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Proposing an Integrated Research Framework for Connectivism: Utilising Theoretical Synergies

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Abstract

Connectivism is receiving acknowledgement as a fresh way of conceptualising learning in the digital age. Thus, as a relatively new instructional framework, it is imperative that research on its applicability and effectiveness in a variety of educational contexts is advanced. In particular, a high premium should be placed on context-specific research that is aimed not only at developing general principles but also at improving practice in local settings. Thus, developmental research approaches become imperative and as such it becomes increasingly necessary to have models that would assist scholars to understand the learning ecologies of connectivism. This paper therefore proposes a research framework for connectivism that integrates approaches commonly used in online learning environments. The paper integrates the theories of online communities of practice, design-based research, and activity theory to construct a research framework that is characterised by a synergistic relationship between them. It demonstrates the viability of the model by using an example of how it was operationalised in one research project. The framework, whose potential strength derives from integrating already established theoretical constructs, is presented as a proposal with the intention that it will be critiqued, tried, and improved upon where necessary and ultimately become part of the menu of other tools that serve connectivism research.

Keywords: Online communities of practice; design-based research; activity theory; connectivism; developmental research; research framework; Botswana

Introduction

The discourse on connectivism has gradually grown since it was articulated by Siemens (2005) and Downes (2005). In particular, the issue of whether connectivism has a theory status has dominated the discussion (Kerr, 2007; Kop & Hill, 2008). Regardless of whether it is a theory or not there is acknowledgement that it is a fresh way of conceptualising learning in the digital age. Thus as a relatively new instructional framework, it is imperative that research on its applicability

and effectiveness in a variety of educational contexts is advanced. While global principles of connectivism are desirable and need to be continually developed and refined, a high premium should also be placed on context-specific research that is aimed not only at developing general principles but also at improving practice in local settings. Thus, developmental research approaches become imperative and as such it becomes increasingly necessary to have models that assist scholars to understand the learning ecologies of connectivism.

This paper therefore proposes a research framework for connectivism that integrates approaches commonly used in online learning environments. It presents an approach that it is hoped will advance the research agenda of connectivism. To this end, the paper will outline the features of connectivism and articulate how it can be realised through online means particularly through the use of communities of practice. It will then discuss design-based research as an approach that can be used to investigate connectivism in specific settings. An argument will be made for activity theory as an appropriate analysis tool for design-based research. Then the paper will integrate these theories to construct a research framework that is characterised by a synergistic relationship between them. It will demonstrate the viability of the model by using an example of how it was operationalised in one research project.

Features of Connectivism

Before venturing into the articulation of the proposed epistemological framework, it is important for purposes of this discussion to characterise connectivism in terms of its key pedagogical features. These key features, as gleaned from the literature (e.g., Siemens, 2005; Downes, 2005; Kop & Hill, 2008), are as follows.

1. The central idea in connectivism is that of learners connecting to a learning community and benefiting from it while also feeding it with information. The learning community is a group of people learning together through continuous dialogue because of their similar interests.
2. The community is viewed as a node which is part of a wider network of nodes. The networks, which are diverse but connected, support autonomous, diverse, and creative knowledge development.
3. Knowledge is viewed as not only residing in the mind of an individual nor in one location but as being distributed across an information network or multiple individuals. Thus learning and knowledge creation are dependent on a diversity of views and opinions and on access to different information streams or hubs.
4. Information is constantly changing and there is a need to continuously evaluate the validity and accuracy of knowledge in light of the new information.
5. There is an inter-disciplinary connection in the knowledge creation processes particularly in the Internet environment with its dispersed nature of information.

It is important to underline that while connectivism is not limited to the online environment, the versatility of this medium enhances the realisation of the features outlined above. Thus the online environment is a critical vehicle in the growth and facilitation of connectivism.

A perusal of the above features of connectivism reveal that connectivist learning environments are inherently complex not only because they are characterised by networks of individuals, groups, and even disciplines, but also due to their dynamic nature and the fact that they require a continuous (or at least continual) engagement by learners. Consequently, an integration of theories such as communities of practice, design-based research, and activity theory for epistemological purposes is needed to adequately capture an understanding of the multifaceted nature of these learning environments. These theories, as shall be discussed below, play unique yet complementary and overlapping roles in the course of knowledge creation, hence a need for an explicit framework integrating them.

Manifesting Connectivism: Online Communities of Practice

The previous section outlined that connectivism is about connecting to communities and to the wide plethora of available resources in any given setting particularly using the networking capabilities of information and communications technologies (ICTs). Thus, the concept of online communities of practice becomes relevant as a way of manifesting connectivism. Online communities of practice as an instructional approach are being used increasingly in the education and training arena as a way of facilitating meaningful and connected learning. This is a corollary to the opportunities that ICTs offer for people to link up and communicate in ways that were not possible in the past. Communities of practice have been defined by Wenger (1998) as naturally occurring phenomena emerging wherever groups of people in pursuit of a common goal or interests are bound by a common need for knowledge. Thus they are usually characterised by

- mutual engagement of the participants that allows them to jointly participate in activities and dialogue; co-participation is key to defining community;
- joint enterprise which results from shared expertise and negotiated meaning, which primarily defines practice; and
- shared repertoire of communal resources that the community uses to carry out its practice and these include routines, tools, actions, words, and symbols.

These characteristics are indeed resonant with the features of connectivism as discussed earlier. In terms of theoretical underpinnings, the concept of communities of practice is informed at a general level by constructivist perspectives of learning especially those that advance the social nature of learning. However, at a very specific level, the social constructivist theories of situated cognition and distributed cognition are fundamental to this concept.

Communities of practice are known to facilitate learning from a number of perspectives. In terms of Piaget's work, which concentrated on cognitive work, communities of practice have the potential to foster equilibration; regarding Vygotsky's emphasis on the influence of culture and social surroundings on learning, they can be used to foster cognitive scaffolding in terms of supporting the learner to bridge the zone of proximal development gap.

Situated cognition, as discussed by Lave and Wenger (1991) and Brown et al. (1989), is central to the notion of communities of practice. The central idea in situated cognition is that learning is inherently social and is shaped by interactions among people, the tools they use, the activity they engage in, and their sociocultural environment (Hansham, 2001). Knowledge is seen as inseparable from the occasions and activities of which it is a product (Brown et al., 1989). In other words, cognition and context are inseparable entities. With regard to how situated cognition relates to communities of practice, Gasson (1997) has this to say: "...situated cognition deals with how individuals learn to participate within communities of practice and how their development is shaped by the activities in which they engage..." (p. 227). Therefore Hung and Chen (2001) submit that, "...learning from a 'communities of practice' perspective is [also] congruent with recent notions of situated cognition..." (p. 4), where context is fundamentally interwoven with cognition and learning.

Equally important, and perhaps of more relevance to connectivism, is the idea of distributed cognition whose underlying assumptions is that no one person or device is in possession of all the information needed to complete a task or solve a problem (Hutchins, 1996; Winn, 2002). The idea, therefore, views knowledge as being spread across a group of people and the tools they use (Stahl, 2005; cf. Hutchins, 1996). In other words, "...knowledge is distributed among a community of people and devices" (Winn, 2002, p. 341). This idea has already been stated as one of the key features of connectivism in the previous section. According to Hutchins (1996), as cited by Bell and Winn (2000), distributed cognition recognises

- that communication forms the basis of distributed cognition and that knowledge has to be shared in order for it to be useful;
- that shared information is pooled information and it can be used by the best equipped person for the good of the whole team;
- that the components of a distributed system must rely on each other to get the job done.

These elements put emphases on communication and information sharing and on utilisation for learning and productive purposes; this is essentially the hallmark of connectivism. Highly interactive and networked learning environments, such as communities of practice, offer opportunities for these elements of distributed cognition to be realised (Bell & Winn, 2000).

In sum, the argument of this section is that online communities of practice are necessarily a manifestation of connectivism. Therefore the formation and functioning of communities of practice, whether naturally or by design, allows connectivism to take its course. But how can we investigate the different aspects of connectivism? The next section is an attempt to explore this question.

Investigating Connectivism: Design-Based Research

The argument in this section will be advanced on the basis of the observation previously made that online communities of practice are a manifestation of connectivism. Therefore an

examination of the methodological pattern of research on online communities of practice will necessarily give ideas of how connectivism might be investigated.

An examination of the literature on online communities of practice in education (e.g., Schwen & Hara, 2004; Kirschner & Wopereis, 2003; Vazquez-Abad et al., 2004) reveals how studies of this nature are usually carried out. Job-Sluder and Barab (2004) place this literature into two categories. The first category consists of case studies focusing on existing social networks that already have well defined histories, norms, identities, and so forth. The second one is of case studies of attempts to build infrastructure for online communities within a given educational setting and studying the results of that design. While both categories are relevant for our purposes, the latter would be of particular interest in this paper as such case studies offer an all-encompassing opportunity to study the whole life cycle of an online community. This category of studies is characterised by designed interventions in the form of a sociotechnical environment that facilitates interaction. The design of these interventions usually undergoes multiple revisions as it is continually tested in real practice. Strictly speaking, because of the iterative and interventionist nature of these studies, they are more than just case studies. While case studies are characterised by in-depth studies (usually using multiple data collection procedures) of an individual unit (e.g., a student, a class, an organisation) and seek to engage with and report the complexity of social activity (Burns, 2000; Krathwohl, 1998), they do not usually involve any iterative design interventions. The emphasis on iterative design interventions is a unique feature of research on technology-based learning environments. This research methodology is known as design-based research (DBR).

DBR, otherwise referred to as design research (e.g., in Collins et al., 2004; Bereiter, 2002) or design experimentation (e.g., in Gorard et al., 2004), has its origins traced back to the work of Brown (1992) and Collins (1992) in which they each carried out what they termed as design experiments or experimentation. These design experiments were done as a way of carrying out formative research to test and refine theory-based educational designs (Collins et al.; Bell & Winn, 2000). It emerged mainly from the need for new and complex methodologies that could capture the systemic nature of educational activities such as learning, teaching, and assessment (Brown). DBR involves intentional design coupled to empirical (observational) research and to theorising about what takes place in authentic contexts where the designed objects come to be used (Joseph, 2004; Bell, 2004). Theory-informed interventions in the form of technological artefacts as well as less concrete innovations like activity structures or particular curricula are tested in particular situations and thus reveal how, when, and why they work in practice.

The decision to conduct DBR usually comes about as a result of identifying a real-life educational problem and coming up with a theory-informed design intervention that seeks to address such a need. The design "...embodies testable conjectures about both significant shifts in learners reasoning and the specific means of supporting those shifts" (Cobb et al., 2003, p. 11). These design experiments are essentially characterised by improving the initial design through a series of iterations consisting of testing and revision of conjectures during the various phases of the intervention. The ongoing analysis requires direct engagement with the enactment process of the

design intervention through observation, collaboration, and comprehensive record-keeping from the multiple sources of data.

Once the design is refined and seems fit for purpose or otherwise, a retrospective analysis is carried out. This analysis looks at the extensive longitudinal data and gives an historical review that attempts to identify an emergent pattern (Cobb et al., 2003). It looks at concerns related to the adoption (and adaptation) of the intervention by a broader audience. Barab and Squire (2004) say that cases undergo multiple transformations and that the sequence of events and their situational consequences need to be discussed in ways that are globally relevant while capturing the dynamism of the phenomena locally. Therefore, the value of design-based research is that it attempts to meet local needs while also advancing a theoretical agenda (Barab & Squire, 2003).

Thus, DBR has emerged as a methodology for carrying out research on technology-based learning environments. The technological interventions that are usually designed are diverse in nature, and they include online communities of practice.

As advanced earlier, in examining studies on online communities of practice the methodological pattern that seems to consistently emerge is that of DBR. For this reason, Bell and Winn (2000) identify

...a natural synergy between the distributed cognition perspective, for example communities of practice, and the design experiment approach to innovation in that they are both focused on understanding the cognitive interaction between components of a complex system in naturalistic settings. (p. 135)

This is particularly so with regard to designing online environments which sustain or facilitate community interaction. A consistency between the features of DBR and literature on designing online communities includes the suggestions by Barab et al. (2004) as follows:

- A co-participatory and co-evolutionary design approach with the users is essential; and
- There is a preference for minimalist design as opposed to over-designed spaces, which ensures that users are not confused and also means improvements can be incrementally added using feedback from users; in this way, they suggest that a tentative platform should be designed and then the virtual community will evolve according to the needs and agendas of its members.

Thus, on the basis of the arguments advanced in the previous section, the synergy that exists between DBR and communities of practice can be extended to connectivism.

As already explained, conducting DBR involves cycles of enactment and at each stage seeks to understand the learning ecology of the authentic contexts where the designed objects are used. Therefore with every cycle, a thorough analysis is needed so that more refined conjectures can be made about subsequent stages. Moreover a retrospective analysis is required to establish patterns,

principles, and even theories. These processes require an analysis tool that can capture both the dynamism and the complexity of the learning ecology. Activity theory is one such framework, and it is discussed in the next section as a viable tool for analysing connectivism.

Analysing Connectivism at Work: Activity Theory

This section introduces activity theory (AT) and analyses it in terms of its assumptions. It also explores some of the literature where it has been used to study online learning settings. It concludes by making a justification for its use in design-based research.

AT, as we know it today, largely builds upon the work of Vygotsky (1978). It is premised upon the belief that there is a dynamic interrelationship between consciousness (the mind) and activity, and on the fact that they co-exist and are mutually supportive (Jonassen & Rohrer-Murphy, 1999). This theory conceptualises learning as an activity system involving a subject (the learner), the object of the activity, and the tools that are used in the activity. According to AT, human learning is fundamentally grounded in activity (Hewitt, 2004). Thus in studying an activity system, the unit of analysis is the activity, which is described by Issroff and Scanlon (2002) as a "...form of doing directed to an object..." (p. 78). The basic activity system is diagrammatically represented by the small top triangle of Figure 1 where the subject(s) seek to transform an object into an outcome using either physical or mental tools. This transformation of an object into an outcome, according to Hung and Wong (2000, cited in Hung & Chen, 2002), motivates the existence of an activity.

Engeström (1987), convinced that activities do not exist in isolation, introduced the aspect of community to the activity system. Activities are socially and contextually bound so that an activity system can only be described in the context of the *community* in which it operates (Jonassen & Rohrer-Murphy, 1999). The community negotiates the *rules* and develops the customs that describe how it functions and what it believes. Individuals or groups of individuals in these communities play different roles towards the object, that is, there is *division of labour*. This aspect of the expanded version of the activity system is represented by the bottom part of the larger triangle of Figure 1.

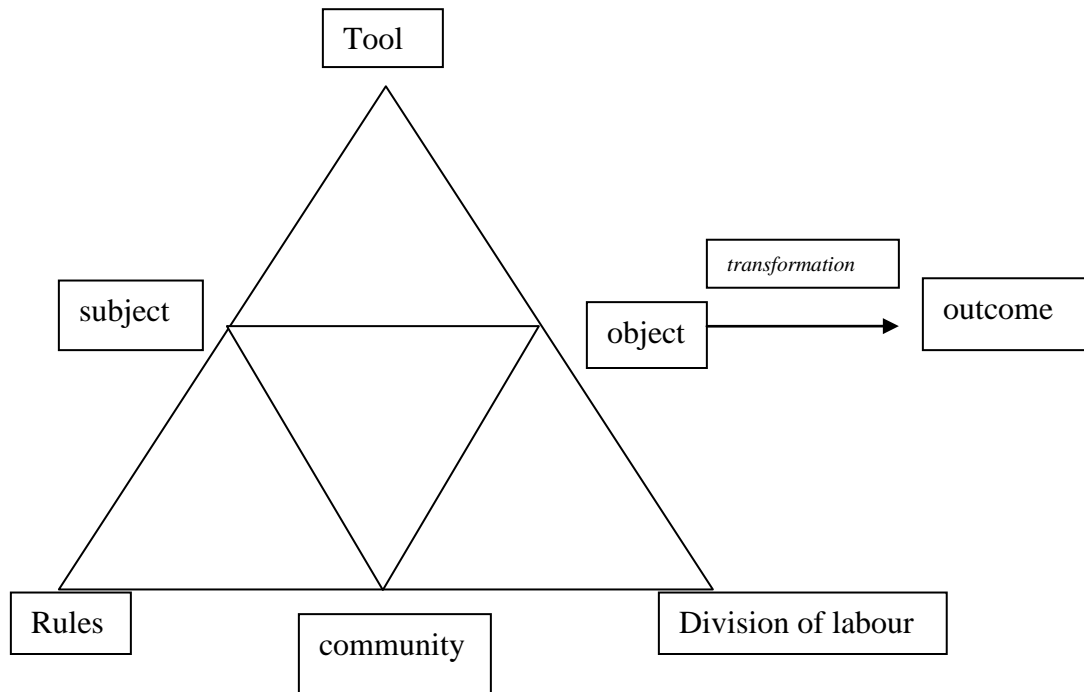


Figure 1. Standard representation of the activity theory framework.

AT operates under certain assumptions (Jonassen, 2000; Jonassen & Rohrer-Murphy, 1999) or principles (Kaptelinin, 1996) as follows.

Unity of Consciousness and Activity

This assumption is considered the most basic principle of AT. The assumption explains the integration between consciousness and activity (Kaptelinin, 1996). That is, rather than separating learning (conscious processing) and activity (mental and physical interaction with the environment or objective reality), AT views them as coexisting and mutually supportive (Jonassen, 2000). A similarity with situated cognition is noted. Therefore, learning is viewed as a transformational process that results from the reciprocal feedback between consciousness and activity. As individuals act they gain understanding and this understanding further improves their actions and so on.

Intentionality

Underlying this assumption is the fact that learning and doing, which are inseparable according to the previous assumption, are initiated by intention. That is, AT “focuses on the purposeful actions that are realised through conscious intentions” (Jonassen, 2000, p. 106). These intentions are directed at objects of activity with the motive being to transform those objects into outcomes. Intentions, therefore, are activity specific and context bound, and they emerge as a result of contradictions that individuals perceive in their environment between what is and what needs to be. This assumption is important because intentionality leads to meaningful learning and in the context of connectivism it is useful to know why individuals connect to communities.

Contradictions

Activity theory recognises the fact that activity systems are not stable and harmonious systems (Yamagata-Lynch, 2003; Cole & Engeström, 1993). The systems are characterised by internal contradictions, which are caused by tensions between their components. That is, when the conditions of one component are in contrast to the working of another a tension emerges that may cause subjects or learners to face contradictory situations that hamper the attainment of an object. Other contradictions may be external in nature where one activity system constrains the functioning of another (Jonassen & Rohrer-Murphy, 1999; Barab et al., 2002; Yamagata-Lynch, 2003). These perturbations or contradictions are what cause activity systems to change and develop (Jonassen, 2000; Barab et al., 2002). That is, activity systems are always adapting towards resolving these contradictions and becoming more stable. One feature of connectivism is that it recognizes the ever-changing nature of information and the need to adapt accordingly in order to resolve the disharmony introduced by such change.

Mediated action

In this assumption it is argued that human activity is mediated by tools or artefacts. These artefacts can be physical, such as computers, or symbolic, such as models, signs, or theories. Thus mediated action is defined by the interplay between agent (subject) and the mediating tool. That is, there is a reciprocal effect between subject and the mediating tool in the carrying out of an action. In this way, while tools can change and shape the nature of human activity, they are, in turn, also affected by it. This assumption has aspects of distributed cognition, which is a key feature to communities of practice and connectivism.

Historicity

According to this assumption, activity is historically and culturally developed (Jonassen, 2000). Therefore, in order to understand the dynamics surrounding an activity, an awareness of how the dynamics have evolved over time is essential. Kaptelinin (1996) calls this assumption “the principle of development” and asserts that to understand a phenomenon means to know how it developed into its current form.

These principles demonstrate that AT has immense power in studying the dynamic interdependence of the individual, social, and cultural influences on human praxis. Thus AT has been suggested as a useful framework for examining ICT-supported learning environments (Nardi, 1996; Kaptelinin, 1996; Hewitt, 2004; Collis & Margayan, 2004; Issroff & Scanlon, 2002). Recently AT has been used widely in this respect. An examination of studies utilising AT reveal that researchers use it flexibly and select and apply principles that best suit their purposes. In other words, a researcher may choose one or more of the principles in their analysis of activity depending on their research intentions.

Waycott et al. (2005) predominantly utilised the principle of mediated action in their study. They used AT to analyse distance learners and mobile workers who were using portable digital assistants (PDAs) for their learning and work activities respectively. They observed a two-way process between the users and their PDAs in which the learners/workers adapted their practice to

the PDAs and in turn their learning and work practices were being shaped by these devices. This finding is consistent with the principle that, “[tools] change the process and they are changed by the process” (Jonassen & Rohrer-Murphy, 1999, p. 67). A study by Issroff and Scanlon (2002) is also of interest in this regard.

On another front, a study by Yamagata-Lynch (2003), which examined a professional development programme for integrating technology into school using AT, was underpinned by the principle of historicity. The focus of this particular study was to gain an historical understanding of the developments in the interaction between participant teachers and the professional development programme over a period of time. The study traced the different stages that the teachers went through and identified four activity systems in the school setting over period of time. Schlager and Fusco (2004), on the other hand, in the context of teacher professional development (TPD) explore the relationship between the activities of teachers involved in TPD initiatives and that of the rest of the school communities where those teachers work. They observe that the two activities can either align or misalign depending on the extent of overlap of professional development project and prior activities in the school. This study essentially investigated the extent of the contradictions between the two related activities and how such tension could be resolved.

A study by Collis and Margaryan (2004) appears to have integrated all of the principles of AT in its attempt to seek understanding of learning in a corporate setting. The authors contend that individual learning in corporate settings is viewed as an expansion of social and intellectual involvement, over time, with other people and the tools available in their culture. They report on how they used activity theory as a framework for design of instruction involving computer-supported collaborative learning and work-based activities in a multinational corporation, thus integrating the strengths of formal and informal learning. In their Health Risk Assessment course for workers in this corporation, the workplace situations specific to each learner became the learning tasks (objects) motivating participation in the learning activity. Work peers, experts in the organisation, managers, and supervisors acted as partners in this activity and provided the necessary support to the learners. The paper concludes by noting that while activity theory-guided design to learning helped in structuring new forms of learning, much still needed to change in the “social climate of the workplace (the community, the rules, and the division of labour) before the potential of the approach will be realised in widespread practice in corporate settings” (p. 50). In this particular study there was clear evidence of how the principles of unity of consciousness and context, intentionality, mediated action, contradictions, and even historicity were used to frame this study.

The above literature reveals a wide range of potentialities of activity theory in analysing complex and diverse learning situations. For this reason AT can be suitably used to analyse the enactment of online interventions, such as communities of practice. Since online communities of practice are largely informed by the ideas of situated and distributed cognition, AT seems to be an appropriate analysis tool as it attends to the social and contextual aspects of learning (Jonassen & Rohrer-Murphy, 1999; Barab et al., 2002; Yamagata-Lynch, 2003). This character of AT also dovetails very well with DBR’s focus of systemically examining learning in naturalistic settings,

particularly how online interventions are influenced by the contexts in which they are enacted and vice versa.

A Framework of Synergies

The discussion in the preceding sections has demonstrated the synergies that exist between online communities of practice, design-based research, and activity theory. The three constructs attend to issues of context, complexity, and culture in very fundamental ways and can thus be integrated to form a framework through which introduction and implementation of ICTs in education could be examined effectively. This discussion has therefore formed a basis for a proposal to integrate the three ideas or theories to act as theoretical foundation, methodology, and analytic tool respectively in the study of connectivism. Thus, a *framework of synergies*, which integrates these three perspectives, is hereby proposed to guide developmental research, primarily, in connectivism. Figure 2 is a diagrammatic conceptualisation of the framework.

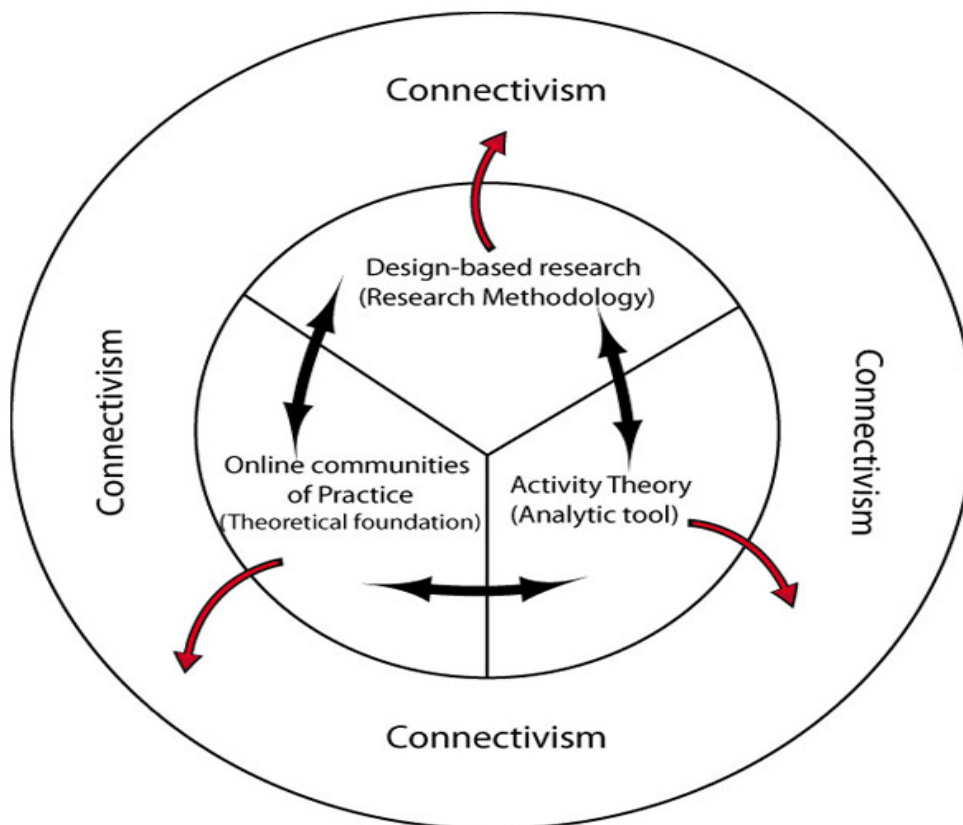


Figure 2. A proposed framework of synergies for conducting developmental research in connectivism.

The compartmentalised inner circle in the diagram shows that each of the three perspectives has a two-way relationship with the others as illustrated by the two-way arrows. They feed into each other for a better understanding of phenomena. A corollary to the functional synergistic

relationship between these three constructs is the growth of understanding of connectivist learning environments in terms of their ecology, hence the arrows feeding into the bigger circle. The framework is dynamic in that it allows a continuous, cyclical, and iterative process of research which may, in principle, start anywhere as evident from the inner circle. It is envisaged that the framework will have high flexibility so that it can be used for studies of different magnitudes: from small-scale research projects to systemic reform initiatives. As earlier argued, such an explicit eclectic framework is necessary if we are to properly conceptualise developmental research that focuses on investigating the complexity of variables and achieve a richer understanding of ecologies of learning in the context of connectivism.

Enacting the Framework: An Example

Enacting this framework is conceptualised as a process that requires creativity and the researcher's latitude depending on the aspects of connectivism being investigated. It is important to underscore that this framework is particularly aimed at developmental research and as such its enactment would be interventionist in nature. The purpose of this section is to demonstrate, with the help of an example of a study from which the idea of an integrated framework emerged, how the framework might be typically enacted. It has to be noted that the example study, which is presented in detail in Boitshwarelo (2007a), was not necessarily conceptualised as a connectivism study. Instead, the study subserviently advanced the course of connectivism because its agenda was about connecting people to one another for professional development purposes. Thus using this example, the general stages that characterise the enactment of this framework are described below.

Understanding the educational situation and conceptualising an intervention.

Just like any developmental research endeavour an analysis of the educational situation would reveal the specific need, challenges, or disconnects that exist in a particular learning environment. This understanding helps in the conceptualisation of an appropriate intervention. Connectivism by its very nature is about connecting people for learning purposes and reducing isolation between stakeholders involved in the learning processes. Therefore the nature of connectivist interventions would be such that they predominantly foster development of learning communities.

In the case of the illustrative study, the setting was a biology teachers' professional development programme run by the University of Botswana through traditional face-to-face workshops at a central venue like Education Centres belonging to the Ministry of Education. The programme, which was sponsored by the Ministry of Education through its Department of Teacher Training and Development (DTT&D), is run once a year during one of the school holidays. The shortcoming of this programme was that once the teachers who are selected by their schools from all over the country to attend these two- or three-day workshops go back to their respective schools they lack support to implement the skills they have acquired. Because of distance and other constraints the teachers are not able to connect to their colleagues with whom they attended

the workshop. It was also discovered that it is not easy for teachers to keep in constant touch with the resource people at the university for continued expert coaching. Given this analysis of the learning situation, it was conceptualised that an extension of this programme through continued online interaction of teachers with both each other and resource people would enhance the implementation of skills that they would have acquired in the workshops. Thus, an intervention that would facilitate an online community of practice among the teachers and their resource person was conceived. Alongside this developmental endeavour, the study was also meant to determine the potential that online learning environments have in facilitating communities of practice among teachers in various schools in Botswana.

Developing and implementing the online community learning environment.

Having conceptualised that a connective learning environment in the form of an online community was necessary, the process of developing it, testing it, and implementing it with the target audience was then actualised. Therefore in the example study, consistent with the principles of DBR, an online intervention founded on the theories of situated cognition and distributed learning was designed and developed to facilitate a community of practice among some of these teachers who attended the workshop.

The online intervention, which was in the form of a sociotechnical learning space, was developed and hosted on WebCT at the University of Botswana. This learning space, which was called Biology Teachers Online (BTO), was developed with the assistance of the Educational Technology Unit at the University of Botswana, following a design statement. The design statement acted as the original blueprint of BTO and included specifications related to design metaphors and media elements as well as instructional approach. In the course of developing BTO, a series of refinements in terms of graphics and other design elements were made before it could be ready for implementation. This involved ongoing interaction with staff of the Educational Technology Unit because of their understanding of the WebCT environment and educational technology use in general. In addition to the physical design, the pedagogical elements of the BTO environment, such as the instructional approach and the selection of content for the resource section, were iteratively developed in consultation with one of the resource people.

The BTO was introduced at the workshop to the teachers, and subsequently further review was made in terms of the nature of the online task for the teachers involved and of the schedule of activities in the online environment. Only 10 teachers out of the over 20 teachers who attended the workshop had volunteered to participate in this intervention. Their primary task was to collaboratively review the worksheets that had been developed at the workshop. These worksheets had been developed to assist teachers in teaching process skills to their biology classes. Therefore as they went back to their schools they were expected to do two things: to interact with their teaching peers and get them to provide their diversity of views and suggest improvements and to assess whether the worksheets could be implemented in their own classrooms. Information emanating from these school-based exercises would then form a basis

for the online discussions. Thus, the online community, BTO, was *connected* to the school communities of the respective individual members as well as to the trainer at the university. Therefore, while the task of collaboratively improving the worksheets was for the BTO community it was meant to benefit from other *nodes* particularly the teacher community in the schools and the classroom environments of the respective members of the BTO. The implementation exercise ran for over two months with the expectation that at the end of that period there would be a tangible product in the form of implementable worksheets.

As evident from the narrative above, the development and implementation of BTO was informed by principles of DBR, particularly the collaborative and iterative nature of the process of refining the intervention.

Evaluating the connectivist learning environment and analysing the outcomes through AT.

During the development and implementation of the online community intervention, an ongoing analysis and evaluation is conducted so that appropriate reviews can be made to meet the objectives of the innovation. However, once the online community has run its course or its intended duration in terms of the research agenda, a summative evaluation and retrospective analysis is carried out to establish the success and/or outcomes, identify emergent patterns, and gain an historical understanding of the intervention. AT plays a key role in this respect. As demonstrated earlier, AT has a number of potentialities in the sense that it can analyse activity systems from different angles depending on the nature of the study. In specific reference to connectivism it is perhaps advisable to view the various nodes as activity systems that influence each other in one way or another. Thus, in analysing the processes and outcomes of learning activities, attention should be given to the relationships both within and between activity systems and how things evolve over time.

In the case study presented here, the success in terms of participation within BTO was minimal and a further probing of why this was so was done. This probing pointed to systemic factors as a reason for low participation. Therefore AT was used to identify and clarify these systemic constraints. In particular, the AT analysis sought to identify the nature and extent of the contradictions or tensions that constrained the success of the online community of practice. Specifically, it looked at how activity systems that were directly related to the intervention shaped its enactment and outcome. In that respect, activity systems that represented three stakeholder organisations in the programme were identified. These stakeholder organisations included the department running the in-service training programme at the University of Botswana, the Ministry of Education (particularly DTT&D), and the schools from which the teachers came; these represented activity systems.

A key activity system or node, however, was the schools where the teachers work: a tension between this activity system and the “BTO activity system” was that “...the socio-cultural, organisational and technical environment [of schools] is not conducive for ongoing, collaborative and contextual learning endeavours” (Boitshwarelo, 2007a, p. 225). This included the way the

ICT resources are managed, which was not friendly for teachers who wanted to access resources for professional development purposes, and the lack of a culture of peer collaboration and innovative teaching practice amongst teachers in schools. A detailed analysis of this activity system can also be found in Boitshwarelo (2007b, 2009).

The school activity system was, in turn, influenced by the Ministry of Education activity system which deals with mostly policy issues. The Ministry generally facilitates and/or sponsors in-service training that is centralised in nature and conducted mostly in education centres, away from schools. Therefore resources (e.g., ICTs) meant for training are concentrated in these education centres, and ICT facilities in schools are primarily meant for teaching purposes and administration but not for teachers to access for their professional development. Therefore electronic networking among teachers is constrained by, among other things, lack of ICT resources in schools. In terms of the university, the culture of the department providing the in-service training seemed to be in misalignment with the intentions of the BTO activity system in the sense that the concept of online communities didn't really fit into the structures, processes, and practices of the department. This meant that there was little capacity to facilitate this connective process of learning.

This brief description is for illustrative purposes; a thorough analysis of the activity systems is done elsewhere (Boitshwarelo, 2007a). However, overall in this study the AT analysis unpacked and clarified issues related to not only individual teachers as learners and their immediate online community but also to other nodes across which the learning activity was distributed, including the social environment, the tools used, and the contextual affordances and constraints that were at play.

A reflection on this case study revealed that there was a high level of harmony between the three concepts towards a cohesive execution of the developmental research project leading to an extensive understanding of the learning ecologies surrounding the intervention. This is a demonstration of the functionality of the integrated framework and as earlier pointed out there is a lot of room for manoeuvre as one uses it.

Conclusion

This paper set out to propose a research framework that will aid in advancing the research agenda of connectivism, particularly developmental work. The framework, whose potential strength derives from integrating already established theoretical constructs, has been presented as a proposal for consideration by connectivism enthusiasts. The arguments upon which it is based are hopefully robust enough to warrant its viability. As a proposal the intention is that it will be critiqued, tried, and improved where necessary to add to the menu of other tools that serve connectivism research.

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