Theme: Information Communication Technologies (ICT) and Human Development problems

Sub-theme: ICT and education

Title: Transformative Applications of ICT in Education: The Case of Botswana expansive School Transformation (BeST) Project

Paul T. Nleya (PhD)
University of Botswana
Department of Educational Technology
P/Bag 0022
Gaborone, Botswana
Nleyapt@mopipi.ub.bw

Abstract

The BeST project was launched under the auspices of World Information Technology Forum (WITFOR) 2005 as an Education Commission project designed with an in-built research component. Activity Theory (AT) was the underpinning theory guiding the research component of the project. Development Work Research (DWR) and the Change Laboratory (CL) and ethnography techniques were the underpinning methodological frameworks guiding the project. Three CL activities were planned and carried out at ten (10) selected pilot secondary schools and summary findings of these studies are reported in the paper.

Key words: Activity theory, change laboratory, developmental work research, expansive, transformation and ethnography.

1 Introduction

The Government of Botswana hosted WITFOR during 2005 organized by the International Federation for Information Processing (IFIP) hosted in Gaborone. The general theme of the forum was "ICT for accelerated development" and one of the sub-themes was Education. The work on this theme was based on IFIP's expert group declaration of July 2005, the Stellenbosch declaration: "ICT in Education: make it work" [1]. This declaration described the challenges of ICT use in education in the developing countries and gave a number of important recommendations. It highlighted the need to use ICT for integrating education to the real world. It also recommended bridging the gap between technologies as well as developing and understanding the use and the effects of ICT in education. The WITFOR Education Commission sought to pursue trend by launching the BeST project.

1.1 Objectives of the study

The objectives of the BeST Project were identified taking into account that more systematic understanding of educational change is needed in the area of ICTs (Wagner et al., 2005). They proposed that education projects should start to coordinate the introduction of computers with national policies and programs related to changes in curriculum, pedagogy, assessment, and teacher training, and respectively, start to think in terms of combinations of input factors that can work together to influence learning. In addition, capacity building is at the heart of the renewal of effective and high quality work in ICTs and education. The objectives of the BeST Project were discerned into four categories:

- *To enhance teachers' capabilities to perform as change agents in the era of ICTs*. To carry out developmental interventions in collaboration with local practitioners and academic researchers and design required pedagogical transformation and reinvent school-community relations aimed at preparing students to be competitive in the global employment market through broadening their learning perspectives using ICTs.

- *To facilitate school transformations related to creative use of ICTs*. The research component to focus on the pedagogical use of ICT's in schools and the advancement of collaboration between schools and the surrounding community. To extend the infrastructure of intellectual capacities for school renewal and establish innovative learning and knowledge communities that stimulate, support and advance school and community experiments and local developmental actions. To go beyond borders through the construction of genuine interaction between schools, community development and academic research in order to make possible learning and systematic knowledge creation on the ICT's use in schools and communities.

- *To build collaborative human capacity infrastructure between the University of Botswana and Helsinki University.* To create sustainability through collaborative effort and bilateral research and development collaboration between The Centre of Activity Theory (AT) and Developmental Work Research (DWR) in the Helsinki University (after reorganising the centre: The Centre for Research on Activity, Development and Learning CRADLE) and Department of Educational Technology (DET) in the University of Botswana.

- *To establish virtual ICT based tools* for collaborative research and development activities and learning based on horizontal collaboration between schools and research institutes. Also to provide an open-source-based and technology-mediated learning environment for the schools.

In reaching these objectives, the project is not designed to transfer models of using ICTs from developed countries but utilizes their experiences as resources for reflecting innovatively on the current practices and future trajectories of the development of schools in Botswana [2]. An implementation plan was made where the Change Laboratory method, and its use in the development of school activity and the pedagogical use of ICT's in schools were introduced. An inter-organizational interest group; Activity Theory Interest Group (ATIG) was involved in the negotiations to direct and guide the use of Change Laboratory in schools. The Government of Botswana had previously selected ten (10) schools to act as pilot schools of the BeST project. In each school, a heterogeneous (across curriculum) group of teachers was formed to assist in the implementation of ICTs.

Inspired by the work done by WITFOR, an international group of researchers was formed for supporting teachers' ICT competence in Southern African Developing Communities (SADC). The Academy of Finland granted a two-year research grant for a feasibility study (2007–2008). The substantial research plan was prepared in collaboration with researchers from the University of Helsinki (UH) and the University of Botswana (UB) through negotiations with representatives of the Ministries of Education, and Communication, Science, and Technology, as well as specialists in distant and non-formal learning sectors of education in Botswana. Based on this collaboration, the Academy of Finland allotted a four-year funding (2009 – 2012) for the project.

In developing country contexts, there is a lack of research on the application of ICTs [3] to teaching and learning in *school-based* settings and only few examples of investigations into how mobile technologies can be used in education. Being school-based, the BeST Project has a significance of investigating the ways in which new forms of technology can enhance teachers' capabilities and improve knowledge and professionalism in Botswana and delineate own way to modern information society. Four interconnected developmental processes have been intertwined in the project: 1) the development of activity in ten pilot schools from which three schools were intensively studied by using Change Laboratory method; 2) the development of a group of change agents at the University of Botswana and its capability to carry out developmental interventions in schools; 3) the development of boundary crossing collaboration and object-oriented interagency among participants (including officials responsible for school development, teacher training, and ICT implementation), and 4) the development of collaborative activities between Finnish investigators and those of SADC region.

2 Theoretical Framework

The BeST project is based on the expansive learning theory and DWR, which have their foundations in Cultural-Historical Activity Theory (AT). AT has an emphasis on semiotic and cultural mediation of human conduct, and human development [4], [5], [6]. The theory originates from psychology but is nowadays a multidisciplinary paradigm that has gained popularity as an approach that takes into account the cultural and organizational context and also directly focuses on day-to-day practical work, thus providing an alternative socio-ecological and unifying approach [7], [8].

Vygotsky is known for formulating the *general genetic law of cultural development*, which has strongly affected to pedagogical-philosophical views of AT. According to this formulation (ibid. p. 57), "every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first between people (interpsychological), and then inside the child (intrapsychological)." This formulation invites the notion of mediation, which offers the way that phenomena of human conduct and people's activities are studied. Mediation has formed the basis of *the method of double stimulation* by which the mental functions are studied with the aid of two sets of stimuli. "These two sets of stimuli fulfil different roles *vis-à-vis* the subject's behaviour. One set of stimuli fulfils the function of the object on which the subject's activity is directed. The second function serves as signs that facilitate the organization of this activity" [4], p.127. Vygotsky's method implies an intervention, which operates with "the second stimuli", the mediating means, by which people are solving an original task, "the first stimulus". These theoretical ideas have formed the foundation which has been applied and used in significant way in studying organisational learning, knowledge building and professional development. Currently, the framework has been used and considered valuable in studies, which focus on technology-mediated and technology-enhanced activities in education.

Three features of a framework found relevant for the BeST project are outlined. *Firstly*, for a systemic analysis, it offers a unit of analysis, which corresponds to people's activity. As such a unit, the model of activity system depicts the constituents of activity within a triangular form of activity (Figure 1).
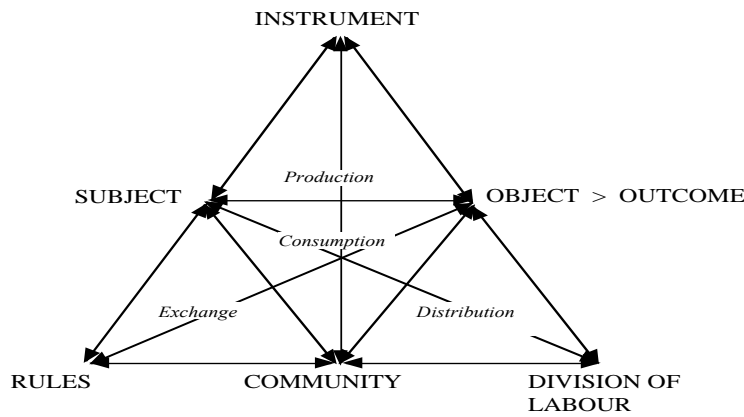
Figure 1: The model of activity system [9].

The activity system serves as a dynamic, continuously changing and developing whole of elements of activity. The model represents relationships between subject (actors), object of work/outcome and instruments used in the activity, as well as social determinants of the activity, such as community, rules and division of labour. The forms of change of an activity system are related to inner contradictions between elements of the activity. The analysis of contradictions provides some basis of an expansive re-conceptualization of the activity.

Secondly, the framework entails the cycle of expansive learning, relating to how to study change as a process of professional development and capacity building. The expansive cycle consists of six steps that are conducted in collaboration between the practitioners of studied community or organization and academic interventionist-researchers. Each phase consists of finding answers to specific questions in the analysis and design process [10].
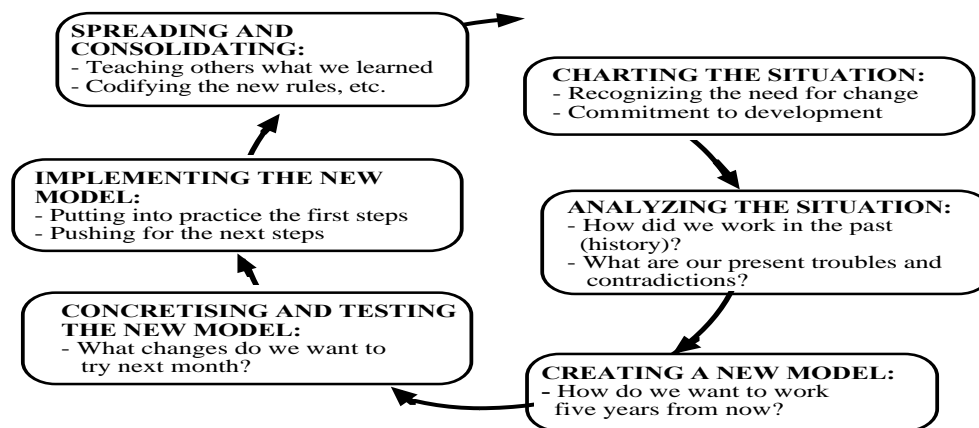

Figure 2: The steps of expansive cycle [10].

These steps can be used in the research design, where participants of the study can push the development further if they name the nature of the change with the help of the expansive cycle, recognize its inner contradictions and find ways of overcoming them. In each phase, a different challenge is faced. *Thirdly*, a central feature of the framework is multi voicedness, which means horizontal and vertical dialogue as well as local experimentations for developing new practices in the context of societal and educational transformations. The dialogue in Botswana aimed at creating and conceptualising new understanding of school activity in the era of ICTs is depicted in Figure 3.
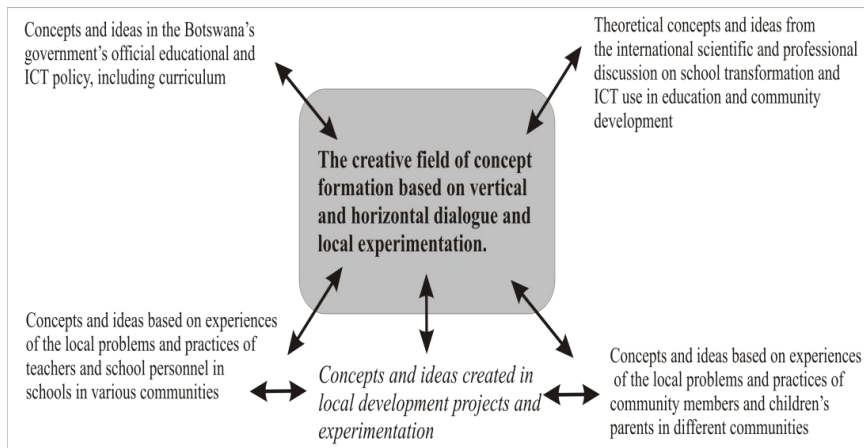
Figure 3: Forms of exchange and dialogue for developing school activity

Figure 3 illustrates the key participants' and stakeholders' shared field in organizing expansive learning. The BeST project concentrated on how to make capacity building with the teachers without losing the relationship between policy implementation represented by governance and educational technology skills offered by the University of Botswana.

3 Methodology

The research design is based on the CL intervention situated within the theoretical framework of the study. The CL consists of six to twelve well-prepared weekly sessions of two to three hours carried out in the school. In addition, a varying number of follow-up sessions after a period of about two month's experimentation with new solutions is recommended. CL is a novel research design for transforming work; a tool and method of crossing the boundary between academic research and practice of any field of activity. It focuses on the daily shop floor practice while still keeping the point of view analytical and systemic. The collaborative analysis and design of a new activity is aided by a set of tools that help the participants of the project to share and jointly process their observations and ideas. Figure 4 visualises the CL design as wallboards that are divided horizontally into three columns, which provide the research tools as well as vertically into rows representing the past, present, and future of the activity.
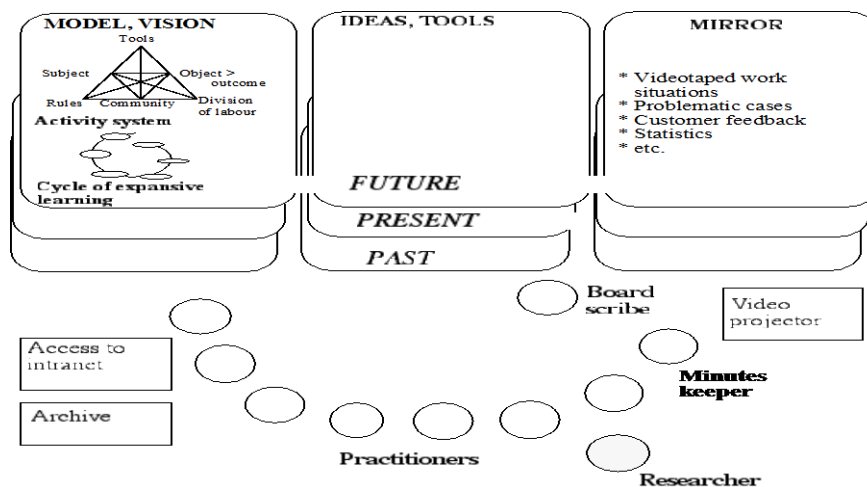

Figure 4: A prototypic layout of Change Laboratory [10].

'Mirror' board in the right-hand column is used to represent and examine concrete data concerning the activity. The mirror of the present activity includes cases that enable the analysis of changing work situations. The mirror of the past outlines data concerning historical changes in the activity. The mirror of the future represents follow-up data concerning participants' experiments with the new concepts and tools, which they have created and with which they begin to build the future form of the activity. The 'model/vision' board is used for modelling the historical forms of the activity with the help of the model of activity system. As the participants move between the mirror (based on ethnography), and the theoretical model of activity, they produce generalizations concerning transformations of the activity and its present form and contradictions. The 'ideas' and 'tools' board is reserved for representing the intermediate-level products of design of the activity discussed in the CL sessions.

The design of CL aims at creating a dynamic interplay between participants' personal involvement and commitment and research-based intellectual distancing as well as a multi-voiced dialogue. Participants can move between concrete observations concerning their own practices and the more abstract system of joint activity in which they participate.

The CL is informed with the expansive cycle of development, which has six main phases (see Figure 4):
1. Drawing on ethnographic evidence to question existing practices;
2. Analysing the historical origins of existing practices and bringing these analyses to bear in analysing current dynamics within and across activities.
3. Modelling an alternative way of working;
4. Examining the model to understand its dynamics, strengths and pitfalls;
5. Implementing the model and monitoring the processes;
6. Drawing on these data to reflect on the outcomes and disseminating them.

3.1 Data collection

The CL design requires some multiple kinds of data collection. These are above all ethnography, interviewing key persons, and video recorded CL sessions. Due to the resources and funding frame of the BeST Project, only three schools from ten pilot schools were selected to conduct their CL. These schools were selected to represent a variety of regional circumstances and diverse school-based resources and cultures.

3.1 Ethnography

In all three schools, ethnography was mainly carried out by an employed international researcher by the project. Both the Department of Educational Technology (DET) and Ministry of Education (MoE), Department of Teacher Training and Development (DTT&D) played an active role in making preparations for the school visits for CL activities. ATIG members collaborated with the international group on trips to the schools where some government 'Kitsong Centres' designed for ICT use by the community were also visited in this process.

Ethnography was realised in two–three weeks' staying at the school. The data gathering included video-recording of some school activities, carrying out interviews and spontaneous discussion with teachers, principals, community institutions, students and parents. The interviews were recorded by means of video- and voice recording. Observations

were written down into field notes. The interviews were transcribed during the same day and analysed for missing data and issues that the recorded data revealed. This information partly guided further data collection. Usually interviewees would mention something that would catch the researcher's interest, and the researcher would follow up until the lead was exhausted. Besides the CL design, the value of ethnography was obvious in the international project where the participants do not share unique contexts of history, geography, language use, organizational patterns, conventions, and others.

Interviewing Key Persons

Key persons from the Ministry Groups were interviewed (video-recorded). Also looking for examples of school-based applications of ICT, the headmasters, heads of the Computer Department, computer studies teachers, and a librarians at the secondary school were also interviewed and video-recorded.

Video Recorded CL Sessions

The conducted CL sessions of the three schools and other meetings were video-recorded. These data were important for self-reflective purposes of the CL in progress, and also later for scientific analyses, and evaluative and documenting purposes of the project.

3.2 Qualitative Research Strategy

CL usually requires a case study research that is based on qualitative research strategy. Qualitative research is also appropriate in the realm of developmental research, due to the ecological, contextual, phenomenological, historical or dynamic perspectives of its processes. Case study has features such as, small number of units (sometimes one), data collected and analysed about often not predetermined features of unit, interest in naturally occurring features or variables in context, data can be quantitative, qualitative or both, and the aim is to understand and theorize through enfolding the research literature. Case study allows questions of *why and how* to be answered with an understanding of the nature and complexity of the systemic phenomena.

3.4 Expected Outcomes of the CL Intervention

The BeST Project was a multiple-case study where each school-based case resulted in CL intervention where relationships between learning, change and development are complex. The framework of expansive development of an activity implies that learning and development were related to the production of transformative knowledge about the activity. A CL intervention seldom brings up a dramatic immediate change. It rather leads to learning that produces new concepts and practical tools and the immediate change is in opening a development process that the new tools make possible, in other words, opening a Zone of Proximal Development (ZPD) of the change agents. The application of new activity takes a longer time, and calls for management of developmental activity. The change does not take place in a simple linear progress. Rather, in contact with other members and organizations, the ideas should be discussed in several phases of developing the new vision, new tools with experimentations, and new rules.

While the results of a CL are initially local, their spreading and diffusion follow the logic of invention and innovation in an open development context. The CLs of the BeST

Project worked on school-based conceptualizations and brought forth information about the micro-genesis of novel solutions and the possibilities and obstacles that will be met during transformation processes. Small cycles may remain isolated events if they are not processed by the concentrated efforts to manage the diversity of sources in knowledge creation in the context of the overall expansive cycle of development. Several information sharing workshops for all the ten selected schools were therefore conducted to achieve this goal.

3.5 Limitations

Due to the international partners' limits to stay in Botswana, the number of sessions had to be limited without much time to follow activities in the school after the completed set of sessions and therefore to support the development and experimentation of new solutions. For the same reason the time between the sessions was tightened to more than one session per week. This schedule meant that teachers had difficulties finding time tor be present in every session.

4 Outcomes of the Project

The three conducted CLs varied amongst each other, due to the region and circumstances in the school, and also how the CL was conceptualized in each school.

Although the CLs resulted in different outcomes, they do not challenge each other, but rather show complementary facets of a prism that is organizing our thinking about complexity of transformations, facets which are linked to the globalized education reforms and information ecologies [11]. All three CLs have taken the first steps of explorative enterprises toward a new school infrastructure, which supports and promotes professional collaboration and partnership, and constructs links from school to the outside world. This has paved the ground in order to implement creative and efficient use of ICTs in Botswana schools and trained the participants to be change agents in their educational environments. From the outcomes of the three CLs, it is possible to scale up the next step of the project's strategy for redesigning school activity. In the light of the identified objectives, for the project, the outcomes of the project were as follows:

- *To enhance teachers' capabilities to perform as change agents in the era of ICTs*.
  A prominent finding was that teachers were active participants and ready for making their own designs through mirroring, analyzing, and sharing practices, including double binds, which have connections to one's own experiences at school work. This needs to be facilitated so as to move out of old ways of working together and thinking

- *To facilitate school transformations related to creative use of ICTs*. Extending the notion of learning technology was based on perspective that the development of mobile technologies allows capitalizing on lighter technical infrastructures. Prevalence of mobile technologies in all spheres of life may play an important role in accelerating educational transformation. Rather than waiting for overall educational transformation to take place, it is essential to put efforts for creating local ecologies of technology-mediated learning and instruction, which will provide models and frameworks for going through the transformation.

- *To build human collaborative capacity infrastructure between the University of Botswana and Helsinki University.* During 2010 and 2011, the University of

Botswana and University of Helsinki held several virtual meetings to plan and discuss a proposed Master's program. Results of a survey conducted reported a dire need for a Masters' degree in educational technology. Courses provided by the University of Helsinki were integrated into the collaborative Masters' degree proposal. Relevant aspects of the needs analysis results were also integrated into the program to support the viability of the programme to the satisfaction of collaborating partners. Several logistical problems regarding collaborative teaching and supervision of students that existed and were also to be resolved before the program is launched. The program has since been approved, but not launched due to financial situation in the country.

- *To establish virtual ICT based tools.* The CLs revealed the institutional tradition of organizing teaching and learning that brought about the constraints for creative use of ICTs at the pilot schools. In terms of such a contradiction, the training of a separate group of students for ICT literacy in the subject-based (computer studies) environment of testing worked against the use of teachers' increasing professional capability to improve quality of teaching and learning of all students with novel ICT–based practices. The present project brings to light the contradiction between democratic policy vision in Botswanan education and old centralized regime with a strong testing culture, originating partly from colonial history, guiding school activity.

5 Summary Findings, Discussion & Conclusion

5.1 Mahupu School

The leading contradiction: The ethnographic data revealed that the school was rather isolated from the community. Teachers questioned parents for a lack of interest in the children's education, which they said was manifested by a lack of school function attendance and alcohol abuse of the parents. Parents also felt they had little control over their children and little contribution to do with their school going. The CL participants discussed the changes that had taken place in child rearing practices between home and school in the village and began to question the present situation. With the actions of designing school activity, CL had effect to infusing the school subjects and integrating human resources within the community. The teachers of this junior secondary school had positive attitudes toward using ICTs, but the role of new technology remained minimally touched in the presented project plans.

5.2 Molefi Senior Secondary

Since the researcher- interventionists came from different cultures, the preliminary data collection was planned to be broad and exploratory [3]. The CL data revealed that teachers felt they were unable to motivate many of their students. Suggested causes for the lack of motivation were social problems such as alcohol abuse, drugs, and teenage pregnancies. There existed among students a growing number of orphan children that the teachers felt were not interested in school. They blamed children's social background and parents for their problems with the students [12]. The various ideas that the CL work groups produced in the seven sessions conducted are presented as elements in a model of a new form of a teachers' activity system (Figure 5).
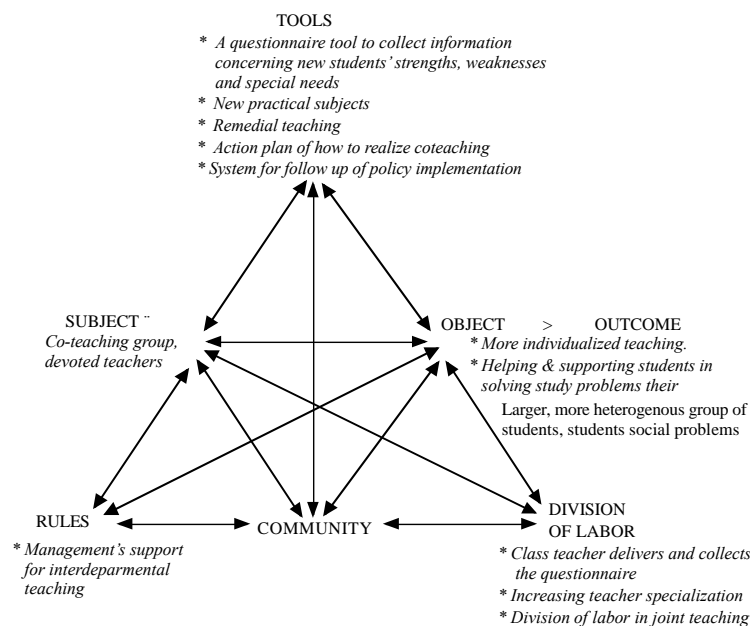
TOOLS
* *A questionnaire tool to collect information concerning new students' strengths, weaknesses and special needs*
* *New practical subjects*
* *Remedial teaching*
* *Action plan of how to realize coteaching*
* *System for follow up of policy implementation*

SUBJECT
Co-teaching group, devoted teachers

OBJECT   >   OUTCOME
* *More individualized teaching.*
* *Helping & supporting students in solving study problems their*
Larger, more heterogenous group of students, students social problems

RULES
* *Management's support for interdeparmental teaching*

COMMUNITY

DIVISION OF LABOR
* *Class teacher delivers and collects the questionnaire*
* *Increasing teacher specialization*
* *Division of labor in joint teaching*

Figure 5: Ideas identified for new solutions in the teachers' activity system model [13].

Teacher work groups prepared a plan of how and when they would experiment with the new solution they had prepared. The main inner contradiction in the activity was one between the more heterogeneous student population with more social problems than earlier and the teachers' tools that were predominantly based on mass teaching that did not allow enough attention to be paid to individual students' specific needs and interests. The main tool used by teachers to manage the increasingly heterogeneous group of students and the performance criteria had been the *categorization* of students into single, double, and triple science syllabus track groups and to subsequently focus their efforts on the latter two groups [14]. The contradiction was aggravated by the demoralizing effect of the categorization on the single science students and because the variance of student's performance was increasingly due to social problems. Tabulawa [14],[1] also observed in another school in Botswana, the apparent neglect of the cultivation of students' substantive study motivation based on their interest in the subject matter. Mirror data presented in the Change Laboratory made the teachers more conscious of this problem and stimulated them to find solutions to it.

Participants increasingly took responsibility for developing new solutions and all groups carried out at least one experiment and the joint developmental work continued further. Group members of CL sessions, fifteen months after the CL, reported continuing the experimentation with the new tools, and that they were planning to establish a new structure to ensure that experiments would be carried out accompanied with a progress report every fortnight on future and present challenges to be overcome.

The most radical of the new solutions developed was the dialogical study planning tool and process that would help the teachers deal with students' varying needs and interests including their social problems and a remarkable breaking away from the prevalent authoritarian and unidirectional teacher role. This experiment also demonstrates the ideas of re-mediation, collaborative teaching as well as the idea to add into the curriculum subjects, other than sciences, that would be relevant to the students' vocational interests, addressed directly the central contradiction in the activity system. The researchers do not have follow-up data on what happened to its development after that, but clearly, the group that was developing it would have gained from an internal-to-the country support group of researchers after the first experiment. Tabulawa [15] has alleged that Botswana's Revised Policy on Education issued

in 1994 is based on two contradictory concepts, one highlighting the objective of producing independent, innovative, and flexible personalities, and the other, a behaviorist model of a revision of the curriculum. This duality is seen in the development projects that the CL group formed. Dialogical study planning and collaborative teaching clearly correspond to the first line of the policy. The following two, policy implementation and development of AV teaching aids, are more in line with the latter although AV teaching aids could later expand to become tools for students' inquiry.

The new system that the teachers created, can, on the one hand, be seen as an elaboration and implementation of the traditional top-down system of school development in Botswana.[1] On the other hand, it can be seen as a step towards the development of a system of internal problem solving and development in the school that is a prerequisite of overcoming the contradiction. However, the contradiction cannot be overcome through a one-time change, but calls for continuous internal development and learning in the school community.

5.3 Mater Spei College
The school was considered by the research team to be ahead in many aspects in ICT use compared to other schools because the local mining company was sponsoring the school with computers, smart board and educational software.

Transcriptions of video recordings were used as primary data to answer the question, *what is the role of expansive cycle of knowledge building within a community of professionals in Botswana schools in shaping a sustainable knowledge based economy?* The main observation was that participating teachers were performing an active role in negotiations on a national change strategy in education. Anchoring on teachers' practice, the project produced an object for negotiations and for an expansive cycle of developing a school activity in an ICT era. The essence was to search for alternatives to the exclusive school-subject interpretation of ICTs within test-oriented pedagogy and, thus, challenge long-established curriculum practices.

> The other alternative policy in the context of purposeful efforts for managing the large-scale developmental cycle was found to be using mobile technology. It not only meant a lighter technological infrastructure, but also allowed teachers to show their competences in the creative use of ICTs. At the end of the project, participating teachers in the school were denominated as *digital ambassadors* by policymakers for showing respect for teachers' knowledge creation potential.

6 Conclusion
The CL process showed that focusing on the object and the historical changes in the activity could disclose the central developmental challenges and needs in the activity that the new technology could help to meet. The teachers' transformative agency can only sustain and expand in an expanding collaboration between teachers and people who can help them in solving practical ICT problems and developing the pedagogical use of the ICTs in their work.

The object-tool dialectic is important in many ways in bringing ICTs into the school. Learning to master a new tool, especially such a general tool as computer, can open up a broad perspective of expansive development for the actors. New concepts of teaching and

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[1] According to Tabulawa (1998, pp. 250-252), the prevalent model of managing pedagogical change in schools has in Botswana been based on a top down, expert-centered, technical approach that ignores the teachers' views, experience, and voice and puts them in the role of a passive adopter and implementer of teaching strategies developed by experts without input from teachers.

school pedagogy are not created from scratch, but entail questioning current ones and changing them. They are also not created from an intellectual curiosity and interest alone. The motivation for developing them arises from a possibility to overcome a central inner contradiction in the current activity. This aspect is often overlooked in a technology-centered approach to bringing ICTs into school. The specific merit of the CL method is, besides amplifying the practitioners' transformative agency, to focus the developmental effort on steps of expansive development that the practitioners can take. All too often, the ideas of ICT use are either beyond the realistic possibilities of the expansive development of the activity or below it thereby providing only an alternative way of continuing the prevailing pedagogical approach.

The increasing collaboration between teachers and ICT professionals as well as the development of various kinds of hybrid roles of pedagogically oriented ICT specialists and ICT oriented teachers is a natural line of further development [16]. The unit of development in the pedagogical use of ICTs is then not a school or a network of schools, but a heterogeneous network of schools and agencies of pedagogical and technical development. In view of the experience of the CL process described in the paper, it seems that a CL process within the school and the establishment of objects of joint pedagogical development in it could be a good first step for building such collaboration. The BeST project has therefore made a significant contribution which WITFOR should pursue further and solicit funding to support the scaling-up of the project to SADC as was initially envisaged.

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