Activity Theory Analysis of Virtualising Teaching and Teaching Environment in a Developing Country University

Article in Education and Information Technologies - July 2018
DOI: 10.1007/s10639-018-9774-7

3 authors:

Ibrahim Osman Adam
University for Development Studies
23 PUBLICATIONS 25 CITATIONS

John Effah
University of Ghana
38 PUBLICATIONS 106 CITATIONS

Richard Boateng
University of Ghana
69 PUBLICATIONS 653 CITATIONS

Some of the authors of this publication are also working on these related projects:

E-Learning in Higher Education Institutions View project

Virtualisation of Work Environment in Higher Education Institutions View project
Activity theory analysis of the virtualisation of teaching and teaching environment in a developing country university

Ibrahim Osman Adam, John Effah & Richard Boateng
Activity theory analysis of the virtualisation of teaching and teaching environment in a developing country university

Ibrahim Osman Adam1 · John Effah2 · Richard Boateng2

Received: 20 May 2018 / Accepted: 3 July 2018 © Springer Science+Business Media, LLC, part of Springer Nature 2018

Abstract This study aims to understand how a developing country higher education institution (HEI) attempted to digitalise teaching. The Internet has disrupted the traditional teaching environment and teaching practices leading to the migration from physical face-to-face teaching to online teaching changing the work environment of the teacher. Information systems literature has examined the academic environment of HEIs from student’s perspective in a virtual learning environment but not from the instructor’s perspective in a teaching work environment. How the teaching work environment can be virtualised has not also been widely explored. Using activity theory and an interpretive case study approach data was obtained from interviews, documents and participant observation. Using hermeneutics as the mode of analysis the findings reveal how tools: an open source technology and rules are modified through the resolution of contradictions to suit developing country context of the HEI. The study provides practitioners insights on how emerging contradictions in tools, implementers and rules in a teaching work environment virtualisation can be used as an avenue for development. It also offers insight into how HEIs can migrate their physical teaching environment to online.
Keywords  Virtual teaching · Work environment · Virtualisation · Activity theory · Higher education institution · Developing country

1 Introduction

The purpose of this study is to understand how a developing country Higher Education Institution (HEI) went through a process to digitalise teaching. The future of work is being reshaped by trends driven by information technology (IT). One of these trends is the virtualisation of work. The virtualisation of work involves moving physical work activity to online platforms where employees are untethered and are able to perform tasks anywhere at any time (Johns and Gratton 2013). Despite this growing virtualisation of work and work environment, Information systems (IS) literature on HEIs in the past has examined the academic environment of HEIs from the perspective of students in a virtual learning environment but not from the perspective of the instructors in a teaching work environment. Also, IS research on HEIs has concentrated more on technology virtualisation with less emphasis on work environment virtualisation. Moreover, the virtual work literature that exists on HEIs has largely assumed that virtual work exists and does not consider how virtual work environment is developed. This paper extends the existing research focus to examine the question of how HEIs in a developing country context can virtualise their teaching.

In addressing the question, the study uses an interpretive case study approach as the methodology (Barrett and Walsham 2004; Walsham 2006) and activity theory (Engestrom 2000; Leont'ev 1978; Vygotsky 1978) to understand how an HEI went through a teaching virtualisation process in a technologically mediated change (Allen et al. 2013). The University of Ghana (UG) is the case study site and was selected because the University has recently attempted to virtualise its teaching work through an offshore consultant using an open source technology.

The rest of the paper is structured as follows: we review the literature on work and work environment virtualisation. This is followed by the theoretical foundation of activity theory. The methodology and research context is described next. Based on the case study, the analysis and discussion are presented. The paper conclude by providing the implications of the study and suggestions for future research.

2 Work and work environment virtualization

The nature of work and the workplace is rapidly changing especially in an increasingly connected digital world, making some jobs and work places obsolete. This change has led to some flexibility in terms of where, how and when people work. The changing nature of the workplace is anchored on three pillars referred to as bricks, bytes and behaviour. These three pillars represent the work location, use of Information Technology (IT) and the relationships between employees and management (Lee 2015) with IT being the key trend shaping these changes (Cummings and Worley 2014).

The Higher Educations Institutions (HEIs) workplace is no exception to this change. HEIs are characterised by two main work activities in its work environment; academic and administrative. A work environment is a space in which work is performed (Bødker
and Christiansen (2002) and includes the surrounding conditions which may be physical, such as the physical office space or equipment and work processes or procedures. Over the years, work has been performed in work environments characterised by a physical office and physical workflows where employees share a common workspace and may not necessarily collaborate using communication and collaboration tools such as email and video conferencing (Schweitzer and Duxbury 2010).

Traditionally, teaching in HEIs have been conducted in physically located classrooms and lecture halls with the use of physical tools such as chalk, markers, marker or chalk board, physical office cabinets, paper-based lecture notes and physical workflows with participants having to travel a distance to attend class or lectures. Though technology in teaching and administration in HEIs appears to be dramatic, it can be traced back to the use of legacy systems to teach and perform administrative functions (AlQashami and Heba 2015; Skoumpopoulou and Nguyen-Newby 2015; Waring et al. 2011).

Information communication technologies (ICTs) such as smartphones and tablet computers have contributed to changing work in the twenty-first Century. An important aspect of this change has been the detachment of work from traditional office spaces. Majority of work these days is supported by Internet technologies making it possible for work to be conducted from anywhere at any time (Messenger and Gschwind 2016). This way of working remotely is not a new concept and has existed in forms enabled by early applications of ICT such as telegraphs and telephones for over a century (Leonardi et al. 2010). Where the work of individuals or teams span several different boundaries such as time, space, organisation and culture and the work is electronically mediated, it is usually described as virtual (Watson-Manheim et al. 2012). Virtual work may take the form of telework (telecommuting) which involves individuals working partly or completely externally from their organisation’s workplace with the support of ICT services (Boell et al. 2013; Böll et al. 2014).

Telework has evolved over the years. Messenger and Gschwind (2016) have traced this over three generations to include the home office, mobile office and virtual office. The home office refers to the reduction in commuting time through the relocation of the workplace either partially or wholly outside the employer’s premises and closer to or in the employee’s home. This is done to avoid long and expensive hours of commuting between home and work. The second generation is mobile work which involves smaller wireless devices like smartphones, notebooks and laptops which enable employees to work from home or anywhere they need to work (Bailey and Kurland 2002).

Makimoto and Manners (1997) predicted that future work would be conducted anywhere on the move. When smartphones and mobile devices arrived, it changed the use of technology so much that the third generation of Telework could only be described in terms of these mobile devices called ‘New ICTs’ (Golden and Geisler 2007). Messenger and Gschwind (2016) call this generation virtual office. In the second generation of the mobile office, work was made mobile and all information could be carried around all the time. In the new work generation context, information is stored in clouds and through networks, one only needs a tiny device to access information seamlessly. This has transformed work and many aspects of work can be conducted instantaneously in one’s palm. This enables work to be performed externally from the employer’s premises within a little time frame (Heijstra and Rafnsdottir 2010). Virtual work is carried in workspaces situated in between the home and the office and presents a new workspace enabled by digital network technologies in what Kingma (2016) refers to as the third workspace.
The process of moving physical processes of work and the work environment to a
digital platform is called virtualisation. Virtualisation has been widely discussed in the IS
literature and three themes characterise the virtualisation literature in general. These are
technology virtualisation, work virtualisation, and process virtualisation. Technology
virtualisation represents an information technology (IT) perspective and involves the
process of creating logical computing resources from available physical resources by
creating a layer of abstraction between workloads and the underlying physical hardware.
This type of virtualisation covers the virtualisation of servers, desktops, data, networks and
storage. The human work experience is also being virtualised. More and more people are
able to work remotely because technological advancements make it possible for em-
ployees to telework and to collaborate as part of a virtual team (Waters 2015). Today, it’s
commonplace to work with team members in different buildings, across a country, and
even across the globe. Technology advancement changes the experience of working
physically to working virtually. There is also process virtualisation, and this involves
how physical processes can be moved to the virtual environment (Balci and Rosenkranz
refers to the migration of physical activities into a virtual environment such that rather than
being conducted through physical contacts between humans and objects, such activities
are conducted via the Internet and web information systems. This trend also includes the
migration of organisations from physical to virtual (Hemingway and Breu 2003) where the
overall existence or part of and not just processes are available online.

In HEIs, virtualisation has largely been discussed in terms of technology
virtualisation with a concentration on how technology virtualisation can be applied in
teaching and learning (BouSaba et al. 2010; Dawson Jr et al. 2013; Dobrilovic et al.
2012; Hemanth and Mahammad 2016; Mirzoev 2014). In HEIs, technology
virtualisation has been discussed in many areas of HEIs technology adoption such as
the involvement of desktop virtualisation to offer energy cost saving by deploying
numerous applications which may sometimes conflict with each other on a traditional
desktop (Erskine and Füstös 2013). Horalek et al. (2015) also explored a range of
virtualization technologies in the implementation of a virtual laboratory to serve as an
educational tool. Studies such as (Mohapatra 2015; Mohapatra and Mohanty 2017)
have also explored the various factors that influence the adoption of online education
and learning. Though IS research has explored the virtualisation of the administrative
work environment in HEIs (Adam et al. 2016a, 2016b; Adam et al. 2017) not much of
the literature has explored teaching environment virtualisation.

The study seeks to use activity theory to understand the virtualisation process
because, though activity theory has been widely used in higher education in the areas
of collaborative learning (Greenhow and Belbas 2007), online social networking for
higher education (Hamid et al. 2010), evaluation learning technologies (Scanlon and
Issroff 2005), the theory has not been applied in the area of work and work environ-
ments in HEI context in developing countries.

3 Theoretical foundation: Activity theory

Activity theory is a theoretical framework that proposes that on human interaction
through the use of tools leads to an outcome. The foundation of the theory is the

 Springer
understanding of human activity. An activity is made up of an actor (subject), and an objective (object) which are facilitated by the use of a tool (Leont'ev 1978). Activities do not occur in isolation but within a societal context. This social consists of a community, rules and division of labour, which support the co-operative nature of the activity’s environment. All the different components of an activity and its environment are in a network called an activity system (Engestrom 1987b) (Fig. 1).

An activity system is a key principle of the theory and is considered the unit of analysis. Contradictions is another principle, which explains that activities are moulded by other activities and the activities environment. The influences from other activities and the influences from the main activity’s environment may sometimes cause tensions or contradictions (Engestrom 1987c). When tensions occur and intensify, the activity system may change and the object and motive of the activity may be achieved through an expansive transformation (Engestrom 1987c).

AT has been applied in different areas of IS research, including computer-supported cooperative work (Kuutti 1996), technology development, adoption, implementation and use in education (Issroff and Scanlon 2002), assessment of learning technologies (Scanlon and Issroff 2005), and information system development (Korpela et al. 2004; Mursu et al. 2006).

Activity theory is ideal for analysing this study because the assumptions of the theory are very consistent with the phenomenon under study. First, the work environment virtualisation is an activity, and this is consistent with activity theory which considers the activity as the basic unit of analysis (Jonassen and Rohrer-Murphy 1999). In addition, activity theory in this study provides a well-developed framework for analysing the complex dynamics of the HEI setting. These settings involve a lot of social and technical elements comprising of different human actors (Crawford and Hasan 2007) and it is the researchers’ view that this view of the socio-technical is appropriate in complex settings. Finally, work environment virtualisation involves drastic changes in information technology in organisations, and such changes provide

![Fig. 1 The structure of an activity system (Engestrom 1987c)](image-url)
interesting organisational events for examining the expansive development of work activity (Ripamonti et al. 2016).

4 Research methodology

The study adopted an interpretive case study method (Walsham 2006). The interpretive philosophy aided the researcher’s understanding and conceptualisation of the virtualisation process in the HEI contexts as a research phenomenon by assuming that as various stakeholders within and outside of the HEI environment interacted with the world and with each other they constructed subjective meanings and understandings through their interactions (Orlikowski and Baroudi 1991). This meant that virtualisation of the teaching work environment as a reality could only be understood through the social understanding and interpretations of the actors (Myers 1997, 2013) and through the meanings that the HEI and its external consultant assigned to the reality (Orlikowski and Baroudi 1991).

Data was collected from multiple sources including interviews, documents and participant observation (Myers 2013). To understand the subjective interpretations and views of the participants, semi-structured interviews were used (Walsham 1995). The number of participants was arrived at when the researchers realised that the responses of participants were repetitive and that new information was not being gathered (Guest et al. 2006). The participants included 3 project consultants, 3 members of the local project team, 3 management staff and 10 lecturers identified through purposive sampling. The project consultants, the local project team and the management team were purposively selected. The projected consultants, local project team and the management were selected because they were directly involved with the virtualisation process. The first two lecturers were selected purposively because they have led the use of the learning management system in the University and had adequate knowledge and experience of the system. Through these two lecturers, eight other lecturers were identified through snowballing. However, when the researchers interviewed the eighth person it was realised that the data that was being provided repetitive. At this stage, data saturation point was deemed to have been reached and the interviews were stopped. The interview guide, which was used to support the interviews, were developed using the various elements of the activity system of the virtualisation activity. This enabled the researchers to access the interpretation of the interviewees that were relevant to the research phenomenon. Documents such as minutes of meetings, email correspondence, requirements documents and project reports and user manuals were reviewed. These documents related to the various phases of the virtualisation process and were relied on because it provided data on insight into several aspects of the research phenomenon. During the data collection, the first author who observed and participated in the use of the virtual teaching environment as a teaching assistant.

The data collection and the data analysis were conducted concurrently (Myers 2013) and was inductive. The first stage in the data analysis was immersion in the data (Green et al. 2007). This involved listening to the recording of each interview especially when so much time had not elapsed, transcribing it, reading and re-reading the interview transcripts instead of waiting until the end of all interviews. Next, the transcripts and
documents were coded. The next stage was the creation of categories. This involved examining the way the codes could be linked in order to create coherent categories. The main themes of the analysis were drawn from key concepts from the virtualisation activity system.

5 Case study description

The University of Ghana (UG) was established in 1948 and is Ghana’s premier University. Ghana is a developing country located in sub-Saharan Africa. It has a population of about 45,000 full-time on campus and distance students and about 1000 lecturers. UG has an administrative staff strength of about 2000. UG has three campuses, which are situated at different parts of the national capital in the southern part of Ghana. UG also runs distance-learning programmes throughout the country. It has centres in all the ten regions of the country. These centres serve as the campuses of the students who are enrolled in the distance learning programmes. Over the years, the centres have been the central points for the students to meet their lecturers and course facilitators for tutorials and guidance. This has proven very expensive administratively for the University.

The University has made attempts to incorporate ICT into teaching over the years and this goes as far back as 1994/95. In 2004, the University introduced the Knowledge Environment for Web-based Learning (KEWL) now KEWL.NEXTGEN (KNG) as an e-learning platform. KEWL.NEXTGEN was developed at University of Western Cape (UWC) as an open source learning management system. However, only 27 lecturers were confirmed to be using the learning platform in teaching after three years of its introduction of KEWL.NEXTGEN.

To ensure proper outreach with the University’s distance learning students, reliable internet connectivity was extended to all the 10 regional centres of the Institute of Continuing and Distance Education and fully equipped computer laboratories and video conferencing centres were established. This phase also introduced an Integrated Digital Mobile Learning Platform (IDMP) to provide distance education students with an internet-enabled mobile tablet device pre-loaded with specialised software that will have several applications to access digital textbook, register for programs and courses at the beginning of each semester using the internet enabled mobile device. This brought a lot of hope to many lecturers and students. One lecturer indicated that:

Lecturers spend so much time and effort from the process of making assignments available to students and its submission and return to students. These puts a lot of pressure on lecturers.

The idea of using Sakai as a better alternative teaching and learning system was introduced and following discussions with the UG management, the trial version of Sakai was adopted. After piloting it on some programmes and courses with some distance education courses, the University adopted the Sakai as campus-wide course management platform in place of Knowledge Environment for Web-based Learning (KEWL.NEXTGEN) in 2012. This served as the beginning of the movement of purely classroom based teaching to some level of virtuality in the UG teaching environment.
Evidence from the data points to the involvement of a key management figure who was instrumental in the choice of Sakai and at the critical stages of the virtualisation. For instance, whilst the University has a designated IT management unit for computing services to provide the computing needs of the University community in terms of hardware, software requirements as well as training, this individual had become a critical member of the training team for faculty use of the system. A staff of the IT management unit put it subtly that:

Sakai was this individual’s idea. He pushed for the University to adopt it when he returned from overseas and enquired about the teaching platform that was in use. The one in existence then could not support many of the teaching aids he wanted to use.

Whilst the IT management unit has the capacity to train and support academic staff in their use of the system.

This individual has become a critical and co-opted member of the Sakai team to the extent he is the leading trainer in both classroom sessions for academic staff and the virtual trainer in training videos on how to use Sakai.

Sakai is supported by a community and commercial affiliates. It has a very configurable environment and at the technical side there are over 500 different properties or settings that can be turned on and off. Every Sakai implementation looks different depending on how that particular organisation decides to configure Sakai. Sakai can easily be integrated with an HEI’s existing applications. Sakai can be shared, hosted and managed by a third party. After choosing Sakai, UG decided that it would be hosted through a commercial affiliate. This option is very helpful when the organisation does not have the needed IT staff who can get Sakai set up and configured. UG chose a commercial affiliate through a tender process. Three tenders were received and Longsight was chosen. The choice UG took depended on the staff capacity, the number of courses that it wanted to put on Sakai and the number of courses that existed in the teaching environment of UG.

UG went through an iterative process with their commercial affiliate in the quest to virtualise the teaching work environment. First, it went through a phase of planning and requirements gathering. This was the stage that a lot of effort was put in to understand UG specific and general needs before the decisions of how Sakai was going to implemented was made. Sakai was not the first system to have been adopted by UG. Therefore, the past experiences of adopting KEWL and attempting to adopt Bluefish had given UG some great level of exposure and level of requirements they need. Several sub-processes were undertaken at this stage. An implementation team was constituted the moment UG decided on Sakai. The team consisted of an instructional designer, end-user support, project manager, trainer, developer, database administrator and systems administrator. Though these were separate roles, one person held several roles and performed the duties because of the level of expertise of the UG team. The next issue was to determine the pilot group with which to try Sakai on.

The requirements for Sakai involved establishing the hardware and hosting needs as well as technical configuration needs and disaster recovery expectations. In establishing
the technical configuration requirements UG had technical meetings with the affiliate to understand the different configurable options that are allowable in Sakai. Following this UG went through the functional configuration requirements of the account types, user account permissions, user workplace templates, site types (course, project or portfolio), tool configurations, course roles and permissions, etc. In effect, the requirements were to meet the needs of who should be logging in and what they should be allowed to see or do. This was to ensure that students do not see or do the same things as the lecturers. UG was particular about these requirements because some of them especially the roles become difficult to do after creating courses in Sakai.

It was also at this stage that the authentication and authorisation requirements were set. This had to do with how users will log in. Sakai was to be integrated with existing user log-in like the Integrated Tertiary Software (ITS) using the existing active directory (AD) and CAS. This meant that the integration requirements needed to be established too. Finally, a skin and name requirements was raised. UG decided to maintain Sakai as the name.

The next phase was to install a development or test instance. This involved installing Sakai production instance on UG’s hardware. Key tasks that occurred at this phase involved performing the technical and functional configurations, testing it and resolving issues found. Integration and the creation of processes for user authentication, user enrolment as well testing and resolving emerging issues were also conducted. At later stage of the virtualisation other external integrations such as the integration of turnitin were conducted. Throughout these stages, the consultant provided the support services to ensure the smooth configuration and implementation. For instance, the Sakai Administrator indicated that:

We agreed that all issues will be dealt with at the local level and will only be escalated to Longsight if it cannot be handled by UG. Since we brokered this contract, there has never been an instance where we had to escalate to Longsight.

The next phase was largely a test and fix stage, though this happened throughout the phases. This was where some students and lecturers were made to log in to check if courses and other resource settings were in place and to ensure that they are able to do the things they should do. At this stage, changes were made to the configurations based on the test results. After this, Sakai was released to the pilot group in order to gather more feedback. Other changes were made to the Sakai configurations based on the pilot group feedback.

The fourth stage was the support, migration and course design phase. There was the need to have a plan to deal with the numerous issues that will be reported from the different user groups. A user support plan was therefore instituted to deal with expected feedback, and a training plan was also carved. The UG team also considered a migration plan. In this plan it was possible to migrate from the previous platform into Sakai but this could not happen.

In this community UG and Longsight openly shared knowledge and UG was dependent on Longsight for the support. The community was based on a clear leadership that provided direction in the UG context. This shaped the collaboration a lot. There was a hierarchy of leadership and communication but the community was still that which exhibited equality because there was no lording of team member
decisions over others. Everybody’s opinion mattered. This was because as one UG project team member stated:

Working in this team needs collaboration. Having good team members within UG and good collaborative efforts with the consultants was critical.

Before the implementation of Sakai, UG had purely manual teaching work processes. This meant that it has been a difficult and cumbersome task moving the physical classroom environment to the virtual work environment. Despite this difficulty, UG has been able to successfully set up a lot of courses on Sakai with few problems. This is supported by the Sakai systems administrator that:

There was no need for UG to rely on external support so much because with the University Computing Services Unit, we have the expertise to be able to implement Sakai. Though a little bit of realignment had to be done to put some staff on the Sakai project.

To ensure a successful pilot and set up, the culture of the UG environment to accept and adopt the system to manage courses was very critical. In order to ensure uptake in some departments, a lot of effort on the part of the project team was needed to create an atmosphere of need for the system as against the history of teaching using traditional means, which has been the norm for decades. A member of the UG project team stated that:

The UG community, goals, culture and history have had a huge influence on how the project team worked. We have been working here for long, we knew the culture of productivity here, and we needed to work hard. This is what we were going to be judged by. It could not fail.

The course management system was finally rolled out in 2012 as a university wide virtual teaching work environment. Log in is enabled for three category of users; lecturers, students and administrators. Upon log in the lecturer is presented with a ‘My Workspace’ in the system, which shows the message of the day and any course announcements, calendar, and message notifications. There are also links to account utilities, enrolled courses, and other system-wide resources. This is the work environment where the lecturer can keep personal documents, create new sites, maintain a schedule and store resources among others. The teaching workspace provides several tools for use by the lecturer. There is a resources tool that allows the lecturer to share a variety of files with their students by uploading the files, creating and posting HTML (web) pages, simple text documents, library citations, as well as share links to useful web sites.

There is no limit to the virtual membership of students to the platform and the lecturer can reach students easily through the virtual platform, anytime anywhere except those who are not part of the physical class setting already. One lecturer indicated that:

This has made things very easy for me to reach out to my class on the go. If I need to extend the submission deadline of an assignment, the rigour of having to
contact the class representative to pass the message on is no longer there, I will just change it in the system and everybody is alerted on the new submission deadline. The outreach is quick and instant saving a lot of time.

Lecturers can organize their files and links into folders and subfolders making it easier for students to locate and access items. The lecturer can do this through automatically notifying the by email that an item has been added to their resources. There is also a syllabus tool that provides a place in the course site to post a syllabus for students to access and a schedule tool to post events in a calendar format. To make an announcement, the lecturer can add a title and content of the announcement and can determine who can view the announcement. If the lecturer wants the announcement to display during a specific time frame, specific dates can be chosen as well as add attachments to announcements. For instance, if the lecturer wants the assignment due date to be added automatically to the schedule or calendar of a class, it can be added. An announcement can then be automatically posted to the site regarding the open date for the assignment. When assignments are submitted, the lecturer may choose to receive notifications of the submissions. When the assignment is assessed a grade notification may be sent to the students. Apart from the assignment, additional attachments such as a grading rubric or peer review rubric can be added by the lecturer. One lecturer expressed how Sakai has reduced his interaction with students and how he deals with student assignments in terms of grading and giving instructions to students by saying that:

In the past I had to assign my teaching assistant to collect all assignments in hardcopy, now everything is submitted through Sakai. This has provided a relief in dealing with volumes of paper work.

For other forms of assessments like tests and quizzes, the lecturer can add multiple choice questions or short answer questions. There are collaborative tools that facilitate communication in the teaching environment between students and the lecturer and between students. These are chat room, wiki, blogs, email, forums, polls, and rosters. One lecturer indicated that:

The system has made things very easy for me to reach out to my class on the go. If I need to extend the submission deadline of an assignment, the rigour of having to contact the class representative to pass the message on is no longer there, I will just change it in the system and everybody is alerted on the new submission deadline. The outreach is quick and instant saving a lot of time.

6 Analysis of findings

This section presents an analysis of the findings.

6.1 Background and context of teaching in the teaching work environment

The tools in use in the traditional teaching work environments were marker boards, markers, projectors, projector screens and computers with paper-based course
materials. Others were physical office cabinets, physical files and folders, physical calendars, office trays, letter boxes and notice boards. The subjects were lecturers and teaching assistants who used the physical tools and interacted physically with students. The rules were in both physically written documents and in soft copies. Some rules existed in the forms of norms and work practices ingrained in the physical teaching environment that has come to be formally accepted. The majority of the rules are in the form of policy documents, job descriptions defining the scope of work of staff and directives.

6.2 The evolution of teaching activity and the teaching work environment virtualisation

During the virtualisation of the teaching work environment, some actions were taken to complete the virtualising activity and these were the requirements gathering, installing, configuring and integrating Sakai, testing and fixing issues that emerged, course design and migration and the final release. The table below presents a hierarchical analysis of the activity of virtualising the teaching work environment. By allowing for the drilling-down of the virtualisation activity into the actions, AT provided the opportunity to consider a deeper level of analysis of the virtualisation in the context of the HEI. This indicated how the actions fed into the central activity of virtualising the teaching work environment presented below (Figs. 2 and 3).

6.3 Activity system analysis of the teaching work environment virtualisation

The teaching work environment virtualisation activity system are depicted in diagram 2.

UG and Longsight were the subjects and they used tools such as the SQL, Java and other internet and web technologies in the virtualisation. Within the UG community the

![Diagram](attachment:image.png)

**Fig. 2 Virtualisation of teaching work environment activity system** (Engestrom 1987b)
other stakeholders were UG IT management Unit, students, and lecturers. The object was to virtualise the physical teaching work environment. The interaction between Longsight and UG occurred at various levels and was guided by rules such as plans and roadmap of implementation developed by UG, requirements documents, and the contract agreement. The contract included the division of labour.

### 6.4 Mediations and contradictions

Evidence from the data showed two key relationships which were identified as crucial for the understanding of virtualisation of the teaching work environment. The first was the relationship between the UG project team and Longsight (Subjects) and the objective (Object) of customising and implementing a virtual teaching work environment system. The second was the relationship between the UG project team, Longsight team and other stakeholders (Community) and the objective (Object). This meant that the tools, rules and division of labour mediated the virtualisation activity in the HEI context throughout the process. The various mediations are presented below:

#### 6.4.1 Java, SQL, internet and web technologies as mediators

The primary tools used were Java, SQL and other internet and web technologies. This was corroborated by UG’s expertise to fully use the tools. Another tool was the quick identification of a pilot group and courses with which UG could pilot its implementation. UG has attempted to virtualise its teaching work environment in the past, and so has experience from the implementation of KEWL and the attempted implementation of Bluefish. The experience from this was used as a learning tool to support the initial stages of the Sakai implementation to deal with some challenges at the early stages. The expertise of the UG local team, the experience of UG in systems implementation and its access and use of Sakai as an open source technology were key driving forces. This facilitated the virtualisation because since UG had the expertise, establishing the technical configuration requirements as well as the hardware requirements did not take
much effort and time. Within the UG community, it was evidenced that there was some lack of effective feedback loop from users of the system. First, the level of feedback was proportionately low considering the fact that a pilot group was used at the initial stages of the implementation and the feedback was not entirely representative of the UG teaching work environment. Though some positive feedback had shaped the system at the initial stages, feedback did not cover many system issues because the pilot group did not cover a larger part of the UG work environment.

The data also revealed that, after the pilot the level of feedback was expected to escalate leading to more iterations resulting from a campus wide use. Unfortunately, this was not so partly because though the system was available for use by lecturers and students, many of them still do not use it and this resulted to low feedback. It was also revealed that there was no unified documentation to enforce faculty use of the system. If such a documentation or policy was available, widespread use of the system could generate more feedback for refined development.

6.4.2 UG policies and its contract with consultant as a mediator

Some existing rules on the teaching work environment facilitated the virtualisation. First at the UG level, the rules on providing course outlines, lecture timetable, assignment and quiz dates, and announcements fitted very well with the structure of the Sakai platform. At the commercial affiliate level, these rules provided Longsight the foreknowledge of how to support UG. This was because they have offered similar support to other universities and could transfer that experience to UG. The contractual agreement between UG and Longsight and the terms there in facilitated the virtualisation. Longsight offered support and hosting services to UG and this guided the relationship between the two actors. For instance, the agreement contained the fact that Longsight will offer some training support to some technical staff of UG to be able to handle many issues at the local level. Within the agreement there are clauses dealing with how UG can contact Longsight in emergencies.

6.4.3 UG’s leadership in choosing Sakai as a mediator

In UG, there was a clear sense of leadership and direction of management and this was instrumental in UG’s decision to adopt Sakai. The decision was largely influenced by some key management personnel who had prior experience and knowledge of Sakai in a different academic environment. This individual had championed this and later became an active lead in the training of UG faculty to use the system. UG had a training plan with technical team members who had been carrying training sessions across faculties and campuses of the University to ensure that both lecturers and students have adequate knowledge to use the system.

6.4.4 Contradictions

From the mediations, the several contradictions emerged. Some of the contradictions were primary and occurred within the elements of the activity system. The other contradictions were secondary and occurred between the elements.
6.4.5 Contradictions in implementing virtual teaching and virtual teaching environment (contradictions within object)

The virtual teaching environment attempted to replace some aspects of the traditional teaching and teaching environment. This replacement eliminates existing interactions, which has existed for a long time. This created tension because the object (i.e. implementing a virtual teaching work environment) has both positive and negative effects on the University community. The tension was because of the adjustments some lecturers had to make to the new ways of teaching. However, the UG local team were completely aware of the interdependencies and work practices that existed in the traditional teaching environment and how these work practices are eliminated or affected by the virtual environment.

6.4.6 Contradictions in work practices and agreements (within the rules)

Within UG, there is no enforced policy to ensure that every single academic staff uses Sakai to manage courses. This contradicts the policy objective of adopting Sakai as University-wide system to manage teaching. The community was distributed because the commercial affiliate is an offshore consultant whilst UG is local. Despite this, there is still a strong sense of community for those community members involved in the virtualisation process.

6.4.7 Contradictions within tools

The mediating tools of the virtualisation activity were varied from physical tools (e.g. a technology such as servers), conceptual such as UG work practices, collaborative practices, programming languages, etc.). All these technologies were used to facilitate the virtualisation. There were practices of rapid testing with immediate feedback with the pilot group, taking into consideration improvisation, and a user-driven development, and all these were seen as an effective strategy that served the primary purpose of building a working system. A bottom up and reactionary approach to development was adopted using the pilot team. At a general UG level, the evidence did not portray any contradiction in tools. All faculty and the UG project team were provided with the requisite tools for the virtualisation process. However, at the faculty level, especially with the school of continuing and distance education, and with the students on the distance learning programmes it was realised that whilst the system’s complete uptake was partly reliant on the teaching staff’s engagement with distance students through the use of the system, it was expected that these interactions would result in critical feedback. The contradiction was in the fact that whilst students were provided with mobile devices to have continuous access to lecturers and resources on the go, the lecturers and facilitators of these programmes were not adequately resourced. Other infrastructural deficits in terms of electricity power outages and unreliable internet access affected the process.

6.4.8 Contradictions between object and division of labour

Contradiction lay in the object (implementing a virtual teaching work environment) and the division of labour. This was because one person was critically influential for the...
choice of Sakai, when in fact there should be a collective influence in choosing the system. The contradiction was that, other community members and some management personnel viewed the initiative as the brainchild of one person who wants to be relevant for a long time in the institution. This to some extent created some tension in some quarters of the IT management unit because some staff felt their job is being taken over by the academics. This contradiction was resolved through an understanding that whilst Sakai may be portrayed as University wide initiative, it is pertinent to understand that, the project was initially designed for only a school/faculty of the University to support its growing number of distance education students. This key individual was a principal officer of this faculty, the success of the Sakai project was a critical part of school’s achievement and growth, and hence his un-relented involvement in all parts of its implementation to make sure it succeeds. Whilst this does not preclude the fact that the IT management unit and its staff should be trainers it justified the involvement and reduced the tension that had existed.

6.5 Activity systems analysis overtime

The analyses present the activity system of the traditional teaching work activity, the virtualisation of work activity and the virtual work activity. The traditional work activity presents a historical analysis of the virtualisation; the virtualisation activity systems represent the activity that led to the achievement of the virtual work, which represents the overall outcome of the virtualisation of work in the HEI. This approach was taken in the analysis because activity theory provides a methodological tool for the analysis of ongoing projects over time. Therefore given that AT provides a snapshot every time it is used, it can be relied on over time to give the trajectory of the IS development and how contractions and tensions change over the life of a developmental project.

The physical teaching work environment that was mainly physical created led to a lot of delays, duplication of teaching materials and overall bureaucracy, and so when the project to virtualise the teaching work was being started, the teaching staff backed it. During the virtualisation some elements of the teaching activity have been transformed while others have been replaced with advanced elements in a different or advanced form of the work environment. This is seen in Fig. 2. An activity’s evolution from start to finish may result in changes in the actual persons constituting the subject(s). The members of the community may also interchange their roles. However, in the new form of work environment the traits of the previous elements carry the traits of the previous. This means that the nature of the new elements is rooted in the history of that element.

The new mediational tools have changed from when work was physical through the virtualisation to when it became virtual as seen in Table 1 below.

For instance, the objects to which activities are directed are varied in the three states. In the traditional teaching environment, the object was to carry out teaching physically. This changed to developing and implementing a virtual teaching environment and finally to carrying teaching work virtually. The tools used in the traditional environment, which was largely physical, changed to a use of the physical tools by both UG and Longsight in the development of the virtual teaching. However, in the virtual teaching environment the tool became a virtual work IS (Sakai). The subjects were
<table>
<thead>
<tr>
<th>Tools</th>
<th>Traditional teaching environment</th>
<th>Virtualisation of teaching environment</th>
<th>Virtual teaching environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>Lecturers, Students of UG</td>
<td>University of Ghana, Longsight</td>
<td>Lecturers and Students of UG</td>
</tr>
<tr>
<td>Object</td>
<td>Carry out teaching work physically/ manually</td>
<td>Develop/implement a virtual teaching work environment</td>
<td>Carry out teaching work virtually</td>
</tr>
<tr>
<td>Rules</td>
<td>Policy documents, lecture timetables, announcements</td>
<td>Master Service Agreement</td>
<td>Rules for faculty members request for their courses to be created on the Sakai platform</td>
</tr>
<tr>
<td></td>
<td>paper-based letter, memos, etc.</td>
<td>Scope of work</td>
<td>Rules on the upload of lecture resources such as lecture notes, assignments etc.</td>
</tr>
<tr>
<td></td>
<td>Physically file documents in physical folders and cabinets</td>
<td>Requirements documents</td>
<td></td>
</tr>
<tr>
<td>Community</td>
<td>University of Ghana</td>
<td>University of Ghana, Lecturers, Students, Longsight</td>
<td>University of Ghana</td>
</tr>
<tr>
<td>Division of labour</td>
<td>Different roles for Lecturers and students</td>
<td>Different roles for UG and Longsight</td>
<td>Different roles for lecturers and students staff</td>
</tr>
</tbody>
</table>
teaching staff in the traditional teaching environment but during the virtualisation, these became UG and Longsight. In the virtual teaching environment, the lecturers emerged again as the subject. The rules have also changed from the norms and practices of writing lecture notes, assignments and so on in paper-based forms to rules guided by service agreements, scope of work documents and requirements documentation in the virtualisation process to rules regarding lecturer workspace, files and folders that need to be set up in the virtual environment.

7 Discussion of findings

7.1 The historical emergence of the traditional teaching environment

This section discusses the findings in the historical context of the HEI and how it influenced the virtualisation. One key tenet of activity theory is that activity have a history (Jonassen & Rohrer-Murphy 1999). This means that it does not suffice to simply describe the virtualisation of the teaching environment in its current state, the history of the teaching environment must be understood to appreciate how the virtualisation emerged and developed over time. The virtualisation process was facilitated by the UG’s history of already having course listings, which fitted the Sakai structure, and so facilitating the preparation and setting up of courses online. This also supported the fact that the virtualisation activity however, did not exist in isolation, but that it existed within a context. The traditional teaching environment that was mainly physical led to a lot of delays, duplication of teaching materials and overall bureaucracy, and so when the project to virtualise the teaching work was being started, many lecturers bought into the idea and fully supported it.

The virtual teaching environment is a socio-technical system that consist of people, processes, information and technology (Alter 2009; Sarker et al. 2013; Silver and Markus 2013). To develop it therefore, the HEI context was considered and understood through a rigorous planning process by UG. This was necessary because when IS is being developed for a developing country like Ghana and the systems developers are from a different context (Tiihonen et al. 2010), a lot of consideration and care is needed. The consultants were from a different context- the US. As a result, the context was very critical in the study. Though the idea of context in IS research remains very broad (Allen et al. 2011), this study perceived context as a dynamic and changing variable and this is consistent with the cultural-historical perspective which views context as a contributing factor of history, embedded in action (Allen et al. 2011). Therefore, the present context of study is a result of the social pressures of the past and the past actions within the HEI, which has giving rise to current practices.

The virtual teaching environment was seen as an innovation embedded in the HEI context. As a result, the development and implementation of the virtual teaching environment was considered in relation to the socio-organisational nature of the HEI. This was because UG was currently embarking on massive change to make it an excellent research oriented institution and had currently adopted the collegiate system. Therefore, both the local organisational context as well as the national and international context of HEIs was critical. The technical decisions and actions involved in the development and implementation process was critical especially in the choice of
international consultants (Avgerou 2001) who had wide experience in developing systems to meet complex needs such as that of UG. Therefore the social and organisational context are both critical in the construction of the virtual teaching environment (Effah and Abbeyquaye 2013; Effah and Nartey 2016). The unique nature of the HEI was also important in shaping the virtualisation. According to Pollock and Comford (2004), HEIs are unique and different from other organisations because of their complexity of purpose, limited measurability of outputs, diffused structure and authority, and internal fragmentation. The social context influenced the process through cultural and institutional forces (Meyer et al. 2011) which restrain undesirable behaviours and suggest what was legitimate and expected and may shape organizational strategies and structures (Scott 1995). By constraining and enabling certain actions and behaviours, some contradictions emerged and as a result shaped the overall process.

The key motivations that led to the introduction of the virtual teaching environment were the constant outreach support and services that will be provided to the growing numbers of the HEIs distance education students and regular on campus students. Easy access to content and rapid communication with lecturers and distance education facilitators, ease of conducting assessments and offering feedback to students were some of the driving forces. The long periods of delay, bureaucracy and red tapes that had bedevilled the traditional teaching work environment and the drudgery of delivering lecturers on a face-to face basis, submission of paper based assessments, tests and quizzes in the teaching work environment were some other issues that drove the change from the physical work environment to the virtual.

Institutional influences such as the organisational strategy to become an excellent university was one of the reasons why the University wanted to virtualise its teaching environment. This is because it is in line with the University’s recent efforts towards a competitive organisational change, so there was the need to strategically align the IT needs with the vision (Henderson & Venkatraman 1993).

UG has harboured plans to virtualise its teaching work environment for long. This is seen in its failed efforts to virtualise through KEWL and Bluefish. Based on its experience it has learnt that to successfully virtualise its work environment, a strong collaborator who could offer technical support was essential. This drove the UG collaboration with Longsight towards a shared object. Though the poly-motivational nature of an activity can lead to difficulty through several contradictions (Karanasios and Allen 2013; Uden et al. 2008) which may hamper the outcome, this was not so in this activity. However, the object was reconstructed through a process of engagement and negotiation with the external consultant and the community before it was realised. The open source nature of Sakai, which was a key tool, facilitated the iterative nature of the development of the virtual teaching platform. This is because emerging requirements could easily be factored into the development.

The execution of the work environment virtualisation as an activity involved the actions of requirements gathering, design and development among others taken towards short-term goals. Whilst there may be legitimate alternative actions that can lead to a successful performance of an activity, the actions in the virtualisation process were considered necessary because the feasibility of different solutions to virtualising the teaching environment were considered. This is supported by Suratmethakul and Hasan (2004) that it is common practice in IS development to consider the feasibility of
different design solutions to an organisational problem such as the virtualisation of the work environment and then choose one solution to implement based on a number of factors. This notwithstanding, it is possible to allow concurrent and different solutions by following different sets of actions for an activity under different circumstances especially if the context differ. The view of virtualising the teaching environment provides lens to see how actions directed at goals lead to the realisation of the object (Karanasios 2014).

7.2 Teaching environment virtualisation activity system as a unit of analysis

The teaching work environment virtualisation activity system brings together both the technical and social context of the virtualisation (Engestrom 1987b). Here, AT focuses on how tools are used to transform work activity in a traditional teaching environment. The tools used were mainly technological. The technological tools, for instance, the open source technologies were used in tandem with the social processes that governed the teaching environment of UG as well as the previous activities that existed in the traditional teaching environment. This is because in the end, the virtual teaching environment as an information system must be seen as embodying the cultural characteristic and the norms of the previous work environment (Kuutti 1996). This is important because the virtual teaching environment exist as an embodiment of the previous activities and the norms and practices that existed. This means that rules and norms that govern an activity are continuously reconstructed and influenced by the technology and vice versa (Karanasios 2014). For example, in the new environment people are assigned new roles, especially roles and responsibilities that did not exist in the physical teaching environment. Other roles were made redundant and some roles were not fit to work in the virtual teaching environment.

The work environment virtualisation activity system provides a holistic view of the activity and captured the HEI context in a sociotechnical way. This is significant because of the nature of the virtualisation as a technologically mediated organisational change (Allen et al. 2013). Perceiving the teaching work environment virtualisation activity system as the unit of analysis was consistent with its object-oriented and collective nature (Engestrom 1987a). In the teaching work environment virtualisation, technology was critical part of the unit of analysis as seen in the use of web development artefacts as tools. With these technological tools and its mediating role, viewing the unit of analysis as an activity system ensured that the technology was not overemphasized neither was the social aspects of the HEI. This portrays some lack of technological determinism in the virtualisation activity and follows the perspective that humans actors can control their own behavior from the outside through the use and creation of artifacts (Allen et al. 2011). This also supports the fact that the technological artefacts that were used as tools in the virtualisation process are integral and inseparable components of human activity (Engeström 1999). This is line with activity theorists who argue that tools with their mediating power and role should not be seen as given, but it must be realised that humans shape the tools, and tools in turn can shape human behavior (Kuutti 1996).

The rules in the work environment were continuously being reconstructed during the virtualisation process. This was because some of the teaching practices in the physical teaching environment are inconsistent with teaching in the virtual work environment.
and the virtual work IS will not support these old ways of teaching. The virtualisation of the teaching environment using template based Sakai Learning Management System is consistent with the work of Hill et al. (2012) who opined that the nature of a course site, in a template, is very useful and should be developed not necessarily according to a template but with careful attention to the context. This supports the fact that the use of templates for the development of a virtual teaching work environment is critical and is a key mediator of the process as it presents a picture of virtual teaching environment whilst mimicking the physical work environment. As a result, the use of templates in the UG development acted a guide to the continuous development and refinement of the virtual teaching environment.

7.3 The emergence of the virtual teaching environment.

Contradictions reveal the nature of activities to be fluid instead of fixed and static (Karanasios 2014). During the virtualisation the contradictions appeared as problems, breakdowns and clashes within the activity (Kuutti 1999). The resolution of contradictions follows a cycle of transformation. Actors involved in the virtualisation activity in an attempt to resolve these disturbances, change and develop further mediators of the activity (Kaptelinin and Nardi 2006).

First, tension existed because of the impact that the objective of implementing the virtual teaching environment had on the UG community. For instance, a virtual teaching environment means lecturers have to engage in some virtual teaching and this means learning new tasks. The tension was apparent because the consultants were not aware of some nuances in the HEI context in terms of the teaching practices that existed in the physical teaching environment and how these physical teaching practices were to be eliminated by the virtual teaching environment. This was resolved through a constant engagement between UG and Longsight which led to Longsight understanding of the contextual issues that pertain in the physical teaching environment and a reassurance to lecturers especially distance learning facilitators that they will not be replaced by the virtual environment.

Second, some positive feedback had shaped the system at the initial stages when it was being piloted on a smaller group. The feedback from this pilot did not cover many system issues because the pilot group did not cover a larger part of the UG work environment. When the system was rolled up for university wide use, feedback continued to be an integral part of the system continuous development and improvement. This is continuous improvement through feedback supported the system’s current robust state. Third, it was also revealed that there is no unified documentation to enforce faculty use of the system. If such a documentation or policy was available, widespread use of the system could generate more feedback for more refined development. Also, UG has a training plan with technical team members who have been carrying training sessions across faculties and campuses of the University to ensure that both lecturers and students have adequate knowledge to use the system.

Though some UG staff have derided the involvement of a key person who seem to be the king pin of the implementation of the system. This contradiction was resolved through an understanding that whilst Sakai may be portrayed as university wide initiative, it is pertinent to understand that, the project was initially designed for only a school/faculty of the University to support its growing number of distance education
students. This key individual was a principal officer of this faculty, the success of the Sakai project was a critical part of school’s achievement and growth, and hence his unrelented involvement in all parts of its implementation to make sure it succeeds. Whilst this does not preclude the fact that the university’s IT management unit and its staff should be trainers it justified the involvement and reduced the tension that had existed. Lastly, considering the activity systems over time provided a methodological tool for the analysis of ongoing projects over time and given that AT provides a snapshot every time it is used, it can be relied on over time to give the trajectory of the IS development and how contractions and tensions change over the life of a developmental project.

Contradictions are considered to be the major source of development in activity theory (Nardi 1996) and the resolution of contradictions is a period of expansive learning that led to a virtual teaching environment. Contradictions have been examined extensively in the literature using AT as an analytical framework. However, many of these studies such as Deken and Lauche (2014) examined technology development in enterprises by looking at the quaternary contradictions between the different enterprises collaboration whilst Bonneau (2013) examined all the levels of contradictions. In this study, contradictions and its resolution in the central activity was examined in a trajectory of activity systems, which provided snapshots of how the central activity emerged and how the central activity led to a different activity-virtual teaching in a virtual teaching environment.

8 Conclusions

The purpose of this study was to understand the attempt by a developing country HEI to virtualise its teaching work environment. The study concentrated on a Ghanaian university’s attempt to convert its traditional, paper-based teaching work environment through an external consultant. The study revealed that contradictions within HEIs could limit virtualisation of teaching work environment. First, tensions among teachers for fear of key interactions between them and their students being substituted by virtual systems and inadequate bandwidth can constrain teaching work environment virtualisation. The study further revealed that contradictions between external consultants and HEIs could derail virtualisation initiatives. Therefore, when consultants spend inadequate time on HEIs campuses and do not properly understand the existing teaching rules and procedures, the implementation and uptake of virtual teaching environment can be negatively impacted.

For research, the originality of this study is based on its contribution to the IS literature by offering rich insight into the contradictions in HEIs teaching environment virtualisation. This study is significant for the management of HEIs who are interested in virtualisation initiatives from paper-based to digital platform especially when they have limited experience in such initiatives. Management could also rely on this study to analyse contradictions that may emerge within HEIs attempt to virtualise their teaching environment through consultancy engagements. The research can therefore serve as a useful tool for investigating IS projects that are based on consultancy or outsourcing relationships in different contexts.

The study employed one HEI in one developing country. As a result, the study is limited by it single case study in one developing country. This is because developing
countries differ and the HEIs within it may use different kinds of technology, a local consultant or build their system completely in-house. Also, some activities in the virtualisation activity systems’ external environment could also affect the outcome of virtualisation. For instance, issues such as constant supply of electricity, adequate network infrastructure including the availability of adequate bandwidth, funding and some cultural issues of the developing country context can affect the seamless implementation of work environment virtualisation. Whilst these issues are important, the findings are to some extent limited by the lack of consideration of these external environmental issues.

Future studies can therefore can compare the experience of different HEIs as well as from a developed country perspective in order to account for contextual and societal differences. Also, whilst this study offers an appropriate theoretical approach for HEI work environment virtualisation research, future studies can use activity theory combined with other theories to investigate the complex and complicated nature of HEI development and implementation of IS in various ways.

Compliance with ethical standards

Conflict of interest
The authors declare that they have no conflict of interest.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References


