Technology Mediated Learning and the Development of Higher Order Cognitive Skills: Using Activity Theory to Analyze the Actors in Distance Education at Makerere University in Uganda

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Abstract
Makerere University, having been in existence since 1926, is one of the most reputable institutions in Africa located in East Africa. Makerere provides educational environment to the present 50,000 students both at undergraduate and graduate levels. One cannot engage with so much enthusiasm in something they do not well comprehend. Technological advancements in this same university have gone through a number of stages: from the use of traditional chalkboard technologies to now a blend of technologies including the use of Information and Communication Technology (ICT). In order to provide a learning environment that enables the development of higher order cognitive skills, innovations like technology mediated learning need to be understood. Technology mediated learning and instruction is an innovation in education and therefore both educators and students need a basic understanding of it for its successful implementation. This paper provides the basics concepts of technology mediated learning as seen through the activity theory lens most especially in the context of Makerer University’s distance education. The paper describes the concepts to be understood in a technology mediated learning environment and concludes with some recommendations for effective technology mediated learning on the various actors therein involved.

Key words: technology mediated learning, higher order cognitive skills, activity theory, zone of proximal development, contradictions.

1. INTRODUCTION
Questions in technology and instruction have shifted from how various technologies are used to how to learning happens in an environment where there is integration of technologies in instruction. While there is an increasing recognition of the role of technologies in transforming instruction and learning practices, there is lack of pedagogical knowledge about how learning exactly happens leading to the development of higher order cognitive skills. This explains why technology enhanced instruction is probably not a venture of many educators most especially in distance education. Makerere University, as a higher institution of learning, provides education to about 50,000 students, both at undergraduate and post graduate. The enrolment numbers called for new innovations in teaching and learning to attain quality education. In the competitive world of tertiary level education, the playing field has shifted to allow technology mediated learning and instruction in addition to distance education. Teaching methods are being recast to leverage new learning media as ushered in by technology [1]
to ensure quality education and development of higher order cognitive skills. Recent advances in information and communication technology have affected learning in higher institutions as exhibited by the numerous online courses world-wide. The numerous online programs, take a Web-based format in presentation and approach, digitally recording traditional, classroom-based courses and making them available online [2]. Media presentations can be viewed on or off a Web browser with integrated media players like QuickTime, Windows Media Player etc. be it with or without the physical presence of an instructor is what is referred to as technology mediated learning in this paper.

Technologies are increasingly being used in higher education for teaching, learning and research. Among the technologies used in distance education are web based applications, distributed applications, online applications, learning management systems etc. There is no doubt that technologies have become part and parcel of the present higher educational environment. They are not only basic, but they have turned out to be very essential in day to day instructional activities. Studies [1,7,11,28] show that a significant pedagogical approach gaining credibility through research and classroom practice is students’ collaborative engagement with problem-solving, technology-based tasks for more effective learning. The organization for such activities requires careful consideration of the mediational role of the technology [3]. Teaching and learning involves a number of multi-model activities, and this is true of everything that can be learnt. The use of technology mediated learning is therefore just an emphasis to such a varied model activity. The models of carrying information, including through technology are socially shaped differently, which conforms to current learner characteristics. This usually causes educators and learners in higher education in different social contexts to think about learning differently. Learning involves change and the varying socio-cultural backgrounds expose students on distance education programs to a completely new environment in which they must learn effectively. Technology mediated learning activities introduce different things in an instructional environment that may require varied responses. Students may respond basing on the various socio-cultural contexts depending on their past experiences or origins [4].

Technology mediated learning also rhymes with the nature and character of present day learners, who are comfortable with using technologies. Present learners in educational institutions can use technologies for research, typing course works and also access content and this does not apply to a majority of the learners a decade ago. Learners can engage with technology to perform higher order cognitive activities like analysis, evaluation and assessment within their zones of proximal development [23]. In this case a technology is deemed to have mediated learning; however the level of cognitive skill attained needs to be envisaged. Higher order cognitive functions that are an indicator of quality products from a higher institution of learning as classified by bloom’s taxonomy are evaluation, synthesis, and analysis. The development of higher cognitive functions is never approached directly even in face-to-face interactions; it is mediated through guided assistance within a zone of proximal development (ZPD) [5]. The ZPD is a biological concept that is opened up
socially. It is presupposed that learners accomplish more with technology guidance than without it [26]. It is technology-mediated learning that is assumed to play a mediational role to bring about higher cognitive development.

2. Technology Mediated Learning
In defining technology mediated learning, themes like: web-based learning, distributed learning, electronic learning, online learning are evident. Technology mediated learning refers to an environment where the instructor and the learners are not necessarily together in both time and space, and instruction is delivered through specifically computing technologies. This is always the scenario in distance education where learners and instructors majorly operated from separate geographical locations. For such learners to engage in activities related to higher order thinking and learning in technology mediated learning, there is need for them to have autonomy over the learning process [6]. Worth noting here is what technology mediated learning is not learning from technologies as has been the traditional assumption. It is what students learn from thinking in meaningful ways while using a technology. Thinking is engaged by the different learning activities which can be embedded in the task and technology application [7].

However the technologies used in distance education at Makerere University do not necessary engage learners in such a way that they develop higher order cognitive skills. Yet still, measurement and assessment of higher order cognitive skills in this case may be an uphill task because this is a fairly new phenomenon. Many times measurement of learning or assessment is done after learning and an aspect of measurement of skilled products is the aspect of high order cognitive function. Researchers have therefore made an attempt to get the impact of technology on learning. In many incidences however, researches have looked at technology as an independent variable. Nonetheless, when the technologies enter the learning environments, they cease to be independent and become part of the complex social and pedagogical interaction [8]. To appropriately analyze and understand technology mediated learning and development of higher order cognitive skills, Activity Theory (AT) comes in handy. AT suggests that there are certain things to look at in order to understand technology mediated learning. Technology and learning form the complex social and pedagogical interaction that requires a careful approach for clear understanding. There is a focus on a group of people sharing a common object and motive over time and a varied range of tools to realize a motive- this is called activity system [9].

Many researchers have found out a diverse effect of technologies in learning, but what comes out clearly from them is that, technology would have a very great impact on learning, but the design of the materials is still poor [10], [2]. Nonetheless, technology is making an impact on the quality and effectiveness of teaching and learning that produces higher order cognitive skills.

3. Activity Theory
Learning involves change and learners bring different socio-cultural backgrounds and meet completely new environments in which they have to operate for effective learning. Some learners are exposed to completely new and strange learning environments like which
results into a contradiction in the way they are used to operate. The resultant contradiction provides a basis for transformation [11] as learners must work hard to meet the requirements. Many times learners find themselves making very structural adjustments in their lives.

Activity theory focuses on learning as an interactive activity and interaction of human activity and consciousness within an environmental context relevant to it. Since conscious learning is a human activity, there are activity structures, tools and sign systems, socio-cultural rules and community expectations that learners must accommodate while learning [12,16]. Technology mediated learning cannot be understood from without the context in which it is happening. Researchers have found out that the concept of activity is a very fundamental one when it comes to understanding activity theory [13]. This is because learning is assumedly activity packed. The analysis of technology mediated learning as a human activity, should not only examine the kinds of activities that people engage in but also who is engaging in that activity, what their goals and intentions are, what objects or products result from the activity, the rules and norms that demarcate that activity, and the larger community in which the activity occurs [13].

According to activity theory [14, 15] an activity is a way of action of a person, or group of persons addressed to an object in order to achieve a goal. In distance education, the mutual relationship between the activity subject and object is always mediated by tools used to perform the activity; subject interactions with the environment are not direct but instead mediated by use of tools (blended with face-to-face). Furthermore, the fact that human activity tends to take place in a social and cultural context introduces the idea of considering the collaborative nature of human activity, including technology mediated learning. The expanded meditational model incorporates the community and other mediators like rules and division of labor [16]. In distance education, the community is composed of all subjects involved in the shared object. Rules are implicit and explicit established by social conventions and relation. Division of labor is devoted to the organization of the work. It would lead to a structure as illustrated in the figure.

![Activity system diagram](Scanlon & Issrof, 2005)

The top of the Activity theory model triangle represents the insertion of new tools of work i.e. computing technologies for instruction and it represents the fact that human activity is always mediated by artifacts. The middle of the triangle shows the subject acting on the object; in this case the subject represents students acting on the object (learning), maybe an idea or experiment. The subject and the object are directly opposite each other and there is the arrow showing the anticipated outcome of their
activity that is higher order cognitive skills. However, all these depend on the technological tools used to mediate learning. Transformation takes place within the framework of the ZPD and in an iterative process of interchange between internalization and externalization [16], [17]. The bottom of the triangle shows the activity theory identified contextual characteristics of a learning environment in distance education where learners are engaged in technology mediated learning. There are rules like making sure a coursework is done at passed. The community refers to all the people in a distance education learning environment including lecturers, technology laboratory technicians, and cleaners among them. These support technology mediated learning in various ways. In the division of labor, it may be noticed that all people in a distance education learning environment are engaged in different activities: learning technologies, lecturers, custodians, registrars, etc. There is therefore a community of people interacting with to deliver effective higher order cognitive skills to students.

4. Contradictions and Higher Order Cognitive Skills
Technology mediated learning can be broken down into actions, which are further subdivided into operations. Using these categories provides an understanding of the steps necessary for users of technologies to carry out a task like learning and development of higher order cognitive skills. These concepts are operationalized to describe how technology mediated learning takes place. In activity system outcomes, in this case high order cognitive thinking results from interrogating objects by means of tools (physical for example pens and technologies as technological artifacts; or psychological- signs and symbols)[18]. Subjects are usually active entities responsible for performing an activity. Tools (technologies) mediate interactions through the activity context that includes Community, Division of Labour and associated Rules [19]. Studies indicate that the division of labor within an activity system creates different positions and contradictions. It is contradiction, which forces one to engage in learning. Internal Contradictions create instability and drive the development of and change in the system [20]. Contradictions are contextualized and change over time. The choice of a technology to mediate a given learning task determines the level of thinking skill attained.

A central notion within the activity theory is that the driving force of development and change storms from contradictions within and between the components of the activities. Contradictions and resolution of the same are the principle of the activity’s self-movement and development. This is coherent with the research that shows that learning (change) should be caused by internal motivation in order to cause a robust, lasting process. The subject must feel imbalanced being confronted with problems without an immediate solution. Objects, as cultural units, are the key unit of analysis within an activity system [21], symbolize communal social practices that transform and further develop during human activity and, in combination with purpose, give the system consistency [20]. The object is not to be confused with the subject as it is not necessarily a ‘thing’ as such. The object of an activity is what people are collectively or individually working on and is to be transformed into an outcome [21]. Objects are mind tools that the learner manipulates through interaction. This is what makes AT different in
its approach, learning in interwoven with interaction, not after interaction as many other theories emphasize. Socially created tools are inseparable from the associated activity and are part of the purpose, relevance and value given to them by the subject, and may become objects, or outcomes, of activity. The implication here is that learning can take place in a fairly stable environment, created by the institution. Socially created tools involved in cognitive mediation may not be ideologically neutral [19]. This is a reason for carefulness in using technologies in learning, because it may bring with it unintended ideologies that may impede learning and instead emphasize technology.

The community involves the social environment in which the activity is performed. In a higher educational environment, it is may refer to other learners and instructors not directly involved in the activity. These subjects may need to perform activities related to the activities of other actors. For example, when a learner has to perform a simulation in a technology mediated learning environment, an instructor must control and evaluate such action. Relating to the subject, the community also establishes relations among members of the group of participants. The instructor having control over actions is intended to direct the learners to the cognitive skill to be attained. Recent development in AT suggests that the unit of analysis is to be seen as minimum two interacting activity systems [22]. This addition makes sense in that technology mediated learning can be conceived as an environment where learners are potentially sharing the object of the activity. When analyzing technology mediated learning as a conscious human activity in distance learning, analysis is not only the kinds of learning that the learner are engaging in, but also the learners themselves, the reasons for learning, the products that come out of their intentions, the rules and norms that govern learning and the larger community in which the learning is taking place. Studies indicate that education should be responsive to the needs of the learners and the world in which they belong [23], the reason for technology mediated learning in distance education is not only to create a workforce that is technology literate, but to also get skilled workers for the highly digitized environment.

Technologies have opened up a new ZPD in the way learners learn at all levels of education. Defined by Vygotsky, a ZPD is the difference in development between what one can do without mediation as determined by the ability to solve problems and what one does with mediation [24]. This indicates that learners are capable of learning certain concepts; nonetheless, they can maximize the learning of those concepts if technologies mediate learning within an individual’s ZPD. The central concepts of mediation within the ZPD bring about understanding of technology mediated learning. Research has also discovered that the technology is a superior other, in mediation, so the notion of learning as mediated by a culturally more competent superior is used to understand how technologies assist students in a learning environment [5].

5. Tasks, Actions and Operations
An activity consists of a goal directed hierarchy of actions that are used to accomplish the object- call them tasks, actions and operations that transform the object. Technology mediated learning is the performance of conscious
actions and consists of chains of actions such as switching on the technology, looking for where the program one wants to interact with, manipulating the program, etc. Actions are chains of operations e.g. technology operation. All operations are actions at the beginning because of their requirement of conscious actions to be performed [13]. In many incidences, with practice and internalization, activities crumple into actions and eventually into operations, as they become more automatic, requiring less conscious effort. The reverse dynamic is also possible: operations can be disrupted and become actions. So the relationships among activities, actions, and operations are dynamic, as indicated by the bi-directional arrows. So, activity theory looks at an individual learning in a distance learning community. Learning capability of an individual ranges from what a learner can do by themselves without help, and what they can do with help, which defines the zone of proximal development. Whenever a learner shows that they have not understood, teachers (more knowledgeable other) will always model the process and allow learners to try again.

![Diagram of activity, action, operation, motive, goal, conditions]

Nature of activities, actions and operations (Jonassen & Rohrer Murphy, 1999).

This is also true in a technology mediated learning environment, where a technology can present the materials to be learnt over and over again. Vygotsky’s assertions that teachers are able to assist learners build structures into which to fit new information- scaffolding may work well here. This is very much comparable in technology mediated learning, where there are tutorials, drills and simulations for learners. Eventually, learning develops from guidance from another to self-guidance, but this needs a sufficient background [25].

Social systems are dynamic and changing. It is only knowledge that serves purpose of effecting changes that should be mediated by technologies. There is therefore the need by everyone in the technology mediated learning environment to create knowledge for the future [26]. Bruner discussed the very vital elements of the structure of a discipline as embedded in knowledge. Even if Bruner’s concept of scientific knowledge is vague, a concept that comes out clearly is the fact that scientific knowledge can be taught to learners at any stage of development [27]. The conclusion is that learners on distance education programs are capable of developing higher order skills provided the appropriate technologies are identified and used to mediate learning tasks.

6. Implications of activity theory on distance technology enhanced learning

Research reports that in technology mediated learning activities, there is move from paper to screen. There is also a heavy presence of images and animated activities as tasks that arouse learner’s ability to critical thinking and evaluation. The contribution of such materials to learning may be very different from what is presented and static on the paperwork. This is what presents the contradiction necessary for learning higher order skills like synthesis and evaluation. Interesting to note however is that learning presupposes a very specific nature and those who learn usually learn the things around
them- learning is some kind of modeling. Nonetheless, such activities are action packed and many times they are hinged on the concepts that the learners are familiar with going all the way to higher order cognitive skills. It is the cognitive system of the learner that acquires and manipulates what has been learnt so that it can be used in a context.

Understanding the human cognitive mechanism underpins many aspects of learning [28]. The compatibility of the learning environment with the learners is pertinent to effective learning of higher order cognitive skills; because it is through it that we understand the constraints of a cognitive system. This is why it is of essential importance to ensure that a distance education environment in which the learner involves in technology mediated learning should be compatible with their cognitive development level. Researches in distance education have sometimes shown that appropriate technologies if put together with other rightful activities may facilitate the development of higher order cognitive development [6]. However, some studies have found out that though this may be true, it is not automatic [12]. An example is the research experiment by Jewitt on the learning language. It was found out that the technologies used provided learners with a number of tools to think. The learners in that environment were supported to learn about character although it is not an issue of personal growth; it requires learners to be analytical [29].

Technology mediated learning in distance education provides an opportunity for students to question what has always been taken for granted, an engagement that will lead to transformation and change[30] and certainly higher order cognitive skills. Some of these questions relate to the manner in which particular tasks are done way beyond applicability skill. Learners are able to question if they are working in multiple perspectives. Working in multiple perspectives requires knowledge of and respect for contested views, and recognition that these are valuable sources of intercultural dialogue and learning [31] - an aspect of higher order cognitive development. If such a dialogue is effective, it uncovers contradictions, facilitate learning and innovation and foster system change. By this happening, new knowledge is produced, learning would have taken place and a new identity of such knowledge would have been formed [31]. In the terms of Engeström, this is called expansive learning- which involves levels of high order cognitive development. This is how learning in distance education should occur. However, contradictions may not be fully resolved, but may be accommodated through consensus leading to continuity of society. Many scholars believe that practitioners in learning communities facilitate this process and contribute to innovations that may bring about sustainability of systems.

Research also supports the view that there are other sophisticated cognitive ways of using technology mediated learning to achieve some higher order cognitive skills outcome, such as making the information more meaningful, cognitively engaging, involving deeper cognitive processing, and making it ‘pop-out’ [28]. But all these involve very careful design of each and every activity in the process that is aimed at getting an output. It is already stated that the motive of the learner is of great use in the design. It relates well to the fact that activity theory identifies the way that objects
interact with the learners to bring about the outputs as listed here.

7. Conclusion
In order to understand technology mediated learning, it is better to look at what technologies bring to collaborative learning. First it has already been stated that learning is a social event and technology mediated learning occurs when the instructional use of the technology is combined with the cooperative group or individual. As students concentrate on content that the technology offers, the group dynamics may develop a more objective tone. For a cooperative project, learners need information. Technologies are very important in supplying this information in many ways. Each of the many ways is an activity. The many ways include information blanks like hypertexts and hypermedia, simulations, micro-worlds, games, virtual environments etc. [12]. Information and Communication Technology applications provide new tools to improved access to information and knowledge sharing in higher educational institutions [7].

Technology mediated learning is a recent innovation in distance education. It serves well therefore for any of the actors in to seek to understand it well and how it happens, who is involved and how they can take advantage of it. Vygotsky’s view of mediation in the zone of proximal development is theorized as a biological processes in a human being that are enable their transformation into higher cognitive functions through cultural artifacts. Much as learning begins from outside, it eventually forms part of one’s personality and self-regulation. This depicts the fact that learning, even at higher institutions of education is a social event. Building on the works of Vygotsky, Engeström projected the Activity Theory [20] which explains technology mediated learning. Educational institutions have innovations like technology mediated learning intended to deliver quality learning and higher order cognitive skills. A number of researches confirm that technology mediated learning helps learners engage in active learning. Activity theory helps us to explain technology mediated learning by defining learning as an activity full of so many activities. Those activities are full of actions and those actions become artifacts society comes to use as mediating tools to learning. The value of activity theory as a model is that it provides a credible, rich and ample framework for use in exploring technology mediated learning environments.

8. References


