information for the Silver Commander, they may not have the same level of understanding as that of a Silver Commander which makes it

difficult for the latter to get the desired information from Bronze Commanders, as can be seen from the excerpt below.

Likewise my officers have their own perception - they only have a small perspective on the situation - haven't got the holistic view that you have got and that's when you are getting lot of information in and lot of them may be misinformation you know, it's not really information it's just its dressed up with information (I16)

Contradiction was also found between Silver Commander and C&C. In general, people at C&C are not trained commanders. When people in C&C log the incident, it may be logged in as is interpreted by that individual which may not represent the actual facts. This also indicates that the information made available to the Silver Commander may not be as accurate as it should be.

You will have access to that sequence of events now you have got to remember, of course, that it is as interpreted by someone who is putting the entry into the log. So, you may not find that it is as complete as you would wish (I14)

Contradiction between Subject (Silver Commander) and Division of Labor

Tactical advisors are available to advise the Silver Commander when s/he needs help. It was found that on some occasions, tactical advisor may get seriously involved in an incident, thus creating a tension and contradiction in the work force.

I have had to pull back tactical firearms advisors before because they have said right we are going to do this and I have said, whoa you tell me what the options are and I will make the decision because it always comes down to the Silver Commander (I14).

Thus, by analyzing activity system of the Silver Commander after s/he reaches the incident location several contradictions emerged. As Engeström (2001) states, these tensions and contradictions in an activity system keep the overall system unstable which is a source of innovation demanding actions of translation (Warmington, Daniels, Edwards, Leadbetter, Martin, Brown and Middleton, 2004). After learning about these tensions and contradictions, people act towards stabilizing the system which leads to an innovative solution.

DISCUSSION

Activity Theory is a descriptive tool rather than a predictive theory. However, analyzing the data using Activity Theory helps a researcher in modeling the reality. Actions which may not be easily visible using other analytical methods can also be understood. With other action theories only linear sequences of work tasks can be analyzed whereas using Activity Theory, the socio-spatial dimension can be identified too (Nardi, 1996). Activity Theory also facilitates analysis of the *complexities of course dynamics* (Barab, Barnett, Yamagata-Lynch, Squire and Keating, 2002). The concept of mediating artifacts aids in analyzing the interaction not only of the subject with tools and technologies but also with other mediating artifacts such as rules, division of labor and community, thus providing a holistic view.

Few questions raised at the beginning of this paper such as what are the main sources of information; issues in seeking information from these sources can be easily explained using Activity Theory. It was found that humans are the main source of information. Silver Commanders seek for information from their C&C and Bronze Commanders. However, tensions and contradictions between the Silver Commanders and other sources of information (Bronze Commanders, C&C) indicate that information from human source is constrained by personal factors. Bronze Commanders lack a holistic view of the overall incident, as a result of which the information obtained by the Silver Commander has limitations. C&C was also found to be influenced by subjectivity which impacts the way in which information from different sources is recorded by C&C which in turn affects the information received by the Silver Commander from C&C.

By analyzing the nodes Subject and Tools, doubts about reliability of tools and technologies in emergency and crisis situations were identified. Moreover, with the introduction of new technologies, it is sometimes difficult for Silver Commanders to get familiar with all these new developments. Thus, system designers should seek to build technologies that are easy to use by the commanders with minimum effort. Off the shelf technologies should be used. Also a minimalist approach needs to be taken. Instead of making a completely new technology, efforts should be made to modify the technologies in use.

Activity Theory informs IS governance and management too. From the contradiction between the Silver Commander and rules, it was found that the Silver Commander may deviate from the rules to achieve the

outcome. Thus there is a need to revisit rules and regulations. Contradictions between the Silver Commander and tactical advisors suggest that rules for division of labor need to be revisited too. At present, an adverse effect can be seen if advisors are too much involved, the Silver Commander may not decide for himself/herself. In such cases, it will be difficult for the commander to justify his/her action during debriefing.

CONCLUSION AND FUTURE WORK

In this paper, Activity Theory was highlighted as a valuable methodological and analytical tool to study the information practices of Silver Commanders of the emergency services. Several issues related to information practices have been identified using Activity Theory which might not have been visible when other analytical methods were used. Tensions and contradictions among different components in an activity system keep the system unstable. The contradictions are catered for by innovating solutions with the objective of keeping the system stable. Thus tensions and contradictions are also considered as a source of innovation.

In the IS literature which has used Activity Theory (Nardi, 1996; Wilson, 2006), it has been argued that Activity Theory needs to be used in a historical context over a long time period. Crawford and Hasan (2006) stated that Activity Theory can be used in situations where the objective and tools are constantly changing. In this research Activity Theory is used to study the immediate responses of commanders over a very short time period and it has been demonstrated that important insights about information practices can be obtained relevant to shorter time frames.

Using Activity Theory in this research had limitations too. It was difficult to distinguish between action and operation from the data collected using interviews. Also, Silver Commanders did not normally talk about operations (actions not at conscious level). This may be because they may not reflect on something that is obvious for them. The best solution is to observe Silver Commanders in action in real time. This in general is not possible in emergency situations. One solution may be to use probing questions during interviews which can reflect on interviewees sub conscious actions.

Activity Theory can be extended to study activities of multi-agencies using the third generation Activity Theory proposed by Engeström (2001) to see how each component of one activity system interacts with the components of another. For example, the activity system of Silver Commanders from the fire and rescue services could be compared with the activity system of police forces. The aim (outcome in Activity Theory terms) is the same for both agencies, i.e. to save life and property, but the object can be different.

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REFERENCES

1. Barab, S.A., Barnett, M., Yamagata-Lynch, L., Squire, K. and Keating, T. (2002) - Using Activity Theory to Understand the Systemic Tensions Characterizing a Technology-Rich Introductory Astronomy Course, *Mind, Culture, and Activity*, 9, 76 - 107.
2. Bland, S.A. (2007) - Emergency Planning, *JR Army Med Corps*, 153, 126-129.
3. Chen, R., Sharman, R., Chakravarti, N., Rao, H.R. and Upadhyaya, S. J. (2008) - Emergency Response Information System Interoperability: Development of Chemical Incident Response Data Model, *Journal of the Association for Information Systems*, 9, 3, 200-230.
4. Collins, P., Shukla, S. and Redmiles, D. (2002) - Activity Theory and System Design: A View from the Trenches, *Computer Supported Cooperative Work (CSCW)*, 11, 55-80.
5. Crawford, K. and Hasan, H. (2006) - Demonstrations of the Activity Theory Framework for Research in Information Systems, *Australasian Journal of Information Systems*, 13, 49-68.
6. Dantas, A. and Seville, E. (2006) - Organisational Issues in Implementing an Information Sharing Framework: Lessons from the Matata Flooding Events in New Zealand, *Journal of Contingencies & Crisis Management*, 14, 38-52.

7. de Souza, C.S. (2008) - Missing links in the rhetoric of Activity Theory, *Interacting with Computers*, 20, 267-271.
8. Diaper, D. and Lindgaard, G. (2008) - West meets East: Adapting Activity Theory for HCI & CSCW applications?, *Interacting with Computers*, 20, 240-246.
9. Eleftherios, I. and Christos, D. (2001) - An information management system for the emergency management of hurrican disasters, *International Journal of Risk Assessment and Management*, 2, 243.
10. Engeström, Y. (1995) - Objects, contradictions and collaboration in medical cognition: an activity-theoretical perspective, *Artificial Intelligence in Medicine*, 7, 395-412.
11. Engeström, Y. (2000) - Activity Theory as a framework for analyzing and redesigning work, *Ergonomics*, 43, 7, 960.
12. Engeström, Y. (2001) - Expansive Learning at Work: toward an activity theoretical reconceptualization, *Journal of Education and Work*, 14, 133-156.
13. Flanagan, J. C. (1954) - The Critical Incident Technique, *Psychological Bulletin*, 51, 4, 327-358.
14. Haddow, G. D., Bullock, J. A. and Coppola, D. P. (2008) *Introduction to Emergency Management*, Butterworth-Heinemann, Elsevier Inc, Oxford.
15. Jonassen, D.H. and Roher-Murphy, L. (1999) - Activity Theory as a Framework for Desining Constructivist Learning Environments, *Educational Technology, Research and Development*, 47, 61-79.
16. Kutti, K. (1999) - Activity Theory, transformation of work, and information systems design, In Y. Engeström, R. Mietinen and R.L. Punamaki (Eds.), *Perspectives on Activity Theory*. New York: Cambridge University Press, 360-376.
17. Lim, C.P. and Hang, D. (2003) - An activity theory approach to research of ICT integration in Singapore schools, *Computers & Education*, 41, 49-63.
18. Nardi, B.A. (1996) - Studying Context: A Comparision of Activity Theory, Situated Action Models, and Distributed Cognition, In B.A. Nardi (Ed.), *Context and Consciousness: Activity Theory and Human-Computer Interaction*, Cambridge, MA: MIT Press.
19. Pitt, M. (2008) - Learning Lessons from the 2007 Floods. Cabinet Office, London, UK www.cabinetoffice.gov.uk/thepittreview Accessed 1 December 2009. Now available at http://webarchive.nationalarchives.gov.uk/20100402231741/http://archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html
20. Rogers, Y. (2008) - 57 Varieties of Activity Theory, *Interacting with Computers*, 20, 247-250.
21. Secretariat, C.C. A Short Guide (revised), in, *Civil Contingencies Act 2004*.
22. Warmington, P., Daniels, H., Edwards, A., Leadbetter, J., Martin, D., Brown, S. and Middleton, D. (2004) - Learning in and for interagency working: conceptual tensions in 'joined up' practice, *TLRP Conference*, Cardiff, UK.
23. Wilson, T.D. (2006) - A re-examination of information seeking behaviour in the context of activity theory, *Information Research*, 11, <http://informationr.net/ir/11-4/paper260.html> Accessed 30 September 2010.
24. Zott, C and Amit, R. (2010) - Business Model Design: An Activity System Perspective, *Long Range Planning*, 43, 216-226.