Training as a means of cultivating communities of practice around health information systems

The potential of a blended learning approach in low and middle income countries

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Thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy (PhD)

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June 2016

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Acknowledgement

The journey that I had to undertake in completing this thesis was long and hard. Without the support of many, it would have just been a dream. Herein I take the opportunity to acknowledge these contributions with gratitude.

First of all, I must extend my heartfelt gratitude and sincere appreciation to my supervisors Professor Sundeep Sahay and Professor Jens Kaasbøll. It was their guidance and support that made me overcome many of the intellectual and practical hurdles encountered in the past few years.

I also like to extend my heartfelt gratitude to Professor Vajira Dissanayake for the support extended in realizing my ambition to undertake a PhD and for his support throughout. I also wish to thank Professor Janaka De Silva, the Director of the Postgraduate Institute of Medicine (PGIM), University of Colombo for his unconditional support in completing my research work. I must also thank Professor Rezvi Sheriff, the former director of the PGIM, for his backing and encouragement in undertaking my research activities.

My sincere gratitude is also extended to the HISP program at the University of Oslo, for its support in carrying out my research work. The DHIS2 core team in Oslo including Lars, Ola, Jarn, Abyot, Matthieu and others including Bob must also receive my gratitude as they extended their fullest cooperation in my research work taking me on-board from day one.

I am also grateful to the academic staff at the Department of Informatics, University of Oslo for their valuable support both academically and in personal capacity towards overcoming the challenges I faced during this period. I am also thankful to my colleagues at the Department of Informatics for their support at various points in time in terms of refining my intellectual and scholarly skills and in keeping my motivation.

Furthermore, I must also extend my sincere appreciation to all the study participants especially the Biomedical Informatics students at the PGIM. Without their support, I would not have been able to complete my studies.

My journey towards completing this thesis wouldn't have been possible if not for the support from my loving family. My loving wife Harshani always backed me up with the work I had to undertake, sacrificing her own career, and looking after the needs of myself and my son's. I am ever so grateful for your unconditional support and love. To my parents, I will always be indebted for your support throughout my life. Specially, for sacrificing their own pleasures to introduce myself and my brother to the world of information technology at a very early age - when computers were mostly unheard of in my country.

Last but not least, I would like to extend my sincere gratitude to the staff at the PGIM, to my brother Athulya and his family, to my friends Roshan, Sahir and his family, Pubudu, and for everyone that supported me in completing my doctoral journey.

Abstract

This thesis is an illustration of an action research study framed within a pragmatic worldview in a developing country context. It was undertaken with the aim of harnessing the potential of training in cultivating communities of practices (CoPs) around the electronic health information system (eHIS) – the District Health Information System 2 (DHIS2). DHIS2 is an open-source public health software used globally in many low and middle income countries (LMICs). The Health Information Systems Program (HISP) at the University of Oslo manages its core activities including providing training for implementers and super-users. Given the expansion of the DHIS2 community and the demand for training, HISP decided to make use of online learning tools to support its flagship training program; the DHIS2 academy. However, introducing online learning tools in place of face-to-face training became a challenge despite its perceived benefits. Thus, the key motivation for undertaking this research was the challenges perceived in introducing online learning tools for eHIS training in LMIC settings.

In pursuing its research aim, this study was informed by the theoretical inputs from literature related to communities of practice (CoP) and boundary objects. The concept of CoP was utilized by this study given the different professional groups involved in providing eHIS training and because it could explain the work-based learning processes existing in a domain such as health. Further, the concept of CoP and its related discourse also informed this study regarding the potential of cultivating CoPs and its applicability in professional domains. When it comes to the notion of boundary objects, it was utilized by this study to understand how online learning tools and blended learning programs behave at the boundary between different professional groups. It was expected that by applying the notion of boundary objects it would be possible for this research to shed light to the tensions that may arise and understand the ways of resolving such tensions in a particular setting. Together, the analytical perspective formed was expected to provide a means of understanding how training can be used in cultivating CoPs in relation to the study context.

Informed by these practical and theoretical inputs, the study formed three research questions. First was to identify the different dimensions of a blended learning program that determine its potential towards cultivating CoPs around eHISs. The second question focused on ways and means of facilitating social construction of learning by integrating between the eHIS and the different dimensions of a blended learning program. The third research question focused on unraveling the role of participation when training is being used as a tool for cultivating CoPs.

The empirical evidence for this study was drawn from multiple iterations of DHIS2 academies based on a blended learning approach from 2011 to 2014. In addition, the study also drew empirical evidence from a cohort of medical doctors from Sri Lanka who also underwent training at DHIS2 academies. This particular cohort allowed this study to follow them up into their work practices and to observe their participation in a Free and Open Source Software (FOSS) community around DHIS2. The gathered empirical evidence was analyzed using qualitative and quantitative means including using social network analysis.

Based on its analysis, the study contributes both theoretically and practically. One of its theoretical contributions is to understand the role of training in relation to CoPs in Information Technology for Development (ICT4D) contexts. Firstly, the study expands the usability of online learning tools in facilitating an environment suitable for generating higher order knowledge among the eHIS users. Secondly, the study contributes to expand the

concept of 'network of actions' by illustrating how it can facilitate micro-level communities, or CoPs, using training as a tool. Thirdly, the study illustrates how training could play a key role in sustaining and scaling ISs. Fourthly, the study contributes to facilitate the call for interdisciplinarity in ICT4D by utilizing pedagogically driven blended learning programs.

Another theoretical contribution made by this study is to elaborate on the epistemic potential of blended learning programs. Based on the findings, the study revealed the association between technological frames or technologies-in-practice with epistemic and boundary objects within the ambits of this research. Secondly, the study contributes to the education literature by shifting the current understanding regarding blended learning programs from being a 'state of permanency' and 'control' to a 'state of fluidity' and 'freedom'. Thirdly, the study elaborates on the potential of an epistemic blended learning program to function as an alternative channel of scientific inquiry around an IS artefact. In terms of the evolutionary process of an IS, this means that a blended learning program - as perceived by this study - may have the potential to accelerate the said evolutionary process, particularly in an ICT4D context.

As the practical contribution, the study elaborates on ways and means of designing and implementing blended learning programs, which are empowering, informal, participatory and equitable. As perceived by this study, such programs not only have the potential to facilitate cultivating CoPs around ISs, but also to sustain IS implementations in LMIC settings.

Chapter 1 - Introduction

Information system (IS) projects piloted in low and middle income countries (LMICs) often fail to progress into full-scale implementations due to different reasons. This may particularly be true in terms of large-scale and complex ISs such as health information systems (HISs). In some instances, even if such projects reach the implementation phase, they may fail to scale and be sustainable as expected. In many such instances, inadequate training and capacity building have been blamed for these failures. Despite these observations, training is often considered a single step in IS implementations with the focus largely set on transferring skills from experts to novice learners. However, in LMIC contexts, a mere transfer of technological skills from one person to another may not create an environment conducive for ISs to evolve. Thus, this research can be described as an attempt to unravel the true potential of training around ISs in creating a favorable environment from the point of view of learning and community building. As a start to this unraveling, this chapter will lay the groundwork for the rest of the thesis, provide a glimpse of the research contributions, and present how the rest of the thesis is organized.

1.1. Personal and theoretical motivation

The motivation toward undertaking this research did not manifest overnight. Especially in terms of personal motivation, there were several experiences, which made me realize the ground situation regarding HISs, training and distance education. One such experience occurred when I worked as a medical intern in one of the district hospitals in Sri Lanka. During that time, I undertook to develop a software program for my consultant to generate a discharge summary for the obstetrics ward. My idea was to spend my free time practicing coding skills and in a way, to fast track the discharge process thus reducing the burden on us [the interns] to produce handwritten discharge summaries. While I succeeded in developing the program (and winning the praise of my consultant), I soon found out that it was only I who could operate the computer, printer and the software fast enough to enable a timely and accurate discharge. This meant that although the burden of writing discharge summaries by hand was relieved from my colleagues, I had to spend more hours generating and printing discharge summaries each day. This was the first instance I realized the importance of training health staff in the use of eHISs and I never in my wildest of dreams had imagined that this would be part of my life endeavors for several years.

My first experience with regard to distance learning however was when I was in grade 8 or 9. In fact, it was my mother who signed herself up for a 'distance learning' program that relied on sending printed material and assignments through 'snail mail' to which she also had to reply using the same medium. For my mother, this was probably the only way to continue her education while working full-time and looking after the needs of the family. Even then, I realized that distance learning was something rather boring and cumbersome. This is because the whole learning process took place without any human contact and at times with the added hassle of an occasional shower ruining the printed material while it remained in our mailbox.

Nevertheless, my second experience with regard to distance learning was somewhat inspiring as it involved the use of online technologies. I gained this experience while I was working as part of a team developing an online educational program for health professionals at one of the universities in Sri Lanka. The program was designed as a fully online training program that would not require health professionals to travel for lectures or for any other program-related events. The idea was to provide an opportunity for the health professionals working in rural areas and those who decide against undertaking such training as a result of family and work commitments, to undertake postgraduate training. The response was overwhelming and the organizers had to arrange selection examinations to limit enrollment as the number of moderators available were not enough to cater to the large demand.

However, soon the program started to attract criticism from various quarters including professional organizations and trade unions. The reason: they did not perceive online learning alone to be a good enough method in providing training for medical professionals. In their opinion, one must have face-to-face contact during training to develop 'expert skills'. Furthermore, I felt that introduction of online learning gave rise to the emergence of factions among teachers (trainers) as not all 'teachers' could perform the task of online moderation although they were excellent teachers. In addition, there were issues in relation to accessing the online learning as internet was not readily available in certain parts of the country. Even when internet was available, certain learning material such as videos and high-resolution graphics were not easily downloadable given the limitations in bandwidth and speed.

Nevertheless, in developing countries, e-learning seems to be the answer to many of their educational challenges. For instance, achieving equity in education is one of the key challenges facing LMICs, not only in primary and secondary education, but also in tertiary education and technical training (Willems & Bossu, 2012). Through the use of distance

learning methods, such inequities can be minimized to a certain extent (Robinson, 2008). Overcoming social exclusion is another strength of distance education methods (Simpson, 2004) such as online learning, as it has the potential to overcome the barriers created among learners by social, economic, political and cultural factors. At the same time, Simpson (2004) also points out that online learning has the potential to impart democratic access to education, which can have wide-ranging implications in LMIC settings. However, the downside of online learning is that it may not fit all learners and for achieving all types of learning objectives (Huang et al., 2012). This means that those who are designing and advocating online learning have a duty toward not being blind to such realities. In other words, the age-old saying in medical ethics - *'first, do no harm'* - could be a useful guide when distance learning seems to show promise as the 'treatment' of choice for education and learning-related 'disorders'.

Sparked by these personal experiences and theoretical debates, I was motivated to dedicate my PhD research to studying training around HIS implementations in LMICs using online technologies. However, I wouldn't have been keen on taking up a project such as this without a challenge, which came in the form of the Health Information Systems Program (HISP) at the University of Oslo. HISP, with its intention to expand its training capacity in LMICs around DHIS2 (an open source eHIS developed by the HISP network) provided me with the perfect setting to launch my research. This thesis illustrates my journey so far, which can only be described in the true Churchillian way as 'only the end of the beginning'.

1.2. Introduction to some important terminologies used in this thesis

Given the multi-disciplinary nature of this research, different yet relatively overlapping terminologies had to be used in building some of its arguments. These terminologies are explained briefly in Table 1 for the comprehensibility of this thesis as it progresses. However, the understanding of some of these terminologies evolved as the research progressed and therefore what is presented in Table 1 should be considered only as a benchmark for the rest of the thesis.

Table 1 : Clarification of important terminologies used in the thesis

Terminology	Clarification
Distance education (DE)	Formal education that takes place when the teacher and the learner are separated by both time and space
Distance learning	Learning taking place when the teacher and the learner are separated by both time and space
Online learning	Pedagogically-driven learning taking place via the internet
e-learning	Learning taking place with the aid of digital technologies (e.g. Internet, computers, digital media, mobile devices)
Face-to-face/ Traditional learning	Learning taking place in a classroom setting where the teacher and the learner are physically present at the same place at the same time
Blended learning	Learning taking place through organic integration of thoughtfully selected and complementary face-to-face and online approaches and technologies (Garrison &Vaughan, 2008)
Workplace-based learning	Learning taking place while a learner participates in actual work practices
eHIS	A software that aids generating health data, its compilation, analysis and synthesis, and its communication and use, thus providing health information for health decision making (HMN, 2008).
DHIS2	An open source eHIS, designed as a tool for collection, validation, analysis, and presentation of aggregate statistical data, tailored to integrated health information management activities. DHIS2 is developed by the Health Information Systems Programme (HISP).
Super-user	A user who has an expert understanding of local information flows and processes along with the functioning of the eHIS. A super-user will have more privileges than other users in the system and will be able to act as a bridge between software designers and the users.
Implementer	A person who is qualified enough to carry out implementation of an IS in a particular context. In general, implementers are expected to know the context, implementation processes, have a sound understanding of the implemented system and the needs of the users of such systems.

1.3. Training at the level of implementers and super-users of eHISs in LMIC contexts

As stated at the beginning of this chapter, most IS implementations in LMIC contexts fail to mature beyond the piloting stage (Wakerman & Humphreys, 2011; Heeks, 2006; Walsham & Sahay, 2006). While there are many reasons for such projects not realizing their full potential, lack of training and capacity building are amongst some of the most important reasons for failures (Ash, Stavri & Kuperman, 2003; Sellitto & Carbone, 2007). In some instances, lack of attention and lack of investment toward training emanate from it not being considered a 'critical' part of eHIS implementation processes (Kaplan & Harris-Salamone, 2009). This also means that when the resources are limited, funds are generally diverted away from training to other aspects of implementation.

In LMICs, end-user training is usually carried out by trained country teams visiting different districts/health facilities or by conducting mass training programs at a central location (Kimaro & Nhampossa, 2005). Given that end-users generally require a basic set of skills in order to handle an eHIS, even mass training programs would be able to achieve a desirable outcome. However, when it comes to training implementers and super-users, the training requirements may become complicated. For instance, implementers of an eHIS should understand implementation methods suitable to one's own context and methods of overcoming various technical, social and political challenges in addition to the inner workings of the system itself. This requires learning from use-cases, experiences from other implementers and learning from research evidence. Super-users on the other hand would want to know the inner workings of the system, capabilities and the weaknesses of the system, troubleshooting, how to customize the system to fit work practices, effective data management, and harnessing the potential of various features offered by the system to improve the work practices. Furthermore, both these groups would value having channels of communication with the experts as they need to bridge between other users and the designers/developers of eHISs. Thus, in most LMIC contexts, implementers and super-users are still being trained by foreign experts or organizations, such as the HISP, backed by the donor agencies (Manya et al., 2012; Kimaro, 2006). This means that apart from providing software support, international organizations and their experts also play a direct role in the process of training.

In practice, most training programs adopt a classroom based face-to-face approach – or a traditional approach. While such an approach may add value to implementation processes, it may not be practical to conduct such training at frequent intervals, in the same intensity and for a longer period of time. For instance, conducting a face-to-face training program can be a costly logistical exercise as it involves considerable effort and investment in terms of securing suitable training sites and making payments for the participants, including foreign experts, to cover various costs (Sanner & Saebo, 2014; Walsham & Sahay. 2006). This may specially be the case when such training programs are held abroad, as in the case of regional training programs for the DHIS2. Apart from the costs, conducting face-to-face training may also run into difficulty when the demand for training grows ever so fast as in the case of eHISs such as the DHIS2, which are free and open source software (FOSS) (Fitzgerald, 2006).

From an institutional point of view, not all public organizations in LMICs are able to send their personnel for a training program lasting several days as it would interfere with their ongoing service delivery (Travis et al., 2004). The issue might become worse when different programs (e.g. HIV, Tuberculosis, Child health) arrange training in an uncoordinated manner for the same personnel (Travis et al., 2004). The reason for this is that many participants who are expected to attend such training are not full-time implementers or super-users of eHISs but are hybrids who perform multiple roles including patient care (Heeks, 2006). However, in some LMICs, there is a trend toward recruiting dedicated information system officers as in the case of Ghana (HMN, 2009) and Medical officers in Biomedical Informatics in Sri Lanka (Manoj et al., 2013).

1.4.   Online learning in LMIC contexts

As illustrated through my own experiences, online learning is fast becoming an integral part of the educational landscape of most LMICs simply because of its ability to overcome some of the limitations in face-to-face training. For instance, online learning programs do not need teachers and students to be present physically in one geographical location at the same time (Garrison, 2011). This means that the costs associated with conducting residential training will not be part of an online learning program. At the same time, given the nature of online learning, it can accommodate more participants both in the form of moderators and learners. Furthermore, public institutions in the LMICs, such as healthcare organizations, would be able to sanction the participation of their staff in online learning programs as it does not require the staff members to be taken away from their critical duties. For the participants, online learning offers a way of expressing their own learning style (Attwell, 2007) and an opportunity to interact with a pool of resource personnel from the local, regional and global communities – especially in the case of FOSS eHISs.

Apart from the apparent benefits of online learning, the rapid developments in communication infrastructure and the affordability of internet access in LMICs can also be seen as factors that promote online learning and e-learning as a whole (Gulati, 2008). Additionally, information technology (IT) literacy in developing countries is also improving although not all countries are showing a desirable progression (Ezziane, 2007). Nevertheless, as online learning does not require expert knowledge, one may consider that LMICs are now ready for such technologies. Furthermore, when considering the proficiency of personnel seeking training as

implementers and super-users, IT literacy is expected not to be part of the equation in terms of their ability to utilize online learning.

From a different perspective, it may be argued that if web based information systems are being planned for LMIC contexts, there shouldn't be any new infrastructural or capacity related challenges in adopting online learning. Nevertheless, there aren't many examples of pedagogically-driven online training programs utilized for IS training, including training around eHISs in LMIC contexts.

However, when online learning is used for training, its success depends on how well the learners interact with the online learning system and how enthusiastically they participate in the online interactions (Garrison, 2011). In fact, online learning has been recognized as more capable of creating an interactive learning environment than a traditional classroom setting (Zhang et al., 2004). Thus, while it may be true that LMICs are e-learning ready to a large extent, unless online learning programs provide learners the opportunities to interact, the benefits expected of online learning may not materialize in full.

1.5. Blended learning and its usability for eHIS training

When comparing online learning and traditional means of training such as face-to-face training, online learning may have an advantage due to its technological advances. However, face-to-face training may also have its own advantages and is sometimes vital in achieving certain learning goals. Thus, a combination of face-to-face and online learning – or, simply put, blended learning – has been seen as a way of harnessing the best of both worlds. In fact, there is evidence to suggest that blended learning promotes better learning experiences compared to those of online or face-to-face learning alone (Heterick & Twigg, 2003; Makhdoom et al., 2013). This is in addition to many educationists agreeing with the fact that blended learning holds more promise than fully online learning (Allen et al., 2007). Therefore, it may be necessary for the educationists and for the trainers to find the right balance between face-to-face and online learning modalities depending on the expected learning outcomes and the contextual realities (Onguko, 2014).

From an educational point of view, blended learning has been recognized as the most common form of educational strategy in most developed countries (Garrison, 2011). This includes educational programs making use of both e-learning and classroom type of learning to achieve the designated learning objectives. However, there seems to be little agreement

with regard to what constitutes blended learning and how it should fit within the wider educational and training landscape. Nevertheless, blended learning is a recognized field of scientific inquiry as indicated by the growing number of academic researches.

In my experience however, trainers are lured into adopting blended learning due to various reasons. For example, in the example given previously, adoption of blended learning was the result of continued resistance shown by different stakeholders. However, in another distance learning program with which I was involved, face-to-face workshops and clinical placements were used in tandem with online learning as a means of compensating for the lack of interaction in the online setup and to fulfil the learning objectives that required hands-on training. Thus, in the second instance, the decision to adopt blended learning was pedagogically driven.

At times, educational institutions tend to leave aside the term 'blended learning' when describing such programs perhaps as a way of preventing potential students from being confused about the training modality (Garrison, 2011). In other instances, it may be a way of avoiding the potential repercussions of using a learning modality which hasn't yet garnered enough agreement amongst scholars.

In any event, I perceived that in providing eHIS training, blended learning has much to offer as it can incorporate the best of both worlds in achieving the expected learning goals and even beyond. However, I also perceived that blended learning is a learning modality which emerges as a result of the interplay between various socio-cultural, socio-political and socio-economic factors. This would mean that the composition of a blended learning program may not always be determined by design. Nevertheless, if such dynamics can be recognized and negotiated appropriately, blended learning programs may offer so much, especially in terms of creating communities around ISs.

1.6. Theoretical perspective

From the beginning of my study, it became apparent that I was dealing with a field of study which can only be described as a cross-cutting discipline. It meant that this research would have the luxury of drawing from a treasure trove of research emanating from fields of education, social sciences, information systems, information technology, and action research. From the research point of view however, there was a need to unravel several key areas

related to the theme of this research. Blended learning was amongst one of these areas needing to be unraveled.

Literature defines blended learning in several ways although for the purpose of this research, I have utilized Garrison and Vaughan's (2008, p. 148) explanation of blended learning, which is an "*organic integration of thoughtfully selected and complementary face-to-face and online approaches and technologies*". One of the key reasons for utilizing this definition was that it summed up some of the key aspects within the discourse around blended learning into one. For instance, the definition emphasizes on the 'organic' nature of blended learning which according to Garrison (2015) reflects on the groundedness of blended learning on specifics of practice. In other words, the definition reflects on my own understanding that blended learning emerges as a manifestation – by design, by accident, or both – of many different contextual factors (e.g. infrastructure, politics, culture, learning needs). At the same time, the definition also talks about the necessity of integration although it stops short by indicating that the integration should only be between thoughtfully selected online and face-to-face approaches and technologies. This also means that there is room for improvement with regard to the current understanding of blended learning. Last but not least, this definition made more practical sense as it allowed me the necessary flexibility of choosing between different online technologies and approaches that would complement the face-to-face learning in designing and implementing blended learning programs.

However, the definition explained above and other widely cited descriptions of blended learning (Heinze & Procter, 2004; Dziuban, Moskal, & Hartman, 2005; Picciano, 2009) indicate that it refers to a state of permanency, dictated by educational institutions or by individual instructors. Further, these descriptions also indicate that the environment within a blended learning program is largely controlled by the trainers or the instructors rather than by the learners. Understandably, this may be the result of the strict learning goals targeted by the educational institutions and large corporations that employ blended learning programs in their training. Thus, from the point of view of this research, the implied sense of 'permanency' and 'control' of a blended learning program was a challenge.

The second area that needed unraveling was the learning dynamics within the health domain as eHISs are expected to be handled by personnel working within this domain. My previous experience working in a hospital setting in Sri Lanka taught me that at micro-level, these organizations may be having many different 'cliques'. These may comprise different groups

of professionals and in general, they kept on expanding their knowledge by discussing every day issues to find solutions. At the same time, they also applied the synthesized knowledge in their work practices thus gaining further knowledge and expertise. Wenger (1998) described similar groups as 'communities of practice' (CoP) or a group of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. During my internship, I remember being part of a 'clique', which comprised of my intern colleagues and senior house officers. We exchanged our views over a cup of hot tea at the end of each day. As I realize now, we had a common interest in the form of improving our work practices to cater to the high turnover of patients in our wards and to deal with 'difficult' patients. I considered the insights gained from the seniors as highly useful in practice as it allowed me to manage my workload without compromising patient safety. These instructions or insights however were neither available in the textbooks nor were taught at the medical school. While these insights were passed on from senior colleagues to juniors such as myself, within an year, I became the one to pass these experiences to my junior colleagues. However, the information passed on by me to my juniors had additional information, which I learnt or gathered from my own experiences. I also learnt that similar groups also existed among other hospital staff such as consultants, nurses and even among support workers. These experiences are in line with what Lave and Wenger (1991) described as 'situated learning' where they argued that knowledge should be presented in an authentic context and that learning requires interaction and collaboration among the members of the community. Thus, I realized that it may be difficult to avoid the dynamics within and between such groups when a learning program is introduced to people working within the health domain. Given the positive influences such groups had on me and my colleagues, I also realized that it may be a useful tool to propagate new learning among all professionals concerned.

However, when introducing an eHIS training program, the participants of such training may not belong to a single community of practice – instead they may be members of different CoPs. This means that if one expects to harness the benefits of CoPs, one should also think of enabling the formation of such communities similar to what Wenger, McDermott and Snyder (2002) described in cultivating communities of practice. However, during eHIS training, any attempt toward cultivating CoPs would be different to what Wenger et al. (2002) discussed. The reason being that in this case, the target audience may not be definable in terms of a single organization and the tools available may not necessarily be the same used by Wenger et al. (2002) within organizational practices. This means that the cultivation of CoPs in this case

has to rely not only on the context or the socio-cultural processes, but also on certain other means. The alternative means perceived by this research was a pedagogically-informed training program consisting of a mixture of formal, informal and work-based learning.

The third area of this research that needed unraveling came into being as a result of the heterogeneity of individuals and groups including myself that were involved in the process of eHIS training. For these individuals and groups, eHIS training meant different things. For me, eHIS training was an opportunity to do research on the training potential of online learning and to understand the dynamics of learning that takes place around HISs. For eHIS developers, training is a way of gaining insights into the LMIC context and the user needs. From the point of view of implementers, training is a way of building capacity, scaling and creating buy-in for the eHIS. On the other hand, for the academics involved in managing the overall business process, training is a means of expanding reach, gaining recognition and maybe attracting support from international organizations and donor agencies. While all these entities realize the need for using technology for training, it was impossible for me to make them give up their own interests and be aligned with my own notions regarding using online learning and community building. Thus, it was necessary for me as the researcher to recognize the discontinuity of thought processes – or the boundaries as described by Star and Griesemer (1989). This also meant that I had to identify a means of communicating across these boundaries that would also cater to the common interests of all the stakeholders. According to Star and Griesemer (1989), the notion of boundary object fits my purpose as it was described as something "… *plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites"* (p.393). Such conceptualization would then enable me to visualize how different aspects of the training process behave in relation to the boundaries formed, the tensions created. and the means of avoiding such tensions when introducing online learning tools for eHIS training.

1.7. Aims and dispositions of the research

Based on my experiences and the facts gathered, it was clear to me that the transition from traditional to online training creates a continuum of different learning approaches that may fall into the category of 'blended learning'. Depending on various factors, a training program may achieve a state of 'blend' within this continuum with some programs gaining the 'fully online' status. By being aware about the context and the realities that govern learning in such

settings, one should be able to determine the complementarity of the blend without leaving it to happen by accident.

Stemming from these thoughts is the main research aim, **'harnessing the potential of training in the form of blended learning programs in cultivating communities of practice around health information systems'.**

In achieving the above aim, the research undertook the following research questions in relation to HIS implementations in low and middle-income countries.

RQ 1: What are the dimensions of a blended learning program that determine its potential toward cultivating communities of practice around HISs?

As described earlier, the position taken by a blended learning program within the continuum between face-to-face and online learning seems to depend on different dimensions. Thus, it will be useful for this research to recognize the important dimensions pertaining to eHIS training instances in LMICs as a first step in the process of cultivating CoPs.

RQ 2: How to facilitate social construction of learning by integrating between the eHIS and the different dimensions of blended learning?

It was perceived that learning in relation to eHISs does not manifest barely from the teaching or the initial training given. In fact, in an eHIS which is also Free and Open Source Software (FOSS), there can be much tacit knowledge embedded within its FOSS community. This may be even greater when the said eHIS is also backed by many use-cases and by expert practitioners originating from similar contexts to those of the learners. Harnessing such knowledge would essentially require learners to co-construct learning through interactions with the wider community. Thus, RQ 2 looked into ways and means of integrating the different aspects of blended learning in order to maximize the opportunities available for the learners to learn through social construction.

RQ 3: What is the role of participation when training is used as a tool for cultivating communities of practice?

The research also perceived that the success of blended learning in forming communities is dependent on the participation and interactions taking place during the learning process. Thus,

recognizing the role of participation can inform the IS practitioners the ways and means of effectively utilizing the same in their endeavor to cultivate CoPs around a particular IS.

1.8. Empirical basis

The post-2015 development agenda recognizes the need for attaining health equity and high quality health data through eHIS implementations as a priority (WHO, 2012). Thus, from an empirical point of view, this research aligned itself with the post-2015 development agenda by focusing on the LMIC contexts and gathering insights into eHIS training and its effective utility.

However, in line with the aim of this research, it first had to identify a suitable eHIS which is being implemented in LMIC contexts. The District Health Information System (DHIS2) became the obvious choice for this research due to several reasons: First, it is managed by the HISP at the University of Oslo where its design, development, implementation and research have been taking place for nearly two decades. Secondly, the DHIS2 is widely used in LMICs, employed by almost 40 countries with some being national level HISs. Thirdly, DHIS2 is an open source software continuously contributed to by a global network of developers, implementers and researchers. Fourthly, training needs around DHIS2 are not limited to technical skills in operating the software but also include knowledge and skills related to its design, customization, implementation, information use, reporting, data analysis, sharing of health data, ensuring data quality, etc. At the same time, these training needs are not necessarily the same for different levels of learners: super-users, implementers and developers. Last but not least, DHIS2 has evolved over two decades and is continuing to evolve in line with the evolution of technology, best practices, industry standards, health priorities and user needs. All these meant that DHIS2 implementations have to face a training challenge that may render traditional means of training inadequate and less feasible.

Thus, DHIS2 became the focal point in training for this research and most of its empirical data was gathered from training instances called 'DHIS2 Academies'. These training programs were organized largely by the HISP or by its partners in the region as in the case of training in Latin America and the Philippines. It also meant that the empirical setting would expand over three continents as HISP and its partners are responsible for conducting training programs in countries in Africa, Asia and South America. Almost all of these training settings could be classified as LMICs although there were significant diversities between different

settings. These diversities in relation to technological infrastructure, socio-cultural practices, language, learning needs and socio-political manifestations were expected to play a role by enriching the research data.

1.9. Contributions (theoretical/practical)

Based on the research findings and analysis, this research was expected to make both theoretical and practical contributions.

From a theoretical point of view, the research presents its contributions under two key themes. One of these themes is 'understanding the role of training in cultivating CoPs in ICT4D contexts'. Within this theme, I first explain how the research contributes to enhancing the usability of online learning tools in facilitating higher-order knowledge requirements. Secondly I explain the contribution toward extending the 'network of action' approach by enabling micro-level creation of communities, or CoPs. The understanding gathered also enabled this research to elaborate on how blended learning programs can influence scaling of ICT4D projects and to explain how this research contributes to the interdisciplinarity in ICT4D research.

The second theme under which the research contributions are discussed is 'understanding the epistemic potential of blended learning'. In that, I have elaborated how this research contributes to expanding the understanding around development, adaptation and the use of information technology by different user groups. In essence, the contributions are discussed around an epistemic conceptualization of the blended learning object and its impact on the concepts such as technological frames, technologies in practice and boundary objects. I also explain several implications of conceptualizing blended learning as an epistemic object in terms of defining blended learning and in the evolution of an IS in ICT4D contexts.

The practical contribution emanating through this research is guidance toward designing and implementing training programs oriented toward cultivating CoPs around ISs – particularly in LMIC contexts. In this regard, the research emphasizes on the need for practitioners to create multiple learning spaces by adopting blended learning and to sustain these spaces for a longer period allowing learners to gain from formal, informal and workplace based learning at different points in time. The research also emphasizes on the need to create a conducive environment for participation through various means as prescribed through this research. This includes a focus on equity, facilitating participation, integrating between different learning

spaces, and integrating between the learning spaces and the IS. The expected outcome of such a process would be the facilitation of cultivation of a CoP rather than allowing it to happen by accident.

1.10. Organization of the thesis

This thesis is organized into nine chapters including the introductory chapter.

The second chapter of this thesis will discuss the research context, which will illustrate the training approach undertaken by HISP and the context within which this research has been grounded. In the third chapter, the thesis will illustrate the selection, design and the conduct of the online learning program based on the Moodle learning management system.

The fourth chapter is dedicated to discuss the theoretical discourse around the key aspects of this research. Thus, the thesis will focus its attention on the discourse around IS training, current state of online learning, blended learning approach, state of learning within the health domain, CoPs and how these concepts link in terms of eHIS training. It also discusses how FOSS communities contribute to the learning process. These discussions will lead to the formulation of an analytical perspective that is based on the boundary phenomenon and cultivating CoPs.

The fifth chapter will discuss the methodology adopted by this research from its philosophical underpinning to a detailed description of the different iterations in the action research cycle. It will also discuss the inclusion of Social Network Analysis along with qualitative methods.

Chapter six of this thesis will summarize the five research papers that emerged from this research and will present a summary of the paper contributions in relation to the research questions undertaken.

The seventh chapter will be a discussion based on the research findings and will synthesize answers to the research questions undertaken by this research. The eighth chapter in this thesis will illustrate the theoretical and practical contributions of the research.

Following presenting the contributions, the thesis will conclude by summarizing the key frontiers explored through this research in Chapter 9, along with an illustration of the new research frontiers that opened up as a result.

Chapter 2 – The Research Context

"A text without a context is a pretext for a proof text." (Dr. Donald A. Carson)

This chapter will elaborate on the research context of this study, which is critical for the interpretation of the research findings. Given that the research focus was largely on implementer training around eHISs in LMICs, this chapter will begin by enumerating the importance of training around eHISs in LMIC settings. It will then discuss the training needs around DHIS2 before discussing the HISP approach to capacity building. During this discussion, the chapter will also elaborate on the role played by HISP in training a cohort of doctors in Sri Lanka. This chapter will also provide an initial insight into the DHIS2 Academy and will pave way toward a more elaborate discussion on the same in Chapter 3.

2.1. Electronic Health Information Systems (eHISs) in Low and Middle Income Countries

In most LMICs, eHISs are relatively new. Even when a country has been exposed to eHISs, these are more likely to be sporadic and mostly pilot projects rather than national level implementations (Luna et al., 2014). As with many other IS implementations, eHISs in LMICs are also susceptible to abrupt terminations due to various reasons such as lack of funding, changing policies, technological weaknesses and inadequate capacity building (Braa et al., 2007; Heeks, 2006). In some instances, the reason for failure can be a design-reality gap, which makes the software design to deviate away from the needs of its users (Heeks, 2006). This can happen when donor agencies or other interested parties try to push their own agendas and focus only on data requirements of individual programs rather than on health system needs in the country (Kimaro & Nhampossa, 2005). Often, in LMICs, the organization of the healthcare system itself sometimes promotes these programs or institutions to work in isolation and to ignore the 'wholeness' in health information (Nyella, 2009; Kimaro & Nhampossa, 2005; Braa et al., 2007).

The impact of funding on eHIS implementation in LMIC contexts is also a significant contributor toward its success (Lewis et al., 2012). Given that most of these projects are funded by donor agencies and that there is an eventual need for an alternative revenue source, many projects seem to move slowly or wrap up when the funding dries up. Apart from the problem of funding, eHIS projects in LMICs also grapple with issues of technology acceptance by the end-users and cultural appropriateness of such technologies (AbouZahr &

Boerma, 2005). While all these factors may not be the same in all LMIC contexts but will vary across countries and health programs.

When considering such complexities associated with different healthcare systems, the role of an eHIS designer, implementer or even that of a super-user seems not to be the same. Thus, it is essential for designers, implementers and system super-users to be sensitive to the contextual requirements and follow best practices in designing and implementing such systems for LMIC contexts. While this research is not about designing and implementing eHISs, there are several inferences that can be made through this discussion. One, given the complexity of healthcare systems in different LMIC contexts, the eHIS training needs of those who represent such contexts may also be different and complex. Two, this would mean that approaches in designing, implementing and even training around eHISs must be sensitive to the contextual needs of each setting. Building on these understandings, my thesis explores the complexity associated with providing training around a large-scale open-source eHIS solution - the DHIS2 – in LMIC contexts.

2.2. DHIS2 and its Training Needs

In order to understand the complexity associated with training different categories of personnel in DHIS2, it is necessary to understand the ecology around DHIS2 and the different aspects of its implementation processes in different countries. Braa and Sahay (2012a) described the ecology around DHIS2 as an 'innovation ecosystem', which depicts the dynamics between various categories of personnel and agencies around DHIS2.
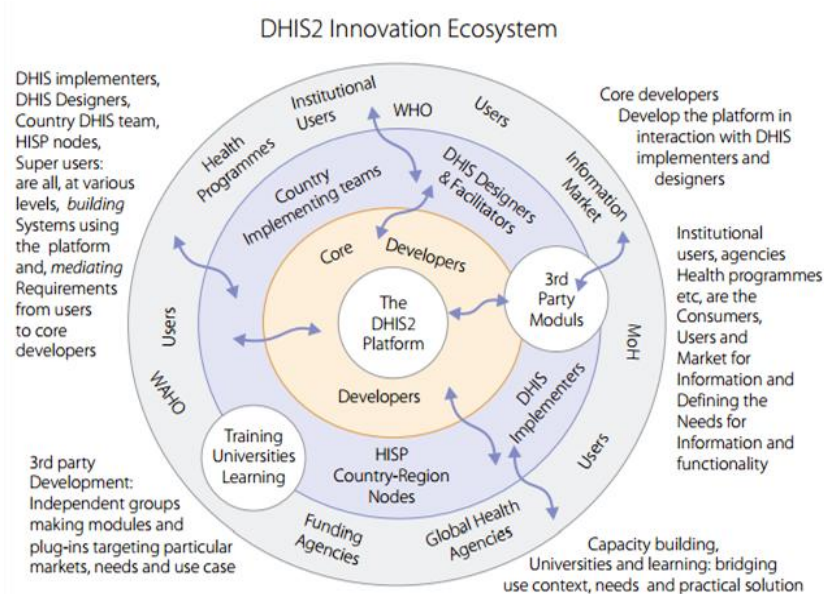
Figure 1 : DHIS2 innovation ecosystem (Source: Braa & Sahay, 2012a)

Within the DHIS2 innovation ecosystem, implementers, super-users, designers, country teams and HISP nodes would all be contributing to the building of systems using the DHIS2 platform at various levels. As pointed out by Braa and Sahay (2012a), in effect, these categories of people are mediating the requirements from end-users to the core developers. However, the important aspect of this depiction is that innovations around DHIS2 do not take place in isolation but instead the ideas in design, implementation, scaling and sustainment circulate among different groups of people. Such an ecosystem would facilitate rapid production cycles and the sharing of local innovations globally. Within this ecosystem, DHIS2 Academy is one platform where different people representing different country implementations or HISs interact. Through interactions, they would be able to build collaborations, share their experiences, learn from each other and contribute back to the larger DHIS2 community. In other words, high level training around DHIS2 is not only about learning the functionalities of DHIS2. Instead, it is more about learning through interactions and aligning oneself with the ongoing processes and practices of the wider DHIS2 community.

From a training point of view, DHIS2 implementation consists of many aspects an implementer or a super-user needs to be aware of. For instance, as pointed out by Braa and Sahay (2012a), one of the first steps in the implementation process is database development. This entails defining what data to capture, creating data sets, defining data elements based on context-specific data dictionaries and indicator dictionaries. Secondly, it is necessary to determine the organizational hierarchy, which would dictate the data flow and reporting structure within a particular context based on the geographical and administrative demarcation of health facilities. Understandably, this would be a challenge in many LMIC contexts, as official standards for reporting may not be existing. In such situations, implementers and designers of DHIS2 would require insights from local stakeholders including super-users who would be having first-hand experience of the data flow, reporting and validation requirements of a particular setting. On the other hand, designers and implementers of DHIS2 would also have to negotiate the challenge of importing and mapping existing databases in collaboration with super-users of such systems. Braa and Sahay see this as an important aspect in an implementation process as being able to work with legacy data would help create buy-in from the stakeholders in early parts of the implementation process. In addition, DHIS2 implementation also entails securing resources and funding, integration of parallel systems,

importing legacy data, setting up reliable national servers, piloting, rollout, training and capacity building, and decentralizing data capture and management.

When considering these aspects, it is clear that implementer training, and to an extent, super-user training, would considerably be outside the scope of any user manual or technical guide. It is a training that needs to harness the rich knowledge and experiences spread across the globe and facilitate the innovative potential of the learners within the DHIS2 innovation ecosystem as described earlier.

2.3.   The HISP approach to training and capacity building

The HISP network was initiated in the 1990s as part of a research endeavor and has since evolved into a globally recognized force in health information systems. At present, the core aspects related to HISP (e.g. core developments of the DHIS2, conducting of the DHIS2 Academy, certain collaborations with partner agencies, research, etc.) are managed by HISP, Oslo established at the University of Oslo in collaboration with other HISP nodes established in many different countries. In fact, the HISP network has established collaborations with more than 40 different countries through design, implementation and piloting of eHISs based on the DHIS2. Given its easy customizability and the global network of support, DHIS2 has gained recognition as a global leader in public health data management. While the success of HISP is considerably dependent on the success of the DHIS2, HISP is unique, as it does not fit the template of a typical software support organization. The reasons for its uniqueness include but are not limited to: the existence of multiple nodes, which forms the HISP network; the large research network affiliated with HISP; and the overall aim of positively influencing the health sector development in LMIC contexts.

In the past two decades, the evolution of HISP was contributed to by two main arguments. One argument was of political empowerment that was fueled by the anti-apartheid struggle in South Africa and the efforts toward overcoming the digital divide (Braa and Sahay, 2012b). The second argument is one of practical learning through hands-on participation, which was fueled by the Scandinavian participatory design and action research tradition (Braa and Sahay, 2012b). In a way, these two arguments also came to reflect the aim of equity which this thesis argued for.

HISP has adopted several approaches in its endeavors toward capacity building. One such approach is to support local higher education institutions in having their academics obtain

masters and doctoral degrees in information systems and health informatics from the University of Oslo. At present, altogether around 70 PhD and master's students in total have graduated or are in the process of graduating following research related to HISs from many different countries (UiO, 2013). Another approach to capacity building is conducting DHIS2 Academies in different parts of Africa, Asia and South America. Given that the DHIS2 Academies were the main research setting of my research, this will be discussed in detail in section 2.4. At the same time, HISP supports the establishment of country teams in order to carry out implementation-related activities in a bid to build capacity through participation. These teams are supported by experts from Oslo who travel to these countries and spend time working with them on design and implementation of eHISs. Furthermore, in collaboration with the University of Oslo, HISP initiates establishment of masters programs in higher educational institutions in LMICs. One example of such an initiative is the Master's degree in Biomedical Informatics at the University of Colombo, Sri Lanka. The outcome of these initiatives is the formation of a network of actions (Braa, Monteiro & Sahay, 2004), to help supports cultivating eHISs in LMICs.

HISP role in eHIS training in Sri Lanka

As stated earlier, HISP became part of eHIS training in Sri Lanka as a result of a joint collaboration between the University of Colombo and the University of Oslo (UiO) in setting up a master's program in Biomedical Informatics. The program attracted doctors from the Ministry of Health in Sri Lanka and in the last year of the master's program, they were introduced to eHISs, including the DHIS2. The Postgraduate Institute of Medicine, which ran the program, made use of the resources from HISP (e.g. DHIS2 academies, resource personnel, expertise), in providing DHIS2 training. From the perspective of the Ministry of Health in Sri Lanka, these graduates would be the key to its vision in adopting technology to improve the country's healthcare system, which has already gained praise for its performance when compared with other LMICs.

In terms of this research, the Sri Lankan setting was important as it allowed the research to follow a group of learners undergoing training in a formal educational setting and subsequently in active service. Given that the learners from Sri Lanka would all be taking over positions within the public health system on completion of their training, following them enabled this research to gain insights into how training translates into work practices over time. Furthermore, the learners in Sri Lanka were a useful empirical source as they were a

homogenous group of learners (e.g. medical doctors) as against the heterogeneous groups of learners present in other DHIS2 academies. This differentiation was a useful element in the interpretations made later in this thesis.

The Sri Lankan setting was also useful for this research to differentiate between the formal and informal learning instances. The fact that the Academy participants in Sri Lanka were located in a formal educational setting made it possible for us to be sensitive to the dynamics of work and educational settings in the process of receiving in-service training. It was expected that such differentiation would allow the research to enumerate the contribution made by formal learning set-ups and their role in the process of eHIS training, implementation and community building.

2.4. The DHIS2 Academy

As described earlier, one key capacity-building strategy undertaken by the HISP is to conduct regional 'DHIS2 Academies'. Although the schedule in which these academies were conducted changed from time to time, in general, HISP organized at least three or four main DHIS2 academies in West Africa, East Africa and Asia. During the study period, the frequency of DHIS2 academies kept on increasing although HISP Oslo gradually minimized its contribution to these academies in the form of both monetary support and expert participation. While there were several reasons for the changing strategy, I perceived the build-up of regional and local expertise that can manage such academies on behalf of HISP Oslo, rising cost of conducting academies, the gradually enlarging HISP network and the changing funding models as the main reasons for this shift in focus.

Learner and trainer profiles

While DHIS2 Academies are conducted to cater to the needs of various categories of implementers and super-users (e.g. beginner, intermediate and advance), the focus of this study were the advance training instances. Many of these participants had an academic background in health sciences while others in information technology, health administration, management, etc. At the same time, many of the participants represented ministries of health in their respective countries, and also from the public health institutions and non-governmental organizations. Some of the common features of this group of participants were: above-average knowledge and skills related to computer use, certain degree of expertise in

their own domain, understanding with regard to basic informational requirements within their own health system, and their potential link with an eHIS based on the DHIS2.

The trainers of the DHIS2 Academy consisted of DHIS2 experts (e.g. developers, implementers and researchers) from HISP Oslo and trainers from the region (e.g. HISP South Africa, India, or from ongoing DHIS2 implementations in the region). These trainers may be experts in DHIS2 implementation, public health, health information management or even DHIS2 development/programming. The initial academies were almost completely contributed to by the experts from HISP Oslo while later on, regional resource personnel made significant contributions to the training process.

Organization of the DHIS2 Academy

In the beginning, the DHIS2 Academy consisted of only a face-to-face training program lasting 10 days conducted residentially. With the introduction of online training, the DHIS2 Academy consisted of at least two components: the online and the face-to-face DHIS2 Academy. Given the importance of its organization to this research, details pertaining to the design of the DHIS2 Academy would be discussed in Chapter 3.

2.5. Synthesis of the research context

In summary, the HISP network and its training arm, the DHIS2 Academy, provided the context for this research. This chapter discussed the issues around eHISs in LMIC contexts, and the contextualized needs of the learning as well as the learners. The chapter also highlighted the complexity of the training needs around DHIS2 and the HISP approach. Among these approaches, DHIS2 Academy was highlighted in this chapter as one of the key methods in fulfilling the learning needs of the implementers and the super-users of DHIS2.

Chapter 3 – The DHIS2 Academy

In Chapter 2, I discussed the context of this research and highlighted that the key focus of this research was the DHIS2 Academy. In this chapter, the DHIS2 Academy will be explained further in terms of its design and conduct, particularly in relation to its online component.

3.1. Overview of the conduct of the DHIS2 Academy

As described earlier, each academy was usually spread over 10 days and the learners were expected to stay together as in a residential training program. A pre-defined schedule was followed throughout, including for hands-on activities. During hands-on activities, learners worked with the trainers to resolve issues pertaining to their own data setsfrom their own settings. Participants also brought their own computers and the organizers took steps to provide internet facilities as much as possible. As stated earlier, the program was initially designed based on the perceived competencies of the learners and during the initial training instances, it became apparent that it was difficult to classify the learners into one group as their knowledge regarding DHIS2 ranged from being 'very limited' to being 'well aware'. As a result, HISP resorted to specific training instances of the DHIS2 Academy, which focused on either beginners or advanced users as was described earlier. While this made academies to be more focused, it increased the workload and the demand on the HISP.

3.2. Online DHIS2 Academy

From 2011 to 2014, around 12 instances of online DHIS2 academies were conducted as a supplement to the face-to-face DHIS2 Academies in different parts of the world. As explained earlier, with the introduction of online learning, the traditional DHIS2 Academy became the 'face-to-face' component of the DHIS2 Academy while the online learning phase became the 'online academy'. The introduction of the 'online academy' was expected to help the DHIS2Academy in several ways.

First, when conducted just prior to the face-to-face academy, it was expected to facilitate sharing of information among the academy participants. Secondly, it expected to provide the trainers a second chance to teach theoretical concepts and at times to save precious time during the face-to-face academy for hands-on work. Thirdly, it was expected to allow the

participants to become familiar with each other even before the face-to-face academy, which could increase the potential for building a more collaborative community of learners. Lastly, the trainers were expected to gain information pertaining to the skills and needs of each participant through the online academy thus allowing them to organize the face-to-face academy in a more effective manner.

3.3. Selection of the online learning management system (LMS)

In order to conduct online training sessions, it was necessary for the HISP to make use of an online learning management system (LMS)[1] that was capable of fulfilling its expectations within an LMIC context. It was perceived that the LMS should be open-source, cost-effective, user-friendly, less resource-intensive and more importantly, capable of facilitating community building.

At the time of starting this research project, Moodle LMS (https://moodle.org/) and the Blackboard LMS (http://www.blackboard.com/) were the two most popular LMSs in North America and Europe. Moodle, which stands for Modular Object-Oriented Dynamic Learning Environment, is a free and open-source software, or, FOSS. Thus, it allows its users to download and even modify the LMS according to their learning needs. However, in most instances, customizing Moodle requires only an average technical competence in handling application software and does not require any knowledge in programming (Park et al., 2011). Blackboard on the other hand is a commercial product, which dominates the market for LMSs in North America and Europe (Machado & Tao, 2007). In fact, Blackboard expanded its market share by acquiring its nearest rival WebCT, which was also a commercial LMS (Machado & Tao, 2007). One of the key reasons for its popularity is said to be the reliability and the diversity in services offered by Blackboard to its customers (Machado & Tao, 2007).

When it comes to Moodle, it also maintains a significant market presence in North America and in Europe just behind Blackboard (Cheung, 2006). However, in LMICs, Moodle is expected to dominate given its cost-effective nature. Nevertheless, it is false to assume that Moodle users prefer it for only its cost-effectiveness as the design and maintenance cost of courses based on Moodle may sometimes be higher than   on Blackboard (Brown & Eis,

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[1] Learning Management System is a web-based technology and software application used to design, manage, support and assess a specific learning process, that provides an instructor with a way to create and deliver

2003). This may particularly be true when an organization has to rely on outside parties for maintaining the LMS including its design and upgrades.

When it comes to overall functionality, users seem to prefer the experience of using Moodle over Blackboard (Beatty & Ulasewicz, 2006; Machado & Tao, 2007; Bremer & Bryant, 2005). However, given the evolving nature of both LMSs, deciding between the two LMSs based on functionality alone would not be ideal. In fact, while adding functionality to proprietary software such as Blackboard would be costly, the development trajectory of FOSS such as Moodle on the other hand may be both uncertain and sometimes unreliable.

Thus, in selecting the LMS, I needed to focus on the resources available at HISP, the context within which the training would be carried out and the available expertise for designing and running an online program. In terms of resources, Moodle was the preferred choice as it is a FOSS and the online DHIS2 Academy did not require any additional features to what is already inherent within the Moodle LMS. In terms of the context, Moodle has endured the limitations of resources, expertise, internet connectivity and trust of its users in LMICs over the years (Ssekakubo et al., 2011). When it comes to available expertise, I had already gathered experience in designing and conducting online training programs using Moodle for postgraduate medical education in Sri Lanka. Given these reasons, I was able to forge ahead with Moodle as the preferred LMS. From the point of view of HISP, this was even more agreeable as it adheres to the principles of FOSS, which is part and parcel of the DHIS2 – the focus of the online training program.

Although Moodle became an obvious choice for me, there are other free online LMSs, which compete with Moodle for its market share. Sakai Project, ATutor and Dokeos are several such LMSs. These LMSs demonstrate different strengths pertaining to different areas. For example, Sakai Project and ATutor are known for their user-friendliness and easy access (Pecheanu et al., 2011), while Dokeos has been recognized for its convenient template based designs (Graf & List, 2005). However, these platforms do not possess a developer and a user community such as that in Moodle (Graf & List, 2005). As a result, the design experience when using these alternatives may be inferior to that of Moodle. In addition, there are limitations for the free use of some of the LMSs such as Dokeos and Sakai Project (Pecheanu et al., 2011). Thus, Moodle was rated higher when compared to other available free LMSs as well.

3.4. Harnessing the constructivist potential within Moodle

Moodle LMS was built based on a constructivist philosophy, where learners are believed to be learning based on their prior experiences, through social interactions, and by actively participating in the learning process (Dougiamas & Taylor, 2002; Al-Ajlan & Zedan, 2008). In other words, a constructivist philosophy asserts that knowledge and reality would be constructed within the learner rather than being fed by a 'teacher'. Given the contextual nature of the problems that arise in implementing, scaling and maintaining an eHIS, this research believed that it was imperative for the learners of an eHIS program to be able to construct their own knowledge that would enable them to resolve issues pertaining to their own settings. This aspect would be further discussed in Chapter 4.

However, the mere adoption of Moodle does not facilitate constructivist learning among the learners (Forment, 2006). To facilitate the social construction of knowledge as perceived through a constructivist philosophy, Moodle has several in-built tools that encourage and facilitate the participation, interaction, collaboration and sharing of knowledge (Kidd, 2009). Among these tools are blogs, wiki, chat rooms, databases and discussion forums. This meant that if the research was to demonstrate the potential of online training programs to facilitate social construction of knowledge and community building, it was necessary to incorporate these tools in the training process. The tool selected in this case was the discussion forums. Its incorporation within the overall design of the training program would be discussed next.

3.5. Design of the online DHIS2 Academy in Moodle

Each academy was designed as a 'course' within Moodle and in general, these week-long courses were conducted just prior to the scheduled start of the face-to-face academy. In general, around three to four moderators including myself took part in each online academy. These moderators were experts in eHIS implementation, customization and health information management while some were DHIS2 developers. As depicted in Figures 2 and 3, within each course, topics were arranged as daily tasks where instructional modalities such as text, presentations, video, audio and quizzes were used to support participant learning.

Advanced DHIS 2 academy Lagos

Teacher: Zefrino Zefrino
Teacher: Olav Poppe
Teacher: Ola Hodne Titlestad
Teacher: Pandula Siribaddana
Teacher: Bob Jolliffe
Teacher: Lars Roland
Teacher: Lars Helge
Teacher: Johan Saebo

Advanced DHIS 2 Academy Entebbe 2013

Teacher: Ola Hodne Titlestad
Teacher: Bob Jolliffe
Teacher: Lars Roland
Teacher: Lars Helge
Teacher: John Lewis
Teacher: Prosper Behumbiize
Teacher: Johan Saebo
Teacher: Pandula Siribaddana
Teacher: Olav Poppe

Figure 2 : Two DHIS2 online academies as seen in Moodle

Day 1 - Pivot tables

Objectives:

1. Recognize and use the layout options, dimensions, and table options in DHIS 2 pivot tables.
2. Download data in a pivot table to an external file.
3. Recognize the constraints when dealing with pivot tables.
4. List the new pivot table improvements in DHIS 2.11

Tasks:

Reading: Pivot Table overview
Reading: Selecting dimension items
Reading: Arranging the table layout
Reading: Using table options
Reading: Creating a favorite
Reading: Downloading data
Reading: Constraints
Reading and video: New pivot table features in DHIS 2.11
Activity: Pivot table Demo
Assignment 1: Changing the pivot table layout
Assignment 2: Creating a pivot table from scratch

Figure 3 : Day 1 learning activities in the advanced DHIS2 online academy

In courses designed for beginners/intermediate learners, the topics covered included introduction to DHIS2, definitions of key terms, conceptual design principles of DHIS2, and

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implementation and deployment strategies. These topics were perceived as not requiring hands-on training and were thought of as the basic knowledge required to follow the face-to-face academies. However, given the inability of the online academy to attract all the participants, in some instances, the opening days of the face-to-face academy had to be dedicated to the same tasks. Advanced online academies followed the same design principles and included content related to basics of eHIS design, methods of implementation, data management, and technical topics such as pivot tables, sharing, geographic information systems, web API and analytics, and DHIS2 mobile. These topics were expected to bring all learners to the same level of understanding before the start of the face-to-face academy.

Discussion		Started by	Replies	Last post
Implementation and deployment issues		Bob Jolliffe	31	Jacinta Mbindyo Sat, 9 Jun 2012, 02:58 PM
Addressing design issues		Ola Hodne Titlestad	24	Tom Arunga Sat, 9 Jun 2012, 12:45 AM
Clearing the doubts with regard to DHIS terminology		Johan Saebo	30	Busiku Hamainza Fri, 8 Jun 2012, 09:57 AM
My experience with DHIS2		Pandula Siribaddana	60	Pandula Siribaddana Thu, 7 Jun 2012, 10:34 PM

Figure 4 : Pre-defined threads for discussion forum

Figure 5 : A sample discussion thread from DHIS2 online academy

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At the end of each day, learners were expected to interact in the discussion forum, which was designed to allow participants to post their own questions and also to contribute to the existing threads relating to the day's learning.

As an ice-breaker event, all participants were invited to contribute to a discussion thread called 'introduce yourself'. The idea of setting up this thread was to actively form the learning community from the very beginning. In order to make the forums personal, every participant was urged to update his or her profile using a photograph. At the same time, given the lack of participation experienced in the initial online learning instances, it was decided to implement several mandatory clauses for the learners to follow during online learning, such as '*all participants have to make at least 3 postings each with substantial content*', '*each participant has to post at least one query for the whole course*' and '*those participants with required number and quality postings would receive a second certificate confirming their successful completion of the online academy*'. Meanwhile, as the coordinator of the online academy, I carried out email communications each day to summarize the day's activities and to provide direct links to the discussion threads urging everyone to participate. At the same time, from the second day onwards, I initiated an additional round of emails listing out the top 5 participants who had made the most number of posts as an encouragement for the others to also participate. In addition to the round of emails to the participants, I also sent daily emails to all the moderators informing them of the ongoing activities in the online academy and reminding them of the possible questions posted in the forum that needed answering.

How many users make use of DHIS in your setting for various health information needs?

	Response	Average	Total
3	a. Less than 50	25%	2
	b. 50 – 100	25%	2
	d. 500 - 1000	12%	1
	e. more than 1000	38%	3
	Total	100%	8/8

Have you ever followed or received training on a distance learning platform such as 'Moodle'?

	Response	Average	Total
4	Yes	38%	3
	No	62%	5
	Total	100%	8/8

In your opinion, how useful would a online training programme be for each of the following categories of users? (please indicate the usefulness in a scale of 1 -5. Note that 5 repre 'most useful' and 1 represents 'least useful')

Average rank

Figure 6 : Screenshot of the responses received for a feedback form

The final activity of the course was to fill a feedback form or a questionnaire, which consisted of questions that were deemed pertinent to improving the next cycle of the online DHIS2 Academy. The responses received can be visualized as depicted in figure 6.

3.6. Role of the moderators within the online academy

From the point of view of this research, the moderators were assigned an important role. They were seen as one of the key elements in interaction generation through initiating discussions, keeping the discussions aligned with the goal of the discussion thread, sharing knowledge and experiences, and initiating collaboration between learners and various resource personnel. At the same time, the moderators were also expected to motivate the learners to engage with the learning tasks and to be active within the discussion forums. However, the moderation of the online academies was a voluntary task and as most of the moderators are busy professionals doing multiple tasks. Instead, moderators were informed of ongoing discussions within their areas of interests through email or other means of communication. Given that most of these moderators functioned as the trainers within the face-to-face DHIS2 Academy, they gained a second chance to address some of the issues raised within the discussion forums when they met the online learners face-to-face.

3.7. Extending the collaborative and interactive potential beyond Moodle

While Moodle was perceived to be a facilitator of collaboration building and knowledge sharing by this research, it also had some limitations. In particular, Moodle was not able to facilitate continuous interactions between the learners beyond the duration of the training program and was not supportive toward the learners in networking with people other than those who were part of the training. In fact, McInnerney and Roberts (2004) recognized that isolated events of interaction within Moodle are not effective in facilitating collaboration building to the extent of forming online communities. At the same time, Ghisland et al. (2008) recognized that discussion forums within Moodle are restrictive as it only allows interaction to those who are registered and enrolled in the training program. Thus, in order to facilitate continuous interactions between the learners of the online training program and the wider DHIS2 community, the training program had to look beyond the boundaries of the LMS. It is in this context, that email communications and the mailing list of the DHIS2 community became extensions of the online training program. These two aspects of the research context would be discussed further in Chapter 5.

Summary

As discussed in this chapter, the online academies were designed using the Moodle LMS, which is a free and open-source software. Moodle was selected as the preferred LMS based on several factors including its cost-effectiveness, time-tested appeal within the LMIC contexts and the expertise already available within HISP. Among the constructivist tools available within Moodle, the online training program made use of the discussion forums tool to facilitate online interactions, knowledge sharing and collaboration building. However, recognizing the potential limitations of Moodle in enabling continuous and learner-driven interactions, the research extended the boundary of its study setting to include online interactions taking place through emails and within the DHIS2 developer forum (the mailing list).

Chapter 4 - Theory

In the first half of this chapter, the thesis will present the current discourse related to eHIS training in LMICs under the heading 'relevant research'. In doing so, the thesis will focus on the discourse around IS training, online learning, blended learning, training of professionals within the health domain, workplace based learning and the relevance of FOSS communities to eHIS training. In the second half of this chapter, I explain how the theoretical discourse presented earlier provides the understanding necessary to develop an analytical perspective based on the concepts of boundary phenomenon and cultivation of communities of practice.

4.1. Relevant research

4.1.1. Discourse around IS training

When it comes to IS training, the focus has largely been on end-user training. The perceived benefits of end-user training on technology acceptance, scaling and sustainability (Arthur et al., 2003) and the willingness of corporations to infuse large sums of money for end-user training (Gupta et al., 2010), may have contributed to the IS training research agenda quite rightly to be end-user focused.

One area that was highlighted in IS literature in relation to end-user training was the differences in learning styles adopted by the learners (Bostrom et al., 1990; Sein et al., 1993; Yi et al., 2003; Sun & Zang, 2005; Gupta et al., 2010). In this regard, Bostrom et al. (1990) recognized the superior ability of abstract learners to perform well in end-user training programs as against the concrete learners. The reason as enumerated by Bostrom et al. (1990) was the ability of abstract learners to discover functionalities of software programs through logical thinking and rational arguments. In contrast, concrete learners would depend on experiences that they might have had on similar programs. In the absence of such experiences, concrete learners may not be able to do well as their abstract learning counterparts. However, given that a learning style is influenced by many different factors including individual experiences, motivation, objectives, cognitive ability and reflective practices (Kolb, 1971), it may be prudent to assume that the learners may adopt different learning styles at various points in time. Further, as perceived by Bostrom (1990), the superior ability of the abstract learners, or any other learner for that matter, was enumerated largely in relation to the novice learners. In advance learners such as those who have been investigated in this research,

however, the impact of the learning style may be different to that of novice learners. Nevertheless, as advocated by Gupta et al. (2010), this also means that training programs in IS should be flexible and cater to multiple learning styles of its learners.

Similar to different learning styles, Sein et al. (1999) highlight the differences that may exist in the knowledge levels required by different end-users. Presenting the hierarchical-knowledge-level model, they demonstrated that training programs that focus only on the software tool and the skills required for its use may only partly fulfill the end-user learning needs. The hierarchical-knowledge-level model consist of six levels out of which the initial three levels are labeled as command based, tool procedural and business procedural knowledge levels. In that command based refers to learning of syntax and semantics of the software while tool procedural refers to the learning of doing generic tasks using the commands. Business procedural level refers to the learning of application of tool procedures to a specific task. As the fourth level, Sein et al describes the tool conceptual level, which refers to the users gaining understanding of the big picture regarding what to do with the tool. The next two levels, which Sein et al describe as a major departure from the existing literature as it refers to motivation and meta-cognition as key knowledge components. Thus, the two levels, business-motivational and meta-cognition, refer to 'what the tool can do for the trainee and the business' and 'learning to learn' respectively. According to this model, organizations need to train its workforce using a comprehensive training strategy guided by a framework that depends on the classification of the trainees (end-users), specific training approaches for different classes of IT tools and the level of knowledge as described earlier. As concluded by Sein et al. (1999), such a guided strategy would be useful in moving training closer to education.

Applying the framework suggested by Sein et al. (1999) for training around collaborative applications, Kang and Santhanam (2003) have recognized that in the process of appropriating a new collaborative application, end-users would institute and develop their own procedures and 'good practices'. These practices may have not been foreseen by the designers of the IS or the management of the organization. Furthermore, Kang and Santhanam also highlighted that around such collaborative applications, end-users with different knowledge levels – as perceived by Sein et al. (1999) – may collaborate with each other through problem solving. Such collaboration would enable them to appropriate the functionalities of the software tool with their work practices. From an IS training point of

view, this would mean that coaching end-users before implementing an IS should not stop at one point, but should continue for a period of time (Kang & Santhanam, 2003).

Olfman, Bostrom and Sein (2006) however re-conceptualized the strategy proposed by Sein et al (1999), recognizing the need for IS training to be positioned within the context of higher-level organizational strategies. This would require different dimensions that may exist within training and learning strategies to be matched and be aligned with overall organizational goals. For instance, Olfman et al suggested that online self-paced end-user training is most appropriate for users who would require command based, tool procedural and business procedural knowledge levels. Instructor led training on the other hand, would be most appropriate for those who require the attainment of other knowledge levels such as tool conceptual knowledge, business motivational knowledge and meta-cognition. In other words, Olfman et al suggest instructor led training for gaining higher order learning. However, the instructor led training as perceived by Olfman et al is not necessarily a simple transfer of knowledge from the instructors to the learners. Instead, it seems to be a guided collaborative learning event taking place between end-users with different knowledge levels as suggested by Kang and Santhanam (2003). From the point of view of Olfman et al, collaborative learning among the end-users may pay rich dividends in an organizational context.

In an organizational context however, the use of technology in training – technology-mediated learning (TML) – has been recognized as a key trend (Gupta & Bostrom, 2009). TML entails the use of all forms of advanced information technology to mediate the learners' interactions with the learning materials, peers, and/or instructors (Alavi & Leidner, 2001). TML therefore is an umbrella term that is used to refer to computer-aided learning (e.g. training packages), computer-mediated communication (e.g. email, bulletin boards, text chats, virtual worlds), computer-supported research, analysis, production and presentation tools (e.g. word processing software, statistical packages, electronic dictionaries), and managed learning environments (e.g. Moodle, Blackboard, WebCT) (Shield, 2002). Gupta and Bostrom (2009) point out that while these technologies have made giant strides in terms of their use, research pertaining to the impact of TML has been lagging behind – both within IS and educational research. At the same time, Gupta and Bostrom have also recognized that there is a gradual shift in organizational settings toward more social forms of learning. This could potentially be enabled by the developments taking place in relation to learning technologies (e.g. online and mobile learning, social media, web 2.0 technologies). However, in the absence of a clear

understanding regarding the impact of TML on individuals and on learning groups, it may not be possible to facilitate effective collaborative learning using technology as a mediator.

The comprehensive theoretical model for TML introduced by Gupta and Bostrom (2009) was expected to cater to this need. It incorporates among others the calls for accommodating individual differences and levels of knowledge in IS training (Sein et al., 1993; Sein et al., 2001), the need to have greater depth and breadth in TML research (Alavi & Leidner, 2001) and the call for addressing the need for collaborative learning through TML (Alavi & Dufner, 2005; Fjermestad et al., 2005). Its comprehensiveness however lies in the fact that the model incorporates multiple dimensions of TML including the learning structures, relationships among structures, the social system associated with the learning environment, influence on social contexts, reciprocal causation, and even the influence of actors and the power dynamics. Given that this research also tackles a type of TML, it may be prudent to expect training around eHISs using online learning to be influenced by similar factors. However, given the extra-organizational nature, the LMIC context, and the technology specificities assigned with this research, the factors that may influence its training may be different to those affecting end-user training within an organizational context. One of the key technology specificities associated with this research is the use of online learning and its supporting tools, which will be discussed in section 4.1.2.

4.1.2. The current state of online learning

> "*'e' in e-learning is disappearing and it is all just learning*" (Masie, 2003, p. 412)

In modern distance education (DE) literature, the terms 'distance education', 'distance learning', 'e-learning' and 'online learning' have been used interchangeably with highly vague and overlapping descriptors (Moore, Dickson-Deane & Galyen, 2011). The reason may be the evolutionary process of DE in terms of both technology and pedagogy. In terms of e-learning, it is defined as "*provision of education or training electronically through the Internet*" (Keegan, 2003, p.1). In line with this definition, Rekkedal et al. (2003) formed a definition which recognizes e-learning as "*interactive learning in which the learning content is available online and provides automatic feedback to the student's learning activities*" *(p.121).* However, Rekkedal et al. (2003) agree with the fact that there is an ambiguity between the terms e-learning and online learning. Nevertheless, not all agree with the fact that e-learning refers to learning taking place solely via the internet or online. For instance,

Benson (2002) and Clark (2002) argue that other technologies such as intranet, CD-ROMs, interactive television, radio and satellite broadcasting should also be included in the definition.

However, when it comes to online learning, the ambiguity between various definitions seems to be exaggerated. This means that contemporary theorists find it difficult to characterize DE and online learning differently although they understand that the two are fundamentally different (Moore et al., 2011). However, many agree that online learning is a newer version of distance learning (Benson, 2002; Hiltz & Turoff, 2005). Nevertheless, what is important in the understanding with regard to this 'new version' of distance learning is that it has attracted discussions not only in relation to accessibility, but also with regard to flexibility, connectivity and its ability to promote various interactions (Oblinger & Oblinger, 2005). For the purpose of this research however, there was a need for online learning to be considered in view of generating meaningful learning. As pointed out by Dabbagh (2005), meaningful learning entails the application of pedagogical models or constructs, instructional and learning strategies and pedagogical tools such as online learning. Thus, for the purpose of this research, online learning entails pedagogically driven learning taking place via the internet.

4.1.3. Understanding the blended learning approach

With online learning technologies and processes becoming more popular, affordable and well recognized among the teaching and learning communities, its applications in the educational setting and other training arenas have also become widespread (Simonson, 2012). In contemporary education, most academic programs utilize some degree of e-learning to facilitate learning among students in addition to the traditional face-to-face or classroom learning (Garrison, 2011). This would mean that educational programs could be presented as a mix, a hybrid or as a blend of distance learning and face-to-face learning (Bates, 2005). While one may be enticed to consider such programs as blended learning by literally adhering to its projected meaning, scholars do not necessarily agree on what constitutes a blended learning program (Picciano et al., 2013).

In understanding the blended learning approach, it is useful to first distinguish between different types of theories that exist within a design-related field such as education. As pointed out by Gibbons and Bunderson (2005), there are three main types of knowledge-producing research enterprises in design related fields – explore, explain, and design models.

When applied to the concept of blended learning, explore models have identified blended learning as combinations of online and face-to-face instruction (Young, 2002; Reay, 2001), of instructional modalities (Thomson, 2002 as cited in Graham, 2006) and also instructional methods (Driscoll 2002). At the same time, some authors have explored models to unearth different categories of blended learning. For example, supplemental model (Twigg, 2003) views blended learning from the point of using online material, quizzes and other online activities as a supplement to face-to-face learning. Within corporate training, 'anchor blend' (Rossett & Frazee, 2006), which prescribes introductory and substantive face-to-face experience and subsequent independent online experiences, is another example. For the purpose of this research however, the model suggested by Garrison and Vaughan (2008, p. 148), which is the "*organic integration of thoughtfully selected and complementary face-to-face and online approaches and technologies*", provides a starting point.

The Explain models of blended learning on the other hand follows the pattern of mentioning theory, application and development of theory rather than defining the blend or designing interventions (Graham, Henrie & Gibbons, 2013). Such models may also attempt to identify variables such as social, teaching, and cognitive presence (Garrison & Arbaugh, 2007); satisfaction, learning effectiveness and cost effectiveness (Moore 2005); learner centeredness, knowledge centeredness, assessment centeredness and community centeredness (Bransford et al., 1999); sense of community (Rovai & Jordan, 2004) and, the sharing of experiences in a community of practice (Picciano & Dziuban, 2007). Overall, the Explain models of blended learning inform this research regarding the necessity of being sensitive to the organizational or research context when identifying different dimensions of blending.

In contrast, design models of blended learning would designate target outcomes and would indicate the core attributes that need to be integrated within the design in order to achieve the said outcomes. However, according to Graham, Henrie and Gibbons (2013), design models of blended learning are flooded with comparison studies (e.g. comparing between blended courses and face-to-face courses) but there is a notable lack of iterative studies which focus on identifying the core attributes and their influence on the learning outcomes.

When analyzing these theories and models, I perceive that a blended learning approach extends beyond just an online and a face-to-face blend. This would mean that in the process of harnessing the power of blended learning around eHIS training, it may not be enough to address any one of the explore, explain and design enterprises discussed earlier. It is also clear

from the discussions that community, collaboration and sharing are important elements in achieving the learning outcomes of a blended learning program, especially in relation to adult learning and organizational contexts. However, an pointed out by Picciano & Dziuban (2007), an important element absent in most of these discussions is the property of 'integration' as in the case of aligning the interactions within different modalities of blending.

4.1.4. State of learning within the health domain: The scaffold for eHIS training

"Half of what we are going to teach you is wrong, and half of it is right. Our problem is that we don't know which half is which."

(Charles Sidney Burwell, Dean, Harvard Medical School, 1935-1949)

Almost half a century after he made this statement, many health educators still quote Charles Burwell as the statement still holds true to some extent. This emphasizes the need for professionals to be 'up to date' on their medical knowledge which is in a constant flux. However, more than any other field, professionals in the health domain have an ethical obligation to become a lifelong learner given their duty towards the health and wellbeing of the patients and the general public as a whole (NMAs, 2000). In fact, lifelong learning, or Continuous Professional Development (CPD) is now considered probably the most important part in the educational continuum in health (Morris & Behrens, 2014). However, CPD is not only referred to by professionals working within the health domain. Professional organizations such as The Chartered Institute for IT (BCS), The Chartered Institute of Management Accountants (CIMA) and The Institution of Mechanical Engineers (IMechE) also offer CPD programs for their membership as part of career development pathways.

The reason for many professional communities opting to use the term CPD as against lifelong learning is that the latter seems to restrict learning to acquisition of knowledge largely through formal means (Ryan, 2003). This is more in line with a positivist ideology where transfer of knowledge is expected to lead to behavioral change (Morris & Behrens, 2014). However, CPD is sensitive to the fact that the change process expected emanating from professional, personal and social contexts (Fox & Bennett, 1998). Therefore, transfer of knowledge or acquisition of learning alone no longer explains the actual learning taking place within the health domain.

When looking at the theoretical basis on which modern CPD programs have emerged, there are many contributions. For instance, adult learning theory (Knowles, 1984) has informed educators and designers of CPD programs that adults are motivated by experience, personal goals and practical needs. Self-direction and lifelong learning (Candy, 1991) posit that CPD should allow learners to choose, undertake and evaluate their own learning according to their perception of the learning needs. And reflective practice and experiential learning (Kolb, 1984; Schon, 1987) inform CPD by emphasizing that the most powerful learning happens through experience and that reflection is an integral part of the learning process. Meanwhile Eraut (2007) and Billet (2004) through learning in practice and workplace learning theories respectively argue that actual learning takes place when one engages with his or her work practices. This would mean that for CPD, the challenge is to enable learning by making it explicit (Morris & Behrens, 2014). However, Wenger's (1998) theory of community of practice posits that learning activities (e.g. CPD) should facilitate the learners' participation in a CoP as learning is essentially a social activity. Sweeney and Griffith (2002) further add the importance of personal and environmental factors that shape learning and the willingness to change.

When considering the theoretical underpinning behind modern day CPD programs, it is clear that learning is seen as a lifelong process which is not limited to traditional methods of acquisition such as classroom based learning sessions. At the same time, it also becomes apparent that work practices play an important role in orienting a person to take up CPD and gain the desired learning as expected through such programs. Given the nature of adult professional learners, there is also a need to enable the social construction of knowledge in order to initiate a change process within the learners. Therefore, it is necessary to also understand how these professionals learn at work in order to design and implement training programs for professional learners.

4.1.5. Work-based learning and communities of practice

Work-based learning came into being as an educational terminology due to the changing economic, social and educational demands of the contemporary society (Boud & Solomon, 2000). It has been enriched by theoretical contributions in the form of linking knowledge and experience (Dewey, 1916; Kerschensteiner, 1950 & Schon, 1987 as cited in Walsh, 2013), linking knowledge and practice (Evans et al., 2009; Malloch et al., 2011) and situating

learning in practice (Lave & Wenger, 1991; Wenger, 1998; Billett, 2002; Fuller & Unwin, 2009). An interesting observation in this regard is how early theoretical contributions from behaviorist and cognitivist theorists were criticized on the grounds that they do not heed to the dynamics within the work environment. Particularly, these theories did not consider that learning is mediated and that it is situated. As a result, the focus was shifted from individual learning to collective learning where knowledge is constructed through interactions with more knowledgeable others.

At the same time, it was also perceived that the mere acquisition of knowledge does not help determine the identity of an individual within his or her work setting. The theories mentioned earlier did not provide an adequate explanation in this regard simply because they focused on an individual's successes in acquiring knowledge (Morris & Behrens, 2014). Filling this vacuum, socio-cultural learning theorists brought forward an array of conceptualizations including situated cognition (Brown, Collins & Duguid, 1989) and legitimate peripheral participation in communities of practice (Lave & Wenger, 1991), that explain how workplace and its activities can support learning.

Communities of practice and work-based learning

"Communities of practice are a natural part of organizational life. They will develop on their own and many will flourish, whether or not the organization recognizes them. Their health depends primarily on the voluntary engagement of their members and on the emergence of internal leadership." (Wenger et al., 2002, p.12)

In its most basic form, a community of practice can be defined as a group of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly (Wenger 1998). Thus, having the same designation (e.g. doctors, nurses, information technologists) does not necessarily mean that they belong to a CoP. In order to be labeled as a CoP, they need to show a commonality with regard to their domain of interest, sense of community and their practice (Wenger, 1998).

In order to fulfill the 'domain' specific commonality, members should demonstrate a shared competence that distinguishes them from other people outside of the CoP. However, the shared competence or the interest may not necessarily have to be recognizable to the outside world. In order to fulfill the characteristic of 'community', the members should work together, build relationships and share their knowledge (Wenger, 1998). This however does

not mean that the members should work together every day. For instance, a group of people interacting through email or through a web forum and sharing their knowledge and experiences would also fulfill the characteristic of 'community'. The characteristic of shared practice on the other hand emerges as a result of sustained and usually lengthy interactions among the practitioners within the community (Wenger, 1998).

From a different point of view, the newcomers to a community of practice would often take up peripheral roles and will move gradually to perform more central roles under the guidance and support of the other community members, or the old-timers (Lave & Wenger, 1991). Referred to as 'legitimate peripheral participation', it postulates that the move from periphery to the center entails learning acquired through interaction taking place within the community. However, even though newcomers undertake peripheral activities, they are also considered part of the community and hence 'legitimate' (Lave & Wenger, 1991). In other words, these newcomers may not necessarily be 'trainees' or 'interns', but could even be experts who shift to a new locality, team, role or an organization (Morris & Behrens, 2014). Furthermore, as newcomers themselves will bring their own new knowledge and experiences, they will also contribute to the process of learning within the community. As such, the applicability of legitimate peripheral participation and CoP to learning instances such as CPD is highly feasible. Nevertheless, critics argue that these theories lack rigor in understanding the influence of power structures within work-based learning (Turnbull, 2000) and in understanding how individual agencies (Billett, 2002) influence one's own graduation within a CoP.

4.1.6. Linking eHIS training, CPD and the FOSS communities

When it comes to eHIS implementation in LMIC settings, the considerable likelihood of their failure or unsustainability have been well documented (Kimaro & Nhampossa, 2005; Heeks, 2006). Heeks (2006) on analyzing the reasons for failures (or successes) of eHISs points out that it may well be due to the fact that there exists a gap between what is perceived by the designers and what actually goes on in practice: the design-reality gap. One important aspect in the said design-reality gap is the competencies of the end-users who are ought to be 'hybrids' rather than specialists in any one field such as IT, clinical practice, nursing and health management.. In fact, those who undergo training to become end-users, super-users and sometimes even implementers of an eHIS are more likely to be part timers rather than dedicated eHIS staff (Rigby et al., 2007). In addition, Heeks (2006) also argues that in low

resource contexts, there is a need to create 'hybrids' who are able to understand both worlds: the developer's world and that of actual practice. In other words, it is necessary for the health staff including doctors, nurses, and other professionals to be aware and be competent in eHISs. From the perspective of this research, such perceptions indicate that eHIS training should be part of the CPD activities available for health staff.

However, taking health professionals away from their work for CPD activities potentially hampers service delivery, which is critical in LMIC settings (Rowe et al., 2005). Therefore, approaches such as on-the-job training or work-based-training and blended learning seem to be more practical than utilizing a formal, classroom-based approach to CPD. Furthermore, online learning has been suggested as an approach that can be used to reach health and other staff in remote areas based on its suitability to the learning objectives of the CPD activity (Harden, 2005). In some instances however, even for the health professionals who can reach training sites, online learning technologies are the most efficient way of delivering CPD (Harden, 2005).

Somewhat alien to the discourse around learning within health and other professional domains, is the contribution made by FOSS communities. From an organizational point of view, FOSS communities have been seen as external repositories of knowledge, which can facilitate learning and innovation (Dahlander & Magnusson, 2008; Von Hippel, 2001). However, unless organizations recognize such knowledge repositories and build capacity within the organization to engage with this, it would not be possible for such organizations to harness its extensive benefits (Dahlander & Magnusson, 2008). Nevertheless, when the knowledge requirement is with regard to HIS, its design, implementation, inter-operability, standardization and utilization; even healthcare organizations and national health systems may benefit from the problem solving capacity offered by the FOSS communities. Furthermore, from an eHIS training perspective, open-source communities facilitate hands-on approach to learning as students can work with the community in resolving real life problems (Whitehurst, 2009). This also means that FOSS communities can offer blueprints to facilitate self-learning among its membership (Sowe and Stamelos 2007). From the point of view of this research, such facilitation gives enough impetus toward harnessing the benefits afforded through FOSS communities for two reasons. One, the eHIS referred to in this research is based on FOSS. Two, the focus is on online tools that facilitate learning through participation, interaction and network formation.

4.2. Analytical perspective

When implementing online learning or blended learning programs, there are two groups that need to be onboard if such programs are to be successful. One, consists of people who would use the online or blended learning program for learning, i.e. the learners. Within the context of this research, these learners were largely implementers of eHISs. Two, those who would use the online learning tools to conduct training, that is, the trainers. Within the context of this research, the trainers group consisted of DHIS2 developers, expert implementers, researchers and those who manage HISP. Thus, in my point of view as a designer and implementer of online learning systems, it is vital to find a common path in achieving the intended learning objectives for both groups. In addition, as described in Chapter 2 of this thesis, when the aim of the training program is to foster learning in relation to systems development, implementation, scaling and sustainment in LMIC contexts, such learning programs may also be assigned the tasks of network building, information sharing, and knowledge building. Furthermore, in the context of a FOSS like DHIS2, the training also expects to link the learners with the FOSS community – both in order to harness the benefits and also to expand the said FOSS community.

Thus, when the expectations from an online or a blended learning program become so broad, it needs to be sensitive to the different perspectives that enable harnessing the fullest potential of the training being given. The rest of this chapter therefore discusses how this research expects to unravel these complexities using the concepts of boundaries and cultivation of CoPs.

4.2.1. The boundary phenomenon

When looking at the health information domain, it is clear that there are different professionals interacting with each other in order to achieve a single aim: patient and population wellbeing. Nevertheless, there exist many conflicts in terms of their roles, remuneration, training, leadership, recognition and practice. Yet, in a ward setting, nurses, doctors, physiotherapists, nutritionists, ECG technicians and even attendants need to work together in a well-coordinated manner from admission to discharge of a patient. As pointed out by Star (2010), such groups rarely reach consensus, and their collaboration is often fragile. However, their cooperation often continues without much of a problem. In the above example, the tool that allows these professionals to intermingle in a professional manner is a

set of papers, forms and reports bundled together as a 'bed-head ticket' or as the 'patient record'. While the patient record as a whole is not useful for everyone, certain sections or certain notes within the record are important to different professionals. For some, as in the case of a nutritionist, it may be important to look at the doctor's prescription, nurses' record on swallowing ability, and the laboratory reports on blood sugar levels when determining the diet the patient should be given. The prescribed diet however would not be useful to the doctor or to the nurse. However, it is useful to the workers at the hospital kitchen to determine the daily rationing. Thus, even the workers at the hospital kitchen would understand certain sections in the patient record or at least extracts of the same.

From the point of view of conceptualizing CoPs, it is clear that different professional groups with their shared interests, practices and community, build their own identity in contrast to other groups. Through such demarcations, the actions and interactions between communities cease to a certain level (Akkerman & Bakker, 2011). However, the need to work together, as in the case of caring for a patient, builds a sense of togetherness among such groups (Arias and Fischer, 2000). When different CoPs come together as described earlier, they would therefore require a way of building common grounds to learn from one another in resolving the emerging problems. This is one instance where boundary objects can emerge.

According to Star and Griesemer's early investigations and theorizations, boundary objects were recognized as "*objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use*" (Star and Griesemer, 1989, p.393). While the term 'object' may imply them to be material in nature, it is recognized that such objects may also include non-material processes and conceptualizations (Star, Bowker & Neumann, 2003; Star, 2010). Furthermore, the ability of a boundary object to exist between social worlds (communities of practice) is achieved through its ill-structured nature (Star, 1989). As a result, communities can adopt the boundary object to fit their practices within their own social worlds. Thus, from the perspective of different CoPs, there exist two forms of the same boundary object – a generalized form and a customized form. Therefore, the groups that are cooperating without consensus may go back and forth between the two forms of the object during their interactions (Star, 2010).

However, given the broad definition of boundary objects, it may be difficult to determine what may not be considered a boundary object. As a response, Star (2010) pointed out that similar to many other concepts, boundary objects would also manifest within a certain level of scale and at most, the concept is more useful in an organizational setting. In addition, whether an object is boundary or not also depends on its scope: the more specific the scope, the more useful the conceptualization of a boundary object would become. In addition to scale and scope, it is also argued that when movement between two forms of boundary objects are scaled up or become standardized, such boundary objects themselves can move and form infrastructures, standards, things, and other processes (Star, 2010). In these instances, the boundary objects may no longer serve the purpose of linking between different communities.

Expanding the discourse surrounding the boundary objects is their potential to be 'epistemic'. As described by Ewenstein and Whyte (2009), epistemic objects garner scientific inquiry and pursuit and therefore have the potential to act as pragmatic tools attracting cooperation and communication between different interest groups. However, in comparison to boundary objects, epistemic objects are abstract in nature and may include 'things' such as "conceptual distinctions, experimental set-ups, fields of applications, methods of observation, mathematical models, and forms of data presentation" (Glaser et al., 2012, p.44). Characteristically, these objects lack form, shape, are incomplete, and appear in temporary instantiations. In fact, Knorr Cetina (Cetina, 1997) describes epistemic objects as being open, lacking completeness of being, and having a capacity to evolve indefinitely. Such indetermination entices inquiry although fulfillment of an inquiry opens up many other inquiries rather than terminating the inquiry process (ibid). This means that knowledge surrounding an epistemic object garners an 'unfolding ontology' until the object ceases to gain epistemic inquiry.

When considering online and blended learning, it is interesting to note that while it may be possible to define online learning instances based on their materiality; blended learning has always troubled scholars in terms of a universally acceptable definition. In a way, this research viewed the indeterminate nature of blended learning as attracting scientific inquiry. Thus, as with epistemic objects, blended learning has continued to evolve and maintain its potentially epistemic nature. In other words, it may also be possible to postulate that both online learning and blended learning act along the boundaries between different stakeholder groups. From the perspective of this research, this meant that the boundary phenomenon

might be able to explain the dynamics that take place when online learning tools are introduced into eHIS training including in its perceived facilitator role in formation of communities.

4.2.2. Blended learning programs as a path to cultivating CoPs

Given the importance of organizational knowledge within a fast-paced knowledge economy, it is essential that organizations take every possible step to facilitate knowledge creation and enable innovation. In doing so, attempts at creating CoPs out of thin air are not unheard of (Wenger et al., 2002). However, given the spontaneous, natural and self-directed nature of CoPs and the characteristics such as shared domain of knowledge, sense of community and shared practices, most attempts at forming CoPs are bound to end in failure. Wenger et al. (2002) however described how organizations can entertain the idea of CoPs through a mechanism of 'cultivation' rather than 'creation' which follows a strategy of planting 'seeds' that favors the evolution of CoPs.

The first principle of cultivating a CoP, as pointed out by Wenger et al. (2002), is the design for evolution, which emphasizes the creation of catalysts for the natural evolution of the CoP. However, in order to do this, one must recognize the potential among certain groups to evolve into a CoP rather than building such groups from scratch. In accordance with the modern understanding of adult learning, it is clear that no one within or outside an organization would be acting alone but rather would be part of a network of his or her own. In fact, the discourse around social capital as a means of knowledge and power indicates that relationships are the key to power as they allow access to those who seek knowledge (Kilpatrick et al., 2003; Coleman, 1988; Putnam, 1993). From the point of view of cultivating CoPs, this would mean that there is a need to consider these networks and how best to utilize them in order to maintain the dynamic nature of the communities.

While designing for evolution plays a key role in cultivating a CoP, enabling the gathering of insider and outsider perspectives is also significant (Wenger et al., 2002). An insider's perspective is useful in recognizing the real players within the community and their relationships in addition to issues at hand, challenges faced and the potential for emerging ideas and techniques. However, without gaining an outsider's perspective, it may not be possible for the community members to see the possibilities of evolving further. Thus, cultivating a CoP would require linking outsider and insider perspectives through various

means such as by having a well-connected leader or by enabling members of one community to gain insights from another, more advanced community. In a multi-site, multi-stage eHIS implementation and training scenario such as HISP, these connections may be formed between groups of people from different sites who are at different stages of implementation and scaling of the eHIS. In a FOSS scenario, such linkages may be formed when people interact within a FOSS community. Such a view gains strength from conceptualizations such as that expressed by Berdou (2006) where FOSS communities were seen not as being but as covering a constellation of practices. This would mean that within FOSS communities, there is always room for innovation, propagation of knowledge and more importantly, for learning.

Enabling participation is another key aspect in cultivating a CoP (Wenger et al., 2002) although the common understanding of 'equal participation' by all members of the community may not necessarily be the ultimate goal. Instead, one should realize that communities may have a core group of people who will act as auxiliaries to the coordinator of the community and are usually surrounded by another smaller group of active members. However, the largest group would be a 'peripheral' group of members who take interest in the activities within the community, contribute occasionally and most of the times assimilate passively. In addition, a group of outsiders may also be interested in the activities of the community (Wenger et al., 2002). These members may move from one group to another depending on their interests, shift of topics within the community and due to various other reasons. This also emphasizes that the boundaries within CoPs are fluid enough to allow such movement. Thus, from a cultivation point of view, what is needed is to provide opportunities for members to participate at all levels. Such participation will enable movement between levels, and facilitate taking up limited leadership roles by those members who are active in the community.

Furthermore, Wenger et al. (2002) suggest that public spaces be created through various events in order to enhance the interaction among the community members. This should be supplemented through 'back channels', which will enable the same members to strengthen their relationships over resources both within and outside the community. In other words, public and private spaces created within an organization are interrelated and proper orchestration of these spaces may lead to effective community building. Such spaces also exist in the online environments and these may be large public networks such as FOSS communities or smaller developer networks as in the case of mailing lists (Oguz et al., 2010).

Supplementing these principles is the need to make members realize the value of the community. As argued by Wenger et al. (2002), although initial value creation can be done through resolution of current problems, more robust value creation may take longer. However, value as perceived by the members of the community should be harnessed and made explicit throughout the lifetime of the community.

Informality is another aspect needing attention when thinking of cultivating CoPs and in this regard, Wenger posits that it is vital to combine familiarity and excitement in order to differentiate the CoP from teams. At the same time, each community should have its own rhythm which according to Wenger et al. (2002, p. 63) comprises of "*syncopation of familiar and exciting events, frequency of private interactions, the ebb and flow of people from the sidelines into active participation and the pace of the community's overall evolution*".

When looking at the opportunities presented through blended learning, it can be argued that some of these opportunities facilitate cultivation of CoPs. For instance, if one considers face-to-face and online learning being managed by two separate communities (Parkin, 2011), blended learning could be an opportunity for these communities to gain an insight into each other's practices. On the other hand, if one considers blended learning as epistemic in nature, it attracts scientific inquiry from the communities involved. Thus, there is a chance that the blended learning program and the communities benefited by such scientific inquiry may evolve in parallel. At the same time, as blended learning makes use of online interaction strategies in addition to face-to-face interactions, it enhances the potential for participation and interaction for all levels of members and also for the 'outsiders' (Garrison, 2011). In addition, different spaces of learning would be created through blended learning programs including online, face-to-face and work-based learning spaces. These spaces may enable members of the community to build personal and professional relationships and thereby to understand the value of the community as a whole.

From a different point of view, CoPs themselves may be able to facilitate successful implementation of blended learning programs. In the educational setting, it has been recognized that CoPs consisting of teachers and management could share knowledge and experiences among themselves in adopting blended learning thus enhancing the confidence among the potential adopters regarding the same (Parkin, 2011). The informal nature of CoPs would also encourage potential adopters of blended learning to participate in ongoing staff

development activities, which are essential for successful implementation of blended learning programs (Garrison & Vaughan, 2008).

Given the reciprocal association between blended learning and the cultivation of CoPs, it is prudent to utilize the same as part of the analytical perspective for this research.

Chapter 5 – Methodology

This chapter will begin with a self-reflection in which I describe how I negotiated various influences on my research perspective as a result of being a medical professional, an educationist, a citizen from an LMIC and a researcher at the University of Oslo (UiO). I will thereafter discuss and justify why this research is considered an action research. During the discussion regarding the research design, I will explain the reasons for classifying this research as having characteristics of both qualitative and quantitative research traditions. In addition, the chapter will also provide insights into the research setting, data collection methods, data analysis and the limitations of the chosen research method.

5.1. Philosophical underpinning

At the beginning of this research, during the phase of conceptualization, I had my own perceptions regarding training and using online teaching methods. However, because of my medical background, I was immersed within a largely positivist paradigm or in a culture where 'scientific method' is viewed in terms of numbers and statistics. In fact, the positivist or quantitative dominance over naturalistic inquiry in the biomedical research is well documented (Hampton, 2002). In other words, I have learned to look at objective reality that exists in relation to certain elements, phenomena or practices around me. However, as I began my career as a medical educationist, the positivist approach per se did not necessarily give me enough tools to assess the societal, cultural and other influences on teaching and learning. At this point, in line with the arguments brought forward by scholars such as Rubin and Rubin (2005) and Silverman (2001), I realized that people tend to assign different meanings to objects, things and events based on their personal, societal and historical experiences. Similarly, when I study a certain phenomenon, I would also make my own interpretations based on my own personal, societal and historical experiences. This would mean that the philosophical paradigm I adopt should allow me to understand the complexity of views in relation to the focus of my study and overcome the positivist dominance in my professional context.

However, there exists another philosophical paradigm, known as the transformative approach, which criticizes the structural and theoretical misfit of positivist and post-positivist approaches toward marginalized groups (Mertens, 2007). As a researcher from an LMIC

where inequity, injustice, marginalization and discrimination are thought to exist in abundance, the transformative approach was particularly attractive to my research mind. It would enable me to address issues of injustice that may take place when applying teaching and learning methods and when utilizing technologies in learning. However, the transformative approach did not convince me of its ability to provide me the necessary flexibility toward investigating and comparing different contexts in which such marginalization may not be apparent. In fact, a key limitation in transformative worldview is its restricted applicability to a particular social group (Hall, 2012), which may not necessarily represent my study population.

The answer to my indetermination came from a different philosophical approach; pragmatism (Dewey, 1931; Rorty, 1991; Creswell & Clark, 2007; Feilzer, 2010; Morgan, 2007; Biesta & Burbules, 2003). The term 'pragmatism' derives from the Greek term 'pragma', which refers to 'actions' (James, 2000). As pointed out by Rorty (1991), the 'actions' within the philosophical conceptualization of pragmatism entail inquiries and practices that relieve or benefit the condition of the man. Thus, pragmatism as a research paradigm encourages the researchers to focus on the practical consequences of an idea or a concept rather than be embroiled in the contentious issues of truth and reality. In fact, pragmatists accept the existence of singular or multiple realities and perform empirical inquiry toward solving real world practical issues (Creswell & Clark, 2007), sometimes using pluralist strategies.

Thus, I perceived pragmatism as a means of focusing not merely on the method, but on the real problems and the use of whatever the approaches available (a pluralistic strategy) in understanding the said problem. This enabled me to free myself from any one philosophical approach and to draw from both qualitative and quantitative assumptions. Furthermore, a pragmatic worldview will agree with the fact that societal, historical, political and other contextual factors will have an effect on the phenomena under study (Feilzer, 2010). This also meant that a pragmatic view would enable me to be sensitive to the transformative viewpoints as in the case of investigating LMICs. Thus, the research design described in the next sections can best be described as being formulated by adopting a pragmatic worldview with a pluralistic approach in mind.

5.2. Action research

Even before beginning my doctoral studies, I was intrigued by the fact that particularly in LMICs, medical practitioners tend to distance themselves from studying their own environment in order to experiment workable solutions for perceived practical issues. However, I also understood that medical practitioners in LMICs do not necessarily have the luxury of immersing themselves in research due to many different reasons. By adopting a pragmatic worldview, I was able to be sensitive to my own environment and to the contexts in which I was to undertake my research. This helped fulfill my craving to be both a researcher and a practitioner without distancing myself from either. In fact, I had a good reason to be a researcher-cum-practitioner: the research that I have undertaken is an intersection between education, health and information technology, which made it difficult for me to find the necessary expertise within any one of these niches. Thus, it compelled me to take up the challenge of engaging with the study context and be part of the environment that I was expected to study. I perceived that this would help me bridge between different expert domains that contribute to my chosen context. It is in this sense that I believed in becoming an action researcher. Furthermore, my perception of action research is further strengthened by the fact that many action researchers have also employed a pragmatic worldview as their orientation to inquiry (Reason, 2003; Baskerville & Myers, 2004).

When defining action research, it is clear that there is no single agreement. However, many believe action research to be an umbrella term used to describe different activities aimed to foster change – within groups, organizations and even within societal levels (Dickens & Watkins, 1999). From its roots, it is evident that Lewin (1946) coined the term action research in an era where distance between those who were making decisions and those who were subjected to those decisions manifested as a destructive force in World War II. Thus, in a way, action research emerged as a way of bridging between social action and social theory. The outcome of this is the creation of a democratic platform for the practitioners and the people thus enabling everyone concerned to be part of the decision-making processes (Dickens & Watkins, 1999). However, the idea behind being an action researcher is not only to be part of the decision-making process but also to contribute to theory building and to pursue social change. Thus, as pointed out by Carr and Kemmis (2003), characteristics of action research include participatory character, democratic impulse, and simultaneous contribution to social science (knowledge) and social change (practice).

In positioning myself within an action research framework, I could argue that I fulfilled being participative as I was actively involved in the research setting resolving the very issues that I was studying. However, my participation alone would have not made me an action researcher or my research an action research. In other words, the trainers of DHIS2 Academies, the members of the HISP and the staff being trained should also perceive the need to change and be willing to actively participate in this study. In terms of this research, I took over studying a change process, which was already recognized by the HISP and its members as a current need. Thus, it indicated to me that everyone concerned was already part of the research study, at least to some extent.

Secondly, the already established DHIS2 trainer community saw themselves as equals in developing the training program. It meant that following the start of my research, the same group contributed equally to the development process of the online tool and its implementation. This ensured that the democratic impulse of the research was maintained. Furthermore, by developing the online learning approach and utilizing it in actual training instances, I was contributing to the practice of training.

At the same time, the evolving theoretical discourse that paralleled the practical interventions made it possible for this research to contribute to different knowledge domains as well. Thus, through simultaneous contributions to both practice and knowledge, the research fulfilled the characteristic of 'simultaneous contribution to social science (knowledge) and social change (practice)' as described earlier by Carr and Kemmis (2003).

5.3. Action research approach

The basic approach to action research consists of five stages: problem diagnosis, action planning, action taking, evaluation, and specifying learning (Susman & Evered, 1978). It is typically an iterative process and capitalizes on the learning emerging within the subjects' own context (Baskerville & Myers, 2004). At the same time, as suggested by Kemmis and McTaggart (1988), action research should allow researchers to revisit the same problems that they are studying and reflect on the same at a higher level than what was initially possible. This means that action research may not only be an iterative process, but the nature of the iterations may depend on the problem and the context that is under investigation (Davison et al., 2004).

In terms of IS research, Baskerville (1997) describes the different stages of the action research approach in line with Susman and Evered's (1978) description, as depicted in Figure 7.
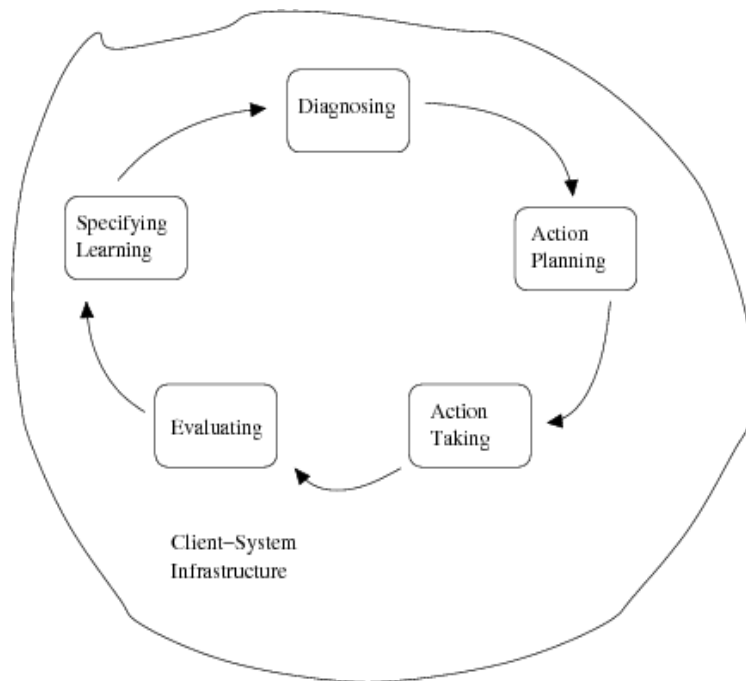
Figure 7 : Action research cycle

In that, Baskerville (1997) highlights the necessity of having a client-system infrastructure within which the action research takes place. This would demarcate the environment for the research including the boundaries, actors, authority, sanctions, responsibilities and even the means of disseminating the knowledge gained (Baskerville, 1999; Davison et al., 2004). In the first stage, or the diagnosis stage, the action researcher is expected to perform a self-interpretation of the organizational problem. While the diagnosis may not involve reduction or simplification, it may involve certain theoretical assumptions (Baskerville, 1999; McKay & Marshall, 2001). However, given the iterative nature of action research, the theoretical assumptions at the beginning may even be at an abstract level.

The second stage, or the action planning stage, entails collaborative planning between the researcher and the practitioners. As pointed out by Baskerville (1999), the planning stage may be contributed to by the theoretical framework in terms of recognizing the desirable future state and the process to achieve such a change.

The next stage will include action taking based on the planned actions in the earlier stage. However, as pointed out by Davison et al. (2004), the actions taken may have to adapt to the changing circumstances of the context and therefore researchers need not be overly committed to planned actions. Nevertheless, this flexibility should be understood both by the researcher and the practitioners collaborating in the research.

The following evaluation stage requires the researcher to be sensitive to the successes and the failures of the actions and to how theoretical assumptions were effected through those actions (Baskerville, 1999). This would be the stage in which the theoretical assumptions will be revised and reframed for the next iteration.

Specifying learning is the next stage of the action research cycle according to Baskerville (1999) although it may take place at any of the stages described earlier. This may be the most important aspect of an action research cycle (Lau, 1997) and it epitomizes the responsibility of the researcher to the client, and to the research community.

While these stages are recognizable within most action research projects, as pointed out by Koshy et al. (2010), the demarcations may not take place as a sequence of events. This would mean that an action research approach may be fluid and open-ended as the research evolves. In relation to this research, it is possible to state that the study began by defining its client-system environment in line with Baskerville (1999), which was the DHIS2 Academies. In fact, by the time I began my research, the DHIS2 trainers were already involved in the process of introducing online learning and had recognized the necessity and the value of its introduction. This made it easier for me to collaborate with these practitioners-cum-researchers and demarcate the client-system environment within which the proposed action research would be carried out.

From a theoretical point of view, it was realized that introduction of online technologies would have to rely on promoting participation and interactions among the learners. It was also recognized that the learners should be incorporated into the wider FOSS community for them to gain from the knowledge embedded within the network of actions. These assumptions were the foundation for the diagnosis stage. Thus, it is true to state that the initial iteration of the research was planned on abstract conceptualizations than based on a fully-fledged theoretical framework.

In terms of action planning, it became a collaborative effort between me and the other DHIS2 trainers. The collaborative decisions were based on the knowledge and experience gathered from previous instances of DHIS2 training carried out in various countries and on the theoretical assumptions stated earlier. In practical terms, the initial plan was to design and implement an online learning platform based on the Moodle learning management system for DHIS2. The content for the online learning platform was extracted from the DHIS2 user

manuals and other training material and the initial target group was the beginners attending DHIS2 Academies in LMICs. The plan of introduction was to test run the online learning platform at one of the DHIS2 Academies held in Ghana in November 2011. This plan of action was materialized in the 1st iteration as described below.

The 1st iteration

The first iteration can also be described as the first instance of 'action taking' within the action research cycle. In that the online learning tool was introduced during the DHIS2 academy in Ghana and the participants of the academy were asked to use the online learning tool as a means of improving their basic understanding of DHIS2. However, due to technical issues, it failed to attract much participation from the target group. Nevertheless, its introduction meant that there was an interest generated among the participants, who themselves were engaged in training other users in their own countries and communities.

Thus, this instance of training became a brainstorming session where the feedback received from the participants was used to modify the content, structure, the presentation of the online learning tool, etc. in the next DHIS2 Academy. Based on the observations made, feedback received and conceptualization arrived at, the online learning tool was next tested in line with the DHIS2 Academy held in Shimla, India in January 2012. The approach was to conduct a week-long online training prior to the 10 day face-to-face academy in Shimla. This training instance also failed to generate much online interaction within the discussion forums but gave participants a chance to prepare for the face-to-face academy. It also enabled me as the lead researcher to gather feedback from the participants as well as from the trainers in India and Oslo, with regard to the design and conduct of the DHIS2 Academy.

While there were two instances of training conducted herein, this research recognizes these two instances as belonging to the 1st iteration given their relative similarities in the stages of evaluation and specifying learning. The outcomes of these stages in relation to different iterations including the 1st iteration are described in Table 2.

Subsequent iterations

Following the 1st iteration, the DHIS2 Academy and the online learning tool were studied for four more iterations (8-9 training instances). At each iteration, the online learning design and its conduct were re-organized following being informed by the previous iteration, feedback, and the needs arising in the actual training environment.

Table 2: Action research iterations

	Action (Online academies)	Observations, feedback and evaluation	Specifying learning
1st iteration	Ghana, November 2011 (for West Africa) / Sri Lanka, January 2012 (for BMI students) / India, January 2012 (for Asia and BMI students)	• Experimental implementations • Online interactions minimal • Feedback mainly in relation to design and use • Enabled profiling of the participants, their perception about online learning, its usability, and challenges in LMICs relating to e-learning	• Emergence of blended learning • Focus toward building online learning communities • Usable technologies within e-learning • Rights based approach to equity in HIS training (paper 1)
2nd iteration	Kenya, June 2012 (for East Africa) / Liberia, November 2012 (for West Africa)	• Online training complimenting the face-to-face training • Feedback was mainly in relation to improving quality of content and interactions • Glimpse toward formation of online learning communities	• Strategies toward forming learning communities • Motivational strategies to promote participation and interaction • Conceptualizing the integration of e-learning in HIS training (paper II) • Boundary phenomenon (paper IV)
3rd iteration	Philippines, August 2012 (local training) / Colombia, January 2013 (for Latin America)	• Adaptability of the e-learning tool in other LMICs for HIS training • Lead role played by the regional partners and trainers	• Conceptualizing the integration of e-learning in HIS training (paper II) • Usability of e-learning in implementer training than in user training (paper III) • Epistemic nature of blended learning and e-learning as a boundary object (paper IV)
4th iteration	Uganda, May 2013 (for East and South Africa) / Nigeria, November 2013 (for Western Africa)	• Advanced training with built-in evaluations • Reasonable recognition for the e-learning tool as an integral part of the DHIS Academy • More participation from trainers and students • Promoting cross-participation and continued participation from East and West Africa.	• Importance of participation and network formation (paper III, V) • Quality of learning taking place online. (paper III) • Social network analysis of online eHIS training (paper III) • Nature of the e-learning tool and blended learning within the boundary phenomenon. (paper IV)
5th iteration	Sri Lanka, December 2013 (for Biomedical Informatics (BMI) students) / Rwanda, May 2014 (for Eastern and Southern Africa and BMI) / Informal training via online technologies (for BMIs)	• Follow-up study of BMI students and the tendency to form communities of practice • Feedback on interactions and community formation (online and CoP) • Focus on both formal and informal learning • Extended the use of online technologies associated with DHIS on network formation	• Informal and formal learning in eHIS training (paper V) • Spillover effects of HIS training and formation of CoPs (paper V) • Linking online learning with other informal learning tools in LMICs. (paper V)

When looking at Table 2, there are certain mismatches in the sequence of in terms of the actual contribution made by these events to the action research cycle. For instance, one of the training instances (in Philippines) classified as part of the 3rd iteration actually took place before one of the training instances in the 2nd iteration. Similarly, although the training instance in Rwanda was classified under the 5th iteration, it was designed and conducted in the same manner as other training instances in the 4th iteration. At the same time, it should also be noted that the knowledge gained from one iteration not only facilitated specifying learning of the said iteration but also in the subsequent iterations. In addition, the training instances within the same iteration also underwent minor changes based on the training needs and based on the knowledge gained through active engagement with the study setting. Thus, although this action research initiative followed the general pattern suggested through literature, it was also subjected to the laws of 'nature' that influence action research initiatives (Dickens & Watkings, 1999).

5.4. Research design

5.4.1. Qualitative tradition

As a result of being positioned within an action research framework, my research approach inherited the characteristics of a qualitative research tradition. As described by Streubert & Carpenter (1995), the idea behind qualitative methodology is to describe and understand rather than to predict and control. In other words, it [qualitative method] differs from quantitative method as it shifts focus from numbers and statistics to human experiences and different perceptions of the people who are actually living the said experiences. Wuest (1995) described qualitative researchers as non-believers of a single - objective - reality. Instead, they believe in the existence of multiple realities based on subjective experiences and circumstances. To an extent, the research context and the phenomena that I studied consisted of lived experiences of people. Therefore, the best method of harnessing these experiences and the subjective realities assigned to these experiences by people were through qualitative means. At the same time, my tendency toward becoming an action researcher was also justified by the fact that qualitative methodology allows information sharing between the researcher and the participants thus creating an opportunity to share and learn (McDonald, 2012).

5.4.2. Quantitative contribution

At times, qualitative analysis of action research may be made weak as a result of researcher bias and idiosyncrasies (Kumaravadivelu, 2003). From the point of view of researchers and practitioners in health and educational domains, quantitative methods were synonymous with validity, reliability and 'evidence based practice'. At the same time, evaluating the emergence of CoPs required this research to have an objective idea about the various actors and the connections that may form between each one of them. Therefore, this research recognized social network analysis (SNA) (Scott, 2012) as one acceptable method in the given circumstances to investigate the study subjects and the network building.

In fact, SNA is a recognized method of evaluating CoPs in relation to different contexts such as education, healthcare and in business organizations (Ranmuthugala et al., 2011; Cocciolo et al., 2007; Cross et al., 2002). Furthermore, this research required focus on relationships formed between different actors within a network rather than on the attributes of each individual actor. As pointed out by Schenkel et al. (2001), SNA does just that and therefore allows researchers to make inferences related to the evolutionary process of a CoP (Scott, 2012; Assimakopoulos & Yan, 2005).

Monge's (1987) argument of "groups emerge by being densely connected regions of the network" (p. 242) further strengthened the decision to use SNA to recognize the emergence of CoPs or online communities. In doing so, it necessitated the research to quantify certain qualitative findings at the time of analyzing the data. Thus, this research made use of both qualitative and quantitative approaches although the mixing of the methods took place at the point of analysis.

5.4.3. Combining qualitative and quantitative techniques

As pointed out by Johnson and Onwuegbuzie (2004), mixing of quantitative and qualitative traditions can take place in relation to the study technique, method, approach and even in relation to the language of a particular study. However, it is the duty of the researcher to justify his or her decision to 'mix', as otherwise the combination of two different ontological and epistemological traditions may be interpreted out of context. Thus, in relation to this research, one of the key reasons for adopting both qualitative and quantitative methods was to harness the complementarity of the data emerging from the two traditions (Greene et al.,

1989). Secondly, as stated earlier, employing such an approach allowed this research to make strong claims and be more persuasive (Gorard & Tylor, 2004) in a domain such as health where quantitative findings are used synonymously as 'evidence'. Thirdly, this research was able to circumvent some of the criticisms toward action research in the IS field by minimizing the weaknesses of qualitative inquiry by harnessing the strengths of both qualitative and quantitative techniques (Johnson & Turner, 2003). Lastly, analytical results emanating from qualitative and quantitative methods meant that this research was able to perform triangulations by viewing the same issue from different angles (Creswell & Clark, 2007). Such triangulation enabled this research to further strengthen the claims made through its findings and explain any discrepancies much clearer than having to depend only on any one research method.

5.4.4. Research setting

As described in Chapter 2, The Research Context, and later in Chapter 3, The DHIS2 Academy, the setting for this research was the DHIS2 Academies conducted in different LMIC contexts. However, the main focus of the investigation was the online training based on the Moodle platform, which was relevant to each of the academies. In some instances however, as in the case of Ghana, India and Sri Lanka, the face-to-face component of the training instances was also included in the study. The Sri Lankan setting in particular allowed this research to expand its scope into the work practices of the DHIS2 Academy participants and therefore to enrich the evidence gathered. Table 3 depicts each of the DHIS2 training instances that were subjected to study within this research.

Table 3 : DHIS2 academy training instances

DHIS academies and training instances	Brief description
Ghana, November 2011 (for West Africa)	This was the first training instance in which the e-learning tool was tested and it was attended by 38 participants. The content was aimed at beginners and not much emphasis was made on online interactions. An introduction to the e-learning tool was given at the academy and the views of the participants were obtained during a workshop session and through interviews. Online questionnaires were used to obtain suggestions to improve the design and usability of the e-learning tool. The academy lasted for 10 days.

Sri Lanka, January 2012 (for Biomedical informatics (BMI) students)	The same design was tested on a group of doctors (12 in number) undergoing masters training in Biomedical informatics in Sri Lanka. The aim was to make them aware about the basics of DHIS2 before they participated in a face-to-face academy in India. The online training lasted for 1 week and the interactions within the discussion forums were perceived as minimal.
India, January 2012 (for Asia and BMI students)	The online component of the academy, which was again aimed at beginners, was held 1 week before the face-to-face training in India. There were 19 registered participants for the online training from Asia including several from the group of doctors from Sri Lanka who had almost completed their masters training in Biomedical Informatics. Online interactions did not materialize as expected although during the face-to-face training, the same platform was used as a repository for training material. The online academy lasted for 1 week while the face-to-face academy lasted for 10 days.
Kenya, June 2012 (for East Africa)	The DHIS academies conducted in Kenya (with 38 participants) and Liberia (with 56 participants) were preceded by a week-long online training using refined content aimed at beginners. These online learning instances contained a more structured online discussion forum where relatively significant participation and interaction were achieved. The online design complemented the face-to-face training and online questionnaires were used to obtain feedback regarding the design and conduct of the e-learning activity from the participants.
Liberia, November 2012 (for West Africa)	
Philippines, August 2012 (local training)	These two instances (Philippines with 26 participants and Colombia with 84 participants) were conducted by partner organizations of HISP for their own training purposes. However, these partner organizations made use of the structure and the content of the e-learning tool and in certain instances, translated the content to fit the learning needs of the region. The moderation of these learning instances was also carried out by the partner organizations. From the perspective of the organizers, the main aim of the e-learning tool in these two instances was as a repository of learning material.
Colombia, January 2013 (for Latin America)	
Uganda, May 2013 (for East and South Africa)	These two training instances (Uganda with 79 participants and Nigeria with 70 participants) also followed the previous format with the online training conducted for a duration of 1 to 2 weeks just before the start of the face-to-face academy. However, from 2013 onwards, a decision was taken to conduct the e-learning to fit advance learners than the beginners. Therefore, the content was refined and the discussion forums were also updated to fit the learning needs of the advance participants. Another feature during these training instances was that participants from previous academies were invited to take part and follow the discussion forum and contribute as they wish.
Nigeria, November 2013 (for Western Africa)	

Sri Lanka, December 2013 (for BMI students)	These three training instances were considered together as these were the settings in which the same group of participants (11 in number) was observed for a period of 1 year. The first training instance was an online training similar to the advance training offered previously. Following a 1-week online training, the participants attended a DHIS2 Academy in India conducted by HISP India. They also gained an opportunity to interact with the participants of the DHIS2 online academy in Rwanda (with 119 participants) for another 1 week. Following these training instances, the Sri Lankan participants were supposed to undertake research projects based on DHIS2 and during this period, they were introduced to the DHIS2 Launchpad2 to obtain support from the global developer network. Furthermore, these participants were observed in their work practices during the research following being assigned to various government health institutions in Sri Lanka, where HIS development needs were recognized.
Rwanda, May 2014 (for Eastern and Southern Africa and BMI)	
Informal training via online technologies (for BMIs)	

5.4.5. Data collection methods

Interviews

As with most qualitative research (Johnson & Turner, 2003), in-depth face-to-face interviews played a key role in this research. Face-to-face interviews were conducted with DHIS2 Academy participants in Ghana, India and Sri Lanka. At the same time, a selected group of DHIS2 core group members (trainers) were also interviewed toward the end of the research study. The selection of the core group members was done on the basis of those who were directly involved with the DHIS2 Academy. In Sri Lanka, all the students who underwent DHIS2 training and who did their project work in 2014 were interviewed. In certain instances, when face-to-face interviews were impractical, skype video calls were used as an alternative. In other training instances, a convenient sampling method was used to select interviewees depending on their availability and their awareness regarding conducting training in their own settings. The views from the core group members were used in recognizing participants who were active in local training initiatives. All interviews were recorded in the digital format following obtaining consent from the interviewees.

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[2] Launchpad – a collection of web services enabling software developers to keep track of different registries and stages. One of its services is the mailing list.

Figure 8 : DHIS Academy in India

Figure 9 : DHIS Academy in Ghana

Discussion forum posts

The Moodle platform, which was used for the online learning, was also one of the key data sources for this study. As discussed in Chapter 3, the main tool that was utilized to promote interactions among the participants was the discussion forum. Thus, almost all of the posts made in the discussion forums by both learners and trainers were extracted from training instances where there were significant online interactions. Posts which made a significant contribution to the ongoing discussions were considered for the qualitative analysis. At the same time, these posts were also used to enumerate quantified data necessary for generating the adjacency matrix for the Social Network Analysis described later in this chapter.

However, one of the limitations in the Moodle discussion forum was that it was not freely open for outside participants (e.g. implementers, developers or others who are interested in DHIS2) without having to first register in the course. It was also not practical for the Moodle discussion forums to continue beyond the duration of the DHIS2 Academy. Furthermore, the participants were keen on interacting through other means such as through email and through the DHIS2 mailing list. Thus, as explained later, this research also made use of the email communications and the posts made within the DHIS2 mailing list as data for the research.

Participant observations

Field notes were created based on the observations made during face-to-face training instances, during lab work and teaching sessions of the Sri Lankan cohort and during the field visits. The field visits in Sri Lanka were used to obtain a firsthand experience of the work practices of the learners and the challenges with regard to their training. The site visits to the rural healthcare facilities in Sri Lanka coincided with onsite training of healthcare workers on

one of the DHIS2 pilot systems. Site visits were also made to information unit of the Ministry of Health, Sri Lanka and to the Postgraduate Institute of Medicine, University of Colombo where a master's program in biomedical informatics was conducted.

I also made use of the opportunity to expand my understanding of the dynamics of implementing eHISs by becoming part of a mission to Sri Lanka representing the University of Oslo. In that, a team of four from the University of Oslo embarked on an evaluation of eHIS projects, health information flows and capacity building in Sri Lanka for a two-week period. The notes made during this mission were also utilized to understand the dynamics between the Sri Lankan study participants and their work practices. This was possible because the sites visited during this mission were the same sites to which the learners [the Sri Lankan study subjects] were attached during placement. Some learners were then recruited by these institutions following the completion of their training. The drafted field notes were digitized before being subjected to analysis.

Figure 10: Discussion with one of the student practitioners at his work place
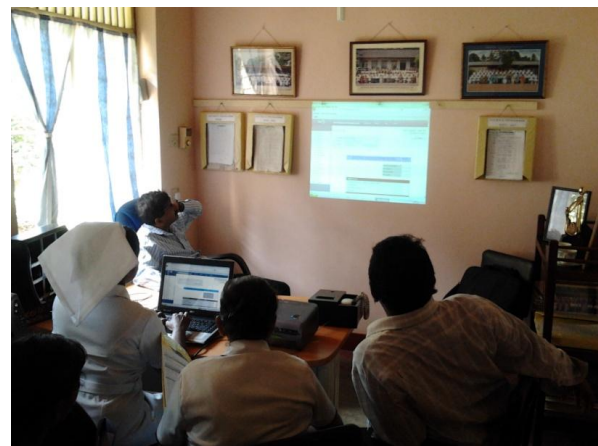
Figure 11: DHIS training program site visit

Email correspondence

Given that the study participants were continuously interacting using email conversations, it was a considerable source of data for this study. Therefore, all relevant emails pertaining to each instance of DHIS2 Academy and to the follow-up group in Sri Lanka were extracted for the analysis. However, the sensitive contents within these emails were erased and codes were used instead of names and email addresses when archiving the email data. Email correspondences were also used to generate quantified data in the form of an adjacency matrix for the SNA. However, this meant that the identification codes used for recognizing the

emails and their origins had to tally with the codes used to recognize discussion forum posts and other communications originating from the same participants and trainers.

DHIS2 Mailing List (Launchpad)

During the follow-up of the Sri Lankan study cohort, it was necessary to understand the dynamics of online interactions between the learners and the DHIS2 core group members. The gateway to observing the said interactions was the DHIS2 mailing list, which was based on the Launchpad software platform. DHIS2 core group members utilize this platform to share knowledge, which is mainly of technical nature. While not all academy participants were expected to utilize the Launchpad, their participation was needed to be captured as it could provide the study with vital insights into their practices and online behaviors. For this reason as well as because of the limitations explained earlier in utilizing Moodle discussion forums, all submissions made to the DHIS2 Launchpad by the Sri Lankan study subjects during the study period were extracted and digitized. The posts made in the mailing list were also used to generate quantified data for SNA. A summary of the collected data is presented in Table 4.

Table 4 : Summary of data collection methods

Data collection method	Relevant facts
Observatory notes	Face-to-face DHIS2 Academies in Ghana, India and Sri Lanka
	Field visits (Primary care sites in North Western Province of Sri Lanka, total of 8 primary care sites)
	Postgraduate Institute of Medicine, Sri Lanka: Laboratory work and teaching sessions of masters students working in DHIS2
	UiO mission to Sri Lanka (2 weeks)
Interviews	Semi-structured interview of 6 participants (DHIS Academy, Ghana) – lasting 30 minutes each.
	Semi-structured interview of 4 participants (DHIS Academy, India) – lasting 30 minutes each
	Semi-structured interview of 7 medical professionals following DHIS training and project work in Sri Lanka – lasting 45 minutes to 1 hour
	Semi-structured interview of 6 DHIS2 core group members in Oslo (trainers) – lasting 30 to 45 minutes each.
Moodle discussion forums	Kenya, June 2012 (for East Africa) (145 posts)
	Liberia, November 2012 (for West Africa) (61 posts)
	Philippines, August 2012 (local training) (35 posts)
	Uganda, May 2013 (for East and South Africa) (94 posts)
	Nigeria, November 2013 (for Western Africa) (128 posts)
	Sri Lanka, December 2013 (for BMI students) (81 posts)
	Rwanda, May 2014 (79 posts)
Email conversations	Approx. 130
DHIS2 Launchpad	(32 posts)

5.5. Analysis

As per the action research cycle, the data analysis pertaining to this research took place at different points in time while further data collections were ongoing; at the end of each iterative cycle, there was an attempt to inform learning and this required analyzing the already collected data. At the same time, as stated by Johnson and Christensen (2008), ongoing analysis of already collected data can give new insights to an action researcher with regard to probable themes, categories and patterns, which may further enhance the future data collection processes. In fact, the decision to follow the group of doctors from Sri Lanka and the decision to obtain data related to interactions in the DHIS2 Launchpad were some of the outcomes of keeping abreast with the manifestations during the action research cycle. In a way, as stated by Miles and Huberman (1994), adjustments to the research approach based on early analysis enabled me to re-focus the data collection toward sources which are better suited to address my research questions.

When it came to the actual process of analysis, I made use of the eight-step structured content analysis procedure as explained by Tesch (1990), as it allowed me to make inferences that were more valid and reliable. I began the process with transcribing the audio recordings of all the interviews verbatim and filtered the emails and discussion posts according to their potential contribution to the study. The second step of the analysis was to define the coding unit; in relation to the data collected, I decided to consider a thematic coding technique (Minichiello et al., 1990). In that, chunks of text were assigned codes according to their representation of a single theme or an issue relevant to the research questions.

As the third step, categories and coding schemes were developed and in this regard, the research made use of a deductive method to develop a list of codes and categories based on its theoretical grounding. However, as stated by Miles and Huberman (1994), the research also allowed themes and categories to emerge from the raw data inductively during the course of the analysis. For instance, in one of the papers (paper IV), I have described the use of interaction analysis model (IAM) (Gunawardena et al., 1997) as the choice for classifying themes and categories for the purpose of analyzing the quality of interaction between online participants. However, the IAM was not used in other instances as the analysis differed based on the research question being answered. This meant that in some instances, the research utilized purely inductive methods in enumerating themes and categories during the analysis. In instances where the research was using standardized coding methods, it considered the

reliability of using such tools particularly when there was more than one coder involved in the process. For instance, when the IAM was used, the inter-rater reliability was measured using percent agreement (codes agreed upon/codes agreed + disagreed) and the aim was to achieve a inter-rater reliability of 0.70, which was regarded as a 'reliable' value (De Wever et al., 2006).

During this step, the research also began quantifying the qualitative findings when there was an indication of the existence of a connection between two or more people. Recognizing these connections was important in applying the social network analysis (SNA). As mentioned earlier, SNA is an approach developed to study social relationships between a set of actors within a defined 'social network' (Wasserman & Faust, 1994). The aim is therefore to understand the distribution and exchange of resources amongst these actors. In this research, the resource exchanged between different actors was 'information'. Depending on the various attributes assigned to each of the relationships, SNA is able to characterize these relationships and assess its qualitative nature within the context under study (Scott, 2012). In SNA, the traditional approach to analysis is usually to create the network using a name generating survey, which is a quantitative technique. However, SNAs can also be done using qualitatively collected data such as through observations and interviews. Nevertheless, there is a necessity for the qualitatively collected data to be quantified in order to visualize the studied network (Edwards & Crossley, 2009). This can be done by creating an adjacency matrix which will represent a qualitatively recognized relationship as a '1', and a '0' when such a relationship does not exist. Thus, the adjacency matrixes were generated during this phase of the analytical process (Figure 12).

However, enumerating the existence or the strength (number of connections made, centrality of the actor, proximity to other actors, etc.) of a relationship itself would not be enough to assess the quality of such relationships (Scott, 2012). By 'quality', I am referring to the type and the nature of the information exchanged between two actors and the circumstances within which these relationships were built.
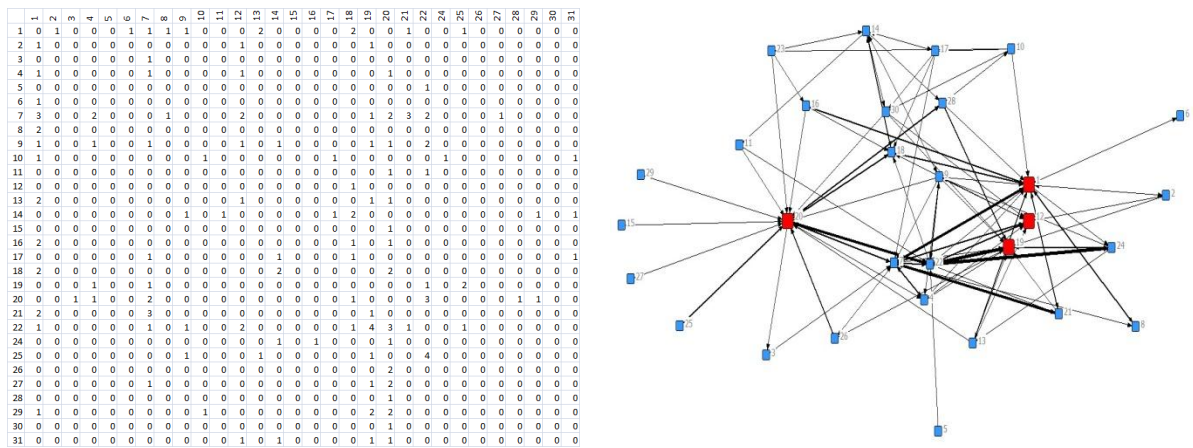
Figure 12: Quantified data in the form of an adjacency matrix for SNA

Following the generation and testing of the code scheme in step 4, all the data in text form was coded, marking the fifth step in the analysis process. . However, the research allowed new themes to emerge as new data continue to accumulate during the iterative action research cycles. In step 6, the generated codes were re-visited to assess their consistency and relevance to the research questions. Following this was the process of analyzing the codes and the emerging themes in order to derive a broader sense of the phenomenon under study. My interpretations of these codes have led to the recognition of overarching themes, patterns and meaning-making which manifested in each of my papers. With regard to the quantitative data in the form of adjacency matrixes, I analyzed the same using the UCINET 6.0 (Borgatti et al., 2002) and SocNetV (Kalamaras, 2010) SNA tools to derive various parameters. At the same time, to visualize the various nodes [students and DHIS2 experts] and their relationships existing within each learning instance, I utilized the NetDraw 2.0 (Borgatti, 2002) visualization tool and the visualization function available through SocNetV.

As the final step in the analytical process, I made sure to embed raw chunks of qualitative data when presenting my conclusions in each of the papers in order to build an immersive experience for the readers.

5.6. Some limitations of the research method

While a pragmatic worldview enabled me to become an action researcher and adopt both qualitative and quantitative methods in realizing my research objectives, it also meant that I would have to develop an adequate degree of knowledge and skill in using somewhat unfamiliar research methods and tools. In fact, Bazeley (2002) points out that although a researcher may be able to learn new techniques and tools to carry out a mixed method research – similar in nature to this research project – he or she may not gain the tacit

knowledge that one gains when immersed in years of reviewing literature and research within any one research tradition. In such instances, researcher bias may manifest as they try to adopt tools and methods which are more familiar to them rather than the ones that are suitable for a given mixed method research design (Patton, 1988). To an extent, this research can be thought of as more weighted toward a qualitative tradition, which may be the result of the Scandinavian action research context within which I conceptualized my theoretical and methodological approach.

At the same time, Hall (2012) points out that although pragmatism implies that it is possible to determine the usefulness of a mixed method design in advance, this may not be the case until the findings of such research can be interpreted. Given that the mixing of methods may depend on the research questions and the purpose of the research among many other factors, a pragmatic approach therefore may hinder the flexibility of the research design. However, as a result of positioning this research within an action research framework, it created room for experimentation and therefore time to understand and apply what works in terms of its research design.

Use of SNA as a means of analyzing quantified data may also be limiting as the sociograms created through such analysis may give rise to false interpretations. The reason is that by altering certain variables, it is possible to create unlimited number of diagrams, each conveying a different picture about the same network (Streeter & Gillespie, 1993). Thus, it was necessary for this research to be sensitive to this fact when making conclusions based on visual representation of a sociogram.

Chapter 6 - Results

"The measure of greatness in a scientific idea is the extent to which it stimulates thought and opens up new lines of research." (Paul A.M. Dirac - English theoretical physicist)

This chapter will briefly present the key research findings, analysis and the conclusions made in the five selected papers associated with this research study. The five chosen papers include journal articles and conference papers and will be arranged in a chronological order. The chapter consists of two main sections: a summary of each of the research papers, and a synthesis of the research findings in accordance with the research aim and the research questions presented in Chapter 1. The second section will also include a mapping of the research questions and research papers, which will aid the comprehension of the presented results.

6.1. Summary of research papers

6.1.1. Paper 1: Designing rights-based health information systems training programs for developing countries: Step towards mainstreaming equity in health (In the process of review for the journal, the Information Society) (Pandula Siribaddana & Sundeep Sahay)

The paper can be described as being heavily influenced by a transformative worldview as it embarked on recognizing the various dimensions associated with online and blended learning, particularly in relation to LMIC contexts. As a result, the paper adopted the notion that one of the key strengths in online learning is its ability to reach out to 'marginalized groups' and facilitate 'equity in learning'. However, the marginalized groups as perceived through this paper were the ones not being able to gain enough training and support due to various issues such as funding, connectivity, geographical location, communication issues or as a result of their duty concerns. The paper believed that such a view might enable online learning to facilitate equity in professional training, which has the potential to spill over into other aspects of health in LMIC settings.

In formulating its hypothesis and the objectives, the paper first enumerated the challenges faced by eHIS trainers (eHIS experts from HISP) in LMIC contexts. These included resource and time constraints, socio-cultural and socio-political influences, logistical and geographical

challenges, diversity in learning needs and learning styles, etc. The paper then highlighted the research evidence pointing toward online learning being a remedy to some of these challenges. Thereafter the paper illustrated the state of the art in relation to equity in education, equity in training and eHIS training with the aim of establishing a right for learning for the eHIS learners. Through these discussions, the paper pointed out that in LMIC contexts, eHIS training is far more than building technical competence and it would have wide-ranging implications within the health domain. As such, the paper argued the relatedness between right to education, right to health and right to eHIS training. This opened up an avenue for the paper to introduce the concepts of availability, accessibility, acceptability and adaptability (the 4As framework), which were used in addressing the issue of equity in education (Tomasevski, 2001) and in conceptualizing 'health for all' (WHO, 2007). The idea was to use the 4As framework as a tool in identifying the promoters and barriers to training among eHIS training participants. In doing so, the paper assumed that eHIS learners from LMICs may also experience similar issues to the ones faced by those who seek education and health in achieving their goals. In other words, the 4As framework has the potential to be applied to eHIS training in order to identify the inequities in training and to design equitable training programs.

Thus, the working hypothesis for this paper was "*by applying a rights based approach and utilizing online learning tools, it is possible to design equitable HIS training instances in LMIC contexts*". From a methodological point of view, the paper adopted a case based approach where it made use of three DHIS2 Academies in West Africa, Asia and East Africa where online learning tools were utilized as a supplementary learning strategy. These three academies were aimed at beginners and advanced users of DHIS2 who would one day perform the roles of 'implementer' and/or 'super-user' in their respective settings. The data collection was done through qualitative means including through interviews conducted with the learners.

Given the nature of the participants in the three selected cases, the paper was able to enumerate different yet supplementary empirical findings. For instance, the West African academy highlighted the variation among the learners or the participants of DHIS2 Academies and the difficulties faced by the learners when the training material is not presented in their mother tongue. The variation among the learners also meant that their learning needs differed and it exposed the trainers' failure to address this variation. The

academy also brought forward the challenge of poor technical infrastructure within the academy itself, for which the academy organizers failed to plan. This meant that the learners were not able to access the online learning platform equally. The West African academy also highlighted the need for at least the online learning to be open to more learners than those who were privileged to attend the face-to-face academy. The Asian academy gave rise to similar empirical findings in terms of technological challenges, language barriers, and learning needs while adding the need to address communication issues and the need to consider time constraints of the learners when conducting online and face-to-face training. Similarly, the findings from the East African academy strengthened the findings from previous cases in addition to enumerating inequalities arising as a result of personal factors such as learning styles, pace of work, attitudes and related perceptions regarding online learning.

The empirical findings were then analyzed by applying the rights-based 4As framework. This enabled the paper to evaluate the training in terms of the four components of the 4As framework. For instance, the paper enumerated how online tools fulfilled the requirement of availability by facilitating the learners to network and build relationships and thereby to gain vital social capital. Online learning also altered the power dynamics between the trainers and the learners in a way that learners were able to choose for themselves and be in control of their own learning. At the same time, the paper recognized instances of inequity when some learners were deprived of gaining social capital and empowerment to the same extent as others. Furthermore, the paper also enumerated violations of rights - as perceived by the study – especially in relation to the health staffs' right to CPD, which eHIS implementers take for granted when designing training programs. In terms of accessibility, the paper highlighted a duty toward finding alternatives when it comes to technical challenges experienced by the learners in accessing online learning. This was particularly true given that eHIS implementers would utilize various methods such as mobile technologies, community access centers and offline functioning to overcome similar challenges in accessing eHISs.

The paper was also critical about the lack of will among the trainers in facilitating instructional content in the learners' own language. It did so by comparing the same with capitalistic attempts of exerting power by interested parties to maintain the social structures that they expect to establish. The paper also compared non-accommodation of different learning styles with 'marginalization' – as within the educational domain, learning styles are

viewed in par with other determinants such as race, age, gender, socio-economic status, etc. In relation to acceptability, the paper highlighted the need to be culturally sensitive when designing instructional content. The paper also pointed out that it is possible to remain culturally neutral when designing training programs. However, given the objective of eHIS training and eHIS implementations, which is to impart change within the healthcare systems, it may not be possible for eHIS training to remain culturally neutral. Thus, the paper posited that designing eHIS training is essentially a social process. Lastly, in relation to adaptability, the paper identified the need for online learning systems to be culturally adaptive rather than imparting their own rules, structures and pedagogies over the learners.

The analysis enabled the paper to recommend solutions to minimize the perceived inequity in eHIS training as depicted in Table 5.

Table 5 : Approach to designing more equitable blended/online HIS training programs

4As	Recommendations
Availability	1. Provide unrestricted communication/advertising of the training session, its schedule and the training material to its intended audience 2. Utilize multiple communication strategies apart from email communications to inform the intended audience 3. Expand the enrolment to include more than the number accommodated at face-to-face training instances based on the training needs 4. Provide avenues for continued professional development for those who are enrolled for online training 5. Establish discussion forums that would aid relationship building among participants, tutors and with the global experts
Accessibility	1. Profile the participants in terms of having internet access and the quality of such accesses [availability, speed, bandwidth, etc.] 2. Provide the training material in off-line mode to those who with poor internet connectivity 3. Consider using mobile devices as an alternative to those who do not have wired internet connections 4. Translate learning material to the working language of the participants 5. Allow interactions using the participant's own working language 6. Provide responses using the same language used by the participant 7. Include different forms [video, text, images, graphs, presentations, etc.] of the same learning content

Acceptability	1. Ensure the provision of relevant content at all times 2. Make use of relevant examples emerging from the participants' own settings 3. Design instructional content by being culturally sensitive 4. Determine instances where the content needs to be culturally neutral 5. Utilize a collaborative approach with local content experts when designing instructional content 6. Increase the number of discussion threads and allow the participants to decide on the themes they wish to discuss 7. Provide each such discussion thread the same attention as the structured discussion threads 8. Expand the duration of online learning to allow participants adequate time to complete the training 9. Provide a gap between the online and face-to-face training instances to prevent overlapping travelling arrangements
Adaptability	1. Accommodate a bottom-up design of training to complement the top-down design approach 2. Profile the users depending on their learning needs and provide suitable instructions to match various levels of training needs 3. Define learning outcomes based on trainee competence and experience 4. Be sensitive to 'differently skilled' participants and provide avenues for them to interact within the online learning system through formal [e.g. discussion threads] as well as informal means [e.g. email communications] 5. Keep the participants informed of the ongoing and interesting discussions even if they do not interact with the online community

Thus, the paper contributed by illustrating the potential use of a rights-based approach in the design process of equitable eHIS training initiatives. Practically, the paper presented numerous suggestions regarding designing an equitable training program which utilizes online learning tools aimed at the eHIS staff in LMIC contexts. However, the paper stopped short of concluding whether such an approach could lead to better training outcomes and pointed out that this is an area for research in the future.

6.1.2. Paper 2: Siribaddana, P. and Sahay, S. (2013). Integrating blended learning for health information systems training in developing countries: Towards a conceptual framework. *Proceedings of the 12th International Conference on Social Implications of Computers in Developing Countries (IFIP 9.4)*, Jamaica. Kingston: University of West Indies, Mona.

The second paper can be described as my first attempt at discussing blended learning as a potential training strategy for eHIS training in LMIC contexts. The aim of this paper was to conceptualize the link between online learning, face-to-face learning and work practices, which should enable practitioners and theorists alike to venture further into using blended learning as a means of providing blended learning programs. The motivation for this paper emanated from the growing challenges faced by the HISP network in providing training to a global audience of DHIS2. These challenges included cost, lack of resource personnel, growing demand, maintaining quality of the training, building and sustaining the DHIS2 community, etc. Although online learning was recognized as a potential solution for these challenges, its application encountered many hurdles, requiring the approach to be evaluated in detail. In doing so, it was perceived that learners of eHISs should be viewed as social actors and not only as super-users or implementers of systems. This would mean that these users and implementers might need a way to link between their learning and their work practices, which should be the foundation of any training activity.

In line with this perception, the theoretical grounding for the paper was provided by the theory of community of practice (Wenger, 1998) and the concept of situated learning (Lave & Wenger, 1991). Based on these theories and concepts, the paper denoted that super-users and implementers of DHIS2 may be part of a CoP in their own work settings, which has its own social structures enabling or limiting the person's ability to learn. The so-called experts of the community may garner 'power' in terms of bringing novice learners from performing peripheral tasks to performing central tasks within the work setting. However, when blended learning is used, the paper perceived that it creates its own learning spaces; online, face-to-face, etc. At this point, the paper brought in the concept of 'immutable mobile' (Latour, 1987) to conceptualize how learning objectives have to maintain their 'shape' until the learners are able to apply the same in their own work setting. The forces holding these learning objectives in shape according to the paper are the expert contributions in all three spaces and the use of real life examples from the participants' own setting. At the same time, close liaison between

the virtual and face-to-face learning spaces was also recognized as vital in maintaining the shape of learning objectives. These conceptualizations were brought together in defining the conceptual framework as depicted in Figure 13.
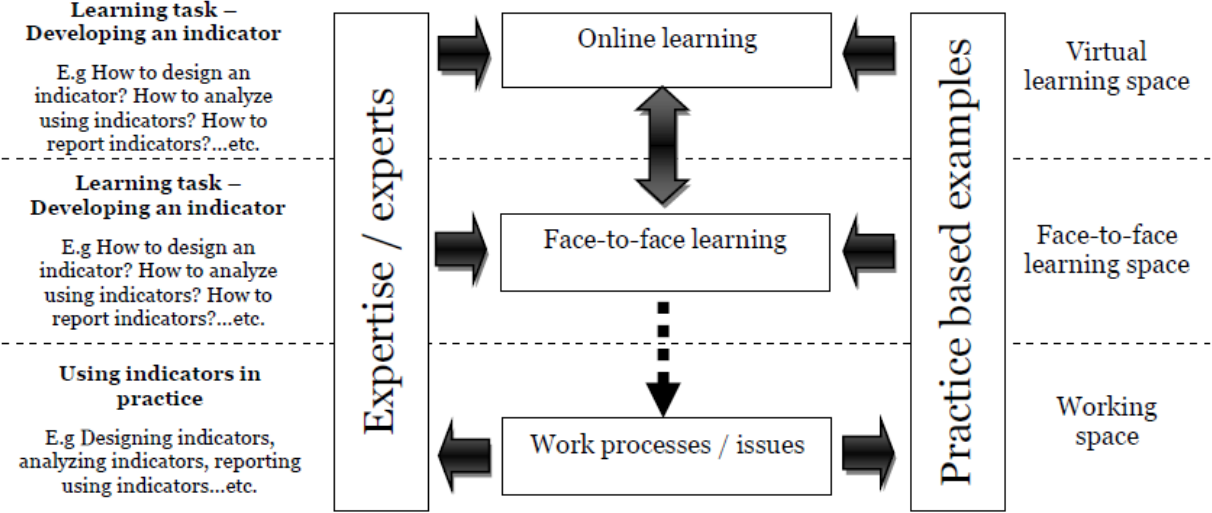
Figure 13: Conceptual framework for integrating different components of blended learning (adopted from paper II)

The conceptual framework was applied to two DHIS2 training instances in order to understand its usability. One DHIS2 training instance took place in India with the participation of learners expected to function at super-user and implementer level in their respective countries in the region. The online learning in this instance did not garner much participation in terms of interactions and learners were left to grope in the dark with regard to applicability of the training content to their work practices. They highlighted language difficulties, lack of examples from their own settings, not catering to the learning needs of the individuals, not adhering to the time schedules of the learners, barriers to access and the lack of connection between the face-to-face and the online learning components of the academy.

The second DHIS2 training took place in the East African region with a group of learners similar to that of the Asian academy. The academy was better planned in this instance and many local and regional experts took part as moderators of the online learning. These experts were experienced in the local contexts of the learners and the learners themselves were aware about the expertise and the contribution of these experts in their own settings. The paper recognized that in this instance, learners demonstrated a better participation in the online learning. Several factors contributed to this observation. These included, having local and regional experts as moderators, making use of contextual examples, better linkage between

online and face-to-face training, attempts at building motivation and the emergence of resource personnel among the learners themselves.

Based on the findings from the two cases, the paper enumerated that the proposed framework was best suited to describe the learning instance with the most participation and most online and off-line interactions. At the same time, the paper recognized that the introduction of 'local experts' enabled better interactions within the virtual space and these interactions were mostly focused on resolving practical issues pertaining to the participants' own settings. However, the paper wasn't able to comment on how the framework may impact the work setting as the influence of learning on work practices needs to be measured over a lengthy period of time. Nevertheless, the framework paved way toward re-designing subsequent action research iterations in line with the proposed framework.

6.1.3. Paper 3: Siribaddana, P. A. (2014). Making Distance Learning an Effective Health Information Systems Training Strategy: A Combined Social Network Analysis and Content Analysis Perspective. *The Electronic Journal of Information Systems in Developing Countries*, *61*.

This paper can be described as the beginning of adopting a pluralist methodology to the research as it embarked on enumerating the best practices in conducting online training programs for implementer training. The basis for this paper was the recognition that not all online training instances generated the desired levels of participation and interaction among the intended audience. Thus, the aim of the paper was to evaluate the interactions that took place in two online training instances in relation to quality and participation.

From a methodological point of view, it made use of social network analysis (SNA) (Scott, 2012) and content analysis as tools in assessing online interactions. In this instance however, the SNA was used to assess online interactions taking place in short online courses such as those carried out for super-users and implementers in DHIS2. In accordance with the SNA principles, the paper utilized 'relationships' between the participants as the unit of analysis. This enabled the paper to assess each participant in relation to other participants within the network in terms of their centrality, in and out degrees, as well as to depict the relationships diagrammatically using Sociograms. Content analysis on the other hand enabled the paper to identify knowledge building and learning in relation to each of the relationships enumerated

through the SNA. Given the nature of online learning and the network relationships the study expected to evaluate, it was decided to utilize the interaction analysis model (IAM) (Gunawardena et al., 1997) for the purpose of content analysis. This enabled the paper to differentiate between learning and knowledge building at different levels of cognition and thereby classify the quality of learning taking place in different interactions.

When comparing the two cases using the SNA, it became apparent that the first case (C1) gathered active participation from its learners than the second case (C2). However, first case only lasted half the duration of the second (1 week as against 2 weeks respectively). C1 also attracted more participation from the moderators than C2 as recognized through the sociograms created for the two instances. It was also recognized that in C2, most learners remained peripheral in terms of online interactions while in C1, more learners became central points of connection building. Furthermore, learners of C1 have gained more equitable attention from others while in C2 only few learners were able to garner attention and therefore create connections online. When it came to the findings from the content analysis using the IAM, it revealed that even though C1 was of short duration, the discussion generated spread along different cognitive levels including higher order cognitions such as construction of meaning. However, in C2, the content of the discussions was largely belonging to lower cognitive levels such as statements of description and opinions even though it lasted a lengthier period of time.

Based on these findings, the paper enumerated that presence of sufficient number of moderators – moderators being content experts and them being active in the online discussion forums as factors contributing to higher quality online interactions. It also recognized that lengthening of online training programs per se did not necessarily increase participation or interactions although enthusiasm generated among the participants is more important to achieve sufficient degree of interactions. At the same time, the paper also favored having pre-structured discussion forums in order to generate better participation and interactions, especially with regard to short training programs. However, the paper did concede that there needs to be more rigorous evaluation of both the online and the face-to-face interactions in order to evaluate the summative effects of online and face-to-face interactions as in the case of blended learning.

6.1.4. Paper 4: Siribaddana, P.A, Sahay, S, Kaasbøll, J (2015), Using a blended approach to strengthen the acceptability of e-learning: case of health information systems training in a global context, *Proceedings of the 13th International Conference on Social Implications of Computers in Developing Countries (IFIP 9.4)*. Sri Lanka: Department of informatics, University of Oslo.

The fourth paper can be considered distinct from other papers as it focused on eHIS trainers as against eHIS learners. The motivation for this paper was the observation that even after many years following the setting up of the online learning platform and undertaking several iterations of online learning, online training did not garner the necessary backing to be recognized as a mainstream training modality for eHIS training. This paper however conceded that there were context-specific reasons such as lack of technological infrastructure and the relative novelty of online learning in LMIC settings for its failure to replace the ongoing traditional training practices, at least partially. The paper also conceded to the fact that face-to-face training does provide the best opportunity for learners from LMIC contexts to build a sense of community and for the developers to gain vital insights, which may aid the eHIS development processes. However, even after conceding to these arguments and facts, the paper postulated that there is a different reason other than the materiality of the online learning tool that may be hindering its successful adoption by the trainer community. The paper conceptualized the said reason as 'negative social meaning', which made the online learning tool a 'negative boundary object' (Fox, 2011).

In problematizing the said perception, the paper first recognized the trainer community as a CoP with multiple boundaries within and between other communities. Internal boundaries were formed during the negotiation processes in relation to finding common interests, practices and in building a sense of community. External boundaries were formed when the HISP trainer community interacted with other global trainers and with other eHIS experts who were not part of the core training team.

Through the empirical findings, the paper recognized that the trainer community differed in their interpretation of online learning to that of its designers. This generated conflicts, a sense of intrusiveness, doubt and to an extent, bad faith. At the same time, findings also suggested that the trainer community made use of the online learning tool in a previously unintended manner as if they were trying to find solace with the online learning tool, and the designers of

the online tools tried to re-design the online tool in a manner that would minimize its negative projection.. The findings also demonstrated how online learning became more acceptable to the trainers in its blended form, which enabled the trainers to see online learning tools beyond being an IT artefact. Blended learning also showed to attract scientific inquiry, was open in terms of its interpretation and expansion, and was giving rise to unintended consequences in terms of eHIS training. In these circumstances, the empirical findings suggested that the online tools and blended learning both were functioning at the boundary between professional communities. However, blended learning as a practice was able to attract further scientific inquiry, similar in nature to an epistemic object. Online learning tool on the other hand was seen functioning in a similar way to a boundary object fostering usability to different communities.

Based on its analysis, the paper concluded that the online learning tool could perform the role of a boundary object although its effect changed from being negative to positive during the study period. However, the shift from being a negative boundary object to a positive boundary object did not occur by itself but because online learning adopted an epistemic ontology in the form of blended learning. Blended learning, being an epistemic object, may also have the potential to evolve into a more acceptable form or a technical object. Although the paper was not able to comment on the ultimate form of a 'technical object' in terms of eHIS training, it can be postulated that the same would be a CPD program such as that discussed earlier. Thus, one of the contributions made by this paper to the eHIS training community is to clear the pathway toward introducing online learning tools by adjusting its encapsulated social meaning. Such a focus could prevent practitioners having to deal with delays in negotiating training modalities in time-constrained eHIS implementations in LMIC settings. At the same time, the paper contributed theoretically by conceptualizing blended learning as having an epistemic ontology to that of online learning, which may contribute in explaining the diversity of views existing in scholarly publications regarding blended learning.

6.1.5. Paper 5: Siribaddana, P.A. and Hewapathirana, R. (2016). From online learning to cultivating communities of practice in free and open source health information systems: A model for low and middle income countries. *Electronic Journal of Information Systems in Developing Countries*, 73, 3.

The fifth and the final paper included in this thesis looked into the long-term effects of using online learning tools, first as part of a blended learning strategy and secondly as a supplement to work practices. The paper was a longitudinal study following up on a group of doctors being trained in eHISs using online and face-to-face modalities. However, the strength of the paper is that it followed the trainees into their work practices and was able to recognize the evolutionary process of a community of practice. Thus, the empirical data pertaining to this paper not only emanated from the online learning platform or the online DHIS2 academies, but also from the work practices of the study subjects and their interactions with the FOSS community.

The paper argued that when eHIS implementation, especially in the case of Free and Open Source Software (FOSS) such as DHIS2, comes across challenges in relation to creating support networks, effecting innovation and bridging between various knowledge domains; one potential solution is to cultivate communities of practice. However, the complexity of the healthcare systems and administrative structures in LMIC settings would mean that implementers of eHISs may not receive adequate support from relevant organizations in cultivating CoPs. The paper posited that eHIS training is an opportunity that provides the implementers of eHISs with informal and formal online, face-to-face and workplace based tools and approaches to drive a group of trainees in becoming a CoP. Nevertheless, the generally shorter duration of eHIS training programs does not allow enough time for participants to interact, build a sense of community, to define a shared domain of knowledge and a shared repertoire of practices. Thus, the paper argued that by enabling long-term opportunities for participation and interactions, it would be possible for eHIS training in the form of online, face-to-face and work-based training to be used as a means of cultivating a community of practice around eHISs in LMIC settings.

The paper in its theorization brought to the forefront the potential of online learning in linking formal and informal aspects of learning. At the same time, it brought forward the discourse around learning in FOSS communities as DHIS2 itself is a free and open source software. It

was evident from these discussions that participation was a key aspect in the learning process. The paper also saw that online learning tools would be able to facilitate such participation in addition to providing members of a potential community an opportunity to share and reflect. This meant that the work-based learning taking place through interactions, which usually remain tacit, can also be made explicit at its very onset and thereby channelled to garner innovation and to cultivate CoPs.

The paper depended upon social network analysis of different instances of interactions and qualitative assessment of participant interviews, other forms of communications and observations in analyzing its data. Based on these analyses, the paper concluded that it was in fact possible for training programs, which incorporate online, face-to-face and work place based training, to initiate the formation of a community of practices. However, three different aspects of the training program – linking of formal and informal learning, participation, and sense of community – needed special attention if this was to be successful.

In terms of 'linking formal and informal learning', the paper revealed that one needs to support 'comfort zones' of the participants by linking learning with practice and promote connectivism by enabling link and network building. Different expression styles also need facilitation as not all learners of HISs have the same style of expression. In relation to participation, it was recognized that the training programs should facilitate both contextual awareness and 'globalness', which are essential aspects in FOSS implementation and developments. While local experts can facilitate contextual awareness, the paper pointed out that the learners would value the presence of global experts and participants, either within the online learning or within the FOSS communities, in the build-up of globalness. Furthermore, in creating a sense of community, it was recognized that the training programs should support harnessing common interests, aid participants in forming their own identities within the CoP and facilitate cliques.

The goals, focus areas and the implementation choices enumerated through this paper are summarized in Table 6.

Table 6: Approach to cultivating CoPs using blended learning

Goal	Focus areas	Implementation choices
Linking formal and informal learning	*Comfort zones*	*Online curriculum linked with discussion forums*
		Online and face-to-face moderators who are responsive and accessible
		Supplementing curriculum with used cases from similar contexts
	Connectivism	*Introducing external knowledge bases including user manuals, used cases, videos, etc.*
		Actively promote link-building between students and experts within discussion forums and in face-to-face learning
		Introduce students to local and regional project owners
		Using moderators who themselves are well-connected and networked
	Expression style	*Facilitate both online and face-to-face discussions in relation to same learning objectives*
Participation	*Contextual awareness*	*Using project owners as moderators in online and face-to-face training*
		Designing discussion topics to reflect contextual issues
		Field visits
		Encouraging past students to contribute as moderators
	Globalness	*Include used cases from similar contexts elsewhere from the region or globe*
		Facilitate the participation of members from the global community
Sense of community	*Common interest*	*Include activities which generate issues of similar nature for all students*
		Arrange group sessions discussing various issues
		Design themed discussions based on general issues
	Identity formation	*Create networking opportunities with project owners*
		Facilitate participation in live projects
		Utilize moderators with similar background to the students as role models
	Cliquing	*Recognize cliques and facilitate their functioning*
		Enable formed cliques to express themselves to others

6.2. Mapping of research papers and their responses with the research questions

As was seen in the five chosen papers, it was difficult or somewhat impossible for one paper to address any one research question in entirety or any one paper to touch all research questions at the same time. Thus, it is necessary to summarize the research findings in order to assimilate the relevancy of these papers to the study questions. Table 7 illustrates the research questions and the various papers contributing to each of the research questions.

Table 7 : Mapping of research questions and papers

Research question	*Paper*
RQ1: What are the dimensions of a blended learning program that determine its potential toward cultivating communities of practice around HISs?	Paper I, II and V
RQ2: How to facilitate social construction of learning by integrating between the eHIS and the different dimensions of blended learning?	Paper II, III, IV and V
RQ3: What is the role of participation when training is used as a tool for cultivating communities of practice?	Paper I, II, III, IV and V

Based on the findings of the paper, Table 8 depicts the responses that these papers make in terms of each of the research questions.

Table 8: Mapping of papers and their responses to the research questions

Paper title	Response to the RQs
Paper I - Designing rights-based health information systems training programs for developing countries: Step toward mainstreaming equity in health	RQ1 – Blended learning designs for eHIS training in LMIC contexts should be equitable to all those who need training. Its design and implementation therefore can be framed in terms of the different dimensions of a rights based approach including availability, accessibility, acceptability and adaptability. RQ3 – Equitable training programs such as online eHIS training provide an opportunity for the learners to participate in online discussions and to gain desirable social capital. Gaining of social capital would mean being part of a community and it may even manifest into a community of practice over a period of time.
Paper II - Integrating blended learning for health information systems training in developing countries: Toward a conceptual framework	RQ1 – From a learning point of view, blended learning programs aimed at e-HIS training in LMIC contexts should integrate online, face-to-face and workplace learning in a manner that learning can be translated into work practices. RQ2 – Linking online, face-to-face and workplace learning by having local experts and contextual inputs would facilitate better interaction and therefore socially constructed learning. RQ3 – Blended learning creates an opportunity to introduce both local and global experts into the training at different instances in addition to the trainers of such programs. Their active presence promotes participation and interaction of the learners. Given that these experts are more likely to represent communities of practice in the learners' own setting, their presence can improve the chances for the learners to be part of the said communities.

Paper III - Making distance learning an effective health information systems training strategy: A combined social network analysis and content analysis perspective	RQ2 - Online learning itself can facilitate social construction of knowledge through participation and interaction building among learners, moderators, and experts of e-HISs. RQ3 – SNA along with qualitative measures can enumerate the relationships formed and therefore the potential for community building among the learners in a blended learning program. RQ3 - Participation of the moderators-cum-content-experts is a significant contributor toward quality online learning. RQ2 and RQ3 - Participation of learners in online forums facilitates knowledge construction of higher order, which is reminiscent of socially constructed learning and community building.
Paper IV - Using a blended approach to strengthen the acceptability of e-learning: Case of health information systems training in a global context	RQ2 – Online training tools when introduced into a heterogeneous trainer community as a training method may impart a negative meaning for its adopters. Thereby it may hinder the integration process between different aspects of a blended learning program such as technology, setting, context and the participants. RQ2 – Blended learning however may have a better chance of being acceptable to a heterogeneous trainer community and thereby to facilitate socially constructed learning. RQ3 – A blended learning program has to project a positive social meaning to the trainer community in order to garner their active participation throughout the design and implementation process of the said learning program.
Paper V - From online learning to cultivating communities of practice in free and open source health information systems: A model for low and middle income countries	RQ1 – From a FOSS point of view, this paper adds that the dimension of FOSS community should also be incorporated in blended learning initiatives as it has many facets that would aid learning and community building. RQ2 – Online communities including that of FOSS community can allow trainers a method to link between technology (Moodle and DHIS2), setting (face-to-face academy), context (LMIC) and the participants (super-users and implementers) toward facilitating socially constructed learning. RQ3 – Promoting participation by enabling learners to create their own identity within local, regional and global e-HIS communities can facilitate cohesion among learners and thereby facilitate the formation of CoPs. RQ3 – Homogeneity of e-HIS professionals may contribute to their likelihood of forming CoPs when trained through blended learning.

Chapter 7 – Discussion

By now, it is clear that this thesis focused on some important aspects related to a continuum that extends from (online) learning to cultivating communities of practice in accordance with its research aim. However, I perceive that the manifestations of a research is not necessarily the sum of all the papers it has published and therefore this chapter will synthesize the research findings, personal experiences and the state of the art in relevant literature in highlighting the key points that emerge from the whole research process in accordance with the investigated research questions.

7.1. Dimensions of a blended learning program that determine its potential toward cultivating CoPs around HISs

As stated in Chapter 1, this research came into being as a result of multiple training challenges experienced by the HISP Oslo team in LMIC contexts. Some of these challenges included accommodating all those who are in need of training, maintaining quality of the training provided, rising cost of holding regional academies and limited availability of human resources to conduct face-to-face training. It was expected that online training programs could help overcome such challenges and enable eHIS implementers and trainers to cater to the growing demand. It was also expected that online learning programs may help maintain quality of the training when external parties are involved in its delivery. From the point of view of the HISP network, being able to train a larger user-base also meant better integration of its information system (DHIS2) and creating better buy-in from the stakeholders, especially in LMIC contexts. However, most eHIS training initiatives including that of DHIS2 relied heavily on formal training approaches such as classroom or workshop based training (Braa et al., 2004), which are conducted according to a pre-defined curriculum.

Through this research, it became apparent that formal learning that takes place within a classroom or workshop setup was only a part of the learning process. In fact, many super-users and implementers had to continue their learning beyond the formal learning instances in order to resolve everyday issues that they face. In some instances, formal learning did not cater to some of the learning needs even during the training period. It was these observations that made this research realize the importance of informal and sometimes non-formal learning (learning taking place through loosely-structured learning events). Thus, the research

determined that one of the dimensions of a blended learning program that needs to be considered in this case is the dimension of 'learning context' represented by formal, informal and non-formal learning. Unfortunately, through the experience of this research, it was evident that HISP, or an external organization for that matter, does not gain free access to work practices of its learners in LMIC contexts. As informal learning generally takes place within the work setting (Eraut, 2004; Beckett & Hager, 2013), the research saw a need for alternative means of creating non-formal and informal learning opportunities within the training programs.

In this regard, online learning has been recognized as capable of generating informal learning when users of such learning platforms are provided with an opportunity to interact with the moderators, content experts and with their own colleagues (Dabbagh & Kitsantas, 2012). However, given the implicit, reactive and deliberative nature of informal learning, it is difficult to facilitate informal learning that would supplement the formal learning arrangements of a training program (Eraut, 2004). Thus, some form of structuring, as in the case of non-formal learning, was envisaged by this research.

In the meantime, it was also evident that the online learning platform was not versatile enough to use for continuous learning purposes as its overall design facilitated only structured learning programs of a designated duration. In other words, in the case of eHIS training, short duration of the formal learning programs did not allow learners to use the online learning tools to fulfill their learning needs when they engaged in their work practices. However, the research recognized a potential continuous learning opportunity in mailing lists, which are used in most open source software projects to facilitate communication between members of the FOSS community. Similarly, in the case of DHIS2, the mailing list was the lifeline for its FOSS community. It consisted of local, regional and global experts and novices who are interested in design and development issues related to DHIS2. The discussions in the mailing list mimicked the discussions taking place in a CoP as almost all discussions revolved around a problem emerging from the work practices. This also meant however that FOSS communities, or the mailing lists for that matter, cannot be used in carrying out a structured learning program. Nevertheless, by empowering the learners with the capacity and the motivation to be part of the FOSS community, it may be possible for them to use the mailing list as a means of continuous learning.

From the point of view of this research, these discussions pointed toward the necessity of creating multiple learning spaces within eHIS training programs. These spaces included online, face-to-face and workplace spaces and the FOSS community. Managing these spaces therefore became vital in achieving the learning goals, building networks and communities, and facilitating long-term learning. Thus, 'learning spaces' became another dimension in blended learning programs that this research recognized as facilitating the cultivation of CoPs around eHISs.

When considering these two dimensions – the learning context and the learning spaces – the research needed to conceptualize how learning goals or the objectives can be fulfilled across different spaces supplemented by different learning contexts. Utilizing Latour's (1987) conceptualization of immutable mobiles, the research postulated that by incorporating stabilizing factors such as local experts and 'use cases' from the learners' own context, it would be possible to maintain the 'shape' of a learning object. It was these conceptualizations that led to the development of the initial framework as depicted in Figure 13.

However, in practical terms, it may be wrong to assume that just because the learners in the online learning interacted within the online discussion forums, they would do the same in a mailing list linking them with the FOSS community. In the process of cultivating CoPs, the research demonstrated the need to adopt a constructivist approach where moderators and instructional designers facilitate linking learners with external knowledge bases and with local, regional and global experts. This was in addition to the moderators of online learning having to motivate the learners by demonstrating the trustworthiness of these links in resolving issues related to the learners' own setting.

Thus, as perceived by this research, it was the moderators' expertise regarding knowledge networks, important actors, and insights into the FOSS community that enabled them to propagate a constructivist approach to learning and thereby to facilitate learners to reach out to the FOSS community. This also meant that moderators of online eHIS training should also be aware of the politics, cultures, bureaucracies, power structures and important actors in LMIC contexts in order to mimic work-based learning within the online environment. However, even when moderators or the trainers were able to make links to local, regional and global experts within the online discussion forums, unless these experts contributed back to the discussion forum, it would be impossible for the expected learning, networking or

community building to take place. Thus, in addition to the participation of the learners and the moderators-cum-trainers, expert participation was also recognized through this research as an essential factor. Altogether, the research enumerated 'participation' as yet another dimension of a blended learning program aimed to facilitate cultivation of CoPs.

Finally, with the focus placed on LMIC contexts, the dimension of 'equity' also became an important consideration for this research in terms of blended learning programs. Equitable training designs agree with the current trends in delivering healthcare services (WHO, 2007), supporting development work (Groves & Hinton, 2013; Chambers, 2013), and providing education (Campbell & Storo, 1996), in LMIC settings. This would mean that in terms of eHIS implementation, training would garner a greater importance as it becomes an ethical obligation, duty and a responsibility of the trainers, eHIS implementers, implementing organizations and of the donor agencies. At the same time, the principles of a rights based approach such as availability, accessibility, acceptability and adaptability have the potential to function as a design tool as was demonstrated by this research. Thus, the research believes that by creating equitable training programs for eHIS training based on a rights based approach, blended learning programs can foster social capital, empower learners and initiate the formation of networks and potentially CoPs.

The dimensions recognized and their sub-components are summarized in Table 9.

Table 9 : Dimensions recognized for blended eHIS training design and implementation

Dimension recognized	Sub-components of each dimension
Participation	Learner participation, moderator participation, expert participation
Learning context	Formal, non-formal and informal
Learning spaces	Formal, informal, workplace and FOSS community
Equity	Availability, accessibility, acceptability and adaptability

The same dimensions and their components can be depicted diagrammatically in the formation of an eHIS training program as depicted in Figure 14.
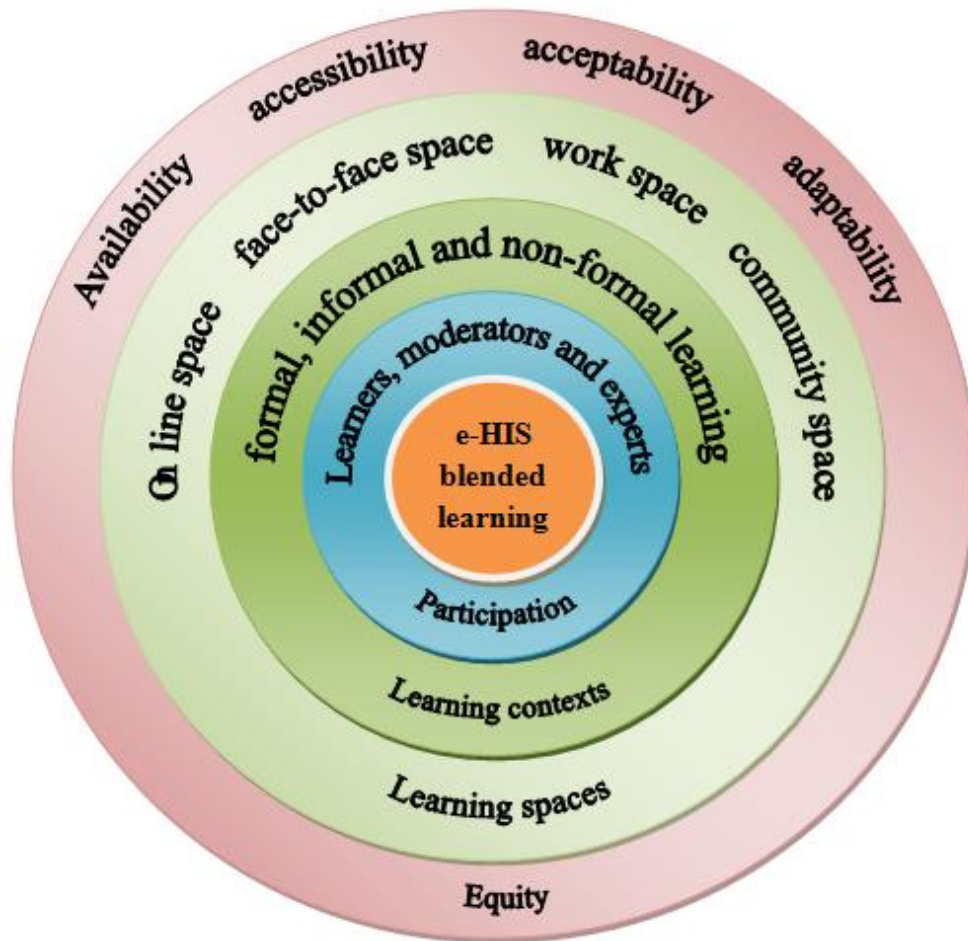
Figure 14: Equitable blended learning design for eHIS training in LMIC contexts

As depicted in Figure 14, the overall design and implementation of a eHIS blended learning program should be bounded by the rights based principles of equity which may define the technology, pedagogy, style, duration, content and other characteristics of the learning program. The learning spaces and learning contexts on the other hand should supplement each other and thus their close proximity in the diagram. Participation plays a central role in the whole design, therefore positioned as the innermost layer of the eHIS training design. The model highlights the areas a designer or a trainer should focus on when the aim of the training program is to cultivate CoPs around eHISs in LMIC contexts.

7.2. Facilitating social construction of learning by integrating the eHIS and the different dimensions of blended learning

From its inception, this research recognized that the aim of a blended learning initiative around an open source eHIS should not only be to transfer technical skills to its learners;, information systems such as eHISs have been recognized as social systems rather than pure

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technical systems (Walsham et al., 1988). This means that technical skills alone do not help super-users and implementers of eHISs to resolve the complex issues that emerge in LMIC settings. In fact, Kang and Santhanam (2003) have also explained the necessity for even the end-users to collaborate with others with different knowledge levels in order to resolve issues around ISs. These issues may emanate from the complexities within the health system and its information flows (De Savigny & Adam, 2009), financial and other resource constraints (Kimaro & Nhampossa, 2007), limitations in technological infrastructures (Sahay, 2001; Lewis et al., 2012) or even due to wider socio-political pressures (Avgerou, 2008). These issues however may have been experienced by experts within the wider eHIS community and therefore could be resolvable through harnessing such knowledge through different means.

The primary means of harnessing this knowledge, as seen through this research, was social construction of learning. However, the challenge foreseen was to facilitate social construction of learning within the ambits of a blended learning program. The focus of the research therefore was to find means of establishing integration between different dimensions of blended learning program as discussed earlier, and the eHIS.

Through this research, it became apparent that asynchronous modes of communication such as online discussion forums hosted within Moodle (the LMS) can generate productive online interactions. However, in recent times, the potential of such interactions being able to facilitate social construction of learning has been questioned. For instance, the rise of social media as a mode of interaction among learners has demonstrated the narrowness of asynchronous modes of communication within the structural limitations of an LMS (Lucas et al., 2014). In fact, this research also perceived that in the process of facilitating CoPs, the discussion forums arranged within an LMS such as Moodle may be limited to a certain extent. However, others argue that the communication medium may not be the sole determinant of social construction of learning but it is the appropriate use of interactions and the pedagogies that impact social learning the most (Gomes, 2008). Furthermore, there are other examples of LMS based discussion forums being used to assess social construction of learning even after the emergence of social media tools such as blogs and wikis (Lucas et al., 2014).

At the same time, it is worth remembering that interactions within discussion forums do not materialize on their own, especially when the time scope of a structured training program is

limited. The research revealed several characteristics related to the eHIS learners, in line with the characteristics of an adult learner as described in the literature (Knowles et al., 1998; Merriam, Caffarella & Baumgartner, 2012; Picciano & Dziuban, 2007), which motivated them to interact. First, the learners wanted to link their learning with their practice in order to find relevancy of their learning. Secondly, they strived to find their identity within the local and global eHIS communities. Thirdly, being professionals, these learners also strived to build social capital that would enhance their productivity and propel them further in their careers. However, online learning that makes use of examples from contexts different to that of the learners, and of discussion forums managed by moderators without enough knowledge regarding the learners' context, would not aid the learners in fulfilling their learning needs beyond eHIS-related technical knowledge. One remedy recognized through this research was to incorporate resource personnel and use-cases from the learners' own context. This may not only build relevance in the learners mind but also bring forward contextual characteristics into the online discussions.

Thus, when talking about integrating different dimensions of blended learning in order to facilitate socially constructed learning, moderators seem to play a vital role. This is to an extent in agreement with what Olfman et al. (2006) have perceived in providing organizational training where instructor-led training was recognized to be more appropriate for gaining higher order learning among the end-users. In fact, the main role of the moderators as identified through this research was not to impart knowledge or content transmission, but to engage the learners in meaning-making as envisioned by scholars such as Salmon (2004) and Olfman et al. (2006). Nevertheless, it is beneficial to have moderators with a higher knowledge and understanding of the subject matter than the students in order to provide clarifications and guidance (Rourke & Kanuka, 2009). However, this does not mean that moderators must be content experts (Collison et al., 2000) and at times, having knowledge similar to that of the learners may also be sufficient (Salmon, 2000). While this research also agrees to an extent that online moderators need not be content experts if students themselves are capable of understanding the instructional material, it recognizes the need for the moderators to have sufficient knowledge.

More importantly however, the moderators need to be 'context experts' in order to facilitate link building and knowledge construction. The term 'context experts' refers to moderators who are aware about the resources available to the learners (e.g. local experts, technological

infrastructure, use-cases, ongoing projects) and those who are aware about the socio-political structures that affect the functioning of the learners as future implementers and super-users of eHISs. At the same time, in line with the views expressed by Kim (2000), this research also agrees with the fact that the moderators' role depends on the background and the expertise of the learners themselves. This means that when most of the learners are novices, the role of the moderators becomes significant both as content and context experts. However, as the community grows or when the learners are sufficiently knowledgeable, the moderators can facilitate social construction of knowledge by acting as link builders between learners, and between learners and experts. Thus, while Olfman et al. (2006) argue that self-paced computer-mediated learning would be sufficient for novice end-users needing lower knowledge levels, this research perceives a changing role for the online moderators in the training of novice to expert level super-users and implementers.

Another important aspect with regard to integrating between different dimensions and eHIS was the need to bring different communities together in creating a collaborative learning environment. A key finding in this regard was the need to create a balance between different perceptions of the technology being introduced. As described earlier, the DHIS2 Academies (the face-to-face academies) have been performing multiple roles in addition to the pedagogical goal of imparting DHIS2-related competencies. These roles emerged as a result of different groups involved in the training process having different interests, which is also essential in the evolution of the eHIS. Thus, when online learning tools were introduced, they was subjected to different interpretations and gave rise to unintended consequences. In a way, as described by scholars such as Latour (2000), Callon (1992) and Suchman (1987), the differences in utility of the same online learning platform by different groups mimicked a constructivist approach to technology where the meaning and the effect of technology are determined by the actors who use such technology rather than by its designers. However, this research demonstrated that re-interpretation of the online learning tool as part of a blended learning approach aligned the different interests of different user groups (e.g. developers of eHIS, researchers, managers of the organization, trainers, and learners). Through this alignment, blended learning facilitated collaboration and participation, and therefore the social construction of learning. In a way, the process of integrating different dimensions of blended learning and the eHIS was achieved through 'democratic advance' as perceived by Feenberg (1991). One of the central tenets of a critical approach to technology, 'democratic advance' posits that the citizens, or in this case the users of the online learning tools,

participate in the development, implementation and the diffusion of the 'technology'. Thus, integration herein was the result of different groups recognizing the potential of the online learning tools in facilitating their own interests and the wider organizational interest of capacity building around eHISs.

Lastly, the value of a FOSS community was also recognized through this research as a means of integration. However, the FOSS community did not make sense to novice learners at the beginning as it was not designed to impart basic knowledge. Instead, the predecessor to the FOSS community came in the form of online discussion forums where the learners gained an understanding of the usability of the FOSS community and were introduced to some of its important actors. However, the need for a learner to interact with the FOSS community via the mailing lists did not manifest until the learners became exponents of the eHIS. Nevertheless, in the integration process, one could conceptualize the FOSS community as a learning space that facilitates the translation of knowledge into practice. At the same time, FOSS community may also be viewed as an extension of one's social capital as it enables active members within the FOSS community to challenge the power structures within one's own context. In whatever form, the integration of the FOSS community can enhances the learner's ability to make meaning of his or her learning. Thus, the means of integrating between different dimensions of blended learning and the eHIS in enabling social construction of learning can be summarized as in Table 10.

Table 10 : Means of integrating different dimensions of blended learning and eHIS in order to facilitate social construction of learning

Recommended measures of integration
1. Use of context experts as moderators of online discussions
2. Assigning network building as a foremost task of the moderators
3. Incorporating use-cases, discussion threads, assignments and other activities, which reflect the learners' own context
4. Motivating and encouraging learners to participate in online, face-to-face and FOSS community discussions using appropriate means
5. Ensuring the participation of experts from learners own context in discussion forums
6. Fostering an acceptable social meaning to the online learning tools and regarding the training as a whole
7. Allowing constructivist approach to technology (online learning tools) adoption by its stakeholders
8. Harnessing the democratic advance in the design and implementation of the learning technology
9. Using online and face-to-face activities that require learners to interact with the FOSS community

7.3. Role of participation when training is used as a tool for cultivating communities of practice

Throughout this research, participation was viewed in terms of social participation (Wegner, 1998), which is a prerequisite for socially constructed learning as discussed earlier. Within the boundaries of a CoP, learning takes place through negotiation of meaning (Wenger, 1998), which means that much of its learning is also socially constructed. Thus, when aiming at supplementing or initiating CoPs, participation becomes an essential factor. In line with these conceptualizations, this research facilitated participation within its eHIS training program at various points. For instance, online discussion forums provided an avenue for participation for those engaged in online learning while the face-to-face academy became the site for face-to-face participation. The research also created opportunities of participation via emails, mailing lists (the FOSS community) and through work-based practices.

When considering this research as a whole, there were two main groups of study subjects. One group can be considered heterogeneous as it consisted of information officers, medical officers, IT personnel, health managers and other categories of health and IT staff who attended the DHIS2 Academies. However, it was not the same learners who attended different academies but instead it was a new group of learners at each face-to-face academy. Nevertheless, some of these learners attended the online academy on more than one occasion and were actively contributing to the online discussions. The second group could be described as a homogenous group, which consisted of a set of medical professionals who had been studying for their master's degree in health informatics and undergoing training similar to that of the first group with added emphasis on continuity of training and work-based learning. Therefore, the second group, being homogenous, had more potential in becoming a CoP (Wenger, 1998). However, this does not mean that CoPs consisting of heterogeneous membership – as with the first group – are uncommon (Hartas, 2015; Dulworth & Dulworth, 2008).

Analyzing the experience of the learners from the first group, it became apparent that not everyone had the same expectations from the training. The reason for this may be that they were supposed to play different roles within the healthcare system following gaining their training. They also did not have close communication with each other apart from those who were representing the same country or the same organization. Even when members of this

group were from the same country, they were from different health programs or agencies thus having different work practices. These members also had different networks of relationships with some being more connected than others. Those with more connections were not able to share their connections with the least connected due to their professional, institutional, geographical and socio-cultural differences. In a way, this group can be described as consisting of members representing different CoPs, which Fischer (2005) described as a Community of Interest (CoI). CoI is less formal in structure than a CoP and its membership is usually open, flexible and short term (Fischer, 2005). Members participating in a CoI exchange information within a narrow focus, and therefore the motivation holding a CoI together is the mutual needs of its members (Herranz et al., 2012). In contrast, the motivations that hold a CoP together may include the need to enhance work practices and to form and maintain a strong identity (Wenger, 1998).

From the point of view of DHIS2 Academy, different participants of the blended learning program including learners, moderators, developers, researchers and experts exchanged information among each other thus generating mutual needs. The academy was also narrowly focused upon the DHIS2 and the introduction of the online learning made its membership open and flexible as against a traditional training program. Thus, the community formed around the blended learning initiative showed some of the key characteristics of a CoI as more than just a learning community.

However, when compared to the first group, the second group had common goals and aspirations in terms of customizing and implementing eHISs within the same organizational context, the Ministry of Health. Furthermore, the group had a considerably lengthy period of time to build relationships among themselves and was exposed to almost the same actors, institutions and projects, which ensured gaining of an equitable social capital by all members of the group. Some other similarities between members of the second group included them belonging to the same profession, having almost the same work practices, and being employed at similar work settings. This meant that all the members understood issues of professional nature within their common landscape and were able to consider themselves as equals in their professional practice. This may have facilitated interactions and cohesiveness throughout their training and even beyond. While the group may fit the description of a homogenous community as envisioned by Wenger (1998), the reason for the members of this group to be together was not much different to that of the first group. At the beginning, they

also were motivated by the need for information than anything else and therefore may also be described as a CoI. However, it may not be possible to define them as belonging to multiple CoPs as they did not emerge from different work settings but instead were part of an already existing learning community within an educational institute.

It was interesting to note however that the second group valued their interactions with academy participants from other regions and within the mailing list. The reason for this may be the realization by the second group that they did not possess the knowledge to resolve certain issues in their work practices by themselves. They did not however feel that every member needed to communicate with the FOSS community but instead chose to rely on some members who were either more technically competent or better in communication, or those who conceptualized the issue first for the purpose of linking with external communities. In other words, although each member within this community had the opportunity to build their own social capital as perceived by Baum and Ziersch (2003), they were content with having a community-wide social capital as perceived by Putnam (1995). In a way, such actions demonstrate a strong sense of community among the members of this group similar in nature to a CoP.

At the same time, this also demonstrates a different aspect of participation, which is boundary spanning (Wenger, 1998). In that, members of a CoP may cross boundaries into different communities seeking information necessitated by the previous community. Within the blended learning setup, boundary spanning took place when the learners were introduced to different learning spaces contributed to by experts and non-experts representing different communities. Among them, FOSS community was seen as a key exponent of boundary spanning and therefore a facilitator of participation.

It was also noted that within the said group, members formed cliques on their own, based on various factors such as frequency of meeting, knowledge, and similarities in work practices. Such cliques could have loosened the cohesion among members of the group (Hughes et al., 2013). However, they had alternative spaces to gather and interact in the form of a physical location (the laboratory), an online discussion forum (DHIS2 Academy), the DHIS2 mailing list and their own mailing list. Such alternatives facilitated multiple points of interaction between members of different cliques. Thus, it can be argued that maintaining participation

through multiple spaces enabled this group to link cliques and individual members in forming a larger community.

Nevertheless, the interactions that took place within online discussion forums also indicate that even the academy participants who were classified as belonging to the first group, did have multiple opportunities for participation in online forums, face-to-face academy and within the DHIS2 mailing list. However, they lacked continuity of contact, shared work practices and perhaps a sense of community that would have otherwise led them to form a CoP. It did not however prevent them from sharing their experiences, knowledge and skills with each other in the online forums and to an extent during the face-to-face academies. It also did not hinder some of them moving from being learners to being resource personnel for the online discussion forums, similar in nature to the legitimate peripheral participation (Lave & Wenger, 1991) and an inward trajectory of participation (Wenger, 1998) described in relation to CoPs. However, these characteristics were indicative of some learners becoming part of the global trainer community rather than them forming their own CoP. Thus, even when professional and contextual homogeneity is absent among learners of a blended learning program, the incorporation of different learning spaces could enable them to gain legitimacy, create their own identity, gain desirable social capital, be part of a different CoP altogether and contribute to the improvements in their own organizational work practices.

Thus, through this research, it was evident that both homogeneous professional groups and heterogeneous groups of learners value having multiple spaces for them to participate and learn. This was true even when work practices, sense of community or socio-political and socio-cultural characteristics differ between various groups. However, when professional groups with common interests, work practices and sense of community are given the same opportunities for participation for a considerably long period, they can extend their linkages to the point that they form a CoP. In heterogeneous groups of learners, such opportunities may not necessarily create motivation for them to form CoPs, but for some with the right motivation, attitude, desirable problem domain and appropriate social capital, these opportunities could facilitate defining their own identity and self-efficacy. They may however gain opportunities to be part of different CoPs or CoIs depending on their degree of participation within different spaces of the blended learning program.

Lastly, what transpires from these discussions is that eHIS training programs are not only instances of technical skills transfer at least when it comes to implementer and super-user level training. While technical skills transfer still plays an important role, training programs have much more potential in terms of network building, creating opportunities for learners to find their own identity and more importantly, to facilitate the initiation and sustainment of CoPs around eHISs. However, in order to achieve these goals, the blended learning program should provide enough opportunities for participation, time for such participation to mature into collaborations, and support in findings the right trajectory of participation.

Chapter 8 - Contributions

"Science is facts, just as houses are made of stone. . . .But a pile of stones is not a house, and a collection of facts is not necessarily science."
(Henri Poincare, *French mathematician & physicist*)

So far in this thesis, I have illustrated the motivation, the method, the actions and the fruits of these actions. However, none of these would make sense unless it is put into perspective how my research contributes to the society in the form of theory and practice. This chapter will elaborate on this important aspect and will piece together the jigsaw of eHIS training.

8.1.   Theoretical contribution

From the perspective of this research, its theoretical contribution is largely twofold. First, it aids in understanding the role of training in relation to cultivating CoPs, particularly in terms of information and communication technology for development (ICT4D) contexts. Second, it contributes by exploring the epistemic potential of blended learning programs. The explorative account will aid in better understanding the different stakeholder reactions and practices toward a newly introduced technology. The conceptualization of blended learning as an epistemic object would also contribute to the educational literature by extending the definition of blended learning. In terms of ICT4D, the said conceptualization highlights the potential of an epistemic blended learning object in augmenting the evolutionary process of an IS.

8.1.1. Understanding the role of training in cultivating CoPs in ICT4D contexts

Usability of online learning tools in facilitating higher-order knowledge requirements

Based on the experiences gathered from conducting this research, it became apparent that training needs of its learners evolve over time. This is in addition to recognizing that training is a requirement that will continue throughout the lifetime of an eHIS, especially in LMIC contexts. In a way, these observations may have been the result of the given eHIS being a technically complex and a task-interdependent IS (Sharma & Yetton, 2007). It means that eHIS implementations cannot just rely on formal training programs aimed at transferring and developing only the IS-related technical knowledge and skills respectively. In addition to technical knowledge, a complex and a task-interdependent IS requires its users – especially

the high-level users and implementers – to be aware of different cognitive routines (Edmondson et al., 2001), interdependent processes (Sharma & Yetton, 2007), different applications of the IS (Kang & Santhanam, 2003), and ways and means of streamlining the IS with existing business processes (Robey et al., 2002).

However, as described earlier in Chapter 4, IS literature has already recognized the need for training to be more than just a transfer of technical skills – largely in relation to end-user training (Kang & Santhanam, 2003). According to Kang and Santhanam, one of the means of addressing this need is for the end-users to engage in problem-solving exercises with other high-level and more experienced users as was described in the hierarchical-knowledge-level model by Sein et al. (1999). By suggesting instructor-led training to be more appropriate for training end-users needing higher-order knowledge, Olfman et al. (2006) re-affirmed Kang and Santhanam's argument for interaction between users of different 'knowledge levels'.

Furthermore, in terms of implementing and scaling eHISs in LMICs, super-users and implementers should also be aware about the institutional issues, politics, and the growing of the team itself (Sahay & Walsham, 2006). Learning related to these and the higher-order knowledge as described earlier – levels 4 to 6 in the hierarchical-knowledge-levels model – are more likely to take place informally within a community setting [intra- or extra-organizational] (Carroll, 2009). Thus, there seems to be much impetus toward cultivating CoPs around eHISs, particularly in LMIC contexts. From the point of view of potential implementers [e.g. participants of DHIS2 Academies] of eHISs in LMICs, the community that they are part of within an organizational setting may not necessarily provide them with the desired learning opportunities.

In such a scenario, this research contributes to the IS training literature by demonstrating the capability of a blended learning approach where online tools can be used to facilitate interactions and collaboration-building between IS users. Such interaction and collaboration-building, which can extend beyond organizational boundaries, has the potential to facilitate a learning environment conducive for creating higher-order learning and knowledge creation. This would mean that in addition to the suggestions of Olfman et al. – that online self-paced learning would suit better the end-users who are in need of basic knowledge – online tools are also usable in training users with higher-order knowledge requirements.

Extending the 'network of action' approach

The 'network of action' approach suggested by Braa et al. (2004) envisions the creation of local and regional expert communities in LMICs. This depends on setting up a constellation of expert nodes that mutually support learning processes and facilitate alignment of institutions toward the goal of sustaining the eHISs (Braa et al., 2004; Braa & Nielson, 2015). However, emergence of expert communities may not happen according to the time schedule laid down by the IS implementers, because participation, interaction, and collaboration building, which are recognized as vital by this research for the formation of most communities, are influenced by many factors. Nevertheless, the 'network of action' approach may be described as a proactive way of cultivating such communities rather than letting them emerge by accident.

However, given the ecological nature of network of actions, it may not be controllable by any one entity (Braa & Neilson, 2015). Thus, the network of action approach may not be able to maintain focus on a selected group of individuals and facilitate their integration within the wider community. At the same time, the broader action research focus and the lack of control may not allow the network of action to support building local CoPs through a sustained effort. However, the network that is already in place is an asset to any IS implementation. This is comparable to a large-scale FOSS community, with context-aware local and regional expert nodes.

Thus, this research contributes to the discourse around network of action by re-conceptualizing super-user and implementer training as a means of developing micro-level networks in the form of CoPs. Not only does this extend the reach of the network of action approach, but it also strengthens its key objective, which is to share knowledge and experiences in a way that allows local actions to be sustainable. The implications of such a perspective may be multiple and in terms of ICT4D the following implications could be noted.

Implications on scaling of ISs in ICT4D contexts

It was described earlier in this thesis that many IS pilots fail to scale to expected levels due to different reasons (Wakerman & Humphreys, 2011; Heeks, 2006; Walsham & Sahay, 2006). In LMICs, lack of capacity at different levels is a recognized inhibitor of successful scaling (Braa, Monteiro & Sahay 2004; Ciborra, 2000). However, literature pertaining to the scaling

of ISs is dominated by scaling of the IT artifact without much consideration of the socio-technical aspect of the said systems (Walsham & Sahay, 2006). As explained earlier, at a macro level, the 'network of action' may be a means of scaling capacity. However, at the national and program level, scaling of ISs is supported by gradually scaled training programs aimed at building individual capacity (Sahay & Walsham, 2006). In relation to end-users, this may be adequate as they usually don't have to deal with the complexities created by social, cultural and political factors. At implementer and super-user levels however, understanding the escalation of complexity becomes a key factor (Sahay & Walsham, 2006). In such situations, the embedded knowledge within local, regional and global communities may be of vital importance. The role of training in this scenario would be to link between different communities (e.g. FOSS community) and facilitate implementer and super-user level learners to learn from experiences of each other and those of other experts – beyond organizational boundaries.

Thus, a training program such as that described in this thesis would support scaling of ISs in ICT4D contexts in several ways. First, it will cater to the basic skills development through its formal learning arrangements. Secondly, it will facilitate understanding the complexity related to the IS, and its implementation and scaling by providing opportunities for learning from similar contexts and from those who are with similar experiences. Thirdly, by facilitating the cultivation of CoPs, the training aids in establishing a mechanism where the learning around the IS would continue even when the initial training programs cease to exist.

Implications on interdisciplinarity in ICT4D

When it comes to ICT4D, technologies such as the eHIS and the online learning tools discussed herein should not be viewed only as external tools (Miller & Slater, 2000). In fact, these tools need to be embedded within the socio-cultural practices in LMICs and probably one of the best means of doing so is to establish CoPs around such technologies (Evans et al., 2008). However, this may be a difficult and sometimes an impossible task given the complex socio-political and socio-cultural practices that prevent connections being made among constituents of a specific community, and amongst different communities. In such instances, ICT itself may come to the rescue (Jones, 2004).

For instance, blended learning with its use of multiple training modalities is crucial to the process of cultivating a CoP as perceived through this research. In that, the use of ICT –

Moodle learning management system, email communications and mailing list – facilitated participation, connection-building, and collaboration between learners, learners and trainers, and between learners and local, regional and global experts. The outcome of using ICTs for training in this regard is the emergence of a CoP that has the potential to sustain the eHIS. In other words, this research depicts an instance where one ICT artifact (e.g. e-learning tools) supports the sustainment of another (e.g. the DHIS2) within a developing country context. It also emphasizes and adds a different dimension to Walsham's suggestion to make IS research interdisciplinary (Walsham, 2012), as in this instance, the disciplines of education and health (ICTs) supplemented each other through their own IT artifacts.

Limitations in considering training as a means of cultivating CoPs

However, there are limitations to conceptualizing training as a means of cultivating CoPs as well. For instance, unless the eHIS implementers and trainers yield enough power over their learners, it may not be possible for them to motivate and sustain communities of interest or learning communities (Lieberman & Miller, 2011), which are precursors to future CoPs. At the same time, if organizational climate does not allow trainees to be part of an extra-organizational or cross-organizational community, it may be difficult to attract the necessary commitment from the learners for a longer period. In addition, as with any other learning approach, a learning approach aimed toward initiating CoPs may also depend largely on individual characteristics. However, this research suggests that by utilizing a blended approach, it may be possible to cater to different learning styles and participation preferences, which would help overcome some of these limitations.

8.1.2. Understanding the epistemic potential of blended learning

As described earlier in this thesis, when the online learning tool was introduced to the trainer community, it became a channel of communication between me as the researcher and the rest of the trainer community. While everyone understood the purpose of the online learning tool, following its introduction, different opinions regarding how and when it should be utilized emerged. As a result, different uses of the online learning tool by different stakeholders also emerged (e.g. as a repository of training material, feedback tool, survey tool, a form of assessment).

Thus, in line with the definition formulated by Star and Griesemer (1989), the research recognized online learning tool to be a boundary object, which enabled its users [the trainers] sufficient control regarding its utilization at different levels without losing its original form. The online learning tool also conformed to Ewenstein and Whyte's (2009) conceptualization of a boundary object, which is a concrete object that can mediate knowledge across boundaries. However, presenting the online learning tool as a blended learning approach seemed more attractive to the trainer community. In fact, the online learning tool [Moodle] on its own was perceived negatively by the trainer community thereby restricting its application in eHIS training. These observations made this research to postulate: perhaps the blended learning approach is a more positive boundary object than the online learning tool. However, blended learning is an abstract concept, which garners incompleteness (Picciano et al., 2014). Further, it constitutes different combinations of online and face-to-face learning instances, which means that it could only express itself partially at any given instance. Despite this, it [blended learning approach] was also seen as functioning at the boundary between different user groups. Given that the blended learning approach demonstrated a lack of completeness of being, simultaneously existed in multiple forms, and has generated scientific inquiry, the concept 'blended learning' fell in-line with the concept 'epistemic object' or 'epistemic thing' as described by Rheinberger (1997).

In IS research, the different perceptions existing between different staff members or groups about a particular information technology – as envisioned by this research – has been described using different lenses. One such lens is the 'technological frames' (Orlikowski & Gash, 1994). These technological frames are formed by the assumptions, expectations and the knowledge gathered by an individual or a group and would therefore act as a template in the process of problem-solving. However, the technological frame may facilitate (Walsh, 1995) or even disrupt (Orlikowski & Gash, 1994) the development, adoption or use of an information technology. Thus, in an organizational setting, it would be imperative that the different technological frames existing between different stakeholders (e.g. developers, users, implementers) of an IS are aligned and potential incongruence dealt with. However, technological frames are inherently insensitive to the wider socio-cultural, socio-political and institutional influences on individual and group perceptions (Prell, 2009; Klein & Kleinman, 2002; Hughes, 1994). Furthermore, technological frames may also be limited in their analytical scope, being a heterogeneous concept that may mask the intricacies of structures that influence technology development or its adoption (Prell, 2009). In essence, from a

technological frames point of view, organizations or the environments surrounding information technology are stable structures and changes are either exceptional or episodic (Barrett et al., 2006).

A second lens to view the responses observed in the process of introducing a technology such as online learning is to look at it as technologies-in-practice (Orlikowski, 2000). It differs from technological frames in that users of technology would also draw from their interactions with their environment, the institutional context and the social and cultural conventions associated with such contexts. Thus, the responses and actions generated by those who are supposed to make use of a technology would not be static but would be evolving as the users interact with the technology in their recurrent practices.

When considering the negative and positive social interpretations garnered by DHIS2 trainers during the process of introducing Moodle, it is possible to find parallels between these observations and the implications of boundary objects, epistemic objects, technological frames and technologies-in-practice. For instance, the assumptions, expectations and the knowledge regarding the online learning tool, and to an extent the DHIS2, may have framed the way different trainers responded to the introduction of Moodle. As with diverse technological frames giving rise to disruptions in development, adoption and the use of information technology, the differences in perceptions among trainers prevented the online tool from altering the way the academies were held in the beginning. At this point, Moodle seems to have been perceived as a software artifact similar in nature to, perhaps, the DHIS2. However, given the nature of the actors involved, as the researcher, I was able to use Moodle, a boundary object in reality, as a means of communication between and among the trainers.

With repeated iterations however, different stakeholders of the training community – the implementers, developers and the researchers – realized that the online tool could be used to supplement the face-to-face academies. They also engaged in experimenting with the online tool in different ways and thus the manifestation of different uses of Moodle, as explained earlier. By this time, the trainer community, including myself, was actively engaged in finding the 'right blend' of online and face-to-face learning which resembled an epistemic practice (Cetina, 2001) around the epistemic object of 'blended learning'. It may also be possible that by this time, the trainer community involved in adopting Moodle has formed a different technological frame; different to what was prevailing at the beginning of the adaptation process.

The perceived frame shift in this case however was not only a manifestation of the trainers' assumptions, expectations and knowledge, but also the result of the evolving network of actions, which also demanded online training to be part of the DHIS2 training effort. At the same time, the expanding portfolio of HISP Oslo also made it necessary for online tool to be a significant part in the training process. Thus, the emergence of blended learning as an alternative to both online learning and face-to-face learning, and the determination of the role played by Moodle by the trainer community, were both shaped in a process more compatible with technologies-in-practice than technological frames.

Thus, from an IS point of view, this research contributes by expanding the understanding around development, adaptation and use of information technology by different user groups. Although technological frames and technologies-in-practice were not part of the analytical lens used by this research, the understanding gathered illustrated how an epistemic articulation of a technology [blended learning] facilitated the mainstreaming of the information technology [online learning tool]. It also illustrated the limitation when technological frames are used to understand the development, adaptation and use of a technology, especially when the practices around the said technology continue to evolve based on multiple external factors in addition to the technology-specific factors. Furthermore, in terms of IS training, the research highlights the usefulness of facilitating epistemic practices around the technology to be used in training, rather than enforcing training communities to adopt technologies such as Moodle.

Implications on defining blended learning

While boundary and epistemic determination of technology objects contribute to IS literature as explained earlier, the said conceptualization also contributes back to the education literature by expanding the understanding around blended learning. At the beginning, this research adopted the view that blended learning is "*organic integration of thoughtfully selected and complementary face-to-face and online approaches and technologies*" (Garrison & Vaughan, 2008; p.148). One reason to adopt this definition was its sensitivity toward specifics of practice by allowing for organic integration of different approaches (Garrison, 2015). The organic integration, as perceived by Garrison and Vaughan (2008), refers to instructors of a higher educational institution being autonomous in deciding the online activities and means of promoting student engagement in their own blended learning programs. However, as explained early in the thesis, the said definition and other recognized

definitions of blended learning (Heinze & Procter 2004; Dzuiban, Moskal & Hartman, 2005; Picciano, 2009) imply that blended learning programs are in a state of permanency following its implementation. In other words, it seems that the general view among scholars regarding blended learning programs is that once planned, the composition or the 'blend' of the program may remain indefinite. At the same time, while the definition of blended learning adopted herein refers to 'thoughtfully selected', critics argue that it fails to define what the term actually means (Kanuka & Rourke, 2013). However, given the contexts within which these definitions have emerged (e.g. higher educational settings, large corporations), one may argue that 'thoughtfully selected' refers to the point of view and the control of the trainers or the organization concerned. However, by considering blended learning as an epistemic object, this research contributes by effectively shifting the perception of blended learning from being a 'state of permanency' and 'control' to a 'state of fluidity' and 'freedom'.

To explain further, it can be argued that conceptualizing a blended learning program as an epistemic object enables it to fall in line with the evolutionary process a group of learners would undergo, in becoming a CoP. During this evolutionary process, learners, or the future members of the CoP, cannot depend only on formal learning arrangements. While they will gain some inputs through formal learning, they must also gain further learning through informal means. An epistemic blended learning program will cater to these needs as it can adapt itself at different points in time as demonstrated through this research. For instance, at the beginning, the blended learning program may be dominated by formal learning arrangements and some degree of informal discussions. As learners gain some understanding of the subject matter, the blend in the blended learning will evolve to predominantly informal discussions and workplace-based learning. Later on, the blended learning program may consist of highly problem-oriented learning within the mailing lists and work-based practices. In this case, the 'organic integration' refers not necessarily to the autonomy of the trainers in deciding the best mix of approaches, but to the sensitivity of the blended learning program to the evolving nature of the learners' needs and context. In terms of its meaning, the research perceives 'thoughtfully selected' to be largely referring to the learners' discretion as against the trainers' will. The role of the trainers or the organization for that matter would therefore be to facilitate thoughtful selection by the learners.

Implications on the evolutionary process of an eHIS in an ICT4D context

From an ICT4D point of view, an epistemic object such as a blended learning could add a new dimension to the evolutionary process of an IS. ISs such as the eHIS discussed herein, may undergo an evolutionary process as they negotiate the contextual elements that shape their existence (Ciborra et al., 2000). This means that an IS may garner the characteristics of an epistemic object (Aanestad, 2006), when different stakeholders, including the users, learn, adapt, act and sometimes impart change on the said IS. The slowness of such an evolution, as perceived by Aanestad (2006), may not serve well in achieving a desirable level of integration between the IS and the work practices. This may well be the case in time-bound and resource-constrained IS implementation such as DHIS2 implementations in LMIC contexts. In that sense, the epistemic nature of blended learning creates a second space for scientific inquiry related to the IS, that could enhance the evolutionary process of the said IS. The reason for this notion is that from the point of view of the stakeholders, both the blended learning program and the IS envision the creation of an efficient information practice. Toward this end, blended learning program and the IS generate new learning. Having two channels of epistemic inquiry will therefore augment the learning process, which may facilitate the attainment of the desired information practice in a shorter period. However, this research was not designed to assess the plausibility of this view and would therefore urge further inquiry from the IS community.

8.2. Practical contributions

Given the action research approach adopted by this research, several practical contributions were perceived which may have implications on IS training and implementation in LMIC settings. Section 8.2.1 will elaborate on these contributions under the theme, 'designing and implementing training programs oriented toward cultivating communities around information systems'.

8.2.1. Designing and implementing training programs oriented toward cultivating communities around information systems

In the process of cultivating CoPs, Wenger et al. (2002) described design elements in the form of several principles. Some of these principles focused on participation, communication, creating spaces and inculcating belongingness among the community members. While

acknowledging that CoPs may even emerge across business units, across organizations and sometimes even involve the civil society, Wenger et al. (2002) mostly limited their discussion to organizations with clearly demarcated boundaries. As gathered through this research, eHIS implementers in LMICs do not necessarily gain unrestricted access to the organizations – Ministries of Health and health programs in this instance – or to their HIS staff. Unless an organization itself is motivated enough to facilitate and support CoPs around the eHIS, it is unlikely that implementers of eHISs would be able to experiment with the principles laid down by Wenger and colleagues. However, especially in relation to public sector institutions such as Ministries of Health and public health programs in LMIC contexts, such motivation and support may not come by easily. This means that in LMIC contexts, eHIS implementers, or IS implementers for that matter, may have to look at the cultivation of extra-organizational or cross-organizational CoPs instead. However, in terms of eHIS training, or IS training for that matter, operationalizing cultivation requires focusing on several important aspects. These aspects and means of operationalizing cultivation of CoPs are the practical contributions of this research.

As observed through this research, one reason for training to become a means of cultivating CoPs is its blended nature. For instance, the traditional training practices (e.g. face-to-face training) only provided the trainers with limited opportunities to bring the learners together at times of face-to-face interactions. Following the adoption of blended learning, the number of instances where learners could interact increased. These instances included online, face-to-face, and workplace-based training spaces along with the FOSS community in the form of a mailing list. Furthermore, blended learning also enabled HISP to conduct training at different time frames, at a lower cost, with more capacity for participation. This meant that eHIS trainers were able to closely track a group of learners for a longer period of time than they would be able to with traditional means. In other words, blended learning afforded more 'power' to the trainer community to the extent that they could establish themselves as 'community-coordinators' as postulated by Wenger et al. (2002) in cultivating CoPs. Thus, when IS projects perceive the necessity and the usefulness of cultivating CoPs, one recommendation is to adopt a blended learning approach that creates multiple learning spaces.

Another reason that made training a tool for cultivating CoPs is its empowerment of the learners in becoming active and lifelong learners. While eHIS implementations rely largely on traditional training programs such as face-to-face academies of DHIS2 dominated by formal

learning arrangements, this research recognized that there is more potential for learning around eHISs through informal means. However, as informal learning is an event-driven, spontaneous and natural phenomenon (Eraut, 2004), it usually manifests by 'accident' than by design. Nevertheless, via blended learning, it is possible to create an environment conducive for informal learning by utilizing the power of different learning spaces such as online, face-to-face, workspace and the FOSS community. Thus, IS projects are advised to take measures in creating a conducive environment for informal learning as much as possible throughout and even beyond a designated project duration.

With regard to encouraging informal learning, there were two other important considerations enumerated through this research. These were depicted in Figure 14 as dimensions of blended learning, namely; participation and equity. While creating learning spaces by adopting a blended learning strategy may be straightforward, this research recognizes that achieving participation and equity in training as both challenging and vital for the envisoned community building.

In terms of promoting participation, this research sees the necessity to integrate between different leaning spaces. However, in doing so, the research accepts the inability to consider the information system, the eHIS in this case, and the training, as separate entitites. In fact, it recognizes the need to integrate not only between different learning spaces but also between learning spaces and the information system. As discussed earlier, both the epistemic blended learning object and the eHIS should be considered by IS implementers and trainers as supplementary to each other in the quest toward identifying the suitable application of technology and acheiving a desirable information practice. This would mean that the learners have to be given the opportunity to move between different learning spaces and to engage with the eHIS in real life situations. Obviously, such facilitation cannot be achieved in one-off training instances within a short period of time.

From a training perspective, the practical approach toward this end is to recruit experts who are actively engaged in the learners' own context and who are available for connection-making in different spaces – online, face-to-face, workplace and FOSS community. At the initial phases of the training, trainers could also make use of use-cases from the learners' own context to better facilitate the linking of learning with actual work practices. If cultivating CoPs is one of the aims of the training, it should ideally last the length of the implementation. However, each training session – face-to-face, online or workplace based – could be of short

duration. It is the view of this research that implementers and trainers should look to conduct multiple such training sessions, at regular intervals, as part of the whole learning program. As discussed earlier, each of these training sessions should be made informal-learning-ready. Furthermore, throughout the training, learners should be provided with access to a recognized set of context experts – as described in the discussion chapter – via different means (e.g. mailing list, workplace contacts).

In terms of equity, this research recommended multiple measures (as depicted in Table 5) that would ensure availability, accessibility, acceptability and adaptability of such programs. Focusing on these aspects will enable IS projects to implemenet better training programs in terms of fulfilling the learning needs and the contexual demands of the trainers an the IS as a whole.

Figure 15 illustrates these points of discussion and the handling of the dimensions of learning context and learning spaces toward cultivating CoPs.
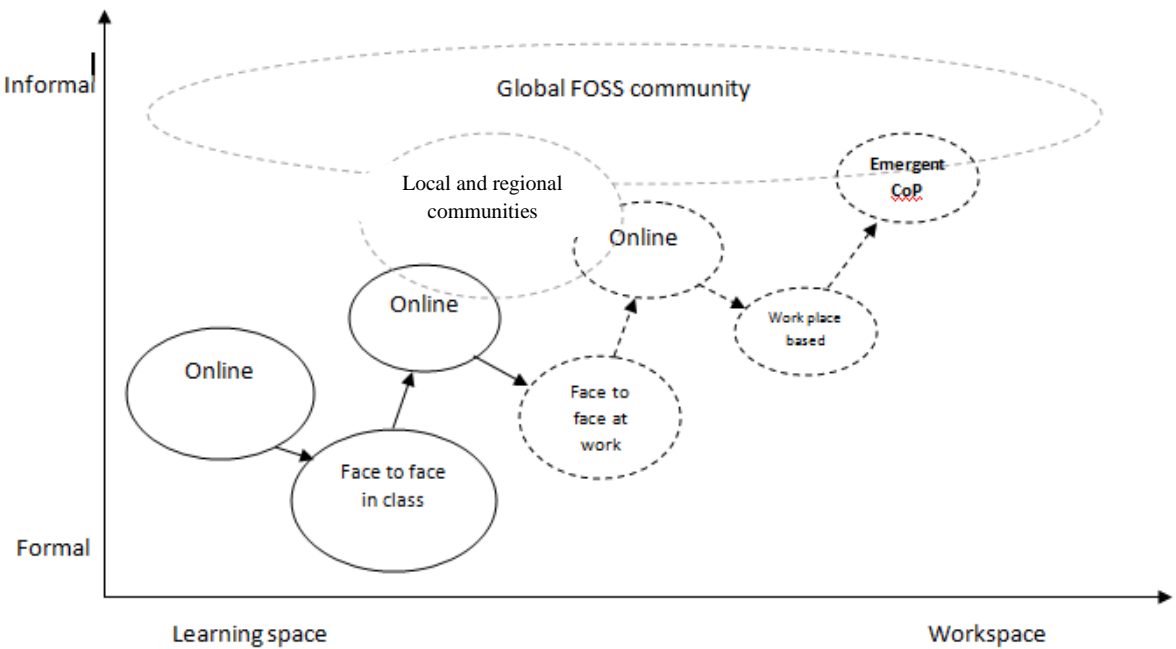
Figure 15: Path towards cultivating communities of practice through training

Figure 15 depicts different instances of online, face-to-face and workplace-based learning as ovals linked by arrows, which indicates the progression of the learners from one training instance to the next. The use of dotted lines around training instances indicates that there can be many iterations of learning, including planned and unplanned involvements in work practices, before a CoP emerges. The dotted lines demarcating the regional networks and the

global FOSS community indicate the flexibility of utilizing these communities in the training process. It also indicates the potential flux in the boundaries around and between these communities as a result of the members moving in and out. As training instances mature, the learners need to be immersed in a learning experience, which gradually evolves from being formal to informal and from being a clearly defined learning space (as indicated by solid lines around online and face-to-face learning spaces) to a workspace experience contributed to by regional and local experts. Online learning enables trainers to link the learners with regional and global FOSS communities which the emerging CoP might itself be part of as it matures. In a way, this research demonstrates a path that can be taken by trainers in facilitating CoPs rather than detailing out the intricacies of developing the CoPs within an organization as described by Wenger et al. (2002).

Chapter 9 - Conclusion

In LMIC contexts, the lack of training and capacity building around ISs is a known issue that prevents many IS projects scale to their full potential. This may be particularly true in complex interdependent systems such as eHISs. Recognizing this issue, HISP has taken the initiative through its DHIS2 Academies to create local expertise to the extent that these experts would be able to independently manage eHIS implementation and its high-end use, and fulfill the learning needs of other eHIS staffs by themselves. However, at super-user and implementer levels, technical skills transfer per se may not provide them with the ability to deal with the emerging issues and to keep abreast with the changing technological landscape. Furthermore, resource-savvy traditional training models may no longer be able to cope with the growing training demand. It is in this sense that HISP decided to utilize online learning tools to train the future super-users and implementers of DHIS2 in LMIC contexts. The attempts at introducing online learning tools provided this research with its empirical setting and motivation to harness the potential of blended learning programs in cultivating CoPs around ISs. During this journey, there were several frontiers that were explored and several new frontiers that were formed.

Frontiers explored

One of the frontiers explored was to understand the different dimensions of blended learning programs that would facilitate the cultivation of CoPs around HISs. To this end, the research enumerated the dimensions of equity, learning spaces, learning contexts and participation as key focus areas when designing and implementing blended learning programs around eHISs. During these discussions, the research highlighted the need for training programs to mainstream equity via a rights-based approach and the necessity to create multiple learning spaces including workplace and FOSS community for the learners to interact. Within these learning spaces, the research recognized the need for learners to have opportunities to engage in formal, informal and non-formal learning as much as possible. However, central to these discussions was the need to facilitate participation of different groups including the learners, moderators, and the experts of the eHIS. By recognizing these dimensions, the research was able to make practical contributions in designing training program around ISs, particularly in relation to ICT4D contexts.

Another frontier explored by this research was the social construction of learning around social systems such as eHISs. In doing so, the research focused on integrating between different dimensions of blended learning. Towards this end, it recognized that moderators seem to play an important role and their contribution becomes imperative when the said moderators are also context experts. Furthermore, the research also highlighted the ways in which a positive social meaning can be promoted among the learners of an eHIS training program. In terms of this research, the said positive social meaning was achieved by shifting the focus from a completely online training approach to a blended learning program. Last, but not least, the research also recognized the usefulness of utilizing the FOSS community as a means of integration, especially by imparting desirable social capital on learner groups or communities. Based on this exploration, the research was able to contribute practically by prescribing different means of facilitating social construction of learning around eHISs.

At the same time, the research also paved way toward theoretically conceptualizing blended learning program as an epistemic object. The said conceptualization contributed to the IS literature by way of illustrating how a technology may be developed, adopted and used by stakeholders with different perceptions about the technology. In doing so, the research was able to illustrate why technological frames may be inadequate in explaining this phenomenon and why technologies-in-practice may be a better lens. Further, from an educational point of view, the perceived epistemicity also extended the current understanding about blended learning programs from a 'state of permanency' and 'control' to a 'state of fluidity' and 'freedom' – especially when much of the learning is socially constructed. In addition, again from an IS stand point, an epistemic blended learning program may also have the potential to act as an additional channel of scientific inquiry around an IS artifact such as an eHIS. The added emphasis on scientific inquiry may fast-track the evolutionary process of an IS, especially in an ICT4D context.

The research also explored the role of participation within blended learning programs from the point of view of cultivating CoPs. In its exploration, the research recognized the emergence of communities of interest early in training programs, both among heterogeneous and homogeneous groups of learners. However, it was enumerated that homogeneous groups of learners have a better chance of evolving into CoPs through participation. One reason for this is that participation allows such groups to acquire community-wide social capital. This also meant that not everyone in the community had to interact with external parties in order to

gain the desirable social capital but limited number of boundary spanners would be able to achieve the same. Furthermore, the research also highlighted the potential of individual learners to become part of the global community by moving through the different learning spaces created through blended learning programs. By doing so, these learners can gain legitimacy, a desirable social identity and access to much needed social capital. As a result of these explorations, the research was not only able to understand the role of participation in cultivating CoPs but also how training can support scaling of ISs in a ICT4D context. In this regard, the research posits that blended learning programs as described herein would be able to support scaling of ISs in several ways: by imparting technical knowledge and competencies, facilitating the learners' understanding of the complexity related to ISs, and by facilitating the cultivation of CoPs that would provide a desirable learning environment even after training programs cease to exist. At the same time, the understanding gathered also enabled this research to add a new dimension to the call for interdisciplinarity in ICT4D research. It did so by recognizing the potential of one IT artifact (Moodle) in supporting the sustainment of another IT artifact (DHIS2) in ICT4D contexts – mediated in this case by training in the form of blended learning programs.

Future research avenues

While the research successfully explored several frontiers, there were several more frontiers opening up as future research avenues. One such frontier is the evolutionary process of a blended learning program perceived as an epistemic object. Although this research postulated that epistemicity would enable the blended learning program to evolve into a concrete technical object, the research was not designed to follow up until such evolution took place. Thus, future research should explore the possibility and the circumstances in which such evolution may cease to exist, if at all.

Secondly, future research can also explore the frontier of mainstreaming equity in health into eHIS training by linking the same with health outcomes or the quality of the data produced. Such explorations will not only encourage future efforts in mainstreaming equity but will also shed light on the potential of eHISs in achieving better and equitable health in the true spirit of ICT4D.

Lastly, this research demonstrates the potential of homogenous professional groups in forming CoPs through appropriately structured training programs that impart power through

participation. Thus, although partly addressed, a future research frontier may be to evaluate the same on heterogeneous groups of professionals involved in similar work practices in LMIC contexts.

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APPENDICES of PUBLICATIONS

I

Designing a rights-based health information systems training programs for developing countries: Step towards mainstreaming equity in health

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Abstract:

In achieving health equity in developing countries, it is essential to reliable and efficient health information systems that generate quality health data. In implementing such systems, training is a key challenge. This paper argues that unless equity is mainstreamed into training, equity in health would be an eternally elusive goal. It proposes a rights-based approach and online tools as remedies. Utilizing multiple case studies from West Africa, Asia and East Africa, the paper enumerates multiple occurrences of inequity within training and provides explanations based on power dynamics, social capital, cultural sensitivity and adaptability, and marginalization. By doing so, it upholds its argument that a rights-based approach can be used to enumerate design needs and cater to key goals of availability, accessibility, acceptability and adaptability in equitable training programs. The paper also makes practical recommendations to make training equitable in developing countries.

Keywords: health information systems, online learning, rights-based approach, equity in learning, health equity, social capital, cultural sensitivity, cultural adaptability, power relations, low and middle income countries

BACKGROUND AND INTRODUCTION

According to the World Health Organization (WHO), inequity in health is a challenge for many countries including for some of the developed nations (Braveman and Sofia 2003). Inequity entails the presence of avoidable and remediable differences among groups of people and it often encroaches on norms of fairness and human rights (WHO, 2015). Given the fact that health itself is a concept which is influenced by many social determinants such as poverty, education, housing, employment and environment (Marmot and Wilkinson 2005), there is a need to mainstream equity in health within everyday practices, policies and even within training.

In the process of achieving equity in health, having strong health information systems (HISs) incorporating population and facility data have been recognized as essential (Braveman & Gruskin, 2003). HISs can be defined as a "*set of components and procedures organized with the objective of generating information which will improve health care management decisions at all levels of health system*"(Sauerborn and Lippeveld 2000;3). For the purpose of this paper however, HISs would refer to electronic forms of components and procedures than anything else. Nevertheless, HISs per se would not be able to facilitate achieving equity in health unless these systems are capable of providing the practitioners, health managers and the policymakers with quality information across the whole health care system. In this regard, it is necessary to improve human capacity within a particular country although different factors such as geography, funding, time, current competencies and bureaucracy may prevent even those who are earmarked to receive training from gaining the same. Thus, particularly in the developing contexts, an inequity may exist in terms of

knowledge, practices and attitudes that may hinder a health care system from achieving quality health information and its effective utilization. Poor quality health information is a recognized factor that could derail efficient resource management and achieving expected health outcomes (Braveman and Gruskin 2003). Therefore, it can be argued that unless those who implement HISs plan towards achieving equity in building technical capacity across the healthcare system, the HISs may not contribute strongly towards achieving health equity after all.

The challenge for implementers of HISs in Low and Middle Income Countries (LMICs) however is to recognize various factors that may hinder their ability to train enough users and implementers across the health care system utilizing the limited available resources. While information system (IS) designers and implementers are advocated to run training programs based on evaluations of user needs (Lippeveld et al 2000), such evaluations alone would not be able to cater to the issue of equity as discussed earlier. Thus, there is a need to consider a different approach in recognizing and remedying the factors, which may hinder an equitable training. This paper proposes a rights-based approach and the use of online learning tools as remedies. In doing so, the paper expects to fulfill the need for an approach to mainstream equity within HIS training and to contribute to IS research by emphasizing the importance of self-critiquing and use online learning tools in HIS implementations in LMIC contexts.

ORGANIZATION OF THIS PAPER

In advocating a rights-based approach and the use of online learning tools for HIS training, this paper will first illustrate the state of HIS training in LMIC contexts before elaborating on how inequity emerges within HIS training and how it affects equity in health as a whole. In line with these discussions, the paper will also shed light to the potential of online learning tools in providing HIS training particularly in the LMIC contexts. Following this would be an elaboration of rights based approaches and its adaptability to HIS training scenario. Based on these discussions, the paper will propose its hypothesis and the objectives that it intend to tackle within this paper before describing the methodology adapted in carrying out the research. The paper will then describe three cases where online tools were used in combination with face-to-face training for training HIS users and implementers in West Africa, Asia and East Africa before discussing its findings in term of a rights-based approach. The findings would then be analyzed and discussed in terms of current discourse surrounding 'equity', 'human rights' and 'adult education', which will lead to a set of recommendations for improving equitable nature of HIS training. The paper will conclude by stating the theoretical and practical implications of adopting a rights-based approach and online tools for HIS training before laying down the future research direction.

HEALTH INFORMATION SYSTEMS (HIS) TRAINING IN DEVELOPING COUNTRIES

When it comes to HIS implementations in LMIC contexts, training is one of the most important activities as it can determine the success or the failure of such implementations (Lemmetty et al 2006). However, the magnitude and the complexity of the training challenge have often dampened the pace and the effectiveness of many HIS implementations in LMICs (Brittain and Norris 2008). From our own experience, we realize that some of the factors, which make HIS training an ongoing challenge include, accommodating a large number of trainees from a vast geographical area, maintaining quality of the training given, catering to

multiple learning styles and learning needs, limitation in resources and the need to keep pace with high turnover of HIS users in LMIC settings.

At the same time, organization of healthcare systems in LMIC contexts is such that those who take over operating HISs, collecting data, analyzing the same and utilizing the information in everyday practices are largely the non-IT and non-technical personnel (Siribaddana and Sahay 2013). These staff may include doctors, nurses, midwives, health managers and administrators. Providing training to such a group would mean that they need to be taken out of their ordinary duties, which can disrupt the delivery of health services in LMICs (Travis et al 2004). In addition, when there are multiple vertical programs utilizing multiple HISs or even the same HIS, it is possible that the staff may be pulled out of their designated duties multiple times to be trained for almost the same purpose (Travis et al, 2004). Furthermore, providing training in LMIC setting may be a costly logistic exercise, as it generally requires transporting, accommodating and compensating international experts, local resource personnel, and even the participants from different geographical locations (Siribaddana 2014; Sanner and Saebo 2013; Sahay and Walsham 2006). To make matters worse, there may be different socio-cultural and socio-political factors influencing the training processes when conducting training in different settings. In these circumstances, HIS projects in LMICs would always struggle to provide quality training on a consistent basis.

Recognizing these challenges, HIS trainers have increasingly looked at online tools as a viable alternative to traditional face-to-face training (Brittain and Norris 2008; Siribaddana 2014). Online learning tools have shown to facilitate almost the same or sometimes better learning outcomes among its learners in different subject areas and have enabled trainers to achieve greater reach and participation to and from their target audience respectively (Garrison 2011). At the same time, Garrison (2011) also points out that online tools remove the necessity for teachers and students to be at the same place at the same time and enable self-paced learning for the students. From the point of view of building support networks, online learning also has the potential to facilitate learning communities and at times to enable such communities to even transition into being communities of practice (Siribaddana 2014).

THE ISSUE OF 'EQUITY'

'Equity in education'

As pointed out by Campbell and Storo (1996), there is no clear-cut definition for the term 'equity in education' and equity advocates continue to debate the boundaries of this somewhat elusive ideology. While some seem to agree on providing equal access to every learner as paramount in achieving equity in education, some believe that equity entails more than just providing equal access. In fact, as pointed out by Campbell and Storo, some advocates believe that equity in education entails providing equal treatment once equal access has been granted to every learner while others believe that regardless of access and treatment, it is the gaining of equal educational outcomes that should constitute 'equity in education'.

The adaption of online education has shown to improve access to education among those who are deprived of education due to accessibility issues (National Education Association 2008). However, once they are enrolled, there can be unequal treatment. At the same time, in some instances, those who are enrolled may not necessarily 'behave' in a way where they allow themselves the opportunity for equal treatment from the tutors as well as from the other participants. Thus, the reasons for unequal treatment may include technology [internet], the design [instructional design], the educational content [instructional material], the presentation of such content, the online tutors, the culture or even some of the personal characteristics of the online participants themselves (Bates 2001).

'Equity in training'

Understandably, most of the discussions related to equity in education have centered on providing secondary education, which this paper categorizes as 'public education'. These discussions do not necessarily address the issues arising out of in-service training [workplace based training] provided using online technologies as in the case of HIS training discussed in this paper. However, Bassanini et al (2005) point out in their discussion paper, citing the Lisbon Strategy adapted by the European Union, *"the accumulation of human capital does not end with schools, and training is key to augment and adapt existing skills to the changes of technology"* (p. 3). In declaring the same, the Lisbon Strategy has made use of 'equal opportunity' and 'social inclusion' to emphasize its commitment towards achieving equity (Bassanini et al 2005). However, the issue of 'inequity' in education and training is seen as a deeply rooted problem in many societies and economies (Zondiros 2008).

From the point of view of a HIS user, super user or an implementer for that matter, gaining competencies around HISs would enable him or her to perform a more efficient job and sometimes to progress further in his or her career. Thus, not gaining the same opportunities as others to develop competencies around the HIS would mean that some staff would be disadvantaged in relation to their efficiency and career progression in comparison to those who are being trained. In terms of service delivery, this would mean that while some staffs are able to contribute towards improving the efficiency of health information flow and its processing, some would lag behind. Such lagging would again translate into inequalities in quality of health data at various points. It is often recognized that lack of quality in health data at various points would prevent a health system from achieving its full potential and thereby hinders its march towards equity in health (Dodd and Cassels 2006).

RIGHTS-BASED APPROACH TOWARDS RESOLVING INEQUITIES IN TRAINING

In recent times, 'rights-based approach' has become a topic of discussion when development plans are formulated by aid agencies and international organizations targeting the LMICs (Groves and Hinton 2013; Chambers 2013; Gauri and Gloppen 2012). Different interpretations have emerged with regard to what constitutes a rights-based approach, particularly in relation to development works. While some perceive rights-based approach in normative terms, others view it as more pragmatic. In normative terms, rights-based approach entails adhering to an internationally agreed set of norms and laws, which would enable citizens of a country to make claims from their state and to hold their state accountable for their duties (Hausermann 1998). In pragmatic terms, rights-based approach entails holding the state and all the actors (including international donor agencies and the NGOs) who are duty bound to ensure the rights of the people, accountable (Cornwall and Nyamu-Musembi 2004). From a different perspective, rights-based approaches are also viewed in terms of 'ethical obligations' and from such a perspective, the key impetus is on the reflexivity of the actors engaged in development activities with regard to issues of power (Hausermann 1998). In other words, from an ethical perspective, a rights-based approache should empower people with a moral right to claim justice as a right and not necessarily as 'charity'. We believe that many HIS projects funded by international donor organizations proceed with the notion of being 'charity' than empowering people. Thus, for the purpose of this paper, the rights-based approach would be viewed mostly in terms of fulfilling ethical obligations than its normative or comparative meaning.

However, as with the discourse around equity, rights-based approach also centers around providing education. In the publication 'Right to education: Primer No 3', Tomasevski (2001) highlights the government obligation towards educating the public under the core elements of availability, accessibility, acceptability and adaptability, which is also known as the 4As' framework. A similar criterion is being used when discussing the concept 'health for all' as it entails the four elements of availability, accessibility, adaptability and quality (AAAQ) (WHO 2007). In whatever form, it is clear that these key elements are usable in applying a rights-based approach to assess equitability both in terms of education and health.

According to Tomasevski (2001), from the point of view of education, the criterion 'availability' ensures that the government either establishes or funds educational institutes or allows the non-state sector to establish such entities in view of making education available to all. The criterion 'accessibility' entails that the government be sensitive to the access requirements of different levels of learners. Therefore, while the compulsory education should be accessible to all children, post compulsory education should be available to those who are in need, for free or for an affordable fee. 'Acceptability' denotes the minimum standard of quality in educational programs including the language being used to provide such education. 'Adaptability' on the other hand describes the strength of the provided education to meet the best interest of the child [learner] as against securing the best interest of the education provider or any other party.

In general, the 4As' framework is laid down in view of compulsory public education aimed at school-aged children and sometimes for secondary education. However, this paper argues that the same criteria can be used when dealing with inequities arising when using online learning to train HIS users and implementers in LMICs. The paper cites the example of Robinson (2008) who adapted the 4As scheme to lay down guidelines when formulating policies for rural teacher training (Table 1). Given the fact that the 4A's framework is rights-based and the fact that it utilized the same or comparable elements to that of 'right to health' concept, the paper argues that it [the 4A's framework] fits the purpose and the domain of this paper and that it can be utilized to make HIS training equitable in LMIC contexts.

HYPOTHESIS AND THE OBJECTIVES

This paper builds on the hypothesis, '*by applying a rights based approach and utilizing online learning tools, it is possible to design equitable HIS training instances in LMIC contexts*'. The paper believes that by managing equity in HIS training, it would be possible to mainstream health equity into training and thereby contribute better to achieving capacity building around HISs and health equity. In line with these assumptions, the paper takes on the objectives, '*assess the usability of a rights-based perspective to recognize issues of equity in HIS training, which make use of online learning tools*' and '*make recommendations based on the assessment to minimize the inequities existing within HIS learning instances*'.

RESEARCH DESIGN

Empirical setting

The scope of this study designates it to focus on HIS training taking place in LMIC contexts and therefore it made use of ongoing HIS implementation and training initiatives undertaken by the Health Information Systems Program (HISP) in Oslo as its empirical setting. HISP conducts regional HIS training on DHIS2 (a free and open source HIS managed by HISP, Oslo) in different parts of the world. These training instances or the 'DHIS2 academies' as they are called, generally consist of a 10 day residential training for HIS staff who will be undertaking customization, implementation and high level use. Thus, the participants of these academies can best be described as 'implementers' and 'super users' although the paper may use the term 'user' when referring to these trainees. The participants of these training instances originate from different countries in the region and this means that at each academy, around 60 to 70 participants representing around 10 countries will be in attendance. In order to remedy some of the challenges in conducting such face-to-face training programs as discussed earlier, HISP decided to make use of the online tools available through an open source learning management system. The idea was to use it initially as a supplement to its face-to-face training with the view of using online training as an alternative in the future. These academies were designed in a way in which the online training would either precede or run parallel to the face-to-face training with the participation of the same group of people. In general, an online training session would run for a week and would focus on providing the participants with a basic understanding of the HIS along with useful public health concepts. The online platform made use of texts, presentations, video demonstrations, quizzes, and assignments as instructional methods while discussion forums were used to allow participants to interact even before they meet each other at the fade-to-face training.

Method and data collection

The study made use of a case study methodology, which according to Yin (2013), allows gaining a deep understanding of different perceptions held by different actors about a particular phenomenon in real life circumstances. Given the diversity in technology, culture and society, existing between different LMICs, the study made use of three case studies, as multiple case studies would enrich the research findings and would improve its generalizability to a certain extent (Yin, 2013). Furthermore, as pointed out by Simons (1989), case study methodology agrees with the fundamental principles such as equity and empowerment pursued by this study as it allows everyone to voice their opinions. In line with the case study design, the study adopted a qualitative research strategy given its ability to provide a vivid understanding of a given social situation, events, interactions, roles

undertaken and about various groups (Silverman 2013). As pointed out by Silverman (2013), qualitative strategy also allows researchers to understand a phenomenon based on the meaning assigned to it by the people. Therefore, the study would be able to make sense of the phenomenon 'equity' from the eyes of the participants using the said strategy. However, it may not be possible to make sense of a phenomenon such as equity or any other for that matter through qualitative approach unless different sources of data are used (Silverman 2013). Therefore, the study also made use of several data collection strategies including formal and informal face-to-face interviews with the participants and trainers, observatory notes taken during face-to-face sessions, email communications relevant to the training programs, discussions taking place in the online forums and data gathered through post-academy online surveys.

Data analysis

The analysis of the data followed the eight steps process described by Tesch (1990) and as a start, the data that were available in the audio form, as in the case of recorded interviews, were transcribed verbatim. The transcribed data were then coded to recognize patterns and themes emerging through the data, which shed light to a potential inequity, a factor affecting inequity or a violation of the learners rights. In the analysis, potential manifestations of inequity were interpreted based on the assumption that inequity exists when some of the participants were able to comply with the training demands while the others were not able to do the same. We also assumed that a participant had a 'right' when the demands made by the online training would affect the person's future participation of the follow-up face-to-face training program, which was a mandatory component of the whole learning exercise. When we recognize inequities or violations of the participants learning rights, we classified them within the 4A's framework and suggested counter measures to remedy the same in future training instances.

CASE DESCRIPTIONS

As stated earlier, this study made use of three cases, which were part of an iterative action research cycle in designing, developing and implementing an online learning platform for HIS training in LMIC contexts.

DHIS academy - West Africa

The West African DHIS academy was the first instance where online learning approach was used for DHIS training. In this instance, online tools were used in parallel with the face-to-face training. There were around 40 participants representing several West African countries including Ghana, Nigeria, Mali, Liberia, Bukna Faso, Gambia and Guinea where DHIS based HIS implementations were either ongoing or were expected to take place. Among these participants, not all were communicating in English and therefore on-the-go translations were done in French for the benefit of French speaking participants. However, the online content was largely in English, as it was perceived that the participants would be able to interact in English language given the nature of the subject. No translations took place for the participants speaking predominantly Portuguese but they were grouped together and an expert participant speaking Portuguese was assigned to them for necessary translations during the face-to-face training. When looking at the portfolio of these participants, it was noted that many of them were HIS officers, while some were medical officers and IT professionals. However, not all had the same degree of understanding regarding DHIS2 or on HISs for that

matter. This prompted the trainers to form groups based on countries and allocate experts among the participants themselves to each of the groups to facilitate group work activities.

Around 4 to 5 trainers also attended the academy representing HISP, Oslo and these trainers held positions such as developer, implementer or researcher within the HISP. The participants made use of their own computers and were provided with internet facilities by the organizers. However, the technical infrastructure at the site did not allow an uninterrupted service. The online training was designed in a way to allow participants to re-cap the teaching that took place in the face-to-face training and to gain additional understanding about the topics using online learning tools. The training material used in the face-to-face academy were also uploaded to the online platform at the end of each day to facilitate these activities. They were also encouraged to interact in the discussion forums although no formal guidelines were provided to indicate the degree of interaction expected from the participants. However, it was noted that internet services were not available at the site where participants were residing and therefore most of them were only able to access online learning during the face-to-face sessions.

During the academy, one area within which inequity seems to manifest was in accessing internet and thereby the online training. Statements such as *"internet access is always a problem in [country name 1]and I have to wait until I get to my office to check for email and even then I am not sure whether internet will work"* and *"sometimes we record data in the local machines and upload to [country name 2] web system if and when internet connection is available"* indicate that accessing internet is a general issue in LMIC contexts. In most instances, it emerged that the issue is the lack of communication infrastructure at national or regional level. Furthermore, even when the internet access was freely available, the speed and the continuity of the connections were highly unpredictable. This meant that there was a real chance of some participants not being able to utilize instructional content such as high definition videos as their internet connection did not provide sufficient capacity to download and view such content.

Secondly, the language barrier also made it impossible for some participants to interact in the online environment even when they were able to gain access. This seems to be also the case during the face-to-face training as lack of translation hindered some participants from fully engaging with the training activities. Comments such as *"..if it had been in French we would have made more use of the online content"* and *"translating the content to Portuguese would have been useful for us to follow"* indicate the negative impact made by the language barrier throughout the learning activity.

Another area where an inequity manifested was with regard to the training needs of different participants. For instance, among those who participated in the online activity, some expressed their unhappiness regarding the learning content by stating *"we expected more complex topics to be handled in the online learning"* and *"I gained nothing new from the readings or the videos…"*, as it did not cater to their learning needs. Some believed that the instructional content was disassociated from their true work environments as pointed out during one-on-one interviews in statements such as *"it would have been better if you gave us examples or scenarios from our own setting…so we could have related what has been taught with our work"* and *"we did not understand the scenarios given by you"*. However, via the online questionnaire, it was revealed that participants accepted online learning to be beneficial and effective when training high-level DHIS users and health data managers, as they were in possession of skills and the technologies to access internet as well as to follow the training program.

While the academy attracted many participants from the region, it was clear that it would have liked to accommodate more. This was emphasized by the trainers through

statements such as, "*if we had more funding there are lot more who require training*" and "*we may have to have another academy in West Africa soon to train the others*". The inability of national health systems to support its staff to gain the desired training was also apparent in statements such as "*unless [the funding organization] provides us with money we would not be able to gain training such as this*" and from questions such as "*..can my colleagues back home use the online learning?*" and "*..can you post the presentations in the Moodle [the learning management system used for online training] so my colleagues can access them during the academy?*", made by the participants.

Lastly, it was observed that not all participants received the same experience handling data sets, which was one of the key learning outcomes of the academy. One reason for this was that participants of each country were asked to bring their own data sets and not all countries had such data sets to practice on. This may have prevented some participants from gaining vital analytical skills and an understanding with regard to handling their own data as expressed by one participants by stating "*..it takes time for me to grasp a foreign data set as I am not used to it..i know the technique will be the same but it is difficult for me to understand it application in [country name 3]*". In a way, the organizers of the academy seem to have inadvertently created an inequity although the idea was to give a better and a more contextual learning experience.

Training workshop – Asia

The Asian academy was attended by participants from countries such as India, Nepal, Sri Lanka, Afghanistan and Bangladesh in addition to experts from India and Norway. The arrangement of the online and face-to-face training in Asia was somewhat different to the West African academy as the online training preceded the face-to-face training. Thus, all the participants registered for the academy were invited through email to attend the online training and were sent log-in information and instructions to navigate the system. While many participants logged-in, not many contributed to the discussion forum, which was arranged as the last activity of the online learning.

From the informal discussions carried out with the participants during the face-to-face training session, it was evident that some had trouble logging in with the issued usernames and passwords. However, none made any complaint regarding the same before or during the online training. On inquiry, one participant mentioned that "*I did not think it was important to inform the inability to log-in*" while another mentioned that "*I didn't have time to send an email to you [the interviewer] to get the log-in corrected*". For some, the language used had been an issue, as they were not competent in the English language. As with the previous case, some indicated that the content in the online learning platform did not meet their learning needs while certain others indicated that while engaging in work practices, it was nearly impossible for them to access the online learning platform. This was evident in statements such as "*it's hard to keep up with online activity when I work full-time during the entire week*" , "*there are many others using the same computer for different work and I had to wait for my turn*" and "*it is only in the weekends that I can think of doing an online training because of the work.*" Meanwhile, few mentioned that the scheduling of the online training was too close to the face-to-face training workshop, as they had to make the travel arrangement to attend the face-to-face training workshop during the last few days of the online training.

Furthermore, it was also evident that some did not receive the invitation sent for online learning activity either because they did not access email regularly *("When I saw the invitation for the distance learning it was too late"*) or else they expected the organizers to follow their usual channels of communication [official letters sent through the organizations

hierarchy] ("*I was waiting for an official letter from the DHIS academy*", "*why was the distance learning not mentioned in the official invitation given to us by the DHIS academy to obtain leave?*").

Another interesting finding during the Asian academy was that some of the participants shared their log-in with some of their colleagues in hope of enabling them the chance to gain some insights related to DHIS2. It was also recognized that not all academy participants recognized the importance of online learning or were motivated enough to follow the online training as a precursor to the face-to-face training. Thus, it could be said that not all participants were on the same footing when it came to their preparation for the face-to-face training, thus creating an element of inequality.

Furthermore, given the limited time span, different learning needs and the significant amount of content to cover, the academy made use of parallel sessions, which provided the participants an opportunity to select what they would prefer to do. However, inadvertently, it may have created an inequality as some would have preferred to attend all the sessions. While accommodating all learning needs would be an impossible task in face-to-face learning, it may have been possible to accommodate the same in the online mode.

Training workshop - East Africa

The East African academy utilized the learning from the two previous academies and it consisted of an online training component preceding the face-to-face training and thus followed a similar structure to the Asian academy. The content however was modified according to the participant profiles provided by the local organizers of the academy. At the same time, the discussions forums were structured under different themes and were embedded in the daily training activities. The academy was attended by participants from Tanzania, Uganda, Kenya, Rwanda, and Mozambique and in contrast to other academies, participants of the East African academy were recognized as competent in the English language and no translations were required. Email addresses used to communicate with the participants were first verified to make sure every participant receives the messages sent through the said email address. The participants were then clearly communicated about the online instructional content, its usefulness, its relatedness to the face-to-face training and the need to participate actively in the discussion forums in order to gain certification.

During training, it was observed that many participants did log-in to the online learning platform and interacted in the discussion forums. Some of the participants were eager to share their experiences in DHIS2 related activities and to help other participants with their own issues. It was observed that the said interaction was set forth by an initial activity that requested all participants to introduce themselves by posting their own experience with DHIS2. Thus, the fact that local organizers were consulted in formulating the instructional content and that participants were given the opportunity to express themselves can both be viewed as instances of enhancing the power of the people or stakeholders of the training program by allowing their voices to be heard.

At the same time, the online feedback-form embedded within the online training captured participants' opinion regarding many different aspects of the program. Some of the feedback included comments such as "*we were unable to full use the learning material due to inadequate time*", "*I wasn't able to complete the tasks within the given time frame*" and "*I was a beginner and felt like learning an alien language due to fast paced learning*". Thus, it became evident that the duration of the online training and the expectations were too intense for some participants who have had to simultaneously engage in other work practices. At the same time, they pointed out the necessity to provide different types of learning material including videos, presentations, pdf's and audio to clarify and clearly understand what is

being taught *("it would have been better if we had presentations and more videos in order to learn dhis 2 through the online system")*. They cited the inability to grasp information through only text based reading materials as the reason for these suggestions. The decision we took to remove some of the videos as it did not serve much purpose in previous occasions as the internet connections were too slow to handle such videos might have prompted the participants to make such comments.

Having said that the participation was 'good' in the East African workshop, it was also noted that there were many face-to-face training participants who did not participate in the online training and that there were other participants who logged-in into the online learning platform but did not participate in the discussion forums. On inquiry, some of these participants mentioned that "*I did not thought the online discussions were an essential part of the online activity*", "*none of the discussions caught my interest*" and "*I was waiting for the face-to-face session to clarify my issues*". Thus, there had been an inequity related to the perception regarding the online learning as well.

It was interesting to note however that participants suggested online learning to be the major training component of the academy than the face-to-face training, as it would enable more content to be covered and more interactions to be made. In their opinion, face-to-face learning could facilitate the hands-on aspect of the training. However, it was also noted from the comments such as "*..it is hard to convince someone in my country that online learning is as effective as a traditional training workshop*" and "*..please don't state 'online' in the certificate as it may not be equally acceptable to the administrators...*", made by the participants that online learning does not attract the same degree of respect as a training modality as against a residential training program in the LMIC contexts. From the side of the participants, this would mean that they might be disadvantaged if certification received through a predominantly an online academy go to waste in their career progression.

ANALYSIS AND DISCUSSION

From the case descriptions, it was evident that there were many inequities emerging within the online training instances, which at times spilled over into the face-to-face training as well. However, these inequities were not necessarily the same in all instances. Based on a rights-based analysis of the gathered data, it was possible to classify the inequities and equitable events arising within these training instances using the overarching 4As criteria depicted by Tomasevski (2001).

Availability

The implementation of online learning itself seems to have increased the opportunities available for the DHIS users of a particular setting to engage in their professional development. This was evident from the fact that not only the participants of the DHIS academy, but also their colleagues gained access to the online training program. Online learning therefore had triggered the formation of networks (as in the case of East African academy), trust (as in the case of sharing online access with colleagues in Asian academy) and cooperation for mutual benefit (as in the case of sharing personal experiences and knowledge in East African academy), which are integral components of 'social capital' (Coleman 1988). Putnam (2000, p.19) describes social capital as "*connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them.*" In LMIC contexts, Woolcock (1998) points out that absence of social capital is one of the major reasons hindering its development. However, social capital confined to certain groups can cause polarization and inequity within the society (Aghion and Durlauf 2005). Nevertheless, facilitating community wide or organization wide social capital would

minimize such inequities and thereby increase the efficiency of the work processes (Aghion and Durlauf 2005). Thus, even though it was unintended, generating learning opportunities for a wider audience through online learning has the potential to facilitate building community or organization wide social capital that would facilitate equity.

From a different viewpoint, online learning may have changed the power dynamics existing between the teacher and the student as in the case of classroom learning. Availability of instructional content on the web meant that participants could follow them according to their own preference and pace. This made the role of HIS trainers from being 'information givers' to 'moderators of information'. To an extent, participants gained power over their own learning at least when it came to the online learning. In Weber's view, power entails one's ability to persuade another to do something even if the person has different interests or liking (Gert and Mills 1946). Power is also viewed as not existing within an individual or in a position that the person occupies, but instead, power lies in relationships that may be defined in terms of many dimensions (e.g. hierarchy, knowledge, wealth, politics, morals…etc). In LMIC contexts, power exerted by international donor organizations, non-governmental organizations, experts and even states have often been criticized as it can hinder the empowerment of the local communities if developmental activities are not aligned with the interests, desires and the needs of the people (Crawford 2003; Duffield, 2001). Similarly, critiques may view academies such as that described in this paper as instances where interested parties exerting power over healthcare systems of LMICs in the name of capacity building. Online learning tools however, can facilitate overcoming such criticisms by altering the said power dynamics. This can be done by providing different learning options (e.g. texts, videos, presentations, audios…etc) and by creating opportunities to build relationships (e.g. discussion forums). Such tools will empower those who are trained and enable them to gain control for themselves to resolve their own issues.

At the same time, there were other instances where the concept of 'availability' was not respected. Communication breakdowns and late enrollments preventing some participants from gaining the relevant information to participate in the online training can be cited as two examples. While such manifestations are generally viewed as unavoidable circumstances, from a rights-based perspective, it was the duty of the organizers to foresee such scenarios and prevent them from taking place. In a way, depriving some participants the opportunity to gain knowledge, be empowered and build networks would also deprive them of opportunities towards building social capital. As discussed earlier, absence of social capital may deprive not only the individual but also the organization or the community represented by that person.

Furthermore, as described in the cases, the training provided did not cater to the participants long-term training needs in progressing within their careers or in updating their knowledge as the technology evolve. This can be interpreted as neglecting the participants' right to receive continuous professional development (CPD). CPD becomes a right of its own within the health domain, as health care professionals are required to keep up to date with their knowledge in order to provide a safe and an efficient service to the people (European Union 2006). While HIS related knowledge may not be acutely life critical, it is also a component of CPD in many countries (Smedley 2005; De Lusignan et al. 2003). Thus, implementers of HISs should take into account the necessity to provide CPD for HIS staff, which can efficiently be done using online tools as in the case of many developed health care systems (Gill 2007).

Accessibility

With regard to the online learning instances, it was apparent that many participants were left to idle as poor internet connectivity or absent communication infrastructure prevented them from accessing the online learning as required. In fact, Walsham and Sahay (2006) pointed

out that with regard to information and communication technologies, resolving the digital divide between those who have access and the ability to use technologies and those who don't, is a constant challenge. Nevertheless, it is a failure on the part of the organizers to think that all those who participate in the face-to-face training would be able to access the online training equally and therefore would gain from the same as expected. At the same time, given the fact that HIS training is generally part of an implementation process of a web-based HIS, the challenges encountered in accessing internet for online training should not be much different to the challenges in accessing web-based HISs. Thus, in the same way HIS implementers find solutions to resolve access issues for their systems (e.g. advocating the use of mobile devices, off-line operations, use of community centers), it should be possible to find solutions for the access issues of online learners as well. Furthermore, as pointed out by Castells (2011), the penetration rate of internet is rapidly increasing in the developing countries with the digital divide between Organization for Economic Co-operation and Development (OECD) and developing countries falling from 80.6:1 in 1997 to 5.8:1 in 2007. This would mean that access might not be much of an issue if designers of online learning consider it a duty to find alternative means of access and be innovative in designing and conducting their training initiatives.

An equally important finding with regard to accessibility was that some participants were not gaining the same access to learning events and content due to their language. While some steps were taken during the academies to translate learning material and to accommodate those who speak a language other than English within the online training, resource and time constrains prevented such translations to be done in full. However, critiques may interpret such failures as attempts made by elite groups, colonial powers, donors and western publishing industry to propagate their own interests as their existence depend upon the "*obedience, submission and cooperation of their subjects*" (Brock-Utne 2012, p. 787). Thus, depriving participants of learning in their own language might in turn be viewed as an issue of power and lack of will towards empowering them. Such a view may adversely affect the trust placed on experts and HIS implementers in LMIC contexts (Abbott and Snidal 1998), which may negatively influence the whole implementation and training process.

Similarly, not accommodating the different learning styles of the participants (ex. auditory, visual, verbal and physical learning styles) can also deprive them of gaining fully from online learning as was seen in some of the case descriptions. Given the fact that learning styles are considered in par with other determinants such as age, race, gender, ethnicity, income level, culture and language in relation to education (Rude et al. 2005), it is prudent to argue that non-accommodation of learning styles of the participants would amount to marginalization and therefore should be avoided from a rights-based perspective.

Acceptability

Another instance where inequity seems to have manifested was in relation to the instructional content as not all participants considered the content to be relevant to their practice. Not having use cases from their own work settings or at least cases that mimic their work processes may have caused the training to be unacceptable. However, as pointed out by Reeves and Reeves (1997), relevancy in education runs deeper than its relevancy to one's work practices. Thus, relevancy also entails being sensitive to the cultural values, morals, language, practices, and even to socio-political ideologies when designing and delivering instructional content (Reeves and Reeves 1997; Parrish and Linder-VanBerschot 2010). While designers of online training need to understand the importance of being culturally sensitive, they should also realize that their own cultural beliefs would be embedded in the

instructional content that they design (Thomas et al. 2002). However, one may argue that it may be possible to remain culturally neutral when designing instructional content in certain instances although as pointed out by Schwier et al. (2004), in the process of designing instructional content for social change, instructional designing is generally a social process.

Furthermore, in the described cases, the discussion forums and its themes were designed based on the designers' interpretation of the learning needs and the socio-cultural practices of the participants. However, the findings suggested that perceptions and beliefs held by the designers about the learners and their socio-cultural practices may not align even when such designers themselves have experienced the socio-cultural contexts to which they are trying to cater. As indicated earlier, this is to say that if social processes are central to the learning of a community (Brown and Duguid 1991; Wenger 1999), it is necessary for the designers to adopt a similar process when designing instructional content for such groups.

At the same time, over burdening the participants with too much online content during a short period of time made certain participants to give-up online training. This is in addition to other reasons uncovered for giving up online learning such as being too busy with ongoing work commitments or else shift in focus towards making travel arrangements [to participate in the face-to-face training in the following week] during the last few days. These were some of the other instances where social processes were not considered in designing the instructional content and conducting the training.

Adaptability

It was recognized in the literature that in most instances, online learning systems dictate rules, structures and pedagogies on the learners thus forcing them to adapt to the learning system (Geith and Vignare 2008; Smith and Ayers 2006). In fact, it is a reflection of what the trainers or the organizations believe as what learners should know and do in real life practice. However, while acknowledging that such structured top-down training designs may be useful to some extent when implementing large scale HISs, allowing freedom to its participants to choose what is best for them, or the 'adaptability' of the learning system, should be the hallmark of a equitable training instance (Mcguire et al. 2006). In making online learning 'adaptable', designers of online learning should look beyond catering only to the learning needs, but to make the learning culturally adaptable as well (Parrish and Linder-VanBerschot 2010). This is more so in situations such as DHIS2 academies where a culturally diverse group would be attending training sessions. However, in relation to adaptability as described by Tomasevski (2001), these training instances have to be looked in terms of having 'differently skilled' groups of participants in relation to their existing HIS knowledge, information technology skills, cultural influence on participating in discussions, communication skills, and HIS experience. Such a view will enable the designers to build on the existing skills of the participants and to empower them rather than subjecting them to inequitably designed pedagogical structures.

CONCLUSION AND RECOMMENDATIONS

HISs have become an important component in modern day health care systems, particularly as a means of facilitating equity in health in LMIC contexts. This paper illustrated how equity in health can be mainstreamed in HIS work practices by using online learning tools. The study made use of a rights-based approach as against using a traditional 'needs analysis' performed by IS and instructional designers. While a rights-based approach would not cater to all design needs of an HIS or its training, the study demonstrated its capability in critically

assessing one's own actions and seeking remedies based on the rich discourse surrounding the notions such as 'equity' and 'human rights'.

In the process of mainstreaming equity in HIS training, the study demonstrated the usefulness of online tools as these can cater to some of the key requirements of equitable education such as being culturally sensitive and culturally adaptable. It can also overcome the barriers imposed by time, space and costs in addition to generating social capital via interactions, network building and knowledge sharing. While challenges remain in implementing online learning technologies in LMIC contexts, a rights-based self-critiquing approach would enable overcoming such challenges to a large extent.

From a practical point of view, the study was able to propose several ways of facilitating equity in online learning, especially with regard to HIS training in LMIC contexts. Table 2 illustrates these recommendations under the broad 4As framework. This confirms the applicability of a rights-based approach in making design decisions for online HIS training.

However, although the paper was able to utilize a rights-based approach in evaluating online learning instances in LMIC contexts and make recommendations to achieve equity in HIS training, it would require further research to determine the effectiveness of adapting such an approach in the design, implementation and evaluation of in-service training programs. Thus, the paper concludes that a rights-based approach has the potential to relieve the equity issues in HIS training via online tools in LMIC contexts and therefore future research should explore its potential by linking its use with overall successes and failures of HIS implementations and scaling in similar contexts.

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Table 1 : Framework for teachers' rights to continuing professional development (Tomaševski 2001)

The 4As	Guidelines for rights-based continuing professional development
Availability	• Continuing education opportunities are provided beyond initial training. • Teachers have some freedom of choice in what and how they learn. • Information about the availability of learning opportunities and professional development is freely available. • Availability extends to all teachers, no matter where they are.
Accessibility	• Barriers (organisational, geographical, motivational, financial) to teachers' use of available learning resources and opportunities are removed, as far as possible. • Policies and practices do not exclude or discriminate unfairly against teachers. • Infrastructure is in place to make access to and engagement with professional development a real possibility, and is sustainable.Policies and monitoring are in place to support teachers' ongoing professional learning.
Acceptibility	• The provision is relevant, appropriate and current in content, based on teachers' and pupils' needs. • The provision is equitable and fair. • Standards of quality are explicit, monitored and maintained. • The provision is in accord with teachers' labour rights (according to International Labour Organisation guidelines) including rights to continued professional learning. • Teachers are adequately prepared in any use of technology required to access learning resources and opportunities.
Adaptability	• The provision responds and adapts to the needs and best interests of teachers, collectively and individually. • The provision and system takes account of local variation. • The learning resources promote core values of the teachers' role in fostering social justice (for example, the elimination of physical punishment by teachers or discrimination against disadvantaged pupils).

Table 2 : Rights-based recommendations to alleviate inequity in HIS training when using online learning tools

4As	Recommendations
Availability	1. Provide unrestricted communication / advertising of the training sessions, its schedule and the training material to its intended audience. 2. Utilize multiple communication strategies apart from email communications to inform its intended audience. 3. Expand the enrollment to include more than the number accommodated at face-to-face training instances based on the training needs. 4. Provide avenues for continued professional development for those who are enrolled for online training. 5. Establish discussion forums that would aid relationship building among participants, tutors and with the global experts.
Accessibility	1. Profile the participants in terms of having internet access and the quality of such accesses [e.g availability, speed, bandwidth…etc.] 2. Provide the training material in off-line mode to those who are having poor internet connectivity 3. Consider using mobile devices as an alternative to those who do not have wired internet connections. 4. Translate learning material to the working language of the participants. 5. Allow interactions using the participants own working language. 6. Provide responses using the same language used by the participant. 7. Include different forms [e.g. video, text, images, graphs, presentations…etc.] of the same learning content.
Acceptibility	1. Ensure the provision of relevant content at all times. 2. Make use of relevant examples emerging from the participants own settings. 3. Design instructional content by being culturally sensitive. 4. Determine instances where the content need to be culturally neutral. 5. Utilize a collaborative approach with local content experts when designing instructional content. 6. Increase the number of discussion threads and allow the participants to decide on the themes that they want to start discussing. 7. Provide each such discussion thread the same attention as with the structured discussion threads. 8. Expand the duration of online learning to allow participants adequate time to complete the training. 9. Provide a gap between the online and face-to-face training instances to prevent overlapping travelling arrangements.
Adaptability	1. Accommodate a bottom-up design of training to complement the top-down design approach. 2. Profile the users depending on their learning needs and provide suitable instructions to match various levels of training needs. 3. Define learning outcomes depending on the trainee competence and experience. 4. Be sensitive to the 'differently skilled' participants and provide avenues for them to interact within the online learning system through formal [e.g. discussion threads] as well as through informal means [e.g. email communications]. 5. Keep the participants informed of the ongoing and interesting discussions even if they do not interact with the online community.

II

INTEGRATING BLENDED-LEARNING FOR HEALTH INFORMATION SYSTEMS TRAINING IN DEVELOPING COUNTRIES: TOWARDS A CONCEPTUAL FRAMEWORK

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Abstract: As health information systems(HIS) rapidly gain ground and expand its presence in even developing countries, keeping up with the demand for its training is a deepening challenge. While on-site face-to-face training has become the tradition for providing such training, rising cost, resource constrains and issues related to pedagogy hampers large-scale training in terms of adequacy, quality and relevance. In this backdrop, 'blended-learning' making use of 'online' and 'face-to-face' learning modes have been suggested as a potential remedy. In light of this, by making use of the theory of community of practice and the concept of 'immutable mobiles', the paper proposes a conceptual framework for utilizing blended-learning for providing HIS training in developing countries. The proposed framework was then evaluated using two instances of HIS training in developing countries, which made use of blended-learning. Based on the analysis, it was concluded that by adhering to the proposed conceptual framework, it is possible to improve participation, collaboration building, knowledge sharing and linking practice with learning throughout the blended-learning program. It was also concluded that future research should be directed in a more long term analysis of the HIS users' community of practice and how learning through blended mode enabled its practices.

Keywords: Community of Practice, Blended learning, Online learning, immutable mobiles, participation, developing countries, health information systems, DHIS, HIS training

INTEGRATING BLENDED-LEARNING FOR HEALTH INFORMATION SYSTEMS TRAINING IN DEVELOPING COUNTRIES: TOWARDS A CONCEPTUAL FRAMEWORK

1. INTRODUCTION

Training and education has been recognized as one of the most important aspects of Health Information Systems (HIS) implementation, as it can determine the success or the failure of such HISs (Hayrinen et al 2004 as cited in Lemmetty et al 2006). However, the progress had been slow in implementing HISs as well as in providing training for its users simply because of the magnitude of the training challenge (Brittain et al 2008).

The Health Information Systems Program (HISP) has been involved in developing and implementing Health Information Systems (HIS) in various countries over the last 15 years. A key component of this effort has been to provide training and support to users of the District Health Information Software (DHIS). At present, the DHIS academy, which was established by the HISP to provide training for DHIS users and implementers, conduct three workshops each year in West Africa, East Africa and South Asia. The workshops had been running for 10 consecutive days. On average, each workshop caters to around 50 to 60 participants, which includes implementers, super users and health data managers. Resource persons from the University of Oslo and HISP network also participate in these workshops in addition to the local resource people. Thus, the cost of conducting such workshops regularly has become a financial burden while the demand for such training is on the rise. Furthermore, the local DHIS implementers organize their own training programs aimed at the field level staff based on the needs of their setting. However, there are concerns in relation to the quality of such training and the wasted efforts in duplicating the learning material, which are already available within the HISP network. Thus, in its present form, the DHIS-training needs to address the issues pertaining to coverage, demand, quality standards, duplication of learning material, and the cost.

1.1. Developing a blended-learning program for HIS-training

In view of the growing challenges related to training DHIS users, the DHIS academy developed a 'blended-learning' program. 'Blended-learning' can be defined using many different perspectives. While some argue it to be a 'combination of instructional modalities (e.g. audio, video, text…etc)'(Bersin & Associates 2003), others see it as a 'combination of instructional methods (e.g. constructivist, behaviorist, cognitivist)' (Driscoll, 2002). However, as pointed out by Bonk and Graham (2004), such definitions may encompass almost all the learning systems presently in existence. Thus, for the purpose of this study, we took the viewpoint that 'blended-learning is a combination of face-to-face and online (distance) learning in view of achieving a common learning goal (Rooney 2003, Young, 2002, Garrison 2004).

The online learning component of the blended-learning program was based on the 'Moodle' Learning Management System (LMS). The platform allows the users to login using their own username and password and proceed through to an enrolled course. The courses were arranged in a way where it lasts for a designated period of time during which the participants need to complete the assigned tasks and achieve the designated 'learning objectives'. The tasks would include reading text extracts, watching demonstration videos, going through quizzes and participating in online discussion forums. The DHIS academy moderated the activities in the LMS and intervened appropriately to moderate the discussions and to provide necessary instructions to its users whenever necessary.

1.2.   The challenge of implementing blended-learning for HIS-training in developing countries

However, when implementing blended-learning initiatives, it was evident that unless the participants make use of both the online and face-to-face training and participate actively in the learning process, the training may fail to achieve its intended goals. This also epitomizes the need to adapt a learning approach that would link learning with actual practices pertaining to a given context. This notion is also supported by the fact that information systems (IS) users being considered 'social actors' instead of just 'users' for reasons that they [the IS users] not only use ICTs but also work with multiple applications pertaining to various roles and in various social contexts (Lamb et al 2003). At the same time, the failure to take into account the healthcare culture, concentrating more on 'how' the HIS works instead of 'why' it should be used, and delaying the training during HIS implementations, are also recognized as reasons for failure of such interventions (Littlejohns et al 2003). Given the complexities associated with HIS's-training in developing countries, we felt the need to theorize the processes associated with learning in HIS settings. Such an understanding would allow us to provide the HIS-trainers with a conceptual framework that can be used when adapting blended learning to provide HIS-training. This paper will therefore work towards a conceptual framework, which will be discussed later in relation to two instances of HIS training that made use of the blended learning approach.

2. ORGANIZATION OF THIS PAPER

In the next section, we will state the aim of this study. We will then discuss the theoretical viewpoints in relation to the learning that take place within a HIS context similar to that of DHIS use, aided by the theories of Community of Practice (CoP) (Wenger 1998) and by the concept of 'immutable mobiles' (Latour 1987). We will then utilize these concepts as lenses to visualize the DHIS learning network. Informed through the theoretical perspectives, the development of a conceptual framework will follow. Thereafter, two HIS-training instances will be discussed using the developed conceptual framework. The paper will conclude by stating its contributions and by stating a potential future direction for HIS training research.

3. AIMS

The aim of undertaking this study is to conceptualize how online learning, face-to-face learning and work practices can be integrated in a blended learning program aimed at HIS-training in developing countries.

4. THEORY AND RELATED RESEARCH

4.1.   The community of practice

As described by Wenger, communities of practice (CoP) describes group learning instances which are evolutionary in nature and are formed out of the necessity to accomplish a task and provide the group members with learning avenues (Wenger 1998). These COPs would be having members of which some are central to its activities while some perform a 'peripheral' function. However, the establishment of a CoP is dependent upon three characteristics and these are the domain (the shared interest), the community, and the shared practices (Wenger 1998). In establishing the notion of CoP, the concept of 'legitimate peripheral participation' seems to take the center stage as it describes the process of learning taking place within a CoP (Lave and Wenger 1991). As pointed out by Lave and Wenger, the novices will learn from the more experienced colleagues or 'experts' in gaining 'expertise' with time. In such a CoP, the learners not only learn but also contribute to the ongoing work practices. In the beginning, these contributions will be 'peripheral' or 'minor' in nature although as the time elapse and experience accumulate; the novices will gradually start to contribute more. At the same time,

Brown and Duguid (1991) points out that there may be sub-communities existing within a CoP and contribute to the overall organizational learning. In fact, the sub-communities were individually described as CoPs while as a whole; an organization was described as a 'community of communities of practice'.

4.2.   HIS users as a Community of Practice

In general, our experience tells us that most HIS users who participate in training programs represents a cohort of health care workers providing health care and related services to the population as their primary role. When considering these participants, almost all of them would be part of an organizational structure such as that of a countries health care services (e.g Ministry of Health, Provincial Health Service, Maternity and Child health program, Non-governmental organizations…etc.). Within such an organizational structure, most of these participants are already engaged in handling health information at various levels. Thus, they can be perceived to be part of already established communities of practice of which the central task is the handling of health data and information. However, the same participants can belong to certain other communities of practice depending on their other work commitments. In some instances, where there is an already implemented DHIS system, participants may already be working together with other DHIS users locally or else from outside their organizational structure. Thus, in most HIS training instances, members from multiple CoPs are brought together to learn and share knowledge pertaining to a common interest and practice.

4.3.   Processes of learning within a CoP

When trying to understand the creation of knowledge within a CoP, we perceive that the term 'power', which is defined as *"the ability or capacity to achieve something, whether by influence, force, or control"* Roberts (2006), can play a key role. In relation to learning, understanding the different communities formed within an organization and the distribution of power within them is important to realize the way learning is constructed and travels within the same (Brown and Duguid 1991). One explanation to this is, novice learners becoming experts by initially participating in peripheral practices and gradually gaining a more central role, where transition of power take place in the form of 'actions' (Lave and Wenger 1991).

However, not all novice participants would receive the same 'access' when it comes to engaging in practice, creation of knowledge and therefore gaining power within the CoP (Davies 2005). In fact, gaining legitimacy would be paramount before gaining access to participate by the newcomers. Depending on the level of legitimacy, some would remain peripheral as in the case of 'marginalized' participants while the others would enter an inbound trajectory towards becoming experts or gaining 'full-membership' of the CoP (Lave and Wenger 1991, Davies 2005). This shed light to the fact that social structures do allow the formation of hierarchies within a CoP (Eckert 2000) and therefore could govern 'who learns what', 'when' and to 'what extent'. We experienced that similar circumstances could even be present among the HIS users of a particular context.

4.4. 'Immutable mobiles' and 'blended learning spaces'

With the experience gained through conducting multiple DHIS training instances, we realized the fact that unless the training instances and the work practices becomes supplementary to each other these instances tend to remain in isolation. At the same time, it was also observed that the participants of these training instances should be exposed to a continuum of learning pertaining to each of the intended learning objectives. In other words, the learning objectives should stay stable while it traverse through different learning modalities [online/face-to-face] and when it is translated into actual work practices, for such learning to be meaningful to its learners as they are part of a community of practice intended to utilize DHIS for its practices.

In theorizing the said behavior, we realized that the concept of 'immutable mobiles' (Latour 1987) can provide us with the necessary guidance. According to Latour, 'objects' of a network are 'an effect of stable arrays or networks of relations'. Their existence or holding-on depends on the holding-up of its relations and not altering the 'shape' of the object. As illustrated with the example of a sailing ship [which is an object of multiple relations and elements], which retains its shape through stable relationships while moving from one location to another navigating through the rough seas. The high seas is also considered a 'relational network' in the sense that it consist of tides, wind, rock formations…etc that needs to hold steady [to some extent] if the ship is to navigate safely. In such instances, Latour describes objects such as the 'ship' [which itself is a network of elements and relations] as an 'immutable mobile' as it retains its shape and relationships although it is mobile from one location to another. In other words, the ship moves through the 'Eucledian space' while remaining 'immutable' in the 'network space' (Law 2002). The same concept can be illustrated in relation to a DHIS blended learning instance.

The vessel described by Latour can be compared with a 'learning task' in blended learning. One example would be the learning task, 'developing an indicator'. The learning task 'developing an indicator' itself contains many elements, actions and references which provides it with a unique set of relations in order to derive its full meaning. In case of a DHIS blended-learning instance, the learner should be able to make use of the distance-learning platform to grasp the concept of an indicator, the steps in creating the same in DHIS, as well as how it can be used for analysis. However, while the concept is been taught in a distance mode, the learner will make use of the knowledge gained in order to perform the same function in the actual work setting, initially with the guidance of 'experts' at the face-to-face workshops. This would prepare the participants of a blended-learning program to function within their respective 'workplaces'. But, in order to make meaning, the elements, actions and references which were the 'network relationships' of the learning task [the object] 'developing an indicator' should remain stable and unchanged while the learner translates what he has been taught into real world practice. (Figure 1). At this point, the challenge is to determine how such stability can be maintained and how the learning can be allowed to translate into actual work practices, overcoming the perceived "gap in translation".
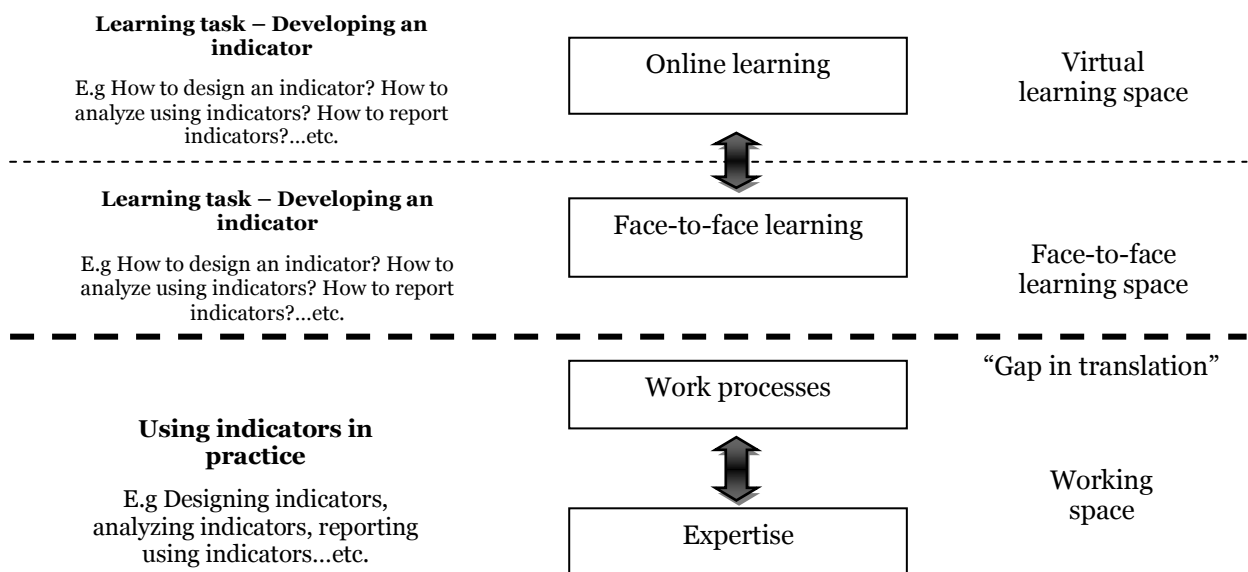
Figure 1 : Diagrammatic representation of learning taking place through a blended-learning program in a potential HIS setting.

In the above scenario, a learning task needs to traverse three perceived spaces, the virtual learning space, face-to-face learning space and the working space. However, in order to maintain 'shape', the learning task needs to be meaningful to its learners in terms of being useful for actual work practices that they intend to undertake. A failure to recognize the constructs that form the learning task would mean that learners would not be able to make use of the learning when they start to negotiate real world problems, giving rise to the perceived "gap" as illustrated in Figure 1. In other words, the 'immutability' of the learning task could be lost if its relationships [emanating from the actual work practices] are not maintained during the translation.

As discussed earlier, the participants of HIS-training are usually 'members' of already established CoPs. Given the process of learning within a CoP, it can be argued that 'experts' and the 'level of engagement' or the 'participation' in work practices are two important elements for negotiating meaning for novice members of a CoP. Based on this argument, it can be emphasized that the 'experts/expertise' and the 'work practices/participation' should reinforce the learning taking place in a blended-learning instance, if the learning tasks to be successfully translated into real world practices. In other words, the 'gap' perceived in figure 1, could well be bridged using these two elements as it will allow the participants of a blended-learning instance to 'make meaning' and 'be a part of the CoP' formed around health information systems in their own settings.

5. CONCEPTUAL FRAMEWORK

The conceptual framework shown in figure 2 illustrates this perception by expanding the earlier diagram (Figure 1).
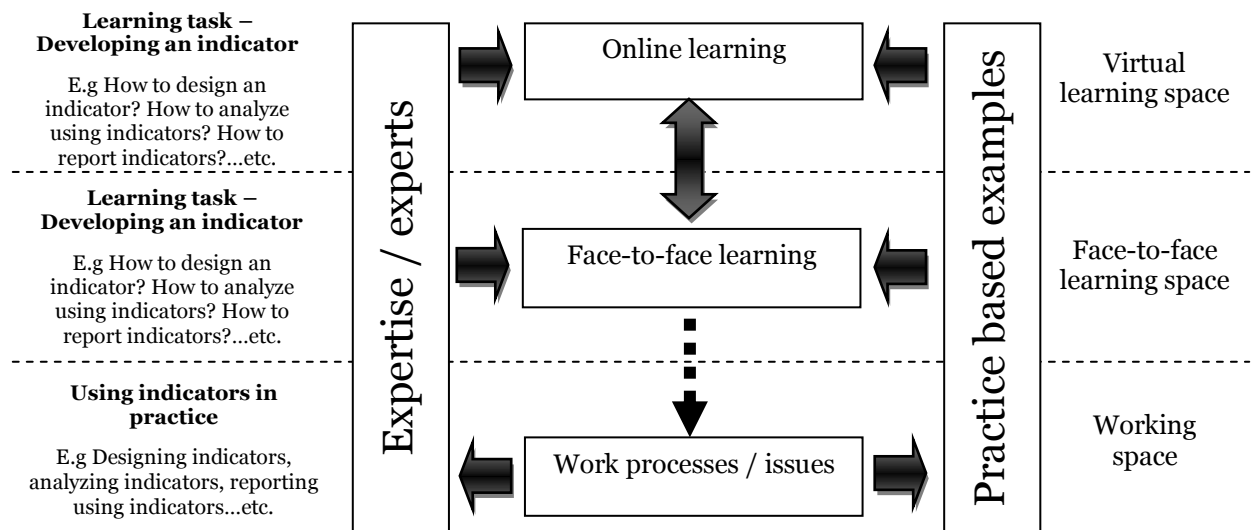
Figure 2 : Conceptual framework depicting the learning taking place through a blended-learning program in a potential HIS setting.

The conceptual framework depicted in figure 2 illustrates how a learning task could be made 'immutable' as it traverse the three spaces of online, face-to-face and work space. By maintaining immutability, it is expected that learners would be able to make meaning out of what they learn and would be able to make use of what they learn in their work practices. The way the immutability is maintained is by having experts participating in the process of learning and by having practice based examples feed the learning in both online and face-to-face spaces. These experts are to originate from the CoPs of which the learners are already part of or else is expected to be taking part. In other words, during the blended-learning

instance, the learners are invariably exposed to a learning that transcends from their actual work practices and therefore is expected to give the learners a better chance of being accepted within the CoP in which they will make use of their learning.

6. METHOD

In order to evaluate the derived conceptual framework, we made use of two DHIS-training instances as case studies. These training instances were part of DHIS workshops organized by the DHIS academy in India and Kenya. Both training instances were part of an action research approach (Baskerville 1999, Baskerville and Wood-Harper 1996, Argyris and Schön 1991) adapted for developing the blended learning program for DHIS-training in developing countries.   The data was collected from field notes, paper based questionnaires, online questionnaires, interviews, observations made during face-to-face and online training, e-mail conversations and informal discussions with the trainers as well as with the participants at each instance. The collected data was used to prepare a complete narration of the learning instance and was subjected to a thematic analysis.

7. CASE DESCRIPTIONS

The idea behind presenting these cases would be to analyze the blended-learning instances in light of the conceptual framework presented earlier and critically evaluate how such training instances performed and could have made more useful to its participants by utilizing the said framework.

7.1. DHIS workshop in Shimla, India

Shimla is the capital of Himachal Pradesh in India. Its importance to HISP is that a Health Management Information System (HMIS) is being implemented in Hospitals in Himachal Pradesh based on the DHIS platform. The Shimla DHIS workshop was intended for Asian countries where DHIS based information systems are implemented or is in the process of being implemented. It followed a similar pattern to other DHIS workshops and was held for 10 days with the participation of around 40 implementers from several countries.

Prior to the workshop, the trainers in India and the trainers from DHIS academy agreed on utilizing the blended-learning approach. It was also agreed during e-mail conversations that the aim of the online module shall be to provide the participants with a basic understanding of DHIS. In order to bring all the participants together within the online platform, a discussion forum was added as the last step of the online training. As the designers of the pre-workshop activity did not know the background and the learning needs of each and every participant, the online activity consisted of the 'minimum required knowledge'. The activity was scheduled to conclude within 5 days of which the last two days were devoted to online discussions. However, the pre-workshop activity was not made mandatory or canvassed as a prerequisite for the face-to-face workshop.

During the training, it was observed through the LMS data that many have logged-in to the LMS at least once. However, only one person contributed to the online discussion. During the face-to-face session, there were few issues raised by the participants in relation to the technical difficulties of using the LMS. However, it was observed that most participants were not so fluent in communicating in English, which was the language used for the online learning. Because of the technical difficulties in allowing all the participants access internet at the same time, Shimla participants did not get a chance to interact in the LMS during the face-to-face session. During informal discussions, some participants expressed their inability to login using the given username and the password while some said they did not have enough time to prepare. Some Shimla participants also said that, '*we would have liked it [the LMS] to*

be in Hindi' or otherwise in their own language. At the same time, there were participants suggesting to have more varied and in-depth learning activities as they thought '*the activities were too simple…*'. It was also apparent that the poor participation in the discussions might have also been influenced by its timing as some mentioned, '*if it had been timed earlier, we would have been able to participate more…*' For some, the information regarding the pre-workshop activity never reached them although their emails were in the group mailing list for the Shimla workshop. It illustrates that email communication could sometimes evade certain people who are not used to checking emails regularly.

We were also able to recognize the willingness of the participants to undergo further online training in relation to their needs, through a paper-based questionnaire. These needs were much more specific than what we have addressed through the pre-workshop online activity. For instance, some of the needs included *server installation, importing and exporting data, designing reports and customizing DHIS,* which were not addressed through the LMS. At the same time, they also emphasized the need for video demonstrations to be either in their own language or else in simple English with a locally understandable accent. Furthermore, some participants felt that by giving the users an 'online training guide', it could facilitate the integration of distance learning in their own setting and that the guide should be in a native language for its better understanding. However, most participants thought the use of online learning should be aimed at training implementers and developers of DHIS based on their experience of ground realities such as lack of internet connectivity, time to interact online, lack of English knowledge and lack of basic IT skills, when the same is used to train the field level staff.

Another characteristic recognized among the Shimla participants was that most of them were unaware about the different uses or the issues that could arise with DHIS as they did not have any work experience with DHIS in their own setting. However, most of them were aware about HISs and were engaged in similar activities. It was noticed during the face-to-face workshop that many had the enthusiasm to log-in to the LMS at least after learning that the workshop presentations would be uploaded to the LMS each day. During the face-to-face session, there was little reference to the online component apart from using the same as a repository for workshop presentations.

Case discussion

In the Shimla case, it was apparent that the 'virtual learning space' and the 'face-to-face learning space' were exploited during the blended-learning activity. However, the online learning component did not take off as expected due to several reasons. It was perceived that not recognizing the participant competencies and the desires for learning HISs lead to the formation of 'uninteresting' online content for its participants, which did not emanate from their own work practices. Having not being able to cater to the participants own language could have also affected their level of engagement, motivation as well as acceptance of the online learning as a useful entity. Furthermore, the non-complimentary nature of the online and face-to-face learning was also evident throughout the workshop, which depleted the value of having online learning prior to a face-to-face session. Thus, the perceived immutability of a learning task traversing between 'virtual learning space' and the 'face-to-face learning space' did not materialize in this instance of blended-learning.

With the recognition of participants whom were not aware about the functionality of DHIS or even not used to work with a similar HIS previously, the difficulty in meaning making was made apparent. Thus, there was not much scaffolding for participants to relate what they learn to their own setting through the online instructional arrangement although it followed a 'story telling' method using case vignettes. Thus, capturing the actual work processes with regard to the health information collection, its processing, reporting…etc and using the same as

instructional content would have been a better approach to allow the participants translate what they learn to actual work practices when they return to their working space.

In general, the scaffolds [the local expertise and the practice orientedness], which would have maintained the stability of the learning tasks, traversing between the online and face-to-face learning, either did not exist or failed to materialize during the Shimla workshop. However, there were many practice oriented and context specific learning events taking place during the face-to-face session which itself might have contributed to bridging the 'gap in translation' discussed earlier. However, this study was not geared to assess the same, as it requires a long-term follow-up of the participants at their work settings.

7.2. DHIS workshop in Kenya

The DHIS workshop in Kenya was conducted for the DHIS implementers from the East African region. It attracted around 50 participants from several different countries. The participants were classified mainly as English-speaking health information managers and technical officers with few medical doctors. Most of them were already involved in managing health information in their own setting while many were already using either DHIS 2 or its older version, the DHIS 1.4.

The Kenyan workshop consisted of a 5-day online training program followed by a 10 day face-to-face training component. Prior to planning the workshop, the DHIS-trainers and the local resource personal from East Africa discussed the potential learning needs of the participants and their ability to follow distance learning as a preparatory course for the face-to-face program via email communications. The content that should be delivered through the online mode was decided to include fundamentals in DHIS use and 'implementation' related knowledge. The face-to-face workshop was planned to supplement the training that take place in the online environment. It was also decided to form four discussion streams, which would run the entire length of the online training program. The discussion topics included, 'my experience with DHIS 2', 'implementation issues', 'design issues' and 'DHIS terminology'. The discussion forum 'my experience with DHIS' was opened earlier than the rest of the discussion forums and was expected to gather participants own views and experience with regard to handling HISs, particularly with regard to DHIS use.

The online component was introduced as an essential part of the training and in order to motivate the participants, they were told that they have to make three or more postings to receive a certificate of successful completion. During the online training, those who made the most contributions were made public in order to acknowledge their contribution as well as to motivate the other participants. Furthermore, the DHIS-trainers ("the experts") frequently communicated with the participants by means of emails reminding them regarding the ongoing activities, links to discussion forums and regarding the important discussion topics.

The discussion forums attracted almost all the participants while many of them made significant contributions in terms of posting their views and queries. Each discussion forum attracted around 30 postings from the participants as well as from the trainers. The thread, which was opened to gather the experiences of the participants, attracted the most postings. It was also noted that around 17 participants answered the online questionnaire, which was embedded within the LMS and was scheduled as the last activity of the online training. Through the online questionnaire, it was derived that most participants believed online training to be *'helpful in building knowledge'* as well as to *'build a sense of community among the participants'*. Furthermore, they also perceived *poor access to internet, lack of computers and inadequacy in the number of available online resource personal* as the main challenges when implementing online training in their own settings. During the online discussions, the trainers of DHIS also had the opportunity to learn from the participants with regard to their

experience on training their own staff. For instance, one of the participants from Uganda mentioned his experience related to DHIS 2 implementation as *"Over 120 hours of workshop training (local and regional) in DHIS2 customization for National Roll out in Uganda (eHMIS). Over 12 months of intensive customization for country use and over 5 months of first-level district and facility end-user training for the current 83 out of the 112 districts in Uganda. Limited experience in DHIS2 server maintenance and customization and use of the beneficiaries module".* This kicked-off a discuss involving many others whom were interested to learn from this participants and ultimately, the participant became a discussion leader and an 'unintentional resource person'. When analyzing the discussions, it was evident that those who contributed significantly were the ones with the most experience with regard to DHIS while the newcomers were mostly posting questions following reading the training material or as a response to a post made by a trainer or a more experienced participant. Such behaviors were reminiscent of the behaviors expected of novice learners of a community of practice who tend to learn from the experts by playing a peripheral role within the community.

Case discussion

The Kenyan case can be described as a DHIS-training instance, which followed the conceptual framework depicted in figure 2. To summarize, the online and face-to-face training programs were derived following the feedback received from the ground level experts and coordinators. They were able to profile the participants attending from their settings and therefore allowed the DHIS team to better focus its training. The introduction of a discussion thread, which ran from the first day onwards, was aimed at gathering participant details and experiences, which allowed building a sense of community within the group. In addition, the same thread also functioned as a means of relating learning with the practice. This made it easy for even the newcomers to relate what they learn and understand what issues to expect in the field based on the postings made by such newcomers. During the face-to-face training, hands-on work was much in the line of resolving the practical issues, which supplemented what had been mentioned in the online discussions. Because of bringing out the issues faced by the participants through the online discussions, the DHIS-trainers were aware about what specific learning tasks that should be stressed during the face-to-face training sessions. Furthermore, the face-to-face learning did not run in isolation from its online component but instead supplemented the learning that took place online. However, because of prior learning, trainers were able to build on what has already been taught instead of starting from scratch during the face-to-face session.

It was also evident in the Kenyan case that there were several motivations for the participants to interact in the online discussion forums. Among them, the presence of experts in the form of those who actively engaged in their own settings, the necessity to participate in order to receive accreditation, being given to understand that the online learning is an essential part of the whole DHIS-training program as well as catering to their learning needs could be highlighted. In general, having expert participation and acquiring practical examples at all levels of learning made the two learning spaces to supplement each other and therefore may have aided in maintaining the immutability of a learning task during its translation into the participants work practices.

8. CONCLUSION

Based on the case analysis, it was evident that the proposed conceptual framework is better suited to describe the case with the most participation and online/offline interactions. It also demonstrates that by allowing the participants to come-up with their own experiences, it was possible to build a sense of community among the participant group. As depicted in the conceptual framework, having a sense of community enables better integration between virtual and face-to-face learning spaces. Similarly, by bringing-in 'expertise' and practical

experiences, it was possible to enrich the discussions and allow the emergence of 'leaders', in the discussion forums. In the Kenyan case, where the participation was better, the practice-oriented nature of the online discussions could have made the learning tasks to traverse through to the 'working space' much more efficiently. From the two cases described, it was also evident that there are multiple factors that contribute to the designing of a blended-learning program for HIS-training, which may vary from one context to another. Thus, it can be argued that the expertise originating through such contexts could be useful in recognizing these factors and therefore adjust the blended-learning design accordingly. However, given the relatively short duration of the case studies, this paper was not able to evaluate if the learning tasks have actually enabled practices in the perceived CoPs. Thus, we believe the future research should focus its attention on evaluating how the proposed framework enabled HIS learning tasks to translate itself into work practices within the perceived CoPs. This should ideally be done over a period of time after such training initiatives have taken place.

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III

MAKING DISTANCE LEARNING AN EFFECTIVE HEALTH INFORMATION SYSTEMS TRAINING STRATEGY: A COMBINED SOCIAL NETWORK ANALYSIS AND CONTENT ANALYSIS PERSPECTIVE

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ABSTRACT

Health Information Systems (HIS) training have been recognized as one of the important aspects of any HIS implementation which contributes to its success or failure. Providing high quality training in low resource settings have been a challenge for many HIS initiatives including for the Health Information Systems Program (HISP) with regard to its DHIS 2 implementations. In order to tackle these challenges, it was decided to introduce online distance training as a supplement to its face-to-face training academies. However, the interactions generated within the online training and the perceived knowledge construction was variable in different training instances. Therefore, the study made use of social network analysis (SNA) and content analysis (CA) as tools to understand the type of interactions that took place within such learning instances and the degree of knowledge constructions that was achieved through such interactions. This enabled the study to assess the best practices when utilizing online distance learning for providing HIS training in low resource settings particularly with regard to 'short' online training programs. The findings from the study supports the successful utilization of short online learning programs for the said purpose with adaptation of 'best practices' to enable participant interactions and knowledge construction.

KEYWORDS: Online learning, Health Information Systems, HIS, Social Network Analysis, Content Analysis, HIS training, DHIS, Health Information Systems Program

1. INTRODUCTION AND AIMS OF THE PAPER

It is a recognized fact that training of users, implementers, developers and support staff is vital for successful implementation of any information system (Norris & Brittain, 2000). However, many training programs aim at the technical content and perhaps not pay enough attention to the socio-cognitive processes that may contribute to the 'success' or the 'failure' of a particular system. Communication and interaction between users, implementers and other staff associated with an information system have been recognized as important 'soft skills', which could enable trainers to achieve better training outcomes (Galletta et al, 1995). However, it is never easy to accommodate interactive training programs, which are capable of harnessing such skills, in challenging and low resourced contexts. Healthcare sector in developing countries is one such context where lack of human, financial and infrastructure resources, inadequate protected time for learning during work, tight deadlines and ineffective focus in training may fail to facilitate opportunities to develop relevant 'soft skills' which will aid the necessary capacity building around the health information system (HIS).

Distance learning (DE) has evolved to become a popular mode of training in many fields of study (Anderson, 2008). The advances in the technologies used for distance learning, as in the cases of the internet and mobile technologies, have made it a versatile tool that can cater to many learning needs. Online distance learning or e-learning [defined here as

'distance learning taking place over the internet'] is characterized by its ability to promote interaction between learners, between learners and moderators, between learners and content as well as between moderators. However, the challenge is to promote meaningful interactions especially when it is implemented as part of the information systems training strategy within a low resource context as described earlier.

Although challenging, the Health Information Systems Program[1] (HISP) at the University of Oslo decided to explore the potential shown by online distance learning by using the same to supplement its face-to-face District Health Information System (DHIS) 2 academy[2]. By adapting a distance learning strategy, HISP expected to address the growing demand for high quality DHIS 2 training from different parts of the world. However, after several such attempts, it was observed that the online participation and interaction fluctuated from one learning instance to another, even among participants from the same region (e.g. East Africa). Given the fact that online interactions play a pivotal role in the effectiveness of an online distance learning strategy (Swan, 2003), HISP was confronted with the questions of identifying, what promoted or prevented greater online interaction? Did such interactions lead to effective or desirable knowledge construction? And should HISP continue to invest on short-term distance learning programs for its training purposes?

In this backdrop, there was a need to analyze how participants interacted within the online distance-learning platform and how they constructed knowledge through such interactions. It was also necessary to compare the performance of short-term DE program adopted by HISP against the performance of DE programs adopted by trainers in other fields. Findings from this study will therefore help HISP and perhaps any other HIS implementation to make an informed choice regarding whether to adopt short-term DE programs to facilitate training in HIS implementations and if decided so, to understand what would make such training instances perform better in low resource contexts such as the ones presented in this paper.

2. STRUCTURE OF THE PAPER

This paper will first establish its theoretical footing under the themes, online learning, social network analysis and content analysis. Secondly, it will describe the methodology and two case studies in which online DE was used to supplement two DHIS academies in East Africa in 2012 and 2013. Thirdly, the paper will utilize Social Network Analysis and content analysis to enumerate characteristics of the online interactions observed during the two training instances and compare the same with similar findings from DE programs in other fields. The paper will conclude by stating its contribution to the knowledge of HIS practitioners as well as to the theoretical base that it had utilized.

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[1] HISP is a global network established, managed and coordinated by the Department of Informatics at the University of Oslo. It designs, implement, and sustain HISs (ex. DHIS 2) following a participatory approach to support local management of health care delivery and information flows in selected health facilities, districts, and provinces, and its further spread within and across developing countries.
[2] DHIS 2 academy is a face-to-face workshop conducted several times per year in different parts of the world for the benefit of DHIS 2 implementers, users and administrators. The workshop usually runs for 10 consecutive days and will be participated by DHIS 2 experts from the University of Oslo.

3. THEORETICAL PERSPECTIVE

3.1.   Online learning

Online learning has been defined using many different perspectives although most scholars agree that it is one of the latest additions to the distance-learning armory (Moore et al, 2011). As pointed out by Moore, researchers have discussed many positive aspects in relation to online learning and among them, improved access, educational opportunities, connectivity, flexibility and varied interactions are the most notable. From a practical point of view, the ability of the distance learners to learn anytime-anywhere and the possibility for such learners to learn together despite their differences in time, space and location has made online learning an attractive training strategy (Zheng et al, 2012). However, one critical factor that should be considered in order to make online learning achieve its intended learning goals and for it to be in par with the effectiveness of traditional or classroom learning, is the social interaction (Swan, 2003, Picciano, 2002, Shen et al, 2008). According to Wenger (1998), such interactions are critical in instances where knowledge is constructed collaboratively as in the case of online learning communities. In a different perspective, as described by Haythornthwaite (2005), learning is a social network relation in which a transactions take place when one person teaches and another learns. In that, "it [learning] is a shared experience as colleagues explore a new area, define terms, and create common ground; and it is a common experience as students attend classes and lectures together gaining a similar view of the subject and profession." Thus, online learning can be described as a social network relation where online learners construct knowledge collaboratively.

3.2.   Interaction analysis

Given the viewpoint of online learning being a social network relation, social network analysis (SNA) is a useful tool to study the patterns of interaction between the members of this network (Laat et al, 2007). In fact, in recent times, SNA has become a popular tool when analyzing the patterns of interaction among the members of online learning communities (Vera et al, 2006). As pointed out by Laart, in SNA, the unit of analysis shift from the individual to the relationships they make. This would mean that in an online learning environment, the messages exchanged among participants would be the key towards gathering information pertaining to the patterns of interaction within the network. Based on gathered data, the two key measures derived through SNA would be the 'relationship density' and the 'centrality'. Relationship density refers to the number of communicative links observed within a network expressed as a proportion of the maximum number of links that could have been established within the same network (Scott et al, 2011). Centrality refers to the degree of interaction of one member with the other members of the same network (Borgatti et al, 2000). When the centrality is measured based on the interactions initiated by the others towards a particular member of the network, the result would be the 'in-degree centrality'. When the centrality is measured based on the interactions initiated by a member of the network with other members of the same network, the result would be 'out-degree centrality'. In simple terms, in-degree can be explained as the number of messages received by a particular member while out-degree refers to the number of messages sent by a particular member of the network. A network diagram or a 'sociogram' is the representation of all the nodes [e.g. participants of a discussion forum] and their relationships to each other

in a graphical illustration. In that, each individual or entity is given the name 'node' and the relationship existing between nodes are represented by lines (ties). It is a useful way to identify which nodes play a central role and which remains peripheral. It can also depict the strength of connections between each node if the sociogram is designed using exact numerical representations of the existing number of links [number of messages received or sent].

Using SNA, it is possible for the researchers to examine the intricacies of the ties between members of a network as well as to monitor and model communication patterns and habits among the same (Wellman, 1997, Monge et al, 2001). In addition, SNA is partly useful to determine which interaction patters are more effective towards building new knowledge as expected by a particular learning instance (Zheng et al, 2012).

3.3. *Content analysis*

Although important, the patterns of interaction per se do not provide sufficient clues as to the quality of the interaction or whether the said interaction promoted knowledge building and learning (Mayer, 2004). Thus, it is necessary to do an in-depth analysis of the relationships [ties] existing within a network using certain other strategies, which are sensitive to the quality of such interactions

Laat et al (2007) describes the central role of content analysis as to generalize and abstract from the complexity of the original messages to uncover evidence of learning and knowledge building. It is a way of providing an insight to the nature of the communication that take place within a social network (Gunawardena et al, 1997, Henri, 1992). However, as pointed out by Wever et al (2006), the choice of instruments used for content analysis needs to be based on aspects such as the quality of the analysis instrument, theoretical base of the instrument, unit of analysis and inter-rater reliability. Given the fact that there are many content analysis instruments available through literature, it may be a good idea to make use of an existing schema rather than inventing a new instrument (Rourke at al, 2004). In doing so, the author considered the interaction analysis model (IAM) developed by Gunawardena et al (1997) as suitable for the purpose of this study. One reason for this decision was that the model provides a specific multi-phase approach towards construction of knowledge or negotiation of meaning which should take place in order to resolve substantial disagreements and inconsistencies (Gunawardena et al, 1997). This not only parallel the concept of collaborative learning discussed earlier but also provides a means of measuring the potential knowledge construction at different cognitive levels. Furthermore, as pointed out by Lally (2000), 'IAM focuses on the interaction as the vehicle of constructing knowledge and on the overall pattern of knowledge construction with regard to online conferences' in addition to being a straightforward scheme that can be used to analyze various contexts and learning instances. Both these characteristics supplement the earlier discussion in which the online learning was theorized as a network of relations.

4. METHODOLOGY

Based on the theoretical perspective, this paper will look into two online learning instances (cases) in view of recognizing patterns of interaction, evidence of collaborative learning and factors that lead to positive interaction patterns and behaviors.

4.1. Data collection and analysis

A comparative study was performed on the two DHIS 2 training instances. The interaction patterns were identified following analyzing the Moodle logs of each discussion forum, which included the posts made by the participants as well as by the moderators. The same posts were utilized in the content analysis. A total number of 31 and 34 participants were represented in the analysis from the 2012 and 2013 DHIS 2 training instances respectively. The training instance in 2012 generated around 145 posts (13029 words) while the 2013 training instance generated around 94 posts (8870 words). A selected number of posts were used for the content analysis. As a rule, when a participant makes a post in response to a thread, it was considered a relationship between the person creating the thread and the first level responder. The direction of the said relationship was recognized as from the responder to the creator of the thread. If the said response referred to a specific person or persons, it was noted as a relationship between the responder and the named individuals with the relationship direction being towards the named individuals. If a post is made in relation to another post within a thread, the said post was considered a response to its previous post and therefore a relationship was noted between the creators of the two posts, directed from the newest responder to the previous responder. Based on these rules, an asymmetrical adjacency matrix was created for each training instance (Figure 1, Figure 2).

Figure 1 : Asymmetrical adjacency matrix for 2012 DHIS 2 training instance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26	27	28	29	30	31
1	0	1	0	0	0	1	1	1	1	0	0	0	2	0	0	0	0	2	0	0	1	0	0	1	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	3	0	0	2	0	0	0	1	0	0	0	2	0	0	0	0	0	1	2	3	2	0	0	1	0	0	0	0	0	0
8	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	1	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0
10	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
13	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	1	0	1
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
16	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
18	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
19	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0
20	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	1	1	0
21	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
22	1	0	0	0	0	0	1	0	1	0	0	2	0	0	0	0	0	1	4	3	1	0	0	1	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
29	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0

Figure 2 : Asymmetrical adjacency matrix for the 2013 DHIS 2 training instance

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
6	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1
16	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	1	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	1	0	0

The values within the matrix represented the number of connections existed between the participants represented by both the rows and in the columns. If there were no connections, the same was indicated as a '0'. Each matrix was then analyzed using the UCINET 6.0 (Borgatti et al, 2002) SNA tool to derive various parameters related to the matrix. The same matrix was used to visualize the various nodes [participants and moderators] and their relationships existing within each learning instance via the NetDraw 2.0 (Borgatti, 2002) visualization tool.

The content analysis was done using the interaction analysis model (IAM) (Gunawardena et al, 1997) and two independent raters were given the task of coding and categorizing each post based on its content, into different phases of the IAM (Table 1). It was decided to consider each post made by the participants as the unit of analysis and label each post using a single IAM code. During classification, the raters were advised to remove the posts made by the moderators as well as posts such as self introductory messages, which did not fit the IAM classification (e.g. "*I am [name] from Mozambique, software Engineer, and studying DHIS2 in order to implement in Mozambique. Looking forward to start the academy.*") The inter-rater reliability was measured using percent agreement (codes agreed upon/codes agreed + disagreed) and it was measured as 0.70. According to literature, this was regarded as a 'reliable' value (Wever et al, 2006).

Table 1 : Coding schema of the interaction analysis model (Gunawardena et al., 1997)

Phase I Sharing/ comparing of information	A	A statement of observation or opinion	PhI/A
	B	A statement of agreement from one or more participants	PhI/B
	C	Corroborating examples provided by one or more participants	PhI/C
	D	Asking and answering questions to clarify details of statements	PhI/D

	E	Definition, description, or identification of a problem	PhI/E
Phase II The discovery and exploration of dissonance or inconsistency among ideas, concepts or statements	A	Identifying and stating areas of disagreement	PhII/A
	B	Asking and answering questions to clarify the source and extent of disagreement	PhII/B
	C	Restating the participant's position, and possibly advancing arguments or considerations in its support by references to the participant's experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view	PhII/C
Phase III Negotiation of meaning/ coconstruction of knowledge	A	Negotiation or clarification of the meaning of terms	PhIII/A
	B	Negotiation of the relative weight to be assigned to types of argument	PhIII/B
	C	Identification of areas of agreement to overlap among conflicting concepts	PhIII/C
	D	Proposal and negotiation of new statements embodying compromise, co-construction	PhIII/D
	E	Proposal of integrating or accommodating metaphors or analogies	PhIII/E
Phase IV Testing and modification of proposed synthesis or co-construction	A	Testing the proposed synthesis against "received fact" as shared by the participants and/or their culture	PhIV/A
	B	Testing against existing cognitive schema	PhIV/B
	C	Testing against personal experience	PhIV/C
	D	Testing against formal data collected	PhIV/D
	E	Testing against contradictory testimony in the literature	PhIV/E
Phase V Agreement statements(s)/ applications of newly constructed meaning	A	Summarisation of agreement(s)	PhV/A
	B	Applications of new knowledge	PhV/B
	C	Metacognitive statements by participants illustrating their understanding that their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction	PhV/C

4.2.   Limitations

The methodology adapted to study the two cases could have been somewhat influenced by the differences in instructional content. The reason for this assumption is that the 2013 training instance made use of largely technical instructional content than the 2012 training instance which was based mostly on theoretical and practice oriented content. Thus, the author believes the content presented in 2012 provided the participants with more triggers to interact than their 2013 counterparts. However, it was expected that by introducing debates at the end of the 2013 training instance, the participants were given a fair opportunity to interact with each other and with the experts. Secondly, the research design did not warrant the author to investigate the interaction patters and the content pertaining to the second half of the DHIS 2 training instances, which was the face-to-face DHIS 2 academy. Thus, the research had to restrict its inferences and conclusions only to the interactions and the learning pertaining to the online component of the training.

4.3.   Case descriptions

The study made use of two cases. The cases represented the online components of the DHIS 2 training instances held in East Africa in 2012 and 2013. The online/e-learning components were designed as pre-workshop preparatory learning activities to the face-to-face DHIS 2 Academy, which followed these e-learning instances. The online learning activities were based on the Learning Management System (LMS) 'Moodle'[3].

4.3.1.   DHIS 2 workshop in East Africa, 2012

Overview and training objectives:
This instance of DHIS 2 training was designed to cater to the learning needs of DHIS 2 implementers of the East African region. The online training was conducted for five consecutive days in the week before the face-to-face workshop. Objectives of the e-learning activity were to provide the participants with a basic knowledge related to DHIS 2 implementations and to provide them with an opportunity to learn from the experiences of each other and from the expert moderators. Allowing all the participants a chance to familiarize with each other and with the moderators was another objective of this training instance.

Participant and moderator profile:
There were 25 implementers actively participating in the online training in addition to 5 moderators whom were also content experts. The participants originated from countries such as Uganda, Kenya, South Africa, Malawi, Zimbabwe, Zambia, Tanzania and Ethiopia. They were all engaged or are expected to be engaged in DHIS 2 implementation activities. They were also full time employees of government or non-government organizations. Therefore, the participants had to follow the online training while fulfilling their other service commitments.

Design of instructional content and discussion forum:
The instructional content was designed in a way to supplement the face-to-face workshop, which followed the online learning. The topics covered in the online training included "introduction to DHIS", "definition of key terms", "conceptual design principles of DHIS" and "implementation and deployment strategies of DHIS". While each topic was assigned 1 day for review, the topic 'definition of key terms' was given an extra day. There were four pre-designed discussion threads moderated by four different people. The discussion threads were, "my experience with DHIS 2", "clearing the doubts with regard to DHIS terminology", "implementation and deployment issues" and "addressing design issues." The moderators of the discussions were also subject matter experts and therefore they were able to provide the participants with the necessary advice, answers to questions and expert opinions during the training. However, apart from their own discussion threads, these moderators also contributed to other discussion threads as well. The participants were specifically asked to post only within the pre-designed discussion threads, as it was felt that allowing free posting of discussion threads may lead to confusion and dilution of the discussions.

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[3] Moodle stands for Module Object Oriented Dynamic Learning environment and is a free and open source learning management system or a virtual learning environment. Www. Moodle.org

Course conduct:
Specific instructions were given to the participants regarding the log-in process and how to interact within the Moodle LMS during the training period. They were also informed of the necessity to submit at least three posts in the discussion forum in order to receive certification. They were also introduced to the moderators during the initial email correspondences prior to the start of the training. During the training, regular email correspondences were made to all the participants reminding them to contribute to the online discussions. Mid-way during the training, an email correspondence was sent indicating the leading contributors to the online discussion in hope of motivating the others to contribute more. Useful posts made by the moderators or else by the experienced participants were also communicated via email with appropriate links to the Moodle LMS throughout the training.

Moderator role:
During the training, moderators were advised to go through their discussion threads and provide their expert opinion and feedback to enrich the prevailing discussions. They were also asked to answer relevant questions, which were posted in other discussion threads in addition to contributing to such threads based on their expertise. It is important to note that the moderators were also practicing professionals and were not trained distance learning experts.

4.3.2. DHIS 2 workshop in East Africa, 2013

Overview and training objectives:
The 2013 DHIS 2 training instance for East Africa was the first instance in which the DHIS 2 academy conducted an 'advance course in DHIS 2'. It was aimed at implementers, advance users and administrators of DHIS 2 who have already undertaken training or are experienced with DHIS 2. However, the e-learning activity was again designed as a supplementary activity to the face-to-face workshop with the content being somewhat advanced to its 2012 training instance. Further, the 2013 e-learning instance was used to provide the participants with an idea about the new developments taking place in DHIS 2 and to provide the participants a chance to learn from the experiences of the others, communicate with the DHIS 2 developers as well as to familiarize with the colleagues of the face-to-face workshop. It was decided to conduct the online training for two consecutive weeks instead of just five days, based on the feedback received from the previous online training instances. The online training instance concluded the week before the start of the face-to-face workshop.

Participant and moderator profile:
There were 26 participants actively engaged in the discussion forum. Out of the 26 participants, seven were involved in the 2012 e-learning instance as well. Out of the seven experienced participants, three were selected by the DHIS 2 academy as facilitators of the discussion forum. It was believed that their experience in East Africa will add value to the discussion threads and will help the discussions to be more grounded and experience driven. In addition, it was believed that by having experienced DHIS users/implementers as facilitators in the online discussion forum, it would be possible to compensate for the absence of expert moderators due to various reasons [e.g. DHIS developer team engaged with the new release of DHIS2, work commitments…etc]. The participants originated from countries such as Uganda, Kenya, Malawi, Zambia, Ethiopia, Tanzania and even from Rwanda. As with the 2012 training instance, almost all the participants were full time employees of various

government and non-government institutions and were following the training while attending to their other service commitments. However, the participant profile differed from the 2012 participant profile in that the 2013 batch was more experienced in DHIS 2 functioning, customization and implementation processes.

Design of instructional content and discussion forum:
The content in the 2013 DHIS 2 online learning instance was more technically focused and was covering topics such as pivot tables, data sharing, geographical information systems, DHIS tracker, DHIS mobile and Web API/ Analytics. Each topic was supplemented by a video clip hosted in YouTube that demonstrated the new features in DHIS 2 related to the topic under discussion. Similarly, the discussion threads were also created to match the learning topics apart from the first discussion thread, which was named as "introduce yourself". In addition, two threads were named as 'debates' and were posted during the last few days of the training. The topics covered in the two debates were "is cloud hosting a better deployment strategy?" and "Dhis 2 is 'fit' enough to handle the challenges of privacy, confidentiality and security of personally identifiable health data." Each learning topic was assigned either 2 or 3 days depending on the complexity and the amount of instructional content. The discussion threads were open for postings from the very beginning although the participants were asked to contribute to the discussion thread mainly during the time when the relevant learning topic was active.

Course conduct:
Similar to the 2012 online training, the participants of the 2013 training instance were also given pre-training instructions via email. The instructions included an overview of the content, how to navigate the Moodle, the availability of the discussion threads and log-in information. However, one notable difference was that in 2013 training instance, the participants were not told to make at least 3 posts in order to receiver certification and were not asked to confine their posts to the pre-designed discussion threads. As described earlier, due to the unavailability of the preferred set of moderators [whom were content experts], the DHIS academy decided to only invite the members of the DHIS academy to facilitate the discussion threads as time permits with only one DHIS academy member taking on the role as the thread creator and the moderator. As with the 2012 workshop, frequent emails were sent to all the participants as well as to the invited facilitators, which contained the current topic in discussion, interesting discussion posts and the names of those who have contributed the most. During the last few days, the debate threads were enabled and emails were sent to all the participants and DHIS 2 experts inviting them to participate in the debates.

Moderator role:
As mentioned earlier, only one person was assigned with the task of moderating all the discussion threads. However, several other DHIS experts participated in the discussions and contributed as and when required. The moderator who managed all the threads also acted as a link between DHIS experts and the participants by referring certain questions to DHIS team members with the necessary expertise.

5. FINDINGS AND DISCUSSION

By glancing at the two adjacency matrixes, it is possible to understand that the online relationships formed in the 2012 training instance were scattered and probably numerous than in the 2013 training instance. In fact, the relationship density in 2012 was 16.4% while the

relationship density in 2013 was 8.4% (Table 2). This becomes significant when considering the fact that the two training instances were contributed to by almost the same number of participants and that the 2012 training instance was conducted for just 5 days as against the 2013 training instance, which continued for almost 2 weeks.

Table 2: Comparison of the relationship density between online DHIS 2 training in 2012 and 2013

Matrix name	Avg. value	Std. dev.	Avg. wtg. Degree
East 2012 matrix	0.164	0.496	4.933
East 2013 matrix	0.084	0.534	2.765

When looking at the sociogram of the 2012 learning instance, it is possible to recognize multiple nodes, represented both by the moderators (red color) and by the participants (blue color), communicate extensively with other nodes in the network (Figure 3). The thicknesses of the lines are representative of the frequency of each tie.

Figure 3 : Network diagram for 2012 DHIS 2 training in East Africa
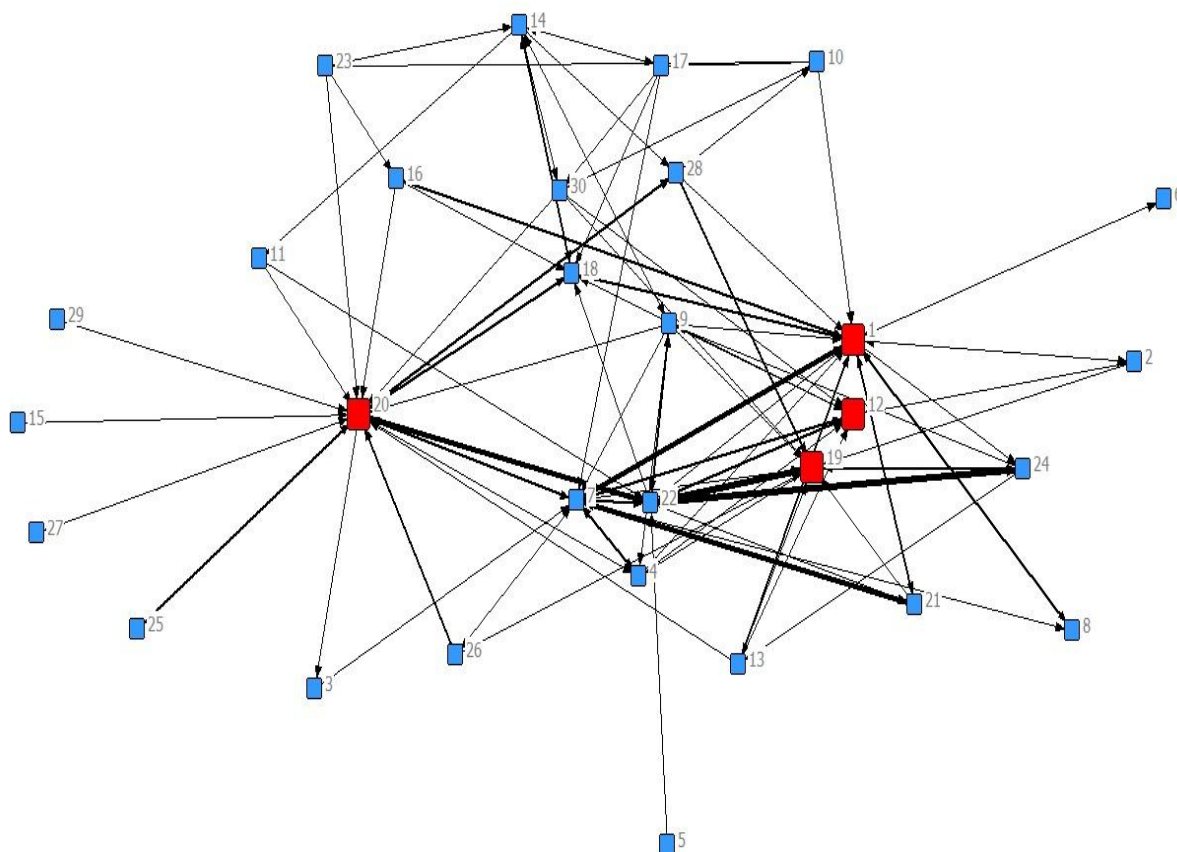
When analyzing the communications made from one node to another, in 2012, the highest message recipients were the nodes 20, 1, 22, 19 and 7. The in-degree column in Table 3 represents these nodes. The highest message senders were the nodes, 7, 22, 1, 20 and 9. The out-degree column in Table 3 represents the same. Among these nodes, the nodes 1, 19, 20 and 22 represented the moderators. Therefore, it is understandable why these nodes received and sent-out more messages during the training. However, there were other participant nodes

that received a significant number of connections and therefore had a higher in-degree in par with the moderators. The same can be said about the out-degree as well.

However, when it comes to the 2013 DHIS 2 training instance, the network diagram centered around a single node (Figure 4). This node (node 24) represented the moderator who took over the task of creating threads and facilitating the whole discussion forum. This was also made apparent by the in-degree assessment as node 24 received an in-degree of 73 while the second highest in-degree was just 3.0 (Table 4).

Table 3: Out-degree and in-degree assessment of 2012 DHIS 2 online training instance

	1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
7	17.000	13.000	14.655	11.207
22	15.000	14.000	12.931	12.069
1	11.000	20.000	9.483	17.241
20	10.000	23.000	8.621	19.828
9	9.000	4.000	7.759	3.448
24	7.000	4.000	6.034	3.448
14	7.000	6.000	6.034	5.172
21	6.000	5.000	5.172	4.310
18	6.000	9.000	5.172	7.759
28	6.000	2.000	5.172	1.724
13	5.000	3.000	4.310	2.586
19	5.000	14.000	4.310	12.069
17	4.000	2.000	3.448	1.724
26	4.000	1.000	3.448	0.862
4	4.000	5.000	3.448	4.310
16	4.000	1.000	3.448	0.862
10	4.000	1.000	3.448	0.862
30	4.000	3.000	3.448	2.586
23	3.000	1.000	2.586	0.862
2	3.000	1.000	2.586	0.862
8	2.000	2.000	1.724	1.724
11	2.000	1.000	1.724	0.862
25	2.000	0.000	1.724	0.000
5	1.000	0.000	0.862	0.000
3	1.000	1.000	0.862	0.862
12	1.000	9.000	0.862	7.759
27	1.000	1.000	0.862	0.862
6	1.000	1.000	0.862	0.862
29	1.000	0.000	0.862	0.000
15	1.000	0.000	0.862	0.000

When compared with the complex and scattered sociogram of 2012, it is possible to determine that the centeredness around a single node was the result of other moderators not participating in creating discussion threads contributed to by the training participants. However, in 2013, the out-degree values did not parallel the in-degree values in that the participant nodes recorded the highest out-degrees in 2013, as against the moderator.

Figure 4 : Network diagram for the 2013 DHIS 2 training instance
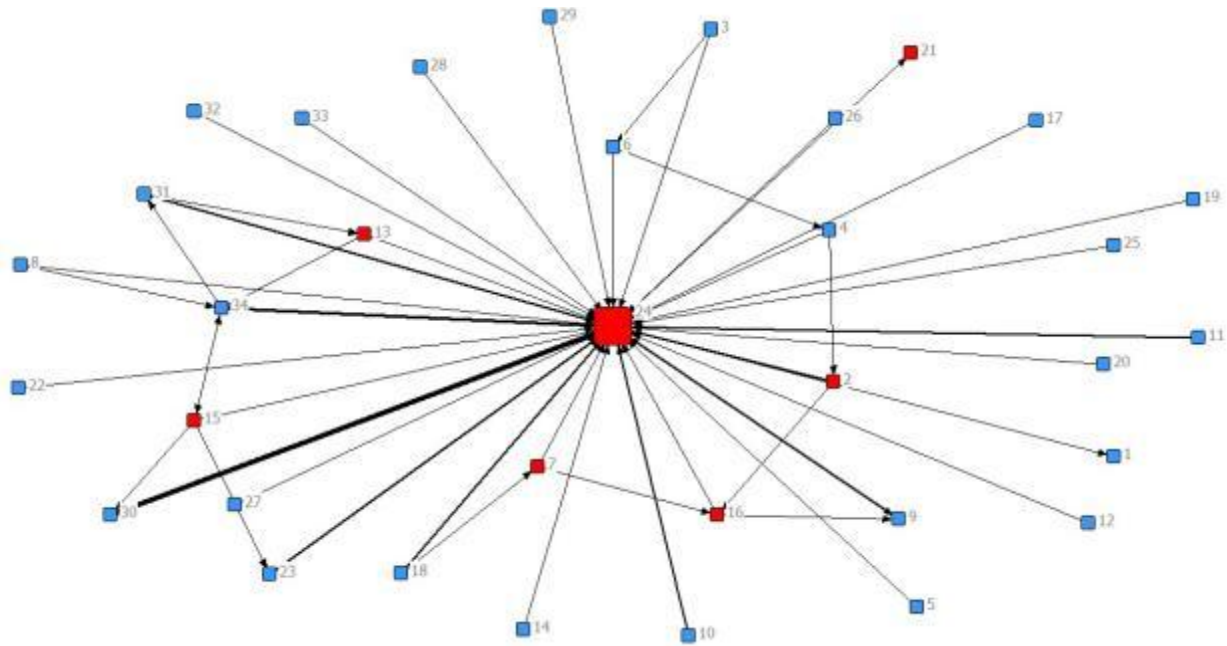
Table 4: Out-degree and in-degree assessment of 2013 DHIS 2 online training instance

	1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
30	11.000	1.000	3.030	0.275
34	9.000	3.000	2.479	0.826
2	5.000	2.000	1.377	0.551
18	5.000	0.000	1.377	0.000
9	5.000	2.000	1.377	0.551
4	4.000	1.000	1.102	0.275
31	4.000	1.000	1.102	0.275
10	4.000	0.000	1.102	0.000
24	4.000	73.000	1.102	20.110
8	3.000	0.000	0.826	0.000
11	3.000	0.000	0.826	0.000
7	3.000	1.000	0.826	0.275
15	3.000	2.000	0.826	0.551
6	3.000	1.000	0.826	0.275
23	3.000	1.000	0.826	0.275
12	2.000	0.000	0.551	0.000
25	2.000	0.000	0.551	0.000
13	2.000	1.000	0.551	0.275
3	2.000	0.000	0.551	0.000
16	2.000	3.000	0.551	0.826
27	2.000	0.000	0.551	0.000
1	1.000	1.000	0.275	0.275
5	1.000	0.000	0.275	0.000
20	1.000	0.000	0.275	0.000
21	1.000	1.000	0.275	0.275
26	1.000	0.000	0.275	0.000
19	1.000	0.000	0.275	0.000
28	1.000	0.000	0.275	0.000
29	1.000	0.000	0.275	0.000
22	1.000	0.000	0.275	0.000
14	1.000	0.000	0.275	0.000
32	1.000	0.000	0.275	0.000
33	1.000	0.000	0.275	0.000
17	1.000	0.000	0.275	0.000

Another importance observation in the network diagram of the 2013 training instance is how most participants remained 'peripheral' within the network when compared with the

2012 sociogram. This means that in the 2013 network, many nodes remained at a distance as against their 2012 counterparts. It is also interesting to note that the mean in/out degree is higher in the 2012 matrix than the 2013 matrix (4.900 against 2.765) (Table 5 and Table 6). This illustrates that the number of connections/ties made by the participants in 2012 were higher than it was in 2013.

Table 5 : Descriptive statistics for 2012 matrix

		1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
1	Mean	4.900	4.900	4.224	4.224
2	Std Dev	4.020	6.024	3.465	5.193
3	Sum	147.000	147.000	126.724	126.724
4	Variance	16.157	36.290	12.007	26.969
5	SSQ	1205.000	1809.000	895.511	1344.382
6	MCSSQ	484.700	1088.700	360.211	809.081
7	Euc Norm	34.713	42.532	29.925	36.666
8	Minimum	1.000	0.000	0.862	0.000
9	Maximum	17.000	23.000	14.655	19.828
10	N of Obs	30.000	30.000	30.000	30.000

```
Network Centralization (Outdegree) = 11.176%
Network Centralization (Indegree) = 16.718%
```

Table 6 : Descriptive statistics for 2013 matrix

		1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
1	Mean	2.765	2.765	0.762	0.762
2	Std Dev	2.250	12.257	0.620	3.377
3	Sum	94.000	94.000	25.895	25.895
4	Variance	5.062	150.239	0.384	11.402
5	SSQ	432.000	5368.000	32.785	407.380
6	MCSSQ	172.118	5108.118	13.062	387.657
7	Euc Norm	20.785	73.267	5.726	20.184
8	Minimum	1.000	0.000	0.275	0.000
9	Maximum	11.000	73.000	3.030	20.110
10	N of Obs	34.000	34.000	34.000	34.000

```
Network Centralization (Outdegree) = 2.410%
Network Centralization (Indegree) = 20.558%
```

It is also interesting to note that according to Table 5 and Table 6, the standard deviation (SD) (the spread of numbers within a population), in relation to the in-degree of the nodes, was relatively high in the 2013 matrix. This can be interpreted as participants of the 2013 training instance received inconsistent attention from other participants with some receiving significantly large incoming connections than the others. However, the numbers might have been influenced by the exponentially higher in-degree of the moderator (node 24). In 2012, the participants have not only received a relatively higher number of incoming connections but the consistency between the nodes was also high (as indicated by a relatively lower SD). In relation to the out-degree, the variance (measure of how far a value is from the mean) in 2012 matrix is 16.157 while the same in 2013 was 5.062. This can be described in terms of predictability or the constrains in behavior among the participants and therefore it can be interpreted that 2013 participants were more predictable or constrained in making

connections while the 2012 participants were more unpredictable or free in doing the same. Thus, based on the analysis, it was possible to make the following inferences.

While it is acknowledged that there can be multiple factors affecting the interaction patterns within an online learning group, presence of moderators facilitating discussions could perhaps be one of the major factors affecting an interaction pattern. When the moderators are also content experts, it was observed that the out-degree of such nodes within the network would be high. Thus, in a technically rich subject such as DHIS 2 advance training, it would have been useful to have content experts moderating the discussions than just a facilitator. Having multiple moderators may also be a positive influence towards increasing the network connectivity as they have the potential to shorten the distance between different nodes within a given network. Although it is not possible to directly link the number of moderators and the shortening of the distances between the nodes through this analysis, it is possible to illustrate that in 2012, the average distance between two nodes were 3.3 whereas in 2013 the same was 4.9 (Table 7 and Table 8). In addition, Table 7 and Table 8 also illustrates that the proportion of nodes furthest from another node is far higher (67% as against 13.3%) in 2013 than in 2012. This may be attributable to the absence of adequate number of moderators/facilitators who could have filled the gap between two nodes within a network. In addition, having a single moderator may reduce the efficiency or the influence that can be made by the said moderator due to the overwhelming nature of the incoming connections. This can be illustrated by the exponentially high in-degree (73) and the relatively low out-degree (4) of node 24 in the 2013 matrix.

Table 7 : Geodesic distances between nodes in 2012 dhis training instance

```
Frequencies

         Value          Freq          Prop
       ----------    ----------    ----------
             1           109          0.125
             2           306          0.352
             3           204          0.234
             4            95          0.109
             5            27          0.031
             6            10          0.011
             7             3          0.003
             8           116          0.133


Average: 3.3
Std Dev: 2.1
```

Table 8 : Geodesic distances between nodes in 2013 dhis training instance

```
Frequencies

         Value          Freq          Prop
       ----------    ----------    ----------
             1            52          0.046
             2           139          0.124
             3           121          0.108
             4            30          0.027
             5            28          0.025
             6           752          0.670


Average: 4.9
Std Dev: 1.7
```

Another inference is that extending the duration of an online training program may not necessarily increase the number of connections or the interaction among the participants or the density of the network. While a longer duration can provide the participants with enough time to follow the learning content, it may have diluted the vigor of interaction that may have been generated by a short training stint.

However, in order to further compare the two training instances and make inferences, it was necessary to understand the nature of the discussions or the quality of the connections that had been created. Based on the IAM, it was possible to derive Table 9 which demonstrates the cognitive level of each discussion post obtained from both 2012 and 2013 DHIS learning instances.

In general, statements such as *"...I think it would be a good Idea to provide the data entry clerks with dongles (mobile modems) so they can still enter data while on the move and not only rely on the internet connection at their respective health facilities which fails sometimes...", "....I totally agree with both of you [name1] and [name2], once you are hands on in DHIS2, org units, indicator and data element are no longer an issue, they flow well but i have a problem with org hierarchy coz as the name suggest its like we are dealing with levels of org units....", "...We are constantly consulting with programmers that have been using it for years so that we can develop a system that is suited for our own setting within the Malaria control program...", "...during customization can one use any other language they are comfortable with other than java for example php?"* and *"...Right now you can only chart data elements (categories totals)..."* were classified as phase I A,B,C and D respectively.

One example for phase II statements include *"...I have tried to follow the step by step in the user manual but it does not come out good except through the backdoor importing which requires some PHP code writing just like you said. However I feel like there has to be an automated tool..."*

Phase III of the IAM contained statements such as *"the way I understand it, Data elements define what is actually recorded in system while Indicators are composed of multiple data elements, and typically consist of a numerator and denominator. Indicators are never entered in DHIS2, but are derived from combinations of data elements and factors..."* and *"Yes [name], I have with me this handbook from the Ministry of Health with a list of indicators. I would not call them indicators in DHIS2 context because they are not made up of anything like a factor, a numerator and a denominator as required by DHIS2."*

An example for a phase IV post is *"…We are implementing supervisory checklist for health workers in our beloved country the checklist is uploaded on android enabled smartphone. The backend software is ODK, which I discovered that it is capable of streaming data into DHIS2. Having read API material I told myself that this the chance to learn how this can be done."* The only post that was classified into phase V was *"I did try to setup the cron job just like you are saying but only managed to have automatic ssh loging without password and then got stuck..."*

According to Table 9, most posts in both 2012 and 2013 online learning instances were classified as posts of 'sharing and comparing information'. In that, the proportion of posts classified as phase I was 88.2% in 2012 while the same in 2013 was 89.8%. However, it was

interesting to note that in 2013, most phase I posts (63.3%) were categorized as phase I/A which was 'statements of observation and opinions'. In 2012, 3.8% of the posts were categorized as phase II while 7.2% belonged to phase III. Although there were no posts categorized in phase IV, there was one post categorized as phase V in 2012. In 2013, there were no posts belonging to phase II and there were four posts (8.1%) belonging to phase III. One post was classified as belonging to phase IV and none as phase V in 2013.

Table 9 : Coding of discussion posts according to the Interaction analysis model

Phase		Code	2012		2013	
			No. of posts	%	No. of posts	%
Phase I Sharing/ comparing of information	A	PhI/A	37	33.6	31	63.3
	B	PhI/B	1	0.9	1	2.0
	C	PhI/C	17	15.5	4	8.2
	D	PhI/D	24	21.8	5	10.2
	E	PhI/E	18	16.4	3	6.1
Phase II The discovery and exploration of dissonance or inconsistency among ideas, concepts or statements	A	PhII/A	3	2.7	0	0.0
	B	PhII/B	1	0.9	0	0.0
	C	PhII/C	0	0.0	0	0.0
Phase III Negotiation of meaning/ co construction of knowledge	A	PhIII/A	4	3.6	0	0.0
	B	PhIII/B	0	0.0	0	0.0
	C	PhIII/C	4	3.6	3	6.1
	D	PhIII/D	0	0.0	1	2.0
	E	PhIII/E	0	0.0	0	0.0
Phase IV Testing and modification of proposed synthesis or co-construction	A	PhIV/A	0	0.0	0	0.0
	B	PhIV/B	0	0.0	1	2.0
	C	PhIV/C	0	0.0	0	0.0
	D	PhIV/D	0	0.0	0	0.0
	E	PhIV/E	0	0.0	0	0.0
Phase V Agreement statements(s)/applications of newly constructed meaning	A	PhV/A	0	0.0	0	0.0
	B	PhV/B	1	0.9	0	0.0
	C	PhV/C	0	0.0	0	0.0

When interpreting the interaction analysis results, it is interesting to note that the 2012 findings were representative of the proportion of posts classified into IAM phases by other researchers in much lengthier online training programs. For instance, the proportion breakdown of Zheng (2012) was 89.2, 3.5, 6.8, 0.3 and 0.1 from phase 1 to 5 in a training program which extended for almost an year. In 2012, the proportion breakdown was, 88.2, 3.8, 7.2, 0 and 0.9. However, the same cognitive distribution was somewhat distorted in 2013 as the proportion breakdown was 89.8, 0, 8.1, 2 and 0. Thus, it is possible to assume that even a short version of an interactive online training instance, such as that in 2012, could achieve similar cognitive gains expected of a much longer version of an online training instance. Furthermore, it is also possible to assume that having sufficient moderation could have improved the knowledge building as was seen in 2012 online learning instance where

interactions were widely distributed among various cognitive levels than in 2013 online learning instance. Another observation based on the interaction analysis was the necessity to supplement the online learning instances in order to promote further knowledge building and generate interactions, which can be classified under phase IV and V. Although extending the time duration of the online training instances might also enhance the knowledge construction towards much higher levels, it is almost impossible to run extended training programs for training needs of DHIS 2 in contexts where in-service training should supplement the ongoing implementations, which are bounded by strict deadlines.

6. CONCLUSION

The two online training instances provided an insight as to some of the factors that contribute towards promoting higher quality online interactions in short (1 to 2 week) online courses focused on health information systems training. Presence of sufficient number of moderators, moderators being content experts and them being active in the online discussion forum are some of these factors. Another useful finding is that lengthening of a short online training program per se may not generate the desired interaction or the quality of interactions among its participants. In a technical content rich in-service program, a short online training might achieve the same or a higher degree of interaction and knowledge construction than when the same is conducted for a lengthier period of time. However, enthusiasm generation and proper moderation will play a key role in such short training instances. At the same time, it is probable that pre-structured discussion forums would be more effective in generating interactions among its participants when it comes to short online training programs. Given the fact that each of these online training instances were followed by a face-to-face training component, the participants may have had more opportunities to interact and to construct knowledge through testing and applying the same in their actual practices. Thus, future research initiatives should look into analyzing how a combination of online and face-to-face training can achieve a higher participant interaction and knowledge construction than what was achieved through online training alone.

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IV

USING A "BLENDED" APPROACH TO STRENGTHEN THE ACCEPTABILITY OF E-LEARNING: CASE OF HEALTH INFORMATION SYSTEMS TRAINING IN A GLOBAL CONTEXT

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Abstract: E-learning has been recognized as a useful strategy for mass scale training. For large-scale information systems training, it could provide cost saving, wider coverage and variety in training options. However, convincing a heterogenous group of information systems (IS) experts, researchers, academics and trainers to utilize the same for training IS users is not straightforward. When introducing to such a heterogenous group, e-learning has shown to function as a boundary object although depending on its encapsulated social meaning, inherent properties and various other factors, it can react positively or negatively towards its intended utility. If e-learning continues to assume the state of being a 'negative' boundary object, it will not succeed in penetrating into the practices of its potential adopters; the members of different communities of practice involved in providing training. However, a different ontology of e-learning in the form of blended learning was able to garner epistemic inquiry from the same members and shift the e-learning from being a negative boundary object to a positive boundary object. Through its analysis, the study positions blended learning as an epistemic object and thereby establish a point of departure for researchers in distance learning, and a useful path for IS practitioners to introduce e-learning as a training tool for its trainers.

Keywords: e-learning, blended-learning, boundary object, epistemic object, information systems training, communities of practice.

1. INTRODUCTION

When developing a health information system (HIS), the minds of its designers would always wonder whether its intended audience would take up this system or not. As pointed out by Heeks (2006), the gap between what is perceived by the designers and real expectations of the users would ultimately decide the fate of most, if not all, information systems. In order to narrow the gap between design and reality, one important step is to provide rigorous training, which most often than not, is a forgotten factor (Ash, Stavri & Kuperman, 2003, Sellitto and Carbone, 2007).

In reality, it is difficult to say exactly why training remains in the backseat during HIS implementations. However, literature on management information systems suggest that the considerable budgetary requirements of up to 20% of a whole project and the enormous amount of man hours required for training may be two key factors (Robey et al, 2002). As experienced in public health training, in low and middle income countries (LMICs), providing quality training

may also be hindered as a result of vast geographical areas to cover and the substantial training demand originating from a large population (Heller et al, 2007). In order to overcome these barriers, organizations have recognized e-learning technologies as a potential solution (Armstrong and Sadler-Smith, 2008). However, as with any other technology, even e-learning can generate both positive and negative reactions from its potential adopters for pedagogic, technical and political reasons. At the same time, Garrison (2011) points out that in order to fully integrate e-learning within an educational system, it should not be viewed as a replacement for the face-to-face learning experiences. In fact, the power of e-learning is its capacity to adapt to different scenarios without necessarily creating winners or losers amongst its adopters. In other words, one may need to find the right mix of e-learning and face-to-face learning when designing training programs in order to make it pedagogically, technically and politically acceptable. Blending is the term used in education sciences to refer to such mixing of e-learning and face-to-face learning in a pedagogically useful manner.

This paper is motivated by the dynamics surrounding the process of adopting e-learning and the emergence of a blended learning program as experienced by one of its authors as an action researcher in IS. By recognizing the complex dynamics that take place, the paper believes that IS practitioners and trainers can be better prepared for potential adoptions of e-learning to harness the 'best of both [face-to-face and e-learning] worlds'.

In doing so, the paper will next present its theoretical grounding before proceeding to describe the methodology of the study in detail. The intervention on which this paper is based on will then be presented in a case study format, leading to a discussion that will explain the dynamics associated with the emergence of a boundary object in the form of e-learning. The paper will conclude by presenting interpretation of the observed dynamics providing practitioners and scholars a point of departure for using e-learning systems and for future action research.

2. THEORETICAL BACKGROUND

2.1. Dynamics of knowledge creation in a heterogeneous community

In most organizations, there exists a culture, which is typically characterized by the potential shown by some of its members to informally network and form groups. These groups are formed not because of institutional values, beliefs, rules, norms or structures as suggested by institutional theorists (Oliver, 1991, Powell and Dimaggio, 1991), but instead because of their interest towards a certain practice. While some of these groups are short lived, there are others that can last for many years if not indefinitely. Wenger et al (2002, p.4) recognize the latter kind of groups as 'communities of practice' (CoP) and describe it as,

> *"Groups of people who share a common, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis."*

As pointed out by Wenger, the manifestation of a CoP is largely a natural process. However, it is also characterized by the voluntary contributions of its members and the dedication of its internal leadership, which would play a significant role in its sustainability. Therefore, if a CoP is to steward knowledge, it should enjoy informality and autonomy (Wenger et al, 2002).

While organizations can designate people to come together and complete a particular task, it is not possible to deliberately form a CoP out of thin air (Wenger et al, 2002). Wenger points out that one of the important requirements that need fulfilling for a CoP to form is to have a shared domain of knowledge. The shared domain provides a common identity for the members of a CoP, which will thereby guide their thoughts, actions and learning while providing the members with a sense of purpose and value (Wenger, 2002). The next important element characterizing a CoP is the 'community' where interactions and relationships are being built with mutual understanding and trust (Wenger et al, 2002). The third element defining a CoP, and perhaps the most relevant in

terms of this paper, is the 'practice'. Wenger (2004, p. 38), defines practice as a set of *"socially defined ways of doing things in a specific domain"*. These include a set of common approaches and a set of standards that forms the basis for actions, communication, problem solving, performance and accountability, which characterizes the said CoP over a period of time. In other words, a CoP becomes a 'mini culture' within the much larger organizational context (Wenger, 2010). As pointed out by Wenger (2002), this mini-culture however does not only consist of behaviors and actions, but it also consists of tools and resources for the members to interact in a mutually useful manner. When these tools and resources do not garner unanimity, it may be possible for sub-cultures to emerge within the said mini-culture. In certain instances however, unless these tools or the resources become widespread and interesting for most if not all the members in the CoP, it [the tools, resources and even the CoP itself] may die a premature death.

While it seems harmless enough for any organization to pursue having multiple CoPs, Wenger himself argues that the same CoPs can sometimes restrict learning and innovation due to various 'disorders' (Wenger et al, 2002). These disorders can manifest in relation to each of the three characteristics of a CoP; domain, community and practice. In fact, the tendency to show symptoms related to these different disorders are high at the boundaries where different domains, communities and practices overlap in pursuit of 'commonness'. On the other hand, the same boundaries could spark innovations and new knowledge creation as well (Carlisle, 2002). These arguments shed light to the importance of studying the so-called 'boundary phenomenon' when analyzing interactions and functioning of the CoPs, especially in instances of heterogeneous communities.

2.2. The boundary phenomenon

As described by Akkerman and Bakker (2011), a boundary emerges when the socio-cultural difference between communities causes a reduction or a discontinuity of action and interaction. Interestingly enough, in instances where boundaries are created, there is always relatedness between the so-called 'different sites'. This relatedness may motivate or compel people, practices and objects to perform a boundary crossing (Akkerman and Bakker, 2011). In doing so, even professionals who are highly competent in one context may become unqualified after they cross a boundary (Suchman, 1994). It is with such boundary crossers that CoPs are able to maintain its integrity and most importantly, to keep abreast with modern times. Although scholars such as Amin and Roberts (2008) accept that boundaries such as these are porous, it is false to assume that these pores will easily allow crossover. Rather, there needs to be a 'vehicle' that would allow boundary crossers to claw their way in-and-out.

Boundary objects can be seen as supporting boundary crossers by providing the access that they require. As described by Star and Griesemer (1989), boundary objects can satisfy the informational requirements of each context or site on either side of the boundary. In other words, it [the boundary object] can adapt to the local needs and constraints while being robust enough to maintain a common identity (Star and Griesemer, 1989). However, having the boundary objects per se may not allow boundary crossers to move back and forth and become hybrids of multiple domains. In fact, Williams and Wake (2007) propose that boundary objects are mostly invisible and that they are taken for granted by the boundary spanners. If boundary objects are 'black boxes', this means that there needs to be an active process opening up and utilizing the boundary objects.

2.3. Social meaning of boundary objects

In an elaborate sociological discussion of the boundary phenomena, Fox (2011) argues that technological objects themselves can perform the function of a boundary object in relation to transferring knowledge between communities. This function can be either facilitative or inhibitory towards cross boundary communication or innovation. However, the most intriguing argument made by Fox is that the functional acceptance of boundary objects would depend on the meaning

that it projects on to the recipient community. Fox brings in the historical case of innovative surgical sterility where much simpler and perhaps highly effective antiseptic technologies (e.g using carbolic acid to disinfect wounds and hands of surgeons) were disregarded by the surgeon community. The reason being that the antiseptic technologies were perceived as encapsulating a social meaning which portrayed surgeons as 'germ carriers', being 'dirty' or being 'infective' rather than as being healers. On the other hand, much complicated and time consuming process of aseptic technologies (e.g. boiling surgical instruments, maintaining a sterile environment in the theatre) were readily accepted by the surgeons as it agreed with the morals and social understanding of cleanliness. In contrast to antiseptic technologies, this [aseptic technologies] projected the image of saviours and 'purity' on the surgeon community.

In line with the arguments made by Fox (2011), Gal et al (2004) had also indicated that boundary objects could also be a resource to construct and communicate social identities in addition to being an agent of knowledge translation and communication. Gal et al (2008) further argues that boundary objects have the potential to alter even the organizational identity through its internal dynamics. Thus, it is possible to argue that communities may react negatively towards a boundary object if it encroaches on a 'sacred' identity associated with the said community.

2.4. E-learning, blended-learning and epistemic objects

In modern distance education (DE) literature, the terms 'online learning', 'e-learning' and 'distance learning' have been used interchangeably with highly vague and overlapping descriptors (Garrison, 2011). According to Garrison, e-learning exists in two main forms, one being fully online and the other being blended-learning. In fact, the most prevalent form of e-learning in today's higher educational institutions is said to be blended-learning (Garrison, 2011). However, not all agree in considering 'blended-learning' simply as one form of e-learning. Laster et al (2005) points out that in order to be classified as a blended-learning program, it has to; integrate online with traditional face-to-face class activities in a planned, pedagogically valuable manner; and a portion (institutionally defined) of face-to-face time be replaced by online activity. An important aspect of this definition is that it eliminates defining courses utilizing stand-alone media in face-to-face courses as blended-learning. At the same time, Graham (2006) present several models of blended-learning which include instances of combining online and face-to-face learning, combining various instructional modalities and combining various instructional strategies. In any event, there isn't seems to be a clear definition or an agreement among the scholars regarding a taxonomy to describe blended learning' or else to define what or to what degree the elements of learning should be blended for a program to be called a blended learning program (Picciano et al, 2013). This brings to the forefront the importance of establishing a meaningful perception regarding blended learning before trying to unravel its subtle intricacies.

In this regard, one possible approach towards meaningful perception building is to consider blended learning as epistemic in nature. Rheinberger (1997) took the initial step of coining the term 'epistemic objects' by describing the central role played by 'epistemic things'. These objects, according to Rheinberger, have the characteristics of being open, question generating and complex. Through scientific inquiry, these objects can evolve not by losing its complexity but in fact by becoming more complicated than before. Rheinberger points out that the aim of introducing the concept of epistemic objects was to provide an object-centered, materially founded account of knowledge production where epistemic objects are clearly material in nature (Rhinberger, 2005). In fact, as put forward by Rhinberger, what generates interest towards these objects and what keeps them 'alive' as a research focus is the opacity, the surplus and the material transcendence. Furthermore, as pointed out by Cetina (2001), epistemic objects have an element of 'unknown', which intrigues those who come across such objects. At the same time, Cetina emphasize that epistemic objects are incomplete and are never themselves and will continue to unfold indefinitely as it gathers new properties. This gives rise to the question of, to what does an epistemic object can change to? Answering this question, Ewenstein and Whyte (2009) points out

that once the epistemic inquiry seizes to exist, the epistemic object could acquire a more definitive form, and transform to become a 'technical object', without a boundary function.

3. RESEARCH DESIGN

The setting for this study is the Health Information Systems Program (HISP) established within the Department of Informatics at the University of Oslo almost 20 years ago. HISP has achieved great heights in the development, implementation and research pertaining to its own HIS, 'dhis2'. The HISP program is unique in the sense that its main clients are from LMICs particularly from the African and Asian continents. However, the program is now expanding into wider markets. The objectives of the HISP program however are not profit driven but instead are to provide a cheap and a more robust information system capable of catering to the low resource contexts to uplift its health information processes. Therefore, HISP considers the contribution made by academics and researchers as equally important to that of software developers and implementers giving rise to a truly heterogeneous community.

This particular study was based on the design and deployment of an e-learning system for the training of users, super users and implementers of dhis2 in LMICs. The e-learning solution was based on the Moodle[1] learning management system. As stated earlier, the focus of study was the dynamics of interaction and adoption of the e-learning system by the 'trainers' of dhis2 both within and outside the HISP program.

Given the fact that qualitative research aims at understanding particular social situations, events, roles, groups and interactions, the study aligned itself with the said research approach. Thus, the paper drew from experiences of the authors, observations made during the implementation process and the perceptions gathered through eight face-to-face interviews conducted with members of the dhis2 trainer community in the HISP program. The interviews were protocol based and lasted an average 45 minutes each. The interviews were tape recorded with the consent of the interviewee before the audio-records were fully transcribed verbatim. Among the interviewees, there were three dedicated software developers cum implementers, two dedicated HIS implementers and three researchers/academics who were all involved in dhis2 training. The collected data in the form of verbatim transcripts of audio recordings, email communications and field notes were first looked at for recognizing its general meaning to decide on the potential 'codes' that would be used in the analysis. The coding of the text was done following the eight step process suggested by Tesch (1990). Based on the coded text, emerging themes (Creswell, 2014) were recognized and were then classified into categories, which provided the researchers with an idea about the dynamics taking place around the observed boundary object, the e-learning tool.

At the same time, the study utilized the definition given for boundary objects by Star and Griesemer (1989), which is *"boundary objects are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites."* For further clarity, the study made use of Wengers' (2000) classification of boundary objects in which one of the categories was recognized as 'artifacts' such as tools, documents and models. Together, these descriptions, theorizations and classifications allowed the study to name the e-learning tool as a boundary object and therefore utilize the same as the object of study. As described by Miles and Huberman (1984), this enabled the study to contrast, compare and classify the said object of study.

In addition, the perceptions generated through the study were largely guided by a pragmatic worldview. It is worth mentioning that the lead author of the study had been engaged with the said trainer group for several years and was part of an action research approach towards developing and implementing the said e-learning solution. Thus, as suggested by Creswell (2014), the author is capable of utilizing a pragmatic worldview in drawing conclusions.

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[1] A free, open-source PHP web application for producing modular internet-based courses that support a modern social constructionist pedagogy, Moodle,org

4. DHIS2 ACADEMY AND ITS ADOPTION OF E-LEARNING

In 2011, the HISP – University of Oslo (referred to as the 'organization' hereafter), decided to try out e-learning as part of its training strategy for dhis2. Dhis-2 is an Open Source HIS, which came into being in South Africa in the early 1990s before it organized itself into an autonomous organization established within the university system. The organization itself has become an incubation medium for researchers who are studying HISs. Being backed by a reputed academic institution, the organization has been able to attract considerable number of students from LMICs particularly through its collaborative projects. From 1990s up to now, the aims, the functioning, organization and the strategies adopted by the organization has changed dramatically as a result of the growing demand and technical strength, shifting funding sources and the ever-expanding research and business network.

At present, the organization is involved in implementing multiple dhis2 instances in many different countries out of which most are LMICs. The sheer size of these implementations and collaborations meant that it has to utilize enormous amounts of resources to fulfill the training demands. The reason being that the designers and implementers of the HIS were dependent on face-to-face training workshops, named as 'academies', which were held several times a year in Africa and Asia. These academies usually last for 10 days and have been designed as residential workshops attended by users and implementers of HISs. In general, around 50 to 70 participants attend these academies which were usually funded by international donor agencies, respective governments or else by the HISP itself. The resource personnel however were usually funded by the organization.

From the organizations' point of view, it was vital to maintain the quality of training and the opportunity for networking through such academies. In the beginning however, around 4 to 5 members of the organization took part in these training programs although with time, as the costs rose, the local partners and rather limited representation from the organization became the norm.

The e-learning system was launched in late 2011 and its first iteration was as a parallel learning tool to the East African dhis2 academy. Given the technical constraints and the lack of preparation from the side of both the trainers and the participants, in its first iteration, the e-learning system merely functioned as a data repository and a self-learning tool for those who desired so. Since then the e-learning tool became part of the dhis2 academies on a regular basis. With each "blended-learning" iteration [1/2 week(s) of e-learning and 10 days of face-to-face learning], the design and its approach was adjusted based on the feedback and the requirements from the face-to-face academy. In general, the e-learning tool was accepted as a sensitizing and community building method supplementary to the face-to-face academy. Over time, this approach and the e-learning tool gained interest from regional partners of HISP in Asia and in South America who used it to facilitate regional and country specific training initiatives.

During each iteration, steps were made to attract members of the organization towards the design and moderation of the e-learning tasks. Before each academy, relevant members of the organization had informal discussions on-site and via email in order to determine the requirements expected to be met through the e-learning system, which further contributed to the design alterations of the e-learning tool.

5. DYNAMICS OF INTRODUCING AN E-LEARNING TOOL

Before the introduction of the e-learning tool in 2011, the e-learning system (the Moodle) was already in place although it was not utilized for training purposes due to time constraints required for its development, and the lack of understanding with regard to its functionality. Or else, it might be that Moodle was perceived as just another IT artifact, which did not encapsulate an acceptable social meaning to the trainer community.

5.1.Encapsulation of social meaning

In fact, some of the statements made by interviewees did indicate a potentially undesirable social meaning projected by the e-learning tool as they were classified into themes such as misinterpretation, conflict, intrusiveness, doubt and bad faith. One example is the statement made by one of the developers,

> *"...Moodle looks promising but it has to compete with others...such as mailing list for instance."*

Another is,

> *"it would be difficult for Moodle to even think of giving the participants the sense of togetherness as in face-to-face training",* which was expressed by one of the implementers.

And also the statement given by one of the researchers,

> *"its nicer to have the training material within the software itself, I mean then the users don't have to be at a different location [pointing to Moodle] to learn",*

among several others, which misinterpreted the pedagogical approach used in e-learning with a 'user guide'. On the other hand, statements such as,

> *"...you know I work one to one with these people and I don't think I could teach them how to use [the HIS] without physically being there...",*

stated by another developer, indicated that the e-learning tool had been perceived as being intrusive on the ongoing practices. In addition, the intrusive nature of the e-learning tool became further apparent from the statement made by one of the implementers/academic,

> *"e-learning has the potential to replace what we have been doing and in reality, that means that some would not be able to gain experiences going to the field or else gain an extra income doing such work",*

which shed light to a more humanistic aspect of the potential adopters. Such statements and the fact that most adopters being well conversant in IT and capabilities of Moodle, made a strong case for projecting a poor social meaning by the e-learning tool. This may be one reason for the sluggish early adoption as experienced by the lead researcher.

In a way, this was a scenario comparable to that of Lord Listers campaign described earlier. In that, Lord Lister promoted the antiseptic technology by dwelling on killing the germs, which in his words were brought into the wound by the surgeons. However, he did not emphasize on the susceptibility of the patient (Fox, 2011). This story re-iterated an important aspect of the boundary phenomenon, which is the possibility of a boundary object to exist in two morphologies, positive and negative. In a way, the e-learning tool also attracted a negative social meaning which made it to be a negative boundary object for certain members of the group.

5.2.Implications of the encapsulated social meaning and inherent qualities of the e-learning tool

In a scenario such as that described earlier, which remained unchanged throughout the study period, it wouldn't have been viable for e-learning to rise against the tide and project itself as a standalone training platform. If that was the case, it may have had to suffer the same consequences as the antiseptic technology in its early days. In fact, members of the training community within the organization had their own individual perceptions regarding the usability of e-learning and what it is capable of doing. For instance, one of the academics asserted that

> *"e-learning can be used as a tool to build the culture of IT use among those who are suppose to be trained in HISs through academies",*

while another implementer expressed that

> "*it [the Moodle] will be a great place to store learning material….like a repository…for the academies and for later use*".

In fact, in many iterations of dhis2 academies discussed earlier, the e-learning platform was used particularly for this purpose, as a repository of training material. In addition, organizers of these academies also used the e-learning setup to hold quizzes and capture feedback from the academy participants. These represented unintended consequences or side effects of the e-learning system. In other words, these side effects may be interpreted as efforts by its users towards finding solace with the training tool, which is now at their disposal. In the analysis, these efforts were classified as 'negotiation' with the e-learning tool.

However, it may not only be the social perceptions that leads to a boundary object being classified as 'negative,' but also certain characteristics of the object itself. Prout (1996) describes the introduction of the metered dose inhaler (MDI) for asthma patients, which at the beginning gained widespread criticism from the doctors. The reasons was that unsupervised use of the MDIs would harm patient safety. However, at a later stage, the innovators of the MDI made necessary changes to its structure and functioning which contributed to its successful adoption. Similarly, with regard to the e-learning system, modifications such as inclusion of video demonstrations, online assignments, and awarding of certification to its participants were done during its iterative implementation. These actions can be claimed as efforts towards preventing it from being a negative boundary object because of its artifactual properties.

5.3. The emergence of 'blended-learning' as an epistemic object and the perceived 'solidity' of the boundary object

From a different point of view, situating e-learning as part of the dhis2 academy, which was a face-to-face training, changed its image from being an IT artifact to a learning tool. This can be understood through statements such as the one made by an implementer cum academic,

> "*the e-learning is basically competing with the e-mail lists…however, because it can be customized to different contexts, it provides us [the organization] with the potential to address different issues through the e-learning system and allow the face-to-face academy to focus on more important aspects needing close interactions.*"

In fact, positing the e-learning system as a blended-learning strategy, which supplemented the face-to-face academy, made it a positive boundary object. It not only enabled the e-learning system to run successfully hand-in-hand with the face-to-face training but also attracted external trainers. As pointed out by Fox (2011), the social meaning projected by the e-learning system alone could have been somewhat intrusive on the training community while its re-organization as 'blended-learning' made it less intrusive on the existing practices without necessarily losing its credibility as a potential replacement for future training, as and when necessary.

At the same time, when looking at the process of introducing the e-learning tool, there were two main propellants. One was the practical need of the organization to have the capability of teaching at a distance and the other was the research purposes of the lead author. Therefore, the e-learning tool was at the centre of scientific inquiry. While at the beginning, the e-learning form generated tensions as described earlier, it managed to operate at the intersection between various communities. By doing so, it [the e-learning tool] gained the properties that would define it as a boundary object. However, with the re-interpretation of the e-learning tool as blended-learning, it generated more questions as to what should be blended? How should the blend take place? In what proportion?...etc, which indicated the openness and the complexity associated with the conceptualization of 'blend'. Some of the statements made by the interviewees such as,

> *"...it is interesting to play around with Moodle in different academies in order to see what is the right blend"* [by one of the developers]

> and,

> *"...you never know how we might be able to use Moodle with our workshop [referring to the face-to-face academies] and...you know that's one strength of the online learning platform"* [by one of the academics-cum-implementers], also highlighted this fact.

When considering these questions, its associated openness and the unintended consequences discussed earlier, it can be argued that the so-called 'boundary object' gave rise to a different ontology, which is the 'blended' epistemic object (Rheinberger, 1997, Cetina, 2001). Amidst the epistemic inquiry and the materialization of blended-learning, the e-learning tool however, remained rather 'solid' evolving with the changing needs. In fact, the materiality of the e-learning tool did not change throughout the exercise but instead, its utilization in the form of blended-learning (a knowledge object), continued to dominate and unfold in different forms.

6. CONCLUSION

Taken as a whole, the e-learning tool could be seen to have traversed several boundaries formed as a result of a group of professionals belonging to several CoPs coming together to provide training. Its role as a boundary object varied from being negative to positive throughout the study period. However, the emergence of the epistemic ontology of the object in the form of 'blended-learning' meant that its acceptability, usability and adoptability improved over time. As a result, it [the e-learning tool] can now 'float' easily with less tension but with the added potential to benefit from the continuous evolution of its epistemic metaphor [the blended-learning]. This however was not the end of the story as the boundary object is now 'burdened' with the fact that it may never achieve its true potential [being able to replace the existing methods of training] unless its epistemic counterpart evolves to a degree in which the two acquire the same morphological characteristics.

For the practitioners of HIS implementations and training or else for those who are intending to use e-learning for training in similar contexts, the findings would provide a theoretical underpinning for an almost reflexive acceptance of e-learning as just a 'supplementary' training tool. This would mean that the time spent on dealing with the tensions of adopting e-learning can be minimized and that the path towards developing an acceptable e-learning program would be clearer. In addition, the findings contribute to a different conceptualization of blended-learning as the paper positions the same in a different plain [epistemic in nature] to that of e-learning. This conceptualization opens up a new avenue for further research as it deviates from the rather simplistic perception of blended-learning being just a mix of e-learning and face-to-face learning.

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V

FROM ONLINE LEARNING TO CULTIVATING COMMUNITIES OF PRACTICE IN FREE AND OPEN SOURCE HEALTH INFORMATION SYSTEMS: A MODEL FOR LOW AND MIDDLE INCOME COUNTRIES

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ABSTRACT

Many attempts at implementing health information systems (HISs) in Low and Middle Income Countries (LMICs) have failed to mature or scale into desirable levels due to various reasons. Among these reasons, not identifying the design reality gap, inability to form support networks and non-availability of 'hybrids' who can link between health and information systems domains by being culturally sensitive can be highlighted. In organizational contexts, such challenges can be overcome by cultivating communities of practice (CoPs). However, HIS projects in LMIC contexts may not have the opportunity to create an environment similar to an organization to facilitate cultivation of CoPs. This paper argues that HIS projects in LMICs can utilize formal, informal and workplace based online and face-to-face training methods along with the networking power of free and open source software (FOSS) communities as a means of cultivating CoPs. In substantiating this argument, the paper utilizes a mixed method longitudinal study design to follow-up a group of implementers trained in a FOSS HIS in Sri Lanka. Based on insights gained through social network analysis (SNA) and qualitative methods, the paper presents a practical model that could be used for implementer training by HIS trainers in LMIC settings to facilitate cultivation of CoPs. The paper also contributes by extending the conceptualization of 'cultivating CoPs' beyond organizational contexts.

KEYWORDS: Health Information Systems, online learning, workplace based learning, formal learning, informal learning, low and middle income countries, social network analysis, cultivating communities of practice, free and open source software,

1. INTRODUCTION

In Low and Middle Income Countries (LMICs), health information systems (HISs) have been recognized as a key facilitator of better and equitable health care (Nolen et al 2005, Warren et al, 2013). However, not many HIS implementations end up being successful or being able to move beyond pilots in these countries due to different reasons even when infrastructure, technology and funding remain adequate. Among these reasons, inability to create support networks (Braa, 2004), failure to address the design-reality gap (Heeks, 2006), absence of 'hybrids' that can bridge between health and information systems domains (Heeks, 2006) and not being sensitive to socio-political, socio-cultural and socio-technical factors within LMIC settings (Avgerou, 2008) can be highlighted. When free and open source (FOSS) HIS solutions become much sought-after in LMIC settings, the need to address these issues become even more important as these systems need contextualization to facilitate local care pathways (Pollock, Williams, and Procter, 2003).

When organizations tasked with implementing HISs in LMIC settings have to deal with creating support networks, effect innovation, bridge between various knowledge domains and cater to contextual elements, one approach is to cultivate communities of practice (CoP) (Wenger, McDermott and Snyder, 2002). In cultivating CoPs, one of the keystones is to manage participation of different members of the organization (Handley et al 2006). From the point of view of HIS implementers in LMIC settings however, there aren't many opportunities available for them to impart participation towards collaboration building amongst HIS staff, between HIS staff and other stakeholders, and between HIS staff and the global expert community as in the case of FOSS HISs. Nevertheless, training may be one opportunity, which can allow HIS implementers the chance to facilitate the desired participation amongst target groups.

This paper argues that HIS implementer training can be made to facilitate cultivation of CoPs in LMIC settings by linking formal and informal online, face-to-face and workplace based learning and the strengths of FOSS communities in a methodical manner. In substantiating its argument, the paper brings to the forefront empirical evidence from a multi-modal FOSS HIS implementer training initiative aimed at a group of medical professionals in Sri Lanka. Based on its analysis, the paper makes a practical contribution by formulating a model for HIS implementers and trainers that could enable cultivating CoPs among target groups. The paper also makes a theoretical contribution in the form of extending the conceptualization of cultivating CoPs beyond the organizational context.

2. AIM AND OBJECTIVES

The aim of this paper is to 'link different learning strategies (formal, informal and workplace based learning) via a blended approach (online and face-to-face) in facilitating the cultivation of CoPs among implementers trained in FOSS HISs in LMIC contexts'. Towards this end, the paper will focus on three objectives, namely; describe the strategies that can be utilized to link formal and informal learning in relation to HIS implementer training in LMIC contexts, identify methods in which learner participation can be enhanced during FOSS HIS training

initiatives, and determine strategies that would facilitate building sense of community among HIS implementers of LMIC contexts.

3. STRUCTURE OF THE PAPER

This paper will next present relevant research pertaining to HIS training in LMIC settings, use of distance online learning in HIS training, different aspects of learning (formal, informal and work-based learning), cultivating CoPs and community building around FOSS. Following presenting the relevant research, the paper will describe its methodology and the research design. This will be followed by a phase wise description of the emerging themes and findings which will lead to a discussion about how the emerging themes narrate the story 'from online learning to communities of practice'. In the conclusion and recommendations, the paper will highlight its theoretical contribution of extending cultivating CoP theory beyond organizational context and will propose a model that can be used by HIS implementers and trainers in facilitating implementer training programs in LMIC settings.

4. RELEVANT RESEARCH

Following the free and open source movement, many organizations took the initiative to design, develop and distribute open source software pertaining to different technical domains. Health is one such domain where open source applications have made a mark (Weber, 2004, Delp et al, 2007, McDonald et al, 2003). This is more prominent in the developing contexts where financial and technical constraints impede the design, development, implementation and scaling of HISs (Mutale et al, 2013). However, with FOSS HISs, there need to be enough local capacity to meet the challenge of contextualizing the software, the training given and its utility, which can otherwise widen the design-reality gap as described by Heeks (2006). In order to minimize the said design reality gap, it is necessary to streamline the HIS functionalities with the business needs of health programmes (Hewapathirana and Rodrigo, 2013). One solution is to create 'hybrids' (Heeks, 2006) who are able to understand both the technical and the business ends of the FOSS HIS. However, creating hybrids per se would not allow harnessing the benefit afforded by FOSS, which is to harness the enormous amount of knowledge accumulated within FOSS communities, in terms of software development, customization and technology translation (Nhampossa, 2005).

4.1.HIS training in LMICs

When it comes to HIS training in LMICs, different levels of users would require different types of training (Braa et al, 2007). For example, Braa et al (2004) suggest those who are at district or provincial level should be able to use HISs innovatively and thereby would benefit from a masters level training, preferably in health informatics. At the same time, Health Matrix Network (HMN) indicated that in addition to training, implementers of HISs should also look into remuneration and career development of the trained staff, if HISs are to be successful in LMIC settings (Whittaker, Mares and Rodney, 2013). The issue of inadequate training pops up in most literature discussing HIS implementations in LMICs with some arguing that lack of skilled personnel have been a limiting factor in migrating from legacy systems to modern HISs (Mengiste, 2010).

While HIS training in LMIC settings haven't exactly focused its attention on initiating CoPs, health sector as a whole has seen such attempts centred around disseminating evidence based practices and promoting healthcare innovation (Li et al, 2009, Mold and Peterson, 2005). Experiences from these attempts have indicated that healthcare professionals tend to rely on long training histories and institutional affiliations when it comes to gathering common purpose (Amin and Roberts, 2008). Interestingly enough, significant proportion of high-end HIS users and implementers in LMICs are also health care professionals (Heeks, 2006) who are assigned with the task of managing HISs.

4.2. Using online learning in HIS training

The use of online learning for training HIS users and implementers is not common. However, Siribaddana (2014) suggests that online leaning is in-fact a plausible training tool in LMIC settings, particularly in conducting short-training programs that need to generate participation and knowledge creation. However, online learning or e-learning on its own may not cater to the learning needs in such settings. Thus, as pointed out by Siribaddana, Sahay and Kaasbøll (2015), trainers of HISs may have to consider a blended approach, which is defined as a combination of online and face-to-face training, in order to facilitate smoother adoption of such training initiatives. In fact, Garrison (2011) points out that most of the e-learning initiatives are in fact 'blended learning' initiatives, which fall within a continuum between fully online and face-to-face learning.

When considering FOSS networks or electronic networks of practice (Wasko and Faraj, 2005) for that matter, contributions made by the members of its discussion forums have been recognized as the key reason for its success. The contributors to these networks do so not because of monetary gains, but because of the professional recognition that they receive, the experience that they have to share and because they are embedded within the given network (Wasko and Faraj, 2005). Even in relation to online learning, the current discourse is mainly focused on collaboration building and creating a more interactive learning environment (Palloff and Pratt, 2007), which allows students to self-reflect. Mezirow (1990) recognizes learning activities that facilitate interaction and collaboration building as 'transformative learning' and states that such learning enables the students to shed constraints of limited perspectives towards real world problems. However, Cranton (2006) emphasizes that unless the learning environment provides students with the necessary material and opportunities for dialogue, it would not be possible to achieve critical reflection on both the material and on one's own self.

4.3. Formal, informal and work-based learning

In modern day education, the importance of shifting away from the traditional classroom learning has been emphasized both at higher education and in work-based training (Leadbeater, 2000). The classroom based learning or the learning that depends on clearly defined curriculums, aims and objectives, timetables, teaching and examinations, is known as 'formal learning' (Colardyn & Bjornavold, 2004). In contrast, 'informal learning' or 'work-based learning' is perceived to be having haphazard, opportunistic and non-rigorous

processes and structures of learning (Swanwick, 2011). However, in recent times, a middle path known as non-formal learning has been identified as a learning modality with its own pedagogy and process (Eraut, 2000, Werquin, 2007). For instance, in medical education, it has been recognized that medical students who undertake longer and more engaging clerkships in ward settings would gather a more holistic appreciation of ill health, patient centeredness and an enhanced professionalism when compared to students who are undertaking short clinical rotations (Holmboe et al, 2011). This however does not mean that traditional curriculum or classroom teaching can be replaced through full time informal or work-based training. The reason being that from an industrial relations perspective, work-based learning would not necessarily be under the control of the learner but instead it would be driven mainly by the needs of the workplace (Evans, Guile and Harris, 2010).

While informal learning is increasingly becoming an essential part of professional training in most fields of study, the task of integrating informal learning in formal learning programs remains a challenge (Svensson, Ellström & Åberg, 2004). In fact, opportunistic or reactive learning taking place in the workplace may usually remain tacit, disconnected with other knowledge and embedded to the context in which the learning took place (Rice and McKendree, 2014). This would mean that recalling such knowledge, sharing, and applying it in different contexts may become practically impossible. Application of learning technologies in the form of online learning to form online communities could potentially prevent such a scenario as it can allow learners the opportunity to reflect and share what they have learned, and thereby generalize the learning to build the necessary cognitive schema (Derry, 1996).

4.4. Cultivating communities of practice

A community of practice (CoP) is a group of people who share a concern or passion for something they do, and learn how to do it better as they interact regularly (Wenger, 1999). These groups are characterized by a shared domain of interest, a sense of community and a shared practice (Wenger, 1999). Generally, these three characteristics would benefit both the members of the CoP and the organization within which the CoP thrives. For instance, members would be able to resolve practice related issues by harnessing the knowledge within the CoP as against depending on outside interventions. At the same time, members would also be able to develop their own professional identity, build a professional network and improve their marketability (Millen, Fontaine and Muller, 2002). From the organizations point of view, CoPs would enable problem solving, time saving, generate synergies across units, reuse resources, innovate, retain talent and also to keep abreast (Wenger, 2002). In an era where approach to knowledge economy is the driving force behind most successful organizations (Leadbeater, 2000), CoPs would be the right tool to harness the organizations potential to compete. However, attempts at forming CoPs artificially often result in failure as establishing a common interest, sense of community and a shared practice take time and sustained interactions among members (Wenger, 2002), which should usually take place naturally, spontaneously, and in a self-directed manner (Wenger, 1999).

However, while acknowledging the difficulty in designing a human institution such as a CoP, Wenger et al (2002) argue the possibility of organizations to cultivate CoPs by

adhering to certain principles. One of these principles is to 'design for evolution', which indicates that CoPs will evolve when certain catalysts are in the right place at the right time. 'Open dialogue between inside and outside perspective' is another principle. Thus, as argued by Wenger et al (2002), while insider perspective will guide members towards generating an understanding about the community and their own selves, the outsider perspective will enable the community to realize its full potential. Facilitating different levels of participation is another principle. In that, Wenger et al (2002) recognize three main groups of participants, the active core group, the active auxiliary members, and the members who remain in the periphery. In addition, there also exists another group of participants who are not necessarily part of the CoP but is interested in the activities of the CoP. It is the dynamic interaction between these groups that would facilitate evolution of the community and knowledge creation. In addition to these principles, cultivation of CoPs also entails paying attention to principles of public and private community spaces, a focus on value, combining familiarity and excitement as well as on creating rhythm for the community (Wenger et al, 2002).

4.5. Community building around FOSS

The emergence of FOSS has radicalized learning in a way, which emphasizes the importance of participation even more. For instance, Whitehurst (2009, p.70) states that "*Open source amplifies a 'hands-on' approach to learning by connecting students to a community of users in an effort to solve problems*." According to Morelli et al (2009), it [FOSS] promotes ethics of sharing and collaboration in the educational process. Thus, FOSS allows students to engage in real world tasks and in active learning. In the eyes of Sowe and Stamelos (2007), this means that FOSS functions as a model for creating self-learning and self-organizing communities, which closely resembles a CoP.

5. METHODOLOGY

This study was part of an ongoing action research initiative and it can best be described as a mixed method longitudinal study (Greene, Caracelli and Graham, 1989, Creswell, 2013). It is described as a mixed method study because it utilized both social network analysis (SNA), which is predominantly a quantitative method, and other qualitative strategies. The study made use of SNA because it can facilitate studying patterns of interaction between members of a given network (Laat et al, 2007), which is also the focus of this study. According to Scott (2012) and Wasserman (1994), it also focuses on formation of networks, emergence of communities of practice and participation among community members, which align with the objectives of this study. This decision was further strengthened by the fact that a previous study carried out by the lead investigator (Siribaddana, 2014) revealed the usefulness of SNA in analysing distance-learning initiatives to provide HIS training in LMIC settings. However, the study perceived that SNA alone cannot provide enough insights to the quality of the formed links within an emerging social network (Mayer, 2004). Therefore, the study also adopted a qualitative strategy when collecting and analyzing its data. In addition, given the nature of the phenomenon under study, the study had to follow-up its participants for a lengthy period of time over several phases. Thus, the study can also be classified as a longitudinal study (Saldaña, 2003).

5.1.Empirical setting

The empirical setting for the study was a HIS training program carried out by the health information systems program (HISP) network (a network of independent organizations formed around the development, implementation and research of the open source health information system, DHIS2) aimed at a group of medical professionals who were following a master's program in health informatics at the University of Colombo, Sri Lanka. These students were selected from amongst medical doctors working within the Ministry of Health in Sri Lanka and were expected to take up lead roles in government initiatives to introduce information technology into the health care system including the implementation of HISs. As part of their program, these students had to undertake a health information project for their master's thesis. Therefore, during their second year, they were introduced to DHIS2[1] as a potential HIS that is usable for their masters project. The focus for this study was the online and face-to-face DHIS2 training provided to these students, subsequent uptake of their projects and work placements following completion of their training. The study was conducted in phases over a 12 – 14 month period and a batch of eleven students were followed-up from training to their work practices.

Phase I – Online and face-to-face training in DHIS2, conducted in collaboration with HISP, India. (December 2013 and January, 2014)

In phase I, the students were first exposed to a one-week online training program in DHIS2, which was designed as an introductory program before they are exposed to DHIS2 face-to-face training in India. The online training was the first instance where the students were exposed to DHIS2. During the online training, students were asked to participate in a discussion forum moderated by several DHIS2 experts from Sri Lanka and India. The discussion forum consisted of fixed discussion threads relevant to the online learning. The participants were not allowed to post their own threads but were asked to discuss their questions within the relevant thread. Following the week long online training, the students participated in a face-to-face training at HISP, India for another one week. While some of the topics covered in online learning were reiterated during the face-to-face workshop, the focus was to have hands-on training and for the students to obtain one to one support from experts from HISP, India. The students were also exposed to used cases from India where DHIS2 implementations have been on-going for several years.

Phase II – Online DHIS2 training conducted in-line with the East African DHIS2 academy conducted by the HISP, Oslo (May 2014)

In the second phase, the training was fully online and it coincided with the two-week online DHIS2 academy conducted for the East African region. The students were asked to follow

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[1] The DHIS 2 is a tool for collection, validation, analysis, and presentation of aggregate statistical data, tailored to integrated health information management activities. DHIS 2 is developed by the Health Information Systems Programme (HISP).

the online content, which was designed for advance DHIS2 users. The students were also invited to participate in the online discussions along with their East African counterparts and the global team of moderators consisting of DHIS2 experts from Norway, East African region, and from Sri Lanka. The focus was for the Sri Lankan students to build networks with the global team and to learn from the experiences of their East African colleagues who already have experience in implementing DHIS2 in different countries. The second phase of training did not have a follow-up face-to-face session.

Phase III – DHIS2 projects and activity within DHIS2 mailing list (May – October 2014)

The third phase of training lasted for 4 to 6 months and there wasn't any formal training programs during this period. It consisted of students undertaking DHIS2 based projects in one of the health care institutions in Sri Lanka. The students had direct communication with local DHIS2 experts in relation to certain aspects of DHIS2 customizations. However, they were introduced to the DHIS2 mailing list (launchpad) and were encouraged to communicate via email with Oslo based DHIS2 experts who are also part of the ongoing Sri Lankan projects.

Phase IV – Evaluation of work practices (January/February 2015)

Following completion of their masters program, the students were assigned to various health care institutions by the Sri Lankan government and during the phase IV of the study, their work practices were evaluated in relation to continued networking with the local and global DHIS2 community and how the training impacted their work practices.

5.2. Data collection

In phase I and II, one source of study data was the discussion forum in the online learning platform. The posts made within the discussion forum indicated connections between two persons. Thus, each and every connection made was considered for the SNA. In all phases, email communications were also used to assess the connections made by the students during the study period. Similarly, the posts made in the DHIS2 launchpad were also utilized for SNA in phase III and IV. In certain instances, connections made by students were also uncovered during the interviews. These connections were also included in the SNA. The content of discussion forum postings, the emails and the posts made in the launchpad were used to assess its implication towards learning, networking and to assess evidence towards evolution of CoPs in all stages whenever these were available. All the students were interviewed after 1 month following their appointments to new work settings. The interviews were recorded and later transcribed in preparation for the analysis. In addition, field notes related to observed group dynamics among the students were also used as data for the analysis. These observations were made during face-to-face lab sessions and classroom sessions at different points in the training program.

5.3. Data analysis

Using the enumerated connections, asymmetrical adjacency matrixes (Scott, 2012) were created for phase I, II and III. These matrixes were then analyzed and visualized using the

Open Source SNA tool SocNetV (Kalamaras, 2010). During the analysis, several measures were used to interpret the SNA findings.

Network Density: This refers to the number of connections made by the actors (students in this case) of a network out of all connections possible between the same actors (Scott, 2012). Network density is expressed as a proportion in this paper and therefore a network that achieves its maximum number of connections would gain a network density of '1'.

Degree Centrality (DC): DC measures the activity of an actor and in this case, it is based on the total number of messages sent by a particular actor (OutDegree). In general, actors with a high OutDegree are considered 'influential' actors within the network, which means that they are able to communicate with more actors and make other actors aware of their views. From the point of view of this study, an actor demonstrating a higher DC can be interpreted as 'more active' than others within the network. Similarly, InDegree refers to the total number of incoming connections to a particular node. It usually indicates the degree of 'prestige' of a given actor within the network and many actors would prefer to have connections with such important actors.

Clustering Coefficient (CO): CO is a measure of the degree to which nodes in the network tend to cluster together (Scott, 2012). In other words, CO of a particular actor in a network indicates how well its neighbouring actors are connected to each other. CO is also expressed as a proportion and therefore it will range from 0 to 1 with 1 indicating neighbours of one actor having achieved all possible connections among each other.

Furthermore, to graphically present these connections, Sociograms (Scott, 2012) were used, which were based on the DC of each actor.

The qualitative analysis was carried out on transcribed text of all relevant discussion forum posts, emails, launchpad postings, field notes and interviews. The data were first looked at for its general meaning before being coded using the eight steps process suggested by Tesch (1990). Coded data were then analyzed further in order to identify the overarching themes emerging at each phase of the study. The SNA findings and the qualitative analysis findings were triangulated in order to justify the emerging themes whenever possible. This enabled the study to establish qualitative validity (Golafshani, 2003) of the study findings. Two researchers were involved in coding and analysis of the data before comparing the identified themes for any deviations. Common themes were selected and agreed upon before proceeding with the analysis. Such an approach was expected to improve the qualitative reliability (Golafshani, 2003) of the study findings.

5.4. Limitations of the study

The fact that the study was not designed to recognize the network building between study participants and those outside the study scope (e.g. IT experts outside DHIS2 community, past students of the masters program...etc.), hindered its ability to fully comprehend the scale of networking undertaken by the students. Furthermore, the fact that the two researchers involved in this study also functioned as moderators of the online program and as supervisors

of student projects meant that students might have not disclosed or have adjusted their statements to avoid any perceived conflicts although they were assured of anonymity of their data. However, such intrusions might have been minimized as the students were interviewed following completing their training program. From an interpretation point of view, the fact that the two researchers being action researchers might have also influenced their interpretations of the study findings. However, through adoption of a mixed method, such influences may have been minimized.

6. FINDINGS AND EMERGING THEMES

6.1. Phase I

During phase I, there were 21 participants (including moderators and invited participants) attending the online training. According to the SNA, a network density of 0.75 was achieved among the online training participants. As demonstrated in Table 1, some students (nodes 8, 9, 10 and 12) have achieved a higher degree centrality (DC) than the two moderators, node 1 and 2. However, amongst the students (nodes 4 to 10, 20, 21), one was not active with a DC of 0 (node 4).

Table 1 : Degree centrality for each participant (Phase I)

Node	DC	DC'	%DC'
1	42	0.0707	7.07
2	43	0.0724	7.24
3	0	0	0
4	0	0	0
5	26	0.0438	4.38
6	22	0.037	3.7
7	20	0.0337	3.37
8	61	0.103	10.3
9	60	0.101	10.1
10	79	0.133	13.3
11	20	0.0337	3.37
12	62	0.104	10.4
13	46	0.0774	7.74
14	40	0.0673	6.73
15	22	0.037	3.7
16	2	0.00337	0.337
17	4	0.00673	0.673
18	0	0	0
19	5	0.00842	0.842
20	20	0.0337	3.37
21	20	0.0337	3.37

Furthermore, the network achieved an average clustering coefficient (CO) of 0.88 with almost all the students achieving a CO greater than the average CO. Based on the DC of each node, Figure 1 depicts the sociogram generated using SocNetV. In Figure 1, the triangles depict the students, circles depict the local moderators and experts, and the ellipses depict the

experts from the region. The size of the symbols depicts the strength of the out-degree and as demonstrated, the students with the highest DC seem to play a central role within the formed network in terms of their connections.
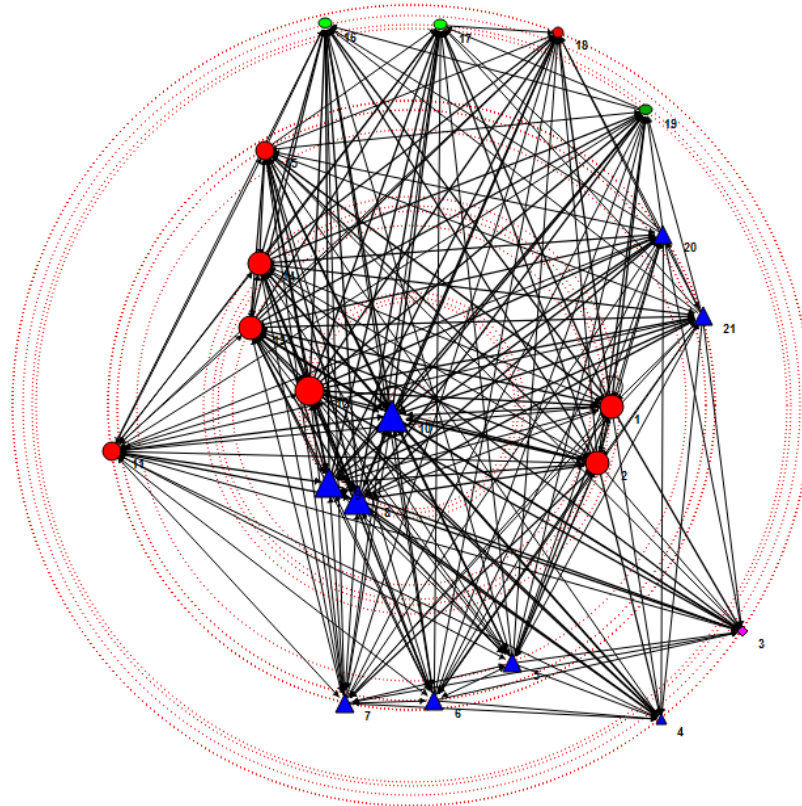

Figure 1 : Degree centrality of the online social network with node-size representing out-degree (Phase 1)

At the beginning of the training, the moderators of the online training attempted to link students with owners of ongoing DHIS2 projects in Sri Lanka in a bid to introduce them to the local expert community. Statements such as, *"...when I talked with Dr <name>, I realized the problems that they had in terms of design and implementation..."* [one of the students] and, *"...no matter how much I studied, I didn't realize how DHIS2 would be helpful for me until I saw what Dr <name2> has designed for the program..."* [one of the students], indicate that to an extent this attempt had succeeded.

In fact, one of the project owners (node 13) accepted the invitation to moderate the online discussions and based on in and out-degrees (in-degree=32, out-degree=42), it is apparent that students interacted with him as much as they did with their colleagues and with the moderators. The discussion forum became a window of opportunity for the students to gain insights to ongoing projects, become aware about political nature of ongoing implementations, and to be informed of important stakeholders and actors within the local HIS circle. For instance, insights such as, *"...the ministry has implemented a process of integrating HISs under the control of <designation>....so you [student] will have to work with other HISs to get things inter-connected...."* [a project owner], *"you [student] need to obtain permission from <designation> in order to conduct an implementation in any health institution"* [local expert], and *"..if you can drop me an email I can send you all the details regarding the project so you will better understand what needs to be done"* [local expert], are

some examples of the online forum being a window of opportunity. These statements indicate students gaining 'contextual awareness' in relation to their potential work environment, which was recognized as an emerging theme.

Another interesting observation during the online discussions was that students were trying to build on their existing knowledge regarding health care setting and information technology. However, they needed to make sure whether the learning is worthwhile for their future. Statements such as, "*Will DHIS2 be able to cater to our setting..*" and, "*Do we need expertise in DHIS2 as it seems like the job of an IT person*", posed by students epitomized these concerns. In fact, they were searching for their 'identity' within the HIS community. However, having 'one of their own [doctors who have become HIS experts and project owners] explaining to them the usefulness of learning HISs made them aligned with the learning process as understood by statements such as, "*..I didn't understand the role we should play in HIS implementations until Dr <name> explained to us what he had been doing....*" [student] and, "*I was thinking whether I should take part in Moodle as it seem to be a waste of time but I realized its importance after having a chat with him [a project owner]*" [student]. Given the recurring emphasize towards identity formation, it was also recognized as an emerging theme.

Another emergent theme during phase I was the craving by the students to be part of the 'global community' or embrace 'globalness'. It was recognized that this craving was not necessarily emergent because of the global recognition of DHIS2, but it was because the students needed variance in their experience and global knowledge regarding HISs. For instance, students mentioned that, "*We don't have enough expertise here if we try to implement DHIS2 and if we need a small change done to the software*" and "*Sri Lanka don't use much HISs and we can't learn on implementation issues unless we ask someone from Africa or India for that matter.*" The fact that regional experts shared their experiences, rather than expertise, it seems to have made an impact on students perception of HISs. This can be realized from student statements such as, "K*nowing that there would be help available, as DHIS2 is a FOSS, it is less riskier for me to use it..*" and, "*..the more I hear from people outside Sri Lanka about using DHIS2 for HISs, the more comfortable I get..*".
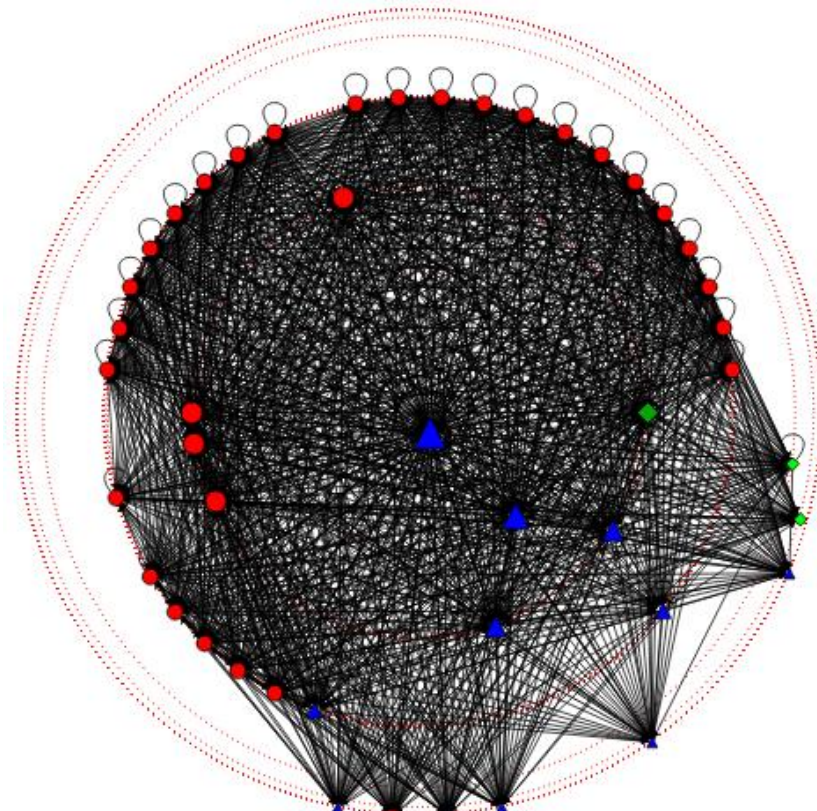
6.2.Phase II

During phase II of the study, the number of participants in the online forum was 46. These included 11 students (nodes 4 to 12, 14 and 15), three moderators (nodes 1,2 and 3) and 31 representatives from the East African region. The overall network density was 0.85, which was higher than the network density achieved in phase I. It was interesting to note that according to Table 2, one of the students (node 9), achieved the highest %DC of 8.54 in phase II while around five students were not active in the network. However, three students (nodes 5,6 and 7) who were comparatively 'less' active during phase I online interactions were seen more active during the phase II (%DC's of 3.97, 2.01 and 5.89 respectively). The student who achieved the highest %DC in phase I (node 10), achieved a %DC of 3.97 in phase II, which is above the mean of %DC, which was 2.17.

Table 2 : Degree centrality for each participant (Phase II)

Node	DC	DC'	%DC'
1	92	0.0393	3.93
2	14	0.00598	0.598
3	4	0.00171	0.171
4	0	0	0
5	93	0.0397	3.97
6	47	0.0201	2.01
7	138	0.0589	5.89
8	0	0	0
9	200	0.0854	8.54
10	93	0.0397	3.97
11 - 14	0	0	0
15 - 20	46	0.0196	1.96
21	95	0.0406	4.06
22	46	0.0196	1.96
23	92	0.0393	3.93
24	92	0.0393	3.93
25	46	0.0196	1.96
26	48	0.0205	2.05
27 – 32	46	0.0196	1.96
33	92	0.0393	3.93
34 - 46	46	0.0196	1.96

The average CO for the phase II was 0.941, which is also greater than the CO of phase I. In other words, it could be argued that nodes in phase II are strongly connected to each other's neighbours than in phase I. Figure 2, demonstrates the Sociogram generated based on the DC data for phase II.

Figure 2 : Degree centrality of social network with node-size representing out-degree (Phase II)

The Sociogram depicts the role played by the students during the discussions and it is evident that those who contributed to the discussion forum seem to have played a central role or are better connected when compared to other participants of the online learning.

During the interaction, it was also evident that common grounds emerged in relation to answering an assignment question, managing complex databases, integrating different database instances and around potential 'bugs'. The importance of these topics was that they were not planned discussions but were discussions evolved based on a problem and continued until they [the participants] found common grounds. For example, one of the students asked the question, "*Is there a way in DHIS2 to re-assign one person from one facility to another...*" to which one of the participants from Africa replied "*..I have also tried to do this but it seems like a 'bug' in the system do not allow such transfers in the current version.*" The two participants were then seen engaging in discussion over their experiences with regard to tracker module of DHIS2 from which the initial question emerged. The discussion attracted several more 'tracker enthusiast' and ended up discussing the future direction of tracker, as illustrated by statements such as, "*..is tracker aiming to be an EMR in the future?*"[one of the students], "*it would have been great to see the tracker helping out in the decision making process...may be with some skip-logics*" [participant from Africa] and "*the curative service provisions are not in the tracker roadmap*" [one of the developers]. Statements such as these indicate the passion shared by these participants with regard to their common interest, the DHIS2 tracker and therefore the theme, 'common interests' emerged.

At the same time, the discussions within the online platform generated 'new links' that would have expanded the students' network. For instance, one of the students posted a query, "*Is there anyone familiar with linking DHIS2 and OpenMRS?*", to which a participant from the African region replied by saying, "*I will send you a link to a person who does that but he is not in the e-learning program*". He followed it up with a link to the person referred, who was an expert in DHIS2 in another country. In another instance, to a similar request from a student, one of the participants replied by saying, "*I have read an interesting article related to your issue and I think it contains what you are looking for <link>*". Thus, linking human and non-human resources outside the social network within the e-learning platform was apparent through the discussion forum and we recognize this under the theme 'connectivist features'.

During the interviews, it was also apparent that students developed their own strategy in interacting with the online discussion forums, which extended to the next phases of the study. The strategy was to discuss issues in a small group and agree on posting the question to the online discussion forum. This was apparent from the statement, "*before we made a post, we used to discuss it among ourselves and if we thought that it need further inputs, we posted it to the discussion forum.*" [one of the students]. While this was not expected by design, it meant that a 'clique' has been formed within the student group, which now tries to fulfil their information needs by reaching out to external parties. We classified such behaviours under the theme, 'cliquing'.

Generally, these cliques were rather small with 2 or 3 members. However, once a post was made, other students, who could have also participated in the discussion face-to-face, would also contribute online. We recognized this phenomenon under the theme, 'expression style' and was corroborated through statements of students such as, "*I knew my friends were discussing certain problems in the lab but I didn't take interest to participate.....but when I saw the question that they were discussing in the online platform I couldn't resist to say what I felt.*"

6.3.Phase III

As explained earlier, phase III consisted of the project work and the interactions that took place within the DHIS2 mailing list and via emails. For analysis, a social network formed by 27 nodes were utilized. Among these 27 nodes, eight represented the students (shown as a triangle in Figure 3), 15 represented 'global experts' (shown as squares in Figure 3) and four represented local experts (represented as circles in Figure 3). The social network formed by these 27 nodes only achieved a density of 0.14 as against 0.75 and 0.85 in phase I and II respectively. However, this can be explained by the nature of the emailing list as against discussion forums used in phase I and II.

Table 3 : Degree centrality for each participant (Phase III)

Node	DC	DC'	%DC'
1	3	0.00929	0.929
2	80	0.248	24.8
3	4	0.0124	1.24
4	13	0.0402	4.02
5	0	0	0
6	23	0.0712	7.12
7	42	0.13	13
8	16	0.0495	4.95
9	58	0.18	18
10 - 11	0	0	0
12	31	0.096	9.6
13	2	0.00619	0.619
14	3	0.00929	0.929
15	1	0.0031	0.31
16	4	0.0124	1.24
17	2	0.00619	0.619
18	7	0.0217	2.17
19 -20	1	0.0031	0.31
21	3	0.00929	0.929
22 - 26	1	0.0031	0.31
27	25	0.0774	7.74

When considering the DC of the students, node 9 achieved the highest %DC of 18 while node 7 achieved a DC% of 13. Node 6 also achieved a %DC of 7.12. Three students however did not gain a DC as they recorded a 0 out-degree. It should be noted that node 9

was considerably active in all three networks with high DC (phase I, II, and III) although node 6 and 7 became more active during phase II and III.

The CO for phase III network was 0.367, which was lower than both phase I and phase II. This indicated that the neighbours of each node in phase III network were less well connected to each other than in phase I and phase II. This could be explained by the fact that in email lists, anyone in the list could have responded directly to the posts made by the students rather than a selected group of experts communicating to all the students. At the same time, because students first discussed their issues among themselves in small cliques before posting, it was only one student who made the post on behalf of several students. Figure 3 shows the Sociogram generated for phase III. In that, it is possible to note that the students have build up connections with both the global and local experts.
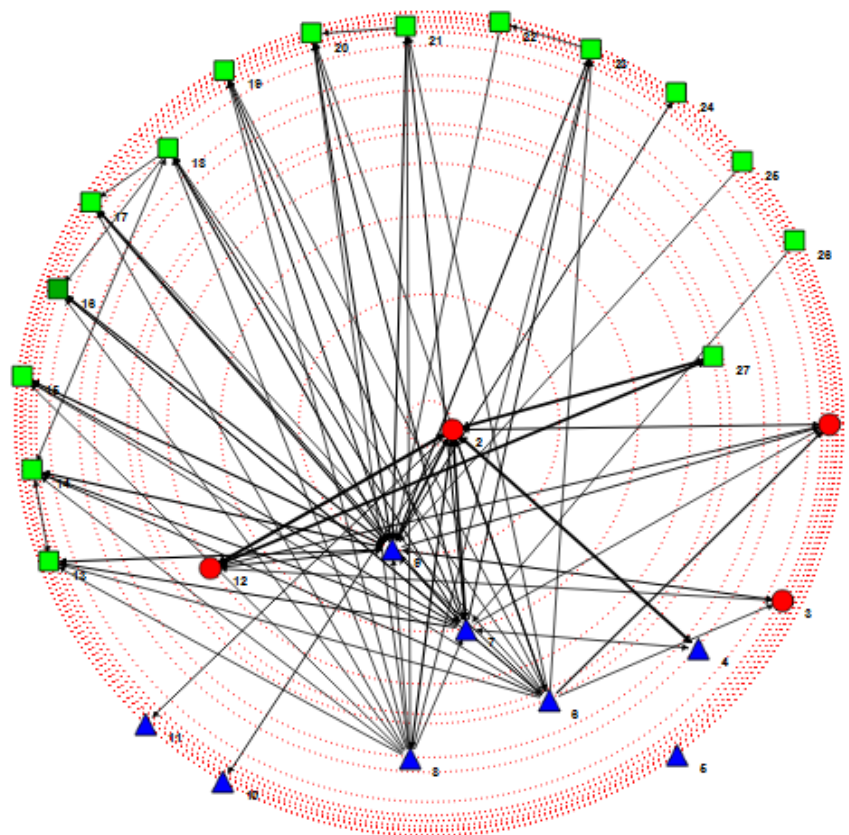

Figure 3 : Degree centrality of social network with node-size representing out-degree (Phase IV)

As expected, the posts made within the emailing list were mostly in relation to technical aspects of DHIS2. However, what noteworthy was that 'cliquing' continued to emerge as the preferred strategy for the students to interact with the global community. One student pointed out that, *"...because we discussed the question among ourselves before we made a post, we were able to gain a useful and a more specific response from the global team....otherwise we would have been asking the same question over and over again at different points in time.",* Another indicated that, *"..although we were doing different projects there were many common issues and most of it were resolved by ourselves and for the rest we needed the developers."*

At the same time, a student who wasn't much active in the mailing list made the remark, "*I managed my project from what I already knew....and if I had an issue, I will first ask from one of my colleagues, then from Dr <name>, then from one of my friends from a previous batch....by that time, I usually resolve my issue.*" Similar remarks highlighted the learning style adopted by the student, and some of the other students for that matter, to manage resources in a pre-defined manner. The approach was based on closeness or accessibility of these resources to the person in question. Even in relation to self-learning, one student pointed out that, "*I usually look at the Moodle and try to search in the web if I have any specific issues. If it is still not clear, I would ask from a colleague or from Dr <name>. The mailing list is usually the last resort.*" Given this general notion of making use of familiar and easily accessible resources, we recognized similar expressions under the theme 'comfort zones'.

6.4. Phase IV

This phase was based on the students experience in work practice soon after their training period. Therefore, the data collection relied upon the interview data. During this period, it was apparent that students have continued their practice of 'cliquing', this time with almost all the members of the group. As stated by one of the students, "*when we received placements I suddenly realized that I no longer have anyone close-by to ask questions....but I was confident as I have enough people to go to via email and mailing list.*"

Another student mentioned that, "*we decided to call ourselves <name> team, as among ourselves, we have the answers to most of our technical issues*". The students, now professionals in health informatics, also indicated that they maintain their own mailing list, which is open only to themselves and to some of the local DHIS2 experts with whom they interacted closely during their training period.

However, they were also keen on maintaining the relationships that they developed with the regional and global community. This was clear from statements such as, "*I keep in touch with <global expert> and <regional expert> through email whenever I need clarifications regarding customization or implementation*"<one of the students>, "*<global expert> told me to talk with <another global expert> for my <issue>*", and "*from time to time I look at the email list and contribute to threads which I find interesting...I think its useful to be part of the community in terms of my work*" <student>. In general, these remarks can be classified under the theme 'sense of community'.

7. DISCUSSION

During different phases of this study, we tried to create opportunities for the students to maximize their participation with different groups of people including DHIS2 experts and DHIS2 users. Findings from the SNA suggest that the students did take these opportunities and some of the students seem to have played a central role in the online interactions.

Table 4 : Comparison between DC and CO of the students in phase I (PI), phase II (PII) and phase III (PIII)

Node	%DC' (P1)	CO (PI)	%DC' (PII)	CO (PII)	%DC'	CO(PIII)
4	0	1	0	0.979	4.02	0.667
5	4.38	0.893	3.97	0.932	0	0
6	3.7	0.893	2.01	0.932	7.12	0.346
7	3.37	0.893	5.89	0.921	13	0.326
8	10.3	0.893	0	0.979	4.95	0.484
9	10.1	0.866	8.54	0.921	18	0.16
10	13.3	0.875	3.97	0.932	0	0
11	3.37	0.893	0	0.979	0	0
12	10.4	0.893	0	0.979	9.6	0
21	3.37	0.893	4.06	0.931	0.929	0

When it comes to the CO of different stages, the strength of clustering became more when the students interacted for the second time in phase II following gaining exposure to the community through phase I (CO of 0.88 in phase II against a CO of 0.75 in phase I). The lowering of the CO in phase III can be attributed to the changing nature of the mailing list as explained earlier. Based on phase IV findings however, it became evident that the cohesion or the grouping amongst the students as observed through CO of phase I and phase II continued beyond phase III and perhaps further established during work placements. However, it would be false to assume that CO per se is indicative of stronger or weaker 'grouping' and networking amongst students. Nevertheless, an improved CO from phase I to phase II along with qualitative findings of identity formation, common interest, cliquing and sense of community over all four phases strengthen the argument that the interactions observed do indicate the formation of a community. Given the fact that these findings seem to extend beyond the training endeavour and that trained students continue to work on HISs as part of their work practice, the community formed was more likely to be a community of practice than anything else.

When considering the background of these students, it is possible to argue that they emerged from several CoPs, which had health care as its knowledge domain. The community that they have been interacting consisted of doctors, nurses, and other health staff. However, during the training, they had a new 'common interest', which was to find methods and utilize DHIS2 for their projects. They also had a new domain of knowledge, which was HIS. These manifestations were shaped at the beginning through formal learning arrangements in online and face-to-face environments. The reason for suggesting formal learning to be responsible for these manifestations was that the said themes were emergent during the early phases of the study, which were dominated by formal learning arrangements. However, these manifestations did not necessarily warrant the group to be called a CoP, but perhaps as a 'learning community' (Speck and Stollenwerk, 1999). Thus, one of the earliest signs of forming of a CoP was students' enthusiasm towards finding their own identity within their new found domain and interest. During the early phases of the study, it was evident that moderators had to facilitate linking between students and other actors within the DHIS2 community. High

DC and high CO of the moderators during phase I and II strengthen this argument. However, in formal learning arrangement, this was expected and was desirable from the point of view of the trainers (Salmon, 2003).

Furthermore, two factors that emerged from the study that may have lead to students finding their 'identity' were, gaining of 'contextual awareness' and the perception of 'globalness'. By being aware about their context, students would have been able to shape their own activities, which is a recognized need in the formation of CoPs *(*Dourish & Bellotti, 1992; Gillet, Helou, Rekik, & Salzmann, 2007). While contextual awareness might have shaped the student activities to a certain extent, the perceived 'globalness' meant that they became aware about the context outside their practice as well. In a way, as pointed out by Gareiss (2001), globalness also enables people to conceptualize relevance of their learning to their own setting. In the eyes of the students, this meant that they have the power and confidence to form and be part of a community by themselves, as external network seems to remain stable, strong and supportive.

At the same time, students formed cliques among themselves in order to deal with the issues arising out of their common interest. By forming small cliques, students have shown that they value sharing their ideas and discussing problems among themselves before seeking external support. During phase III, one reason for the lower CO was the formation of cliques, which made students to interact in the mailing list as a group rather than as an individual. Interestingly enough, the students were networking not only among themselves, but also with the local and global DHIS2 experts. This indicated that students were not intending to work as a close group but as a group wanting to expand their knowledge by being responsive to the ongoing developments. To an extent, this illustrated students' perception that they are novices in DHIS2 and mailing list is a way of establishing their identity within the global DHIS2 community. However, by phase IV, they seem to have distinguished between themselves and the global community as they decided to formally recognize their group as a named community, which is linked with the global community through the boundary spanning members of the group.

While the formation of the CoP evolved over time, there was also evidence indicating the linkage between formal and informal learning. Connectivist features emanating through the study were indicative of this linkage. As pointed out by Siemens (2006), "learning, defined as knowledge patterns on which we can act, can reside outside of ourselves (within an organization or a database), is focused on connecting specialized information sets." This is the fundamental assumption in the connectivist learning theory. During the training, students became aware about where the knowledge reside. For instance, they had the formal learning setting in the form of e-learning platform, which was available for them for reference. They also had a community of regional and global DHIS2 learners to interact with who had practical expertise in LMIC settings. At the same time, students recognized that expert knowledge is available within the mailing list and among themselves to different proportions. In other words, students generated a set of links connecting the formal learning with different informal learning options.

At the same time, students preference to follow 'formal' structures of learning (e.g. e-learning content, moderators), the so-called 'comfort zones', before tapping into the informal learning opportunities (e.g. external resources of learning, regional and global experts). This can also be considered as an approach adopted by students themselves to link formal and informal learning. However, as the learning progressed into phase III, the usefulness of formal learning structures gradually diminished and informal learning modalities became the key learning tools for most students.

Another aspect that needs highlighting was the fact that some students preferred informal settings (e.g. online discussion forum) as against formal learning settings (e.g. laboratory) to express themselves. Recognized by us as the 'expression style', we consider this to be an important aspect as it allowed students other than those directly involved in 'cliques' to take part in the discussions using online tools. In a way, facilitating learning through both online and face-to-face did gave students a choice, allowing greater expression and greater participation.

8. CONCLUSION AND RECOMMENDATIONS

While acknowledging the fact that the group investigated in this study does not resemble a usual group of HIS implementers being trained in most LMICs, the study does points out that a training program incorporating formal and informal online, face-to-face and workplace based training modalities would be able to initiate the formation of a community of practices. However, there are three main goals and areas needing to be focused in the design and implementation of such training programs. The three goals include linking of formal and informal learning, promoting participation and building sense of community. Table 5 depicts these three goals and the focus areas along with implementation choices as a model for HIS trainers.

In relation to linking formal and informal learning, three focus areas were recognized. One is the need to facilitate 'comfort zones' in learning by giving the students enough options to move between formal and informal learning. Second is to design a culture of connectivist learning by emphasizing more on reliable and accessible knowledge residing within regional and global communities. This not only stimulate students to network but also build confidence in them to take up the challenge of HIS design and implementations knowing that support is available at short notice. Thirdly, it is necessary to understand the preference among students in expressing themselves either face-to-face or online, and provide them with the blended option of interaction.

With regard to promoting participation, it is necessary for the students to become aware about their working context through insights from people who they can relate to. At the same time, they should feel that they belong to a society beyond their work boundaries as feeling of 'globalness' encourages students to be proactive in network building and learn from experiences emanating from similar contexts. It should also be pointed out that facilitating different expression styles would also promote participation as it enables students to express themselves.

Last but not least, it is necessary to provide scaffolding for various aspects recognized by the study that enables building of a community. In that, the learning should facilitate generating a common interest and in this regard, assignments, case studies, student projects, themed discussions and even informal chats have the potential to ignite the commonness among the students. Secondly, it is necessary to support students in term of discovering their identity within the context of HISs. However, this has shown to be a gradual process which may not necessarily resemble 'legitimate peripheral participation' as described in situated learning (Lave and Wenger, 1991) at all times. Thirdly, students would form cliques and these cliques would ultimately evolve to become CoPs when students make sense of their learning and work practices. Naturally, such evolution take time and therefore, it is vital that training programs are designed in such a way that students are constantly provided with the necessary scaffolding to form such cliques as much as possible.

Table 5 : Implementer training model for LMIC settings.

Goal	Focus areas	Implementation choices
Linking formal and informal learning	Comfort zones	Online curriculum linked with discussion forums
		Online and face-to-face moderators who are responsive and accessible
		Supplementing curriculum with used cases from similar contexts
	Connectivist approach	Introducing external knowledge bases including user manuals, used cases, videos...etc.
		Actively promote link building between students and experts within discussion forums and in face-to-face learning.
		Introduce students to local and regional project owners.
		Using moderators who themselves are well connected and networked.
	Expression style	Facilitate both online and face-to-face discussions in relation to same learning objectives.
Enhancing Participation	Contextual awareness	Using project owners as moderators in online and face-to-face training
		Designing discussion topics to reflect contextual issues
		Field visits
		Promoting past-students to contribute as moderators
	Globalness	Include used cases from similar contexts elsewhere in the region or globe.
		Facilitate the participation of members from the global community.
Building sense of community	Common interest	Include activities, which generate issues of similar nature for all the students.
		Arrange group sessions discussing various issues
		Design themed discussions based on general issues.
	Identity formation	Create networking opportunities with project owners
		Facilitate participation in live projects
		Utilize moderators with similar background to the students as role models.
	Cliquing	Recognize cliques and facilitate its functioning
		Enable formed cliques to express themselves to others

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